Environmental & Social Impact Assessment

for the proposed development of a Wind Energy Facility in Anloga Extension (WPP1)

Volume 2

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Environmental & Social Impact Assessment

for the proposed development of a Wind Energy Facility in Anloga Extension (WPP1)

APPENDIX 1:

Socio-economic Impact Assessment Study

SOCIO-ECONOMIC IMPACT ASSESSMENT REPORT:

Environmental & Social Impact Assessment for 75 MW Wind Power Project situated at Anloga, Srogbe & Anyanui in the Volta Region - Ghana

Report prepared for:	*Report prepared by:*
Seljen Consult Limited P. O. Box AT 140 Achimota-Accra Ghana-West Africa CSIR – Environmental Management Services P O Box 320 Stellenbosch, 7599 South Africa	*Kofi Gatu* P. O. Box AT 140, Achimota-Accra. Ghana-West Africa Tel. +233 (0) 20 843 4557 *Email*: kofigatu@gmail.coma

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EXECUTIVE SUMMARY

As part of the project's Environmental & Social Impact Assessment (ESIA) Study, Mr. Kofi Gatu of Seljen Consult Limited was engaged to assess the potential socio-economic impacts that might occur through the installation of a proposed 76-Megawatt (MW) wind energy facility that the Volta River Authority (VRA) is developing in Ghana. The terms of reference was to evaluate the baseline socioeconomic environment and the impact of the project on such environment with a view to providing recommendations to mitigate these impacts.

The VRA intends to develop the wind power facility known as Wind Power Project 1 (Anloga Extension) at a site, which is located east of the flat Volta River delta, near the communities of Anloga, Srogbe and Anyanui on the coast in the Keta Municipality in the Volta Region of Ghana. WPP1 will have a planned capacity of 76MW, however, the final capacity of the project would be determined by the micro-siting of the project to minimise potential environmental and social impacts following findings and recommendations of specialist studies. WPP1 will cover an area of approximately 482.16 acres for the preferred layout and 309.83 acres for the alternative layout.

The project is required to comply with the relevant Ghanaian laws and regulations, as well as the relevant international standards for environmental and social sustainability. Key ones of relevance to the project are in the areas of Environmental Protection, Public Health & Safety, Labour & Other Social responsibilities as well as Land Use & Planning. Those reviewed and are of relevance to the wind power project are discussed.

To predict the probable impact of the development it is important to have a clear understanding of the baseline socio-economic conditions of the study area. The revised structure for Ghana ESIA Reports requires the discussion of the following issues as part of the socio-cultural baseline information:

- The land area taken up by the development, its location clearly shown on a map and geographical coordinates provided.

- Human beings: (population composition and distribution, socio-economic conditions, cultural and ethnic diversity, population growth rate);
- Land use: (agriculture, forests, industrial, commercial, residential), transportation routes such as roads, rail, water and air, utility corridors;
- Social services: (electricity, telecommunication, water supply, hospitals, etc.);
- Cultural heritage: (unique features of the area or its people; cemetery, fetish grove, festivals, etc.).

The above data is used as a baseline against which predicted changes can be assessed for their significance. For this reason, the discussion of baseline socio-economic conditions has largely covered these issues within the context of the two project communities, namely Anloga, Srogbe and Anyanui communities, the immediate impact area as well as the Keta Municipality in the Volta Region, which is the broader impact area. The secondary and primary data on socioeconomic baseline information was collated at three levels of assessment, namely through literature review, public disclosure and project briefing with stakeholders. Through this process, an understanding of the social spectrum of the local area, the dynamics, hierarchies and wants of the local community was obtained. The information obtained was then analysed and summarised to identify the baseline socio-economic conditions, to determine the potential project impacts, to develop the mitigation measures and to enable monitoring and evaluation of the Project.

Based on the issues raised at the project briefings, status quo conditions of the study area and the nature of the proposed development, various socio-economic impacts, both positive and negative, are anticipated. The project benefits are at both national and local levels. At the national level, the project benefits will include:

a) Stabilization of electricity access and reduction of power outage in Ghana

b) Promotion of renewable energy and reduction of carbon dioxide equivalent for use in mitigating the country's emission commitments.

c) Stimulating economic growth in Ghana.

At the local level, the positive benefits include:

a) Employment opportunities for the local community during the construction and operation phases of the project (e.g. masons, carpenters, cooks and indirect spins-off, such as livestock and fish trade, ecotourism, etc.);

b) The rehabilitation of existing road networks will facilitate the transportation of livestock and fish products to external markets;

c) The project will provide human and financial assistance in the development of health and education facilities through Corporate Social Responsibility by the Client to improve health conditions and literacy of local community, especially the marginalized groups, the women and the youth.

Against the above positive benefits brought about by the project, there will be some negative socio-economic impacts emanating from both the construction and operation activities of the wind power project, some of which are:

1. Economic displacement due to acquisition of land of an area of 482.16 acres of land.
2. Visual intrusion because of project facilities such as the wind turbines,
3. Contamination of local culture due to influx of construction employees,
4. Increased conflicts and insecurity within the community,
5. Exploitation of natural resources,
6. Increased incidences of diseases such as HIV/AIDS
7. Potential challenges and impacts of labour force management, and
8. Increased accidents and occupational hazards.

Proposed management measures have been designed to promote positive impacts and avoid, minimize, manage, mitigate, or compensate for negative impacts. Subsequently, various recommendations have been proposed for the client to implement to ensure that proposed associated socioeconomic benefits are realised and impacts mitigated. Key amongst them include:

a) Design the wind power facility to good practice standards aiming at preventing releases (liquid waste, solid waste and dust) and minimising their potential consequences such that any effects would be insignificant.

b) Keeping all communities abreast of all project development activities and they should sufficiently be consulted on all matters that concern them.

c) Preparation of a “Compensation Action Plan” in order to minimize the adverse effects of the land acquisition on individuals, communities and/or families or clans to ensure that the PAPs are compensated properly.

d) Development of a suitable programme of mitigation in the event of any significant chance finds in consultation with the Archaeology Department of the University of Ghana and the National Museums Board.

e) Application of relevant national policies, labour laws and codes of concerning employment conduct and local employment and sourcing policies are to be used to give priorities to people within the project affected areas.

f) Preparation of a Labour Management Plan as part of their Health, Safety & Environmental (HSE) Plan for the construction phase.

g) Provision of alternative source of energy during the implementation of the project to ensure that uncontrolled utilization woody resources does not take place in the project area. In addition, there will be a need to explore more efficient ways of making charcoal through efficient kilns and saving energy with efficient stoves such as the Gyampa Stoves.

LIST OF ABBREVIATIONS

ABBREVIATION	MEANING
AIDS	Acquired Immune Deficiency Syndrome
AoI	Area of Influence
ARI	Acute Respiratory Infection
BID	Background Information Document
CBR	Crude Birth Rate
CSIR-SA	Council for Scientific and Industrial Research, South Africa
CWSA	Community Water and Sanitation Agency
DCE	District Chief Executive
EA	Environmental Assessment
EBRD	European Bank for Reconstruction and Development
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency - Ghana
EPA	Environmental Protection Agency
ESIA	Environmental and Social Impact Assessment
GHA	Ghana Highways Authority
GHS	Ghana Health Service
GLSS6/LFS	Ghana Living Standard Survey 6 with Labour Force Module
GMMB	Ghana Museums and Monuments Board
GN1	Guidance Note 1
GNFS	Ghana National Fire Service
GSS	Ghana Statistical Service
HDI	Human Development Index
HIV	Human Immuno Virus
HSE	Health, Safety & Environment
HV	High Voltage
I&AP	Interested and Affected Persons
I&APs	Interested and Affected Party
ICT	Information and Communication Technology
ILO	International Labour Organization
ISSER	Institute of Statistical Social and Economic Research
KVIP	Kumasi Ventilated Improved Pit latrine

ABBREVIATION	MEANING
MCE	Municipal Chief Executive
MDAs	Ministries, Departments and Agencies
MDG	Millennium Development Goal
MMDAs	Metropolitan, Municipal and District Assemblies
NDPC	National Development Planning Commission
OP	Operational Policy
PAP	Project Affected Persons
PHC	Population and Housing Census
PHCR	Population and Housing Census Report
PPE	Personal Protective Equipment
PPP	Public Private Partnership
PS	Performance Standard
PWD	Persons With Disability
RCC	Regional Coordinating Council
REDP	Renewable Energy Development Program
ROW	Right of Way
RPF	Resettlement Policy Framework
SCL	Seljen Consult Limited
STD	Sexually Transmitted Disease
TMS	Traffic Method Statement
TOR	Terms of Reference
UNDP	United Nation Development Programme
VRA	Volta River Authority
WB	World Bank
WC	Water Closet
WHO	World Health Organization
WPP	Wind Power Project
WTG	Wind Turbine Generators

GLOSSARY

DEFINITIONS	
Client	The Client refers to the developer, in this case the Volta River Authority
Cultural Heritage Sites	Cultural heritage sites Tangible and intangible cultural heritage sites and items,
Currently employed	There are two situations in which a person can be classified as being currently employed. Either the person was actually engaged in any work (as defined above) during the reference week, or he/she had an attachment to a job or business but for some reasons did not work during the reference week.
Currently Unemployed	A person is considered as currently unemployed if he/she was not engaged in any work (as defined above), had no attachment to a job or business, reported that he/she was available for work and had taken some specific steps to look for work.
Economically Active	A person is considered as economically active if he/she was employed or unemployed, or was available for work and seeking for work during the reference period; otherwise the person is economically not active.
Economically Not Active	The economically not active persons are those who did not work and were not seeking for work, that is are not currently employed or unemployed. This group includes persons such as those who are studying or performing household duties (homemakers), retired persons, the disabled and persons who were unable to work because of their age (too young or old to work).
Ethnicity	Ethnicity refers to the ethnic group that a person belongs to.
Formal And Informal Settlements	Formal and informal settlements including temporary and permanent human residents with both formal and informal tenure of land/structures
Industry	Industry refers to the type of product produced or service rendered at the respondent's place of work (irrespective of the occupation the person has). In this report, information on only the main product produced or service rendered in the establishment during the reference period has been considered.
Labour Force	This is the proportion of a country's working-age population that engages actively in the labor market, either by working or looking for work. It provides an indication of the relative size of the supply of labor available to engage in the production of goods and services.
Local	Applies to the site and the closest communities which are Anloga, Anyanui, and Srogbe
Municipality	Applies to the Keta Municipality
Occupation	Occupation refers to the type of work the person is engaged in at the establishment where he/she worked.

DEFINITIONS	
Population Dynamics	Population dynamics including population size, structure, settlement patterns and migration;
Regional	Applies to wider area of Volta Region
Social Infrastructure	Social infrastructure including both tangible (i.e. schools, community centers, electricity and potable water services) and intangible items (i.e. meeting places, fishing areas etc.
Stakeholder	A stakeholder to the project refers to any individual or group which is potentially affected directly or indirectly by the proposed project or who has an interest in the proposed Project and its potential impacts.
Work	Work refers to any economic activity performed by the respondent that contributes to economic production of goods and services.
WPP1	The means the 76MW Wind Power Project 1 to be located in Anloga, Srogbe and Anyanui communities and its environs within the Keta Municipal of the Volta Region of Ghana.

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SOCIO-ECONOMIC IMPACT ASSESSMENT

1. INTRODUCTION

Mr. Kofi Gatu of Seljen Consult Limited conducted the assessment of the potential socio-economic impacts that might occur through the proposed construction, operation and decommissioning of a 76-Megawatt (MW) Wind Energy Facility in Anloga, Srogbe and Anyanui communities (WPP1) in the Keta Municipal of the Volta Region of Ghana which is being developed by the Volta River Authority (VRA), a power utility company in Ghana.

This socio-economic baseline study seeks to:

Understand the existing environmental and socio-economic context, and provide a benchmark of pre-project conditions to help predict proposed project induced changes and inform impact predictions (positive and negative), and assessments of the ability of social receptors to benefit from, adapt to and/or accept change;

a) Understand the existing socio-economic development context in the Study Area and the extent to which the proposed Project supports and is aligned with local development objectives, if applicable;

b) Identify individual stakeholders and stakeholder organizations that may have roles and responsibilities about implementation of the proposed Project (e.g. local administrators, politicians and development NGOs) as well as stakeholders who are sensitive to the proposed Project or able to support in the implementation of information disclosure and mitigation measures; and

c) Inform the client on how best to distribute information and collect feedback from stakeholders.

This Report presents an overview of the social receiving environment within the Study Area. It focuses on the social and economic effects that have potential to occur because of the construction and operation of the proposed WPP1.

2. TERMS OF REFERENCE FOR SPECIALIST

The terms of reference were to evaluate the baseline socioeconomic environment and the impact of the project on such environment with a view to providing recommendations to mitigate these impacts. The evaluation was to include an analysis of the situation and possible legal and regulatory requirements. Information to be obtained was to cover the following:

- Population and Demographics
- Ethnic, Religious and Cultural Heritage
- Historical resources
- Aesthetics and Tourism
- Infrastructure
- Education
- Land tenure and Land Ownership
- Land Use
- Employment/Manufacturing
- Agriculture
- Public Health (including HIV/AIDS)

Specifically, the TOR include the following:

- Provide the degree of fit with local, regional and national economic development visions and plans including renewable energy plans.
- To collate the socio-economic baseline data
- Provide a context for understanding feedback from stakeholders, specifically verifying reports from stakeholders and beginning to understand the differences between stakeholders' perceptions of impacts and actual impacts.
- Feed into proposed Project design and customizing of mitigation measures;
- Identify the impacts on overall economic development potential in the area including impacts on commercial enterprises nearby the site (incl. tourism, agriculture, small businesses and others).

- Identify impacts associated with project on direct and indirect employment and household incomes.
- Potential negative impacts on neighbouring land owners that have economic implications.
- Provide a basis for monitoring from which to evaluate actual residual impacts, and the success of mitigation measures following implementation;

3. PROJECT DESCRIPTION

The wind power facility known as Wind Power Project 1 (Anloga Extension) or WPP1 is to be developed at a site, which is located east of the flat Volta River delta, near the communities of Anloga, Srogbe and Anyanui on the coast in the Keta Municipality in the Volta Region of Ghana and has estimated capacity of 76MW. Currently, to reach the demanded capacity, 38 VESTAS V110 each with 2 MW with a hub height of 95 m for the preferred layout or 3.45 MW nominal power and on a hub height of 126 m above ground level for the alternative layout are to be installed bring the capacity to 76 MW. The high number of turbines and the relatively small area has resulted in splitting the study area into the three sub sites for the preferred layout and two for the alternative layout (See **Figure 3-1** and **Table 3-1**).

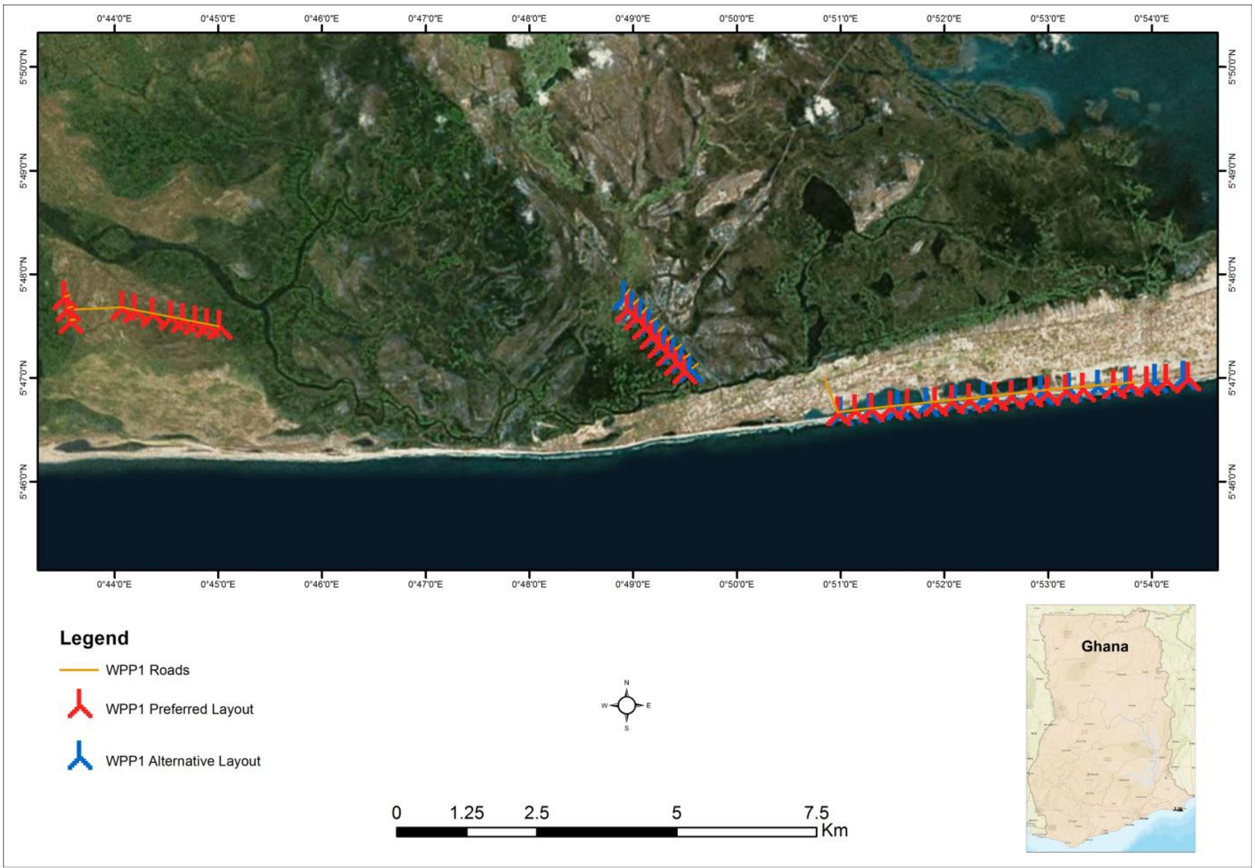

Figure 3-1: Location of the site for WPP1 with preferred and alternative layouts

Table 3-1: Wind Turbine Distribution of WPP 1

Site	Install Capacity for preferred layout	Install Capacity for alternative layout
Anyanui, north of the town	22MW - Eleven (11) Wind Turbines	N/A
Anloga, south of the town along the beach	16MW- Eight (8) Wind Turbines	44.85 MW- Thirteen (13) Wind Turbines
Srogbe	38MW - Nineteen (19) Wind Turbines	31.05 MW- Nine (9) Wind Turbines
Total	**76MW**	**75.9MW**

However, the final capacity of the project would be determined by the micro siting of the project to minimise potential environmental and social impacts following findings and recommendations of specialist studies, for example to reflect findings of pre-construction survey works or to further refine the site layout to avoid areas of deep peat prior to construction.

WPP1 will cover an area of approximately 482.16 acres (refer to Table 6-2) for the preferred layout and 309.83 acres for the alternative layout. WPP1 will have the following main components, which will affect the social and economic characteristics of the affected communities due to the land take and project activities:

- **Wind turbine area**
  - Wind turbines;
  - Hard standing areas

- **Building Infrastructure:**
  - Offices;
  - Operational and maintenance control centre;
  - Warehouse/workshop;
  - Ablution facilities;
  - Converter/Inverter stations;
  - On-site substation building; and
  - Guard Houses.

- **Associated Infrastructure**
  - Access roads;
  - Internal gravel roads;
  - Fencing;
  - Stormwater channels; and
  - Temporary work area during the construction phase (i.e. laydown area).

The electricity generated at the proposed Wind Power Project 1 would be evacuated via a newly constructed 69/33 kV substation onsite and would be connected to the grid via a new 161 kV overhead transmission line of approximately 67.5 km from the onsite substation to the existing Asiekpe Substation. In principle, a single transformer would be sufficient for the transmission of the maximum wind farm capacity of 76 MW. However, to increase the reliability of wind farm operation and to allow maintenance on the transformer, a two-transformer setup is more plausible.

Details on the project description is provided under Chapter 3 of the ESIA report.

4. APPLICABLE LEGISLATION AND PERMIT REQUIREMENTS

4.1 OVERVIEW

The project is required to comply with the relevant Ghanaian laws and regulations, as well as the relevant international standards for environmental and social sustainability**.** Key ones of relevance to the project are in the areas of Environmental Protection, Public Health & Safety, Labour & Other Social responsibilities as well as Land Use & Planning. Those reviewed and are of relevance to the wind power project are listed below and discussed.

4.2 ENVIRONMENTAL PROTECTION

4.2.1 Applicable Laws

a) **The Constitution of the Republic of Ghana, 1992** came into force on January 7th, 1993. The Constitution is the fundamental law of Ghana and provides the framework on which all other laws stand. Within Article 36 of Chapter 0 - Directive principles of State policy, the Ghana Constitution states "The State shall take appropriate measures needed to protect and safeguard the national environment for posterity; and shall seek co-operation with other states and bodies for purposes of protecting the wider international environment for mankind". Within the Article 41(k) of the same Chapter 0, it is also stated, "it shall be the duty of every citizen […] to protect and safeguard the environment". The right to information is guaranteed by the Constitution under Chapter 5 – Fundamental human rights and freedoms, Article 21(1) (f) stating that "All persons shall have the right to information subject to such qualifications and laws as are necessary in a democratic society".

   This principle is shown also in the stakeholder consultation requirements within the EIA process. Based on the framework established by the Constitution of the 4th Republic of Ghana, the government initiates policy actions and legislation to promote sound environmental protection and management. It is also in response to the provisions of the Constitution that the Parliament promulgated the Environmental Protection Agency Act 1994, which establishes the EPA who is responsible for enforcement of environmental laws.

b) The Ghana EPA Guidelines, Volume 2 Report – a follow up report linked to the Environmental Assessment Regulations, LI 1652 (1999) requires that a social impact assessment should address a range of issues. Those potential impacts and benefits considered applicable to the project are as follows:

- ✓ Social discontent, unhappiness, increased illness, and a loss of economic productivity, leading to loss of income;
- ✓ Impact on demographics and employment levels;
- ✓ Impact on the general lifestyle of local communities;
- ✓ Effects on the sacred and cultural sites of importance to the local community due to their cultural beliefs; and
- ✓ Contribution to local infrastructure and economic development and social facilities.

c) World Bank OP 4.01 – Environmental Assessment (Jan. 1999) evaluates a project's potential environmental risks and impacts in its area of influence; examines project alternatives; identifies ways of improving project selection, siting, planning, design, and implementation by preventing, minimising, mitigating, or compensating for adverse environmental impacts and enhancing positive impacts; and includes the process of mitigating and managing adverse environmental impacts throughout project implementation. EA considers the natural environment (air, water, and land); human health and safety; social aspects (involuntary resettlement, indigenous peoples, and physical cultural resources); and trans-boundary and global environmental aspects.

d) IFC Performance Standard 1 (PS1) (2012): Assessment and Management of Environmental and Social Risks and Impacts - and supporting Guidance Note 1 (GN1) requires social risks and impacts of the project to be identified. The level of assessment should be proportionate to the location, scale and potential significance of the impacts. A social baseline should be presented on which to make the assessment. The assessment should consider all relevant risks and impacts, referring, where relevant, to Performance Standards 2-8 (IFC, 2012). If relevant, include mitigation and management measures relating to significant social impacts identified within an ESAP.

4.2.2 Applicability to Project

These legal requirements provide guidance on assessing the proposed Project's potential environmental and social risks and impacts and addressing these through planning and mitigation. The wind power project has been subjected to an environmental assessment and permitting prior to construction and issues on socio economic impacts are to be considered. This is ongoing, and it is important that mitigation measures provided to ensure improved likelihood and compensation are implemented as required.

4.3 PUBLIC HEALTH & SAFETY

4.3.1 Applicable Laws

a) **Factories, Shops and Offices Act of 1970 (Act 328)** was enacted to promote and ensure the health, welfare and safety of persons employed in the country as well as the responsibilities of the employer. Under the Act, employers are required to ensure that a safe and healthy workplace is provided for the safety, health and welfare of all employees.

b) **Ghana National Fire Service Act, 1997 (537)** mandates that a Fire Certificate be required for premises used as a public place or place of work. The owner or occupier of the premises shall apply to the Chief Fire Officer for a Fire Certificate, which will be valid for 12 months from the date of issue and subject to renewal. Power facilities require a fire certificate.

c) **Road Traffic Acts, 2004, Act 683** act deals with restrictions on road use in the interest of Road safety, registration and licensing of motor vehicles and trailers, licensing of drivers of motor vehicles, test of vehicles and issuance of road use certificates and licensing of drivers of commercial vehicles. It is supported by the Road Traffic (Amendment) Regulations (1995), LI 952, LI953 and the Road Traffic (Amendment) Act 2008 (Act 761)

   Any driver plying on the road cannot use a mobile phone, they cannot put a child on their lap whilst driving nor can a child below the age of fifteen sit on a passenger seat beside the driver. The act enforces the rule that all passengers should have their seat belts on. In addition, drivers would be required to carry on their vehicles all necessary accessories like fire extinguishers and genuine driving license. Again, no driver would be allowed to drive when he or she is improperly dressed.

d) **Workmen's Compensation Law, 1986** recasts the law in relation to compensation awarded to workers for personal injuries arising out of and in the course of their employment. It governs, inter alia, the employer's liability in such cases, the distribution of compensation in the event of the worker's death (including a related schedule), degrees of partial incapacity set forth in a schedule, determination of claims, remedies against the employer and third parties, protection of compensation against attachment or assignment, payment of medical expenses and provision of medical aid, and occupational diseases (with 13 such diseases listed in an attached schedule).

   The new enactment grew out of a study undertaken by the Tripartite National Advisory Committee on Labour. It repeals the Workmen's Compensation Act 1963 (No. 174) and the 1966, 1968 and 1969 amendments thereto. Statutory Instruments made under those Acts remain in force until amended, varied or revoked in accordance with the provisions of the new law.

e) **Persons with Disability Act, 2006, Act 715** Act provides for persons with disability, to establish a National Council on Persons with Disability and to provide for related matters. The law requires owners or occupiers of public structures to provide appropriate facilities to make them easily accessible by persons with disability. The Act deals with issues such as rights, employment, education, transportation, housing facilities, effective health care, adequate medical rehabilitation services, generation and dissemination of relevant information and participation of PWDs in cultural activities. Pursuant to the passage of the Disability Act 2006 (Act 715), the National Council on Persons with Disability was established in line with Article 41 of the Persons with Disability Act.

f) **The National HIV & AIDS STI Policy of 2004** and revised in Feb. 2013 has been developed to address the very serious health and developmental challenges posed by HIV/AIDS. The policy provides the framework for Ghana's strategy to reduce the spread of HIV infection. It provides the necessary statement of commitment around which a legislative framework will be built for an Expanded Multi-Sectorial Response to reduce further spread of the epidemic, and for the protection and support of people infected with HIV/AIDS in Ghana. Subsequently, a National HIV/AIDS Strategic Framework for Ghana has been formulated in recognition of the developmental relevance of the disease. Ghana, by this document has joined the global community in a united effort to combat the epidemic. The Strategic Framework document is updated periodically, and it provides for a Workplace HIV Policy. Ghana has now developed a National HIV/AIDS Strategic Plan 2016-20.

g) **IFC Performance Standard 4: Community Health, Safety, and Security** recognises that project activities, equipment, and infrastructure can increase community exposure to risks and impacts. PS4 requires that the risks of health and safety to the Affected Communities is assessed. The risk and impact should be minimised with mitigation and control measures. The risk factors to be included are infrastructure and equipment design, hazardous materials, ecosystem, exposure to disease, and risk of emergency. Security for the development should not use disproportionate force against local communities.

4.3.2 Applicability to Project

The safety of the public as well as all workers is critical in project execution, and these legal requirements seek to ensure public safety and compensation in the event of injury. The laws seek for projects to anticipate and avoid adverse impacts on health and safety of the affected communities during the project life from both routine and non-routine circumstances. Projects are to ensure that the safeguarding of personnel and property is carried out in accordance with relevant human rights principles and in a manner, that avoids or minimises risks to the Affected Communities. Subsequently, risks associated to public health, safety and security is required to be assessed.

The tenets of the law place a large share of the burden of supporting workers injured at the workplace on the shoulders of the employers. The project and its contractors will be responsible for the health and safety of workers and the impacted communities as well as the public. The project shall be responsible for providing for the payment of compensation to workers for personal injuries caused by accidents arising out and during their employment. In addition, developmental activities of the project will provide equal opportunities for all persons, including persons with disabilities and the project should not discriminate against a qualified applicant or employee because of the known disability. HIV&AIDS education for workers is key and must be adhered.

4.4 LABOUR & OTHER SOCIAL RESPONSIBILITY LAWS

4.4.1 Applicable Laws

a) **Labour Act 2003 (Act 651)** of 2003 consolidates and updates the various pieces of former legislation and introduces provisions to reflect International Labour Organisation (ILO) Conventions ratified by Ghana (see Section 3.5). The Labour Act covers all employers and employees except those in strategic positions such as the armed forces, police service, prisons service and the security intelligence agencies. It ensures employer and employee relationships. Section 9(c) mandates an employer to take all practicable steps to ensure that the worker is safe from risk of personal injury or damage to his or her health during and in the course of the workers' health while lawfully on the employer's premises.

Provisions specifically related with occupational health, safety and environment are included with the Part XV of the Labour Act. These include general health and safety conditions, exposure to imminent hazards, employer occupational accidents and diseases reporting.

b) **National Labour Commission Regulations 2006, LI 1822** is to aid the Labour Commission exercise the powers conferred on it under Section 152 of the Labour Act, 2003, Act 651. The Regulations provide for mainly negotiation, mediation and arbitration procedures and arrangements to ensure that labour related disputes and complaints are resolved amicably. It provides a sample form (Complaint Form A) for registering of complaints at the Labour Commission if mediation procedures are to be adopted. The LI provides for various options available to workers or employers through which disputes or complaints can be resolved. The key institution of concern here is the Labour Commission.

c) **Labour Regulations, 2007 (LI 1833)** contains regulations concerning employment agencies, conditions of employment, organised labour, employment of persons with disability, health and employment, restriction on recruitment including prohibition of human trafficking.

d) **Children's Act No. 560 of 1998** defines a child as a person below the age of eighteen years. It is stated within the Sections 12 and 87 of the Act 560, that child must not be engaged in exploitative labour. Exploitative labour is defined by a labour depriving the child of its health, education or development.

e) **Commission on Human Rights and Administrative Justice Act (Act No. 456 of 1993)** establishes a Commission on Human Rights and Administrative Justice to investigate complaints of violations of fundamental human rights and freedoms, injustice and corruption, abuse of power and unfair treatment of persons by public officers in the exercise of their duties, with power to seek remedy in respect of such acts or omissions.

f) **National Vocational Training Act (Act No. 351 of 1970)** obliges all employers to provide training for their employees for the attainment of the level of competence required for the performance of their jobs and to enhance their career, according to the provisions of the

National Vocational Training Act (Act 351) of 1970 and the National Vocational Training Regulations (Executive Instrument 15).

4.4.2 Applicability to Project

These legal requirements seek to promote the fair treatment, non-discrimination and equal opportunity of workers. They aim to stablish, maintain and improve the worker management relationship and to promote compliance with national labour and employment laws. The project is therefore expected to protect workers, including vulnerable categories of workers such as children, migrant workers, workers engaged by third parties, and workers in the clients supply chain. In addition, the project is required to promote safe and healthy working conditions and health of workers and to avoid the use of forced labour.

4.5 LAND USE & PLANNING LAWS

4.5.1 Applicable Laws

a) **The Constitution of Ghana** and the protection of individual property is outlined in Article 20 and this provides for the protection from deprivation of property unless such acquisition is made in the interest of defence, public safety, public order, public morality, town and country planning, or the development or utilisation of property to promote public interest.

   Under the same Article 20 of the Constitution, such compulsory acquisition of property by the State should be made under a law which makes provision for prompt payment of fair and adequate compensation as well as a right of access to a High Court by any person who has interest in or right over the property for the determination of his interest or right and the amount of compensation to which he is entitled.

b) **Local Government Service Act, 2003 Act 656 es**tablished a Local Government Service, and this was to provide for the objects, functions, administration and management of the Service and for connected purposes. The object of the Service is to secure the effective administration and management of local government in the country.

c) **Lands Commission Act (2008) Act 76** provides for the management of public lands and other lands and for related matters. The Commission manages public lands and any other lands vested in the President by the Constitution or by any other enactment or the lands vested in the Commission. The act advises the Government, local authorities and traditional authorities on the policy framework for the development of areas to ensure that the development of individual pieces of land is co-ordinated with the relevant development plan for the area concerned. The commission formulate and submit to Government recommendations on national policy with respect to land use and capability; advice on, and assist in the execution of, a comprehensive programme for the registration of title to land throughout the Republic in consultation with the Title Registration Advisory Board established under section 10 of the Land Title Registration Act, 1986.

d) **State Lands (Amendment) Act (2005) Act 586, relates to** compulsory acquisition in the country which has relied on State Lands Act, 1962 (Act 125) and State Lands (Amendment) 2005, Act 586. The two statutes are limited to the acquisition of private interest in real estate whiles stool lands are acquired drawing on Administration of Lands Act, 1962 (Act 123). States Lands (Act 125) also provide for lump sum of compensation payable to property owners affected by acquisition. Section 4 also spells out the procedure for making claims whiles section 11 also outlines mechanism for settlement of disputes generating from dissatisfaction of compensation.

e) The **State Lands Regulations (1962) LI 230** was passed for inspecting and making a recommendation as to the suitability or otherwise of any land proposed to be acquired. The Regulation requires the setting up of a Site Advisory Committee for this function. After the submission of an application to acquire land, a Site Advisory Committee'' is set up in order to assess the application. The application is then assessed by the Ministry to a Land Commission, which prepare an executive instrument. Once this instrument is accepted and endorsed by the Minister, it is published in the newspapers and property owners can submit claims. The valuation board estimates the corresponding compensation. Compensation is then made to the property owners and sometimes resettlement is followed. Administration of Lands Act 1962 (Act 123) empowers the

Minister responsible for lands to manage stool lands in accordance with the provision of the law.

f) **Stools Lands Act, 1994 (Act 481)** establishes the management and administrative processes applicable to Stool land and describes the appropriate distribution of any revenue accrued from stool lands.

g) **Lands (Statutory Wayleaves) Act 1963 (Act 186)** provides for entry on any land for the construction, installation and maintenance of works of public utility, and for the creation of rights of way for such works. The owner / occupier of the land must be formally notified at least a week in advance of the intent to enter, and be given at least 24 hours' notice before actual entry. An authorized person may enter at any time for inspecting, maintaining, replacing or removing any specified works (Section 5). Any damage due to entry must be compensated in accordance with the established procedure, unless the land is restored or replaced. In the case of roads, not more than one-fifth of a plot may be taken and the remainder must be viable, or the entire plot must be taken; Section 6-3(b). The Act and its accompanying Regulation, the Lands Statutory Wayleave Regulation 1964 (LI 334) provides the modalities and procedures for the acquisition of the Statutory right of ways.

h) **National Museums Decree (1969) NLCD 387,** the Executive instrument (EI 42) of 1972 and the National Museums Regulation (EI 29) of 1973 provides for the management of any antiques and archaeological finds. This is the law governing the activities and operations of the Ghana Museums and Monuments Board (GMMB). Procedures to be followed on the discovery of any such artefacts are outlined in NLCD 387. Any archaeological finds during the construction activities shall be reported accordingly. Ghana ratified the World Heritage Convention in 1975. Therefore, GMMB is guided by the operational guidelines for the implementation of the World Heritage Convention.

i) **Survey Act 1962, Act 127** relates to geological, soil and land survey. Part II of the Act deals with demarcation and survey of lands. Under the law, the sector minister may appoint official surveyors and the Chief Survey Officer (Director of Surveys) may license private surveyors. It is the official surveyor or licensed surveyor that shall certify plans for attachments to instruments of conveyance, leases, assignment, charge or transfer. Under the law it is an offence to damage, destroy or alter any boundary mark.

The Act 127 with its amendments gave legal backing to the Director of Surveys to carryout cadastral and other surveys through official surveyors who work directly under him at the Survey Division of the Lands Commission. It also gave authority to the Director of Surveys to recommend from time to time experienced surveyors to the Minister responsible for Lands to be licensed to undertake surveys.

j) **Resettlement Policy Framework (RPF), 2011** document was developed in 2011 by the Ministry of Finance and Economic Planning as part of the Government of Ghana's Public-Private Partnership (PPP) programme. This programme was established to increase investment in public service delivery and infrastructure in support of the country's growing development needs. The developments and projects proposed by the PPP are likely to involve land acquisition and resettlement impacts, which are addressed by the RPF.

The RPF has been developed in line with the World Bank/IFC Performance Standards and as part of a World Bank funding application for support of the PPP programme. The RPF guidelines and requirements must be adhered to during the planning, construction and operation of any PPP project. This Project will be developed and operated by VRA representing the Government of Ghana in collaboration with various stakeholders. As such, the Project can be considered as PPP, and these guidelines will be taken into consideration in the planning and implementation of the resettlement aspects related to land acquisition.

k) **World Bank OP 4.11 – Physical Cultural Resources (July 2006), Revised April 2013** addresses physical cultural resources, which are defined as movable or immovable objects, sites, structures, groups of structures, and natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance. Physical cultural resources may be located in urban or rural settings, and may be above or below ground, or under water. Their cultural interest may be at the local, provincial or national level, or within the international community. Any project involving significant excavations, demolition, movement of earth, flooding, or other environmental changes are to take cognisance of this policy in the ESIA.

l) **World Bank OP 4.12 - Involuntary Resettlement (December 2001), Revised April 2013** is triggered in situations involving involuntary taking of land and involuntary restrictions of access to legally designated parks and protected areas. The policy aims to avoid involuntary resettlement to the extent feasible, or to minimise and mitigate its adverse social and economic impacts. It promotes participation of displaced people in resettlement planning and implementation, and its key economic objective is to assist displaced persons in their efforts to improve or at least restore their incomes and standards of living after displacement. The policy prescribes compensation and other resettlement measures to achieve its objectives and requires that borrowers prepare adequate resettlement planning instruments prior to Bank appraisal of proposed projects.

m) **IFC Performance Standard 5: Land Acquisition and Involuntary Resettlement** recognises that project-related land acquisition and restrictions on land use can have adverse impacts on communities and persons that use this land. Involuntary resettlement refers both to physical displacement (relocation or loss of shelter) and to economic displacement (loss of assets or access to assets that leads to loss of income sources or other means of livelihood) because of project-related land acquisition and/or restrictions on land use. The objectives are to avoid, and when avoidance is not possible, minimize displacement by exploring alternative project designs.

PS5 also aims to avoid forced eviction and to anticipate and avoid, or where not possible, minimize adverse social and economic impacts from land acquisition or restrictions on land use by:

i) Providing compensation for loss of assets at replacement costs and

ii) Ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected.

Further objectives include the need to improve, or restore, the livelihoods and standards of living of displaced persons and to improve the living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites.

4.5.2 Applicability to Project

These legal requirements seek to avoid, and when avoidance is not possible, minimise avoid forced eviction. It also expects to anticipate and avoid, or where avoidance is not possible, minimise adverse social and economic impacts from land acquisition or restrictions on land use by (i) providing compensation for loss of assets at replacement cost and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected. Projects are expected to improve, or restore, the livelihoods and standards of living of displaced persons as well as the living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites. They also seek to protect cultural heritage from the adverse impacts of project activities and support its preservation and to promote the equitable sharing of benefits from the use of cultural heritage.

Land is to be acquired under the project and this can lead to the possibility of land restrictions and economic displacement of the community members. The Project will need to adhere to the regulations previously mentioned and ensure the project is implemented according to the management structures in place in the region. This is particularly relevant if resettlement and livelihood restoration are needed. The project will need to ensure that they communicate and build relationships with the correct levels of local government in the region where the project site is located. Although the project will take place in an area that has already been disturbed, the project will need to still take cognisance of tangible and intangible cultural heritage sites and items, including archaeological heritage within the Area of Influence. This will also need to include basic mitigation for the construction phase, such as a chance find procedure for the construction phase.

5. METHODOLOGY

To predict the probable impact of the development it is important to have a clear understanding of the baseline socio-economic conditions of the study area. This is used as a baseline against which predicted changes can be assessed for their significance. Subsequently, the terms of reference (TOR) for the socioeconomic assessment study as provided under Section 2.0 of this report required the evaluation of the baseline socioeconomic environment and the impact of the project on the environment with a view to providing recommendations to mitigate these impacts.

The secondary and primary data on socioeconomic baseline information was collated at three levels of assessment, namely through literature review, public disclosure and project briefing with stakeholders. Through this process, we obtained an understanding of the social spectrum of the local area, the dynamics, hierarchies and wants of the local community. This involvement also gave us an opportunity to introduce ourselves and present the project to the local area. The information obtained was then analysed and summarised to identify the baseline socio-economic conditions, to determine the potential project impacts, to develop the mitigation measures and to enable monitoring and evaluation of the Project. Proposed management measures have been designed to promote positive impacts and avoid, minimize, manage, mitigate, or compensate for negative impacts.

5.1 LITERATURE REVIEW

The team reviewed the social economic factors, the existing information and available socio-economic studies of the study area. Key documentations reviewed concerning the baseline socioeconomic data for the project area included the following:

a) 2014-17 Medium Term Development Plan for the Keta Municipal Assembly prepared within the context of the Ghana Shared Growth & Development Agenda.

b) 2010 Population & Housing Census, District Analytical Report, Keta Municipality, Ghana Statistical Service, October 2014

c) 2010 Population & Housing Census, Regional Analytical Report, Volta region, Ghana Statistical Service, June 2013

d) 2010 Population & Housing Census, National Analytical Report, Ghana Statistical Service, May 2013

e) 2014 Year Performance Report: Keta Municipal Health Directorate, February 2014

f) Ghana Living Standards Survey 6 with Labour Force Module (GlSS6/LFS), 2012/2013: Ghana Statistical Service, September 2013.

The team also assessed the legislative requirements for such an assessment in Ghana to international standards and the information obtained discussed under Section 4.0 of this report. In addition, a review of the Scoping Report for WPP1 (June 2016) that was submitted to the Ghana Environmental Protection Agency (EPA) and scoping opinion and all other available consultation feedback has been undertaken to inform this assessment. This allowed for a better understanding of the local context, potential vulnerabilities and stakeholder perceptions. It must be noted that the source of data or information were not independently verified. Never-the-less, the existing data can be seen as indicative of the current situation. The specialist, therefore, does not assume responsibility for their accuracy or fullness in completion of fact or ideas.

5.2 PUBLIC DISCLOSURE

As part of disclosing project information to the public, the study team developed a Background Information Document (BID)[1] for the project. The rationale for the BID is to allow Interested and Affected Party (I&APs) to register their interest in the project to get the opportunity to be involved in the Scoping and ESIA Processes through receiving information, raising issues of concern and commenting on reports. Inputs from I&APs, together with the literature and consultative information and assessment provided for input into this document

[1] See Appendix 1 for the BID

In addition, the Client also placed a Scoping Notice in the national newspapers of the proposed wind energy facilities to serve as public information for the Scoping Report for the EIA Study, as required under the procedures for the conduct of EIA in accordance with Regulation 15 (1) of LI. 1652. The Scoping Notice was disclosed in the August 9, 2016 edition of the Daily Graphic as well as the August 24, 2016 edition of the Ghanaian Times. Any person(s) who have an interest, concern, or special knowledge relating to potential environmental effects of the proposed undertaking may contact or submit such concerns, etc[2]. The Scoping Notice was also placed at the Keta Municipality as well as vantage areas within the communities for the information of the locals. It must be noted that the Scoping Report for the ESIA Study is available at the Client's website at www.vra.com. Feedback on the Scoping Report has served as information source for a good appreciation of the socio-economic dynamics in the area.

5.3 PROJECT BRIEFING OF STAKEHOLDERS

Using a participatory approach, the study team used its existing knowledge of the region and knowledge of the social dynamics within the area to approach and engage government institutions and the communities surrounding the project site. Primary data collected for this analysis was both qualitative and quantitative, and was derived from key informants' interviews, village-level surveys, community meetings and focus group discussions. The Study Team conducted interviews with the various stakeholders including community leaders, local government officials, government departments, the affected farmers or individuals within the project area.

Verbal brief, in Ewe (local language) or in English language as may be appropriate, on project information provided the stakeholders were as follows:

a) Increased electricity demand requires that other sources of generation are developed to meet the demand.

[2] See Appendix 2 for Scoping Notice

b) VRA's REDP intends to develop a mixed Renewable Energy portfolio in various potential locations noted/established to have available RE resources

c) VRA has since 2014 undertaken a one-year wind measurement at eight (8) locations in Ghana for the development of the first 150MW of Wind Energy.

d) Various sites have been identified within the Anloga Beach, Anyanui and the road leading to Saviotula Junction at Srogbe within the Keta Municipality as potential sites for a 75MW.

e) Again, sites have been identified at Goi and Wokumagbe in the Ada West District as potential sites for a 75MW.

f) Feasibility studies are now ongoing to finalise the design for the project at the various sites.

g) Project development will entail the following:

- ✓ Construction of Access and Internal road network linking all wind turbines
- ✓ Procurement and Installation of the finally selected Wind turbines, made up of 75 MW, 38 VESTAS V110 each with 2 MW nominal power and on a hub height of 95 m.
- ✓ Installation of corresponding number of step-up transformers mounted at the foot of each turbine tower
- ✓ Construction of operations and control building; substation and grid connection. The integration of the wind farm to the existing grid will be done by a new to be built sub-station 69/33 kV substation in the wind farm and a new to be built dedicated 69 kV overhead transmission line of approximately 37 km to the existing grid at the Sogakofe Substation. Alternatively, the connection to the 161-kV level existing in substation Asiekpe, located some 30 km additional distance towards the north, has also been selected.

- ✓ Within the wind farm, all 38 WTGs will be connected on MV level to the sub-station.
- ✓ Construction of underground electrical collection system leading to the project substation
- ✓ Impact during Construction phase

h) Operation of the wind farm will require the following environmental issues to be addressed:

- ✓ Land Use Changes
- ✓ Visual Effects
- ✓ Noise Effect
- ✓ Flicker Effects
- ✓ Cultural Heritage and Archaeological Issues
- ✓ Flora
- ✓ Fauna (Wildlife, Birds)
- ✓ Wetland Impacts
- ✓ Aviation & Telecommunications Impact
- ✓ Wind Farm Development Advantages (positive effects)
- ✓ Recreational and Tourism Issues

i) VRA has engaged SCL and CSIR-SA to undertake the ESIA for the study.

j) The ESIA is on-going and relevant health, safety, environmental, social and economic issues are being identified for input into the ESIA study report. Studies being undertaken include Flora & Faunal Assessment, Bird Assessment, Heritage and Archaeological Assessment, Wetland Impact Assessment, Aviation & Communication Impact, Property Valuation, Noise and Flicker Impact, Socio-Economic Evaluation & Assessment.

k) As part of the ESIA, SCL is mandated to undertake stakeholder engagement and issues raised by stakeholders are to inform the terms of reference for the study, which will guide the client in the finalisation of the project design.

l) It is expected that the ESIA Studies for the 2 projects are to be completed by June 2016 for which an Environmental permit is to be issued to allow for physical construction to commence.

m) Physical construction could commence by close of 2017.

A power point presentation on the key issues on the project was also prepared and made to stakeholders during the engagements where applicable. The various briefing with the I&APS undertaken are discussed below[3]. **Table 5-1** provides the list of the issues and needs raised at the various briefing from the perspectives of the various stakeholders.

5.3.1 Meeting with Project Affected Communities

At the scoping sessions with communities around the proposed site, groups and individuals were first provided all relevant information about siting of, construction at and operation of the Wind Farm and the Consultants' experience on projects like the one that is being proposed. The community representatives consulted were:

- ✓ Traditional heads of the project affected community of Srogbe
- ✓ Traditional Heads of the project affected community of Anloga
- ✓ Klevi Clan of the project affected community of Anyanui
- ✓ Barteh Clan of the project affected community of Anyanui
- ✓ Community heads of Wededeanu, a settler community on the Anyanui Lands
- ✓ Community heads of Tunu, a settler community on the Anyanui Lands

[3] See Appendix 3 for pictures for the project briefings

Some of the resident communities already knew about the project, but did not know the specific details, particularly about the environmental issues involved.

5.3.2 Meeting with Landowners

A meeting was held with landowners on January 12, 2016 at the Keta Municipal Assembly. A presentation on the project was made which informed the stakeholders of the client's operations in the power sector and the areas where the wind farm sites will be located and the layouts of the sites. The presentation informed the landowners of the land area required for the project and the type of land acquisition the VRA is seeking. It further informed them on the ongoing EIA and the schedule of the project.

The Municipal Coordinating Director at the time, Mr. Nicholas Niaje, who chaired the meeting in his remarks, informed the meeting that the Municipal Assembly facilitates projects by assisting in acquiring the resources required for projects. He encouraged the landowners to hire experts to advise them on the project and encouraged the landowners to cooperate with VRA.

At the meeting, the Landowners were informed about a new site that had been added which is in Srogbe along the road leading to Savietula Junction. The landowners indicated that the correct town names were important, and that Savietula Junction and Alaklpe Junction are suburbs of Srogbe therefore the Savietula site name should be corrected to Srogbe. Indeed, it was respect to this engagement process that the current project location name of Srogbe was adopted.

5.3.3 Consultations with State Agencies

Various engagements were held with key officials of various state agencies within the Keta Municipality. A major formal consultation was held with relevant state agencies within the Keta Municipal on April 13, 2016 at the Municipal Assembly to brief them on the project to allow for the relevant issues of concern to be discussed. At this forum, the purpose of the EIA and the steps to be followed was presented.

State agencies within the Keta Municipality consulted are listed below:

- ✓ Town & Country Planning Department

- ✓ Information Services Department
- ✓ Physical Planning Department
- ✓ Department of Agriculture
- ✓ Department of Community Development
- ✓ National Commission for Civic Education
- ✓ National Disaster Management Organization
- ✓ Works Department
- ✓ Ghana National Fire & Rescue Services
- ✓ Ghana Wildlife Department
- ✓ Department of Urban Roads
- ✓ Department of Agriculture
- ✓ Department of Social Welfare
- ✓ National Commission of Civic Education
- ✓ Municipal Health Directorate
- ✓ Municipal Education Directorate

5.3.4 Public Forum

In October 2016, the study team organised a major formal consultation involving both the public and state agencies in the Keta Municipal. At these consultations, the outcomes from the EIA study as well as the way forward and opportunity to comments on the ESIA report was presented to attendees.

Table 5-1: Stakeholders' Perceptions & Needs

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
February 5, 2016	Klevi Clan of Anyanui	House of a Community Elder	1. They have been briefed on the project by the personnel from the VRA	No Response needed.
			2. They are glad that their community has been chosen for such a project	No Response needed.
			3. They want the negotiation for the acquisition of their land done quickly and the payment done promptly	This will be done after the project site has been properly demarcated and the total area clearly determined
			4. They expect the other packages such as scholarships and provision other social amenities for the people	The Compensation Action Plan and the VRA's Social Responsibility Program will adequately address this concern
			5. They want workers to be recruited from the community	The Local content policy of VRA will be applicable to the project and the contractor will be required to consider locals for recruitment. The contractor will subsequently be advised to consider this proposal from the community. However, this will be dependent on the skill set available within the community and what is required to successfully execute the project.
			6. They want workers to respect their traditions and observe festivals	These issues are being captured during the ESIA study and will be made known to the contractor for adherence. The workers and the entire team will be adequately briefed on these traditional rights and festivals.
			7. They are prepared to share the compensation with the 'Bate' clan.	VRA is grateful for this decision
			8. They will allow the project to continue while	VRA is grateful for this decision and would be most obliged if

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
			they resolve the ownership issues.	the process if facilitated
February 5, 2016	Community heads of Wededeanu (Anyanui)	Fetish Priest's House	1. They are happy that their community has been chosen	No Response needed.
			2. They will want adequate compensation for their farm lands and crop	Property evaluation will be done and payment effected in line with requirements of the Lands Commission.
			3. They are concerned that the presence of the project will affect their health and reduce the level of rain they receive.	Associated impacts like noise and shadow flicker are being investigated and the siting of the turbines will be done in order to mitigate these. Meanwhile, there is no evidence that the presence of wind power project affect the level of rains receive in that community
			4. They should be considered in the recruitment especially as securities, masons etc.	This is dependent on the skill set available within the community and what is required to successfully execute the project. Meanwhile, the Local content policy of VRA will be applicable to the project and the contractor will be required to consider locals for recruitment
February 5, 2016	Community heads of Tunu (Anyanui)	Community Meeting Place	1. The community heads are not aware of the project development and what it entails.	Details of the project was explained to them
			2. If land is to be acquired, VRA should endeavour to pay adequate compensation for loss of farm lands and crops.	Development of the Compensation Action Plan will adequately address this concern
			3. The issue of local content be considered critically and local labour should be considered during recruitment.	The Local content policy of VRA will be applicable to the project and the contractor will be required to consider locals for recruitment. The contractor will subsequently be advised to consider this proposal from the community. However, this will be dependent on the skill set available within the community

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
				and what is required to successfully execute the project.
			4. VRA should endeavor to provide other packages such as scholarships and provision other social amenities for the people	The community will benefit from the VRA's Community Development programme which provides among others, educational scholarships to needy students in project impacted communities.
February 7, 2016	Barteh Clan of Anyanui	Chief's House	1. They believe they are the true owners of the land as a result they are not happy that the Klevi clan has been consulted for the release of the land for the project instead of the Barteh Clan.	VRA requested them to resolve the land ownership issues with the Klevi Clan so that compensation would be paid to the rightful owner. Meanwhile, it is only when the rightful is determined that any money can be issued, thus, any delay in the resolving the land ownership will also result in compensation payment delays,.
			2. They were however, happy that their area is being considered for the siting of the project	VRA is grateful for this decision
			3. They will allow the project to continue while they resolve the land ownership issues.	VRA is grateful for this decision and would be most obliged if the process if facilitated
February 7, 2016	Traditional Heads of Anloga	House of the Clan Head	1. The locals have been briefed on the project by the personnel from the VRA and has been promised in advance payment of 30% for lands to be acquired.	Any initial part payment to be made will be dependent on the completion of land acquisition process which is currently being firmed up with the help of the Lands Commission
			2. VRA should endeavor to provide other packages such as scholarships and provision other social amenities for the people.	The community will benefit from the VRA's Community Development programme which provides among others, educational scholarships to needy students in project impacted communities.

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
			3. The issue of local content be considered critically and local labour should be considered during recruitment.	The Local content policy of VRA will be applicable to the project and the contractor will be required to consider locals for recruitment. The contractor will subsequently be advised to consider this proposal from the community. However, this will be dependent on the skill set available within the community and what is required to successfully execute the project.
			4. Construction workers should endeavor to respect traditions and observe festivals.	These issues are being captured during the ESIA study and will be made known to the contractor for adherence. The workers and the entire team will be adequately briefed on these traditional rights and festivals.
February 9, 2016	Keta Municipal Assembly	Office of Municipal Coordinating Director	1. Government was glad the power project is being brought to the country as it will augment power production in the country and that VRA has made the Keta Municipality aware of the wind power project since 2014	No Response needed.
			2. A forum was organized for land owners sometime in January 2016 and concerns raised at the forum is that the project implementation seems to delay and this is causing anxiety amongst the affected landowners	Projects development in the power sector is quite laborious and requires very forms of studies to come to a final decision on exactly what is to be done. It is therefore important that land owners and the municipality in general to exercise some patience since a project of such magnitude requires several processes including the Wind Measurement and ESIA before actual construction

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
			3. As a Municipality, we are happy of this intention by the client/proponent and we are willing and ready to provide all the necessary support towards this project from our end.	VRA is grateful for this decision
			4. A key issue in our District is the acquisition of land and land ownership matters. We request this is taken into key considerations before the actual project development commences.	VRA recognises that compensation issues are key to the success of the project. To facilitate compensation payments, Land owners are urged to have a proper land title document to their property. VRA will also conduct further checks to determine the true owners of the land before compensations are paid.
			5. We request the client engage the assembly men to identify key hotspots for consideration in the project development. Also, there should be that corporate social responsibility effort from the client during the project development towards the affected communities.	It is planned to engage the assembly members specifically to serve as contact person for any grievances that will arise. The community will benefit from the VRA's Community Development programme, which provides among others, educational scholarships to needy students in project impacted communities.
			6. Data on district is available in the Medium-Term Development Plan and would be made available to SCL for use in the ESIA.	VRA is grateful for this decision
			7. VRA should also look at its impact on previous projects like the Akosombo hydropower which has resulted in sea erosion and the formation of sand bars of over 4-6m high along the shore at Keta.	This issue is well noted and there will be a flood risk assessment as well as wetland assessment to determine mitigative measures to be employed on the project.

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
February 9, 2016	Keta Municipal Health Directorate	Office of Municipal Public Health Nurse	1. Accidents, robbery and baby delivery mostly happen during the nights, thus generation of electricity is very important to the health service.	No Response needed.
			2. Its good VRA is looking at alternative sources of power to supplement current supply as inadequate power supply is affecting health delivery in the district especially for storage of drugs.	No Response needed.
			3. They however haven't heard of the project and would be grateful if detail information so they can make informed input	Background information document on the project will be made available to them in due course. This document contains all issues there is to the project
			4. Data on district health is available and would be made available to SCL for use in the ESIA	VRA is grateful for this decision
February 9, 2016	Keta Municipal Education Directorate	Office of Public Relations Officer	1. They haven't heard of the project and would be grateful if detail information so they can make informed input.	Background information document on the project will be made available to them in due course. This document contains all issues there is to the project
			2. Data on district education is available and would be made available to SCL for use in the ESIA	VRA is grateful for this decision
February 9, 2016	Traditional Heads of Srogbe	Compound of House of Stool Father	1. They have been briefed on the project by the personnel from the VRA.	No Response needed.

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
			2. They are glad that their community has been chosen for such a project	No Response needed.
			3. They want the negotiation for the acquisition of their land done quickly and the payment done promptly.	This will be done after the project site has been properly demarcated and the total area clearly determined. VRA recognises that compensation issues are key to the success of the project. To facilitate compensation payments, Land owners are urged to have a proper land title document to their property. VRA will also conduct further checks to determine the true owners of the land before compensations are paid.
			4. They expect the other packages such as scholarships and provision other social amenities like schools, improvement in the road network for the people	The community will benefit from the VRA's Community Development programme which provides among others, support for educational activities including scholarships, community infrastructure, health, environmental management, among others in project impacted communities.
			5. They want workers to be recruited from the community	The Local content policy of VRA will be applicable to the project and the contractor will be required to consider locals for recruitment. The contractor will subsequently be advised to consider this proposal from the community. However, this will be dependent on the skill set available within the community and what is required to successfully execute the project.
			6. They want workers to respect their traditions and observe festivals	These issues are being captured during the ESIA study and will be made known to the contractor for adherence. The workers and the entire team will be adequately briefed on these traditional rights and festivals.

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
February 9, 2016	Community heads of Gblife Community (Anyanui)	House of Acting Chief	1. They are not aware of the project and what it entails	Background information to the project will be made available to them in due course. This document contains all issues there is to the project
			2. They will want adequate compensation for their farm lands and crop	This will be done after the project site has been properly demarcated and the total area clearly determined. VRA recognises that compensation issues are key to the success of the project. To facilitate compensation payments, Land owners are urged to have a proper land title document to their property. VRA will also conduct further checks to determine the true owners of the land before compensations are paid.
			3. They are concern that the presence of the project will affect their health	Associated impacts like noise and shadow flicker are being investigated and the siting of the turbines will be done in order to mitigate these.
			4. They should be considered in the recruitment especially as securities, masons etc.	The Local content policy of VRA will be applicable to the project and the contractor will be required to consider locals for recruitment. The contractor will subsequently be advised to consider this proposal from the community. However, this will be dependent on the skill set available within the community and what is required to successfully execute the project
			5. They expect the other packages such as scholarships and provision other social amenities for the people	The community will benefit from the VRA's Community Development programme which provides among others, support for educational activities including scholarships, community infrastructure, health, environmental management, among others in project impacted communities.

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
April 13, 2016	State Agencies within Keta Municipality	Office of the Municipal Coordinating Director	1. What are the impacts on the local people with respect to resettlements?	An area of approximately 177.46 ha of land is required and acquired for the projects. This will result in loss of livelihood for land owners and farmers who utilise the land for agricultural and other socio-economic activities. These lands will be valued and compensation paid for. Development of the Compensation Action Plan will adequately address this concern.
			2. What will be the impact on power generations when the estimated wind speed reduces during project operations?	The project is expected to add on to the net power generated in the country. As with very other source of power, its ability to generate electricity will be affected by one factor or the other. VRA is developing a portfolio of power plants to ensure that there is back up in the event that any is affected.
			3. Compensation issues are very critical to the local people thus, the project should ensure adequate and prompt compensation.	Property valuation will be done, and payment effected in line with requirements of the Lands Commission.
			4. The development on the Akosombo Dam has negatively affected the socio-economic life of the people of Keta, and therefore how assured are they that this current project will not affect same?	The level of impact associated with hydro power is very different from that of the wind power. VRA is undertaken a socio-economic study of the project and all issues regarding this will be assessed and relevant mitigative measures provided and implemented
			5. Can VRA help farmers who pump underground water for their crops have reduced electricity tariffs?	This will require an advocacy effort and farmer groups should lead the discussion with the Municipal Assembly

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
			6. Will the cost of wind power generated be very different from that of hydro and thermal power?	Each source of power has its own cost. Wind power is far more expensive that thermal which is also more expensive than hydro. However, PURC will consolidate the various costs within the energy mix and charge one fee to customers.
			7. Cant VRA provide solar energy in the communities?	VRA is mandated to supply bulk power and therefore does not undertake home connection. However, Energy Commission is now involved in the promotion of home solar panels and should be contacted on such issues.
			8. VRA should endeavour to adhere to all fire requirements associated with the project development	The project will require a Fire permit, thus, VRA will formally notify the GNFRS of the project development to enable them to inspect and advise on fire requirements.
			9. How will the project mitigate the impact on birds, as the project is located close to the Keta Lagoon Complex Ramsar site, which is known to harbour significant number of birds?	A bird's study is underway to assess the impact and provide mitigative measures as required.
			10. Has VRA considered boosting the tourism potential to be realised from the development of the project?	This will be the role of the Keta Municipal assembly and therefor there is the need to start considering its impact in the Municipal developmental agenda.
			11. Information sharing should be a key part of the project so that the Keta Municipal will be apprised with project development issues.	This is a key part of the project to ensure success and VRA will at every step make the affected assembly aware of project status and challenges
October 19, 2016	General Public	Keta Municipal Assembly	1. Method of communication to invite the public to the meeting needs to be improved. The draft report needs to be given to the chiefs in	The client offered to hand deliver copies of the Scoping Report to the various Chiefs as was requested.

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
		Conference Hall	order for them to show community members.	
			2. The project will be constructed on farm land, however many farmers were not aware of this meeting. VRA needs to identify the real owners of all land they will be constructing on. How did VRA identify land owners?	Identification of lands to be acquired is ongoing, and it is only when this has been completed that VRA will deal with the landowners and subsequently the farm owners.
			3. The region is important for migratory birds and turtles. A good study should be conducted to assess the impacts of the facility on these species.	A wetland impact assessment study is ongoing as part of the study to address this impact.
			4. For Srogbe particularly, VRA is to meet with traditional authorities or no construction will take place. Chiefs should be met with so that they may also receive compensation	All required traditional protocols will be observed prior to project construction to address these concerns.
			5. The presumption made by VRA is that the individuals currently on the land are the landowners may not be correct. VRA to be sure of landowners prior to paying out any compensation.	Land search is being done at the Lands Commission to confirm all landowners for compensation purposes. However, VRA will also need the support of the Chiefs and community leaders to assist with the identification process
			6. Will the project cause the rate of coastal erosion to increase?	No, the project will not cause an increase in the rate of coastal erosion. This is because the turbines revolution per hour can't cause any form of erosion. Rather, the project could rather be impacted upon by the coastal erosion and so remediation works will need to be done to mitigate such an impact.
			7. Was off shore wind farm considered by VRA?	No, off shore wind farm has not been considered yet by VRA. VRA at this stage is looking at onshore wind farms.

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
			8. What are the social responsibility aspects of the project? How is VRA giving back to the community? Fishing stakes should be given to farmers as part of this social responsibility.	Communities within the Keta Municipal already benefits form VRA Corporate social responsibility. The community will continue to benefit from the VRA's Community Development programme which provides among others, support for educational activities including scholarships, community infrastructure, health, environmental management, among others in project impacted communities.
			9. The roads should run from West and East to allow for cultural observation	The feasibility study has identified the most feasible route that the project should utilise and VRA will be bound to go according to that.
			10. As vegetation such as coconut trees will be removed, VRA should compensate villagers who use this vegetation for economic gain.	VRA will compensate for any property to be impacted upon by the project
			11. The beaches are of use for the tourism industry. Has VRA thought of utilising the and north of the lagoon as wind speeds are higher than at the coast?	Areas with wind speed has been determined scientifically and these are the areas that VRA is considering, in addition to other socioeconomic factors,
			12. Can VRA sell power generated to people in the village at lower prices?	VRA is mandated by law to generate electricity and sell to bulk utility companies. It supplies electricity directly to its own townships, like Akuse, Akosombo, Aboadze etc. Under this project, VRA cannot sell electricity to the nearby communities.
			13. What is the conventional distance of wind turbines from settlements?	Various factors go into the determination of such distances. For this project, such an assessment is ongoing and factors such as noise and shadow flicker impacts are critical considerations

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
			14. One or two of the chiefs should visit South Africa to learn about how wind farms are operated as part of corporate responsibility from VRA.	The issue is noted and would be relayed to those in Authority for consideration.
			15. VRA should be careful that turbines do not interrupt the sleep patterns of people living in the villages	Studies are ongoing, and impacts associated with noise and shadow slicker are being considered to ensure that nearby communities are not negatively impacted.
			16. Why are experts from South Africa conducting the EIA?	The project is novel in Ghana and the South Africans are known to have good experience in the EIA assessment. They are collaborating with their Ghanaian partner, who is the Lead partner
			17. Will there be replanting of trees and plants that have been removed?	The project will consider such an activity if required.

6. DESCRIPTION OF THE AFFECTED ENVIRONMENT

6.1 OVERVIEW

This section presents a description of the social and economic characteristics of the project area. It is anticipated that the most significant socio-economic impacts will occur within Anloga, Srogbe and Anyanui communities and its environs within the Keta Municipal of the Volta Region of Ghana. For this reason, the discussion of baseline socio-economic conditions as indicted earlier was looked at within the context of these three communities, the immediate impact area as well as the Keta Municipal in the Volta Region, which is the broader impact area.

The revised structure for Ghana ESIA Reports requires the discussion of the following issues as part of the socio-cultural baseline information and these have been examined in this Report:

- The land area taken up by the development, its location clearly shown on a map and geographical coordinates provided.
- Human beings: (population composition and distribution, socio-economic conditions, cultural and ethnic diversity, population growth rate);
- Land use: (agriculture, forests, industrial, commercial, residential), transportation routes such as roads, rail, water and air, utility corridors
- Social services: (electricity, telecommunication, water supply, hospitals, etc);
- Cultural heritage: (unique features of the area or its people; cemetery, fetish grove, festivals etc).

6.2 LAND REQUIREMENTS

Out of the total surface area of 1,086 km^2, approximately 362 km^2 (about 30 percent) is covered by water bodies. The largest of these is Keta Lagoon, which is about 12 km at its widest section and 32 km long. Hence, the remaining land area is only 724 km^2, a situation which creates severe constraints on access to land for development in the Municipality. WPP1 will cover an area of approximately 482.16 acres (refer to Table 6-2) for the preferred layout and 309.83 acres for the alternative layout. The geographical coordinates for the proposed layouts are provided in Table 6-1. A Right of Way of 200m, 100 m each side of a wind turbine will be acquired with respect to the Anloga site, however, that for Anyanui and the Srogbe site will be 120 m, i.e., 60 metres on each side. In addition, land for the substation as well as a right of way of 30m will be acquired with the associated 67.5 Km 161 kV Transmission line.

Table 6-1: Geographical Coordinates for WPP1

Site		Coordinates for preferred layout	Coordinates for alternative layout
Anyanui	Anyanui 1	5° 47’ 37.81” N / 0° 44’ 16.33” E 5° 47’ 33.28” N / 0° 44’ 15.28” E 5° 47’ 25.77” N / 0° 45’ 16.17” E 5° 47’ 21.28” N / 0° 45’ 16.20” E	N/A
	Anyanui 2	5° 47’ 50.71” N / 0° 43’ 28.18” E 5° 47’ 51.10” N / 0° 43’ 32.54” E 5° 47’ 24.29” N / 0° 43’ 32.27” E 5° 47’ 24.29” N / 0° 43’ 32.27” E	N/A
Srogbe		5° 48’ 32.91” N / 0° 48’ 22.56” E 5° 48’ 36.13” N / 0° 48’ 25.52” E 5° 47’ 12.27” N / 0° 49’ 43.10” E 5° 47’ 09.44” N / 0° 49’ 40.42” E	5° 48’ 32.91” N / 0° 48’ 22.56” E 5° 48’ 36.13” N / 0° 48’ 25.52” E 5° 47’ 12.27” N / 0° 49’ 43.10” E 5° 47’ 09.44” N / 0° 49’ 40.42” E
Anloga Beach		5° 46’ 42.08” N / 0° 51’ 02.20” E 5° 46’ 40.66” N / 0° 51’ 02.43” E 5° 47’ 11.69” N / 0° 55’ 06.32” E 5° 47’ 07.13” N / 0° 55’ 06.73” E	5° 46’ 42.08” N / 0° 51’ 02.20” E 5° 46’ 40.66” N / 0° 51’ 02.43” E 5° 47’ 11.69” N / 0° 55’ 06.32” E 5° 47’ 07.13” N / 0° 55’ 06.73” E

Table 6-2: Land Requirements for WPP1

Site	Land Required for preferred layout (acres)	Land Required for alternative layout (acres)
Anyanui		
Agbledomi	*106.60*	
Anyanui	*65.84*	
Total - Anyanui	**172.45**	
Srogbe		
Srogbe	*122.49*	*122.49*
Salo	*65.68*	*65.68*
Total - Srogbe	**188.17**	**188.17**
Anloga Beach		
Amey Clan	*65.43*	*65.43*
Togobo Clan	*9.00*	*9.00*
Whuti	*47.10*	*47.10*
Total - Anloga	**121.54**	**121.66**
Total	**482.16 acres**	**309.83**

Source: VRA Communication – August 2017

6.3 BACKGROUND OF PROJECT COMMUNITIES

Keta Municipality is located east of the Volta estuary, about 160km to the east of Accra, off the Accra-Aflao main road. It shares common borders with Akatsi District to the north, Ketu North and South Districts to the east, South Tongu District to the west and the Gulf of Guinea to the south. The wind farm site is in three communities in the Keta Municipal, namely Anloga, Srogbe and Anyanui. These communities are located on the south-east coast of Ghana, east of the Volta River mouth and west of the Keta Lagoon and therefore slightly above sea level (See Figure 6-1)[4]. Anloga lies to the east of the Volta River and south of the Keta Lagoon. Anloga is the traditional and ritual capital of the 36 traditional states of Anlo Ewe people. The land is owned by the Adzovia clan although sections have been given out to some individuals within the clan. The administration and transfer of the clan land within the community is done by the elders of the clan while those that have been acquired by the individuals are handled by the individuals.

[4] *Source*: Keta Municipal Health Directorate, Year 2014 Report (Feb. 2015)

According to the Regent (Afatsawu Agbavitor), the Stool father (Francis Atsu Lumor), and elders of Srogbe, the community was first settled by a branch of the Like clan known as the Dzezizi. The people of Whuti Sroegbe celebrate Norvikporgbe festival in addition to Hogbetsotso. They have a war deity call Sri. It is believed that Sroegbe is the corrupted form of the town deity 'Sri'. This deity is a tree by the lagoon. The Dzezizi branch of the Like clan also have a deity known as Apim and it is also located along the sea. The Whuti lands are owned by three clans namely; Bate, Adzorvia and Like.

According to Togbe Gamor II, the divisional chief of Anyanui, the town, Anyanui, was derived from a deity called Mama Gbortonunyanui. On the issue of ownership of the proposed land for the project, he said the project land belongs to the Bate clan. To him, the land in question was acquired from the Klevi by his grandfather. He made mention that at time the Anyanui land was advertised to be sold by the Klevi clan, his rich grandfather who was by then living in Togo was informed so he sent money (cowries) through Ashigbi to purchase the land. The payment was made to Torgbui Gadagbui, the head of the Klevi clan in about 1750. It is out of benevolence that the Bate Chiefs allowed Torgbui Gadagbui and his people to stay at the far end of the land at a place called Xorsekordzi. More importantly, in the words of Torgbe Gamor II, even though it is true that an Anyanui land belongs to the Bate clan, it is a communal property and no single individual reserves the right to its ownership. He is of the view that the advent of this important project led to the rise of multiple claims to the ownership of the Anyanui lands by the Klevi clan. Togbe was quick to mention that a legal tussle regarding the true ownership of the land that was adjudicated at the Ho high court in 1965 was won by the Bate clan.

There are some communities such as Tunu, Gblife and Wededeanu within the catchment area of the project although none of them is to be displaced. Tunu is about 300 meters to the north of the project site. According to the elders, Tunu used to be a forest area populated with lions and other dangerous animals. Their ancestors who first settled on the land were hunters who used to set traps for game. One of the hunters set a trap in the forest with the mouth facing the present day Tunu and instructed other hunters not to pass where the gun or the trap was set. Since then the area has been referred to as Tu nu in Ewe; meaning 'gun mouth'. To put simply, the Tunu Township was named after that hunting phrase. Clans currently settled in Tunu include the Lafeawo, Adzorviawo, Toviawo, and Kleviawo. According to the elders, they don't pay tribute to the chief of Anyanui but their forebears used to because Tunu land belongs to the Anyanui traditional area. Gblife is a second community in the project area of Anyanui and it is situated by a lagoon. In the wisdom of the elders, Gblife is named after a male deity called Gbli. Even though the deity is domiciled in Tunu they have a female deity called Kpokpo. The elders made it known to us that Gblife land was given to the Toviawo clan of Glife by the Bate clan in Anyanui. The Gblife people do not have a chief but a Headman (Amegakpui) and their paramountcy is at Dzita.

Figure 6-1: Map of Keta Municipal showing project communities

6.4 GOVERNANCE STRUCTURE

In Ghana, two parallel government systems operate at the local level: the district assembly administrative structure and the traditional administrative system. While the district administration consists of elected representatives and central government appointed personnel, the traditional administration derives from the chieftaincy institutions. At the community level, the elected assemblyperson serves as the main link between the district assembly and the community and these play important roles in community mobilization and development.

Paramount Chiefs and elders constitute the traditional administrative institution and they play both judicial and executive functions within the communities, carrying great influence. They are the traditional custodians of the land and are recognized by the formal administrative structures. In the traditional setting, the traditional authorities also have their own court system, which adjudicates cases relating to land dispute, chieftaincy tittle disputes, violation of traditional customs, and disputes between localities, families and individuals. The chiefs in the district are members of the Regional house of chief and represent the interest of the people.

This section explains briefly the governance and administrative structures relevant to the proposed Project, including informal and formal leadership structures.

6.4.1 Formal Administrative Structures

The Keta Municipal Assembly in the Volta Region is the highest administrative and political authority in the project area. There are two (2) constituencies in the Municipality which are Anlo and Keta Constituencies. The legislative and deliberative organ of the Assembly is made up of seventy-four (74) Assembly Members, including one (1) Municipal Chief Executive (MCE) who chairs the Executive Committee in performing the executive and administrative functions of the Assembly, (2) Members of Parliament from the Keta and Anlo constituencies in addition to fifty (50) elected Assembly Members and twenty-one (21) government appointees. The project is sited within three (3) Sub- District Structures namely Anloga, Whuti-Srogboe and the Dzita-Anyanui Zonal Councils in the Keta Municipal. The project sites fall within the Anlo constituency.

6.4.2 Traditional Administration Structures

The Traditional Council is composed of several area councils. The traditional authorities administer stool lands, holding them in trust for the people, and arrange the celebration of traditional festivals. They are also the custodians of traditional beliefs and customs, passed on from one generation to another. The traditional authorities also have courts that adjudicate on matters relating to stool lands, lineage and family lands, chieftaincy disputes, violations of traditions and disputes between localities, lineages, families and individuals. In the Volta Region, no paramountcy owes allegiance to another paramountcy.

Keta Municipality is fortunate to have one main ethnic group (Anlo), which minimizes potential conflicts resulting from multi ethnicity. The Anlo Traditional Council is headed by a paramount chief, the Awoamefia of Anlo who serves as a symbol of unity among all people in the Municipality. There are other chiefs with their own areas of influence who assist the Awoamefia in the promotion of peace and stability in the Municipality. There is relative peace on the chieftaincy and political fronts due to pre-emptive measures taken by the municipality command with the collaboration of Municipal Security Council. As indicated, the project sites fall within the Anlo constituency, with the traditional authority being the Anlo Traditional Council, the renowned and powerful authority in the entire Anlo Kingdom, and headed by the Awoamefia.

6.5 DEMOGRAPHICS

6.5.1 Population Size, Composition & Age Structure

The 2010 Population and Housing Census put the total population of the Keta Municipality at 147,618, which forms 7.0 percent of the Regional total population. The population constitutes 53.6 percent females and 46.4 percent males with an annual growth rate of 2.5 percent, which is slightly higher than the regional figure of 2.4 percent. The projected population of the Municipality for 2015 is 155,918. Out of the total population of 155,918, males are expected to be 72,408 representing (46.44%) while that of females was 83510 representing (53.5 percent). **Table 6-3** shows the population by age and sex of the three project communities in the 2010 PHC. Anloga is the only urban community amongst the three (3) project communities, which is with a population of above 5,000 people. Anloga's population as at 2010 was 22,722, out of which 10,652 (46.8%) are males. Anyanui has a population of 2,316 with a male population 1075 (46.4%) whilst Srogbe has a population of 1195 out of which 553 (46.2%) are males. These three (3) communities are among the 20 largest communities in the Municipal.

The Municipality is the most urbanised district in the region with more than half 53.3 percent of the district's population living in the urban areas with 46.7 percent of the population living in the rural areas. The population density of the Keta Municipality was 211.9 persons per km^2 in 2000 (water bodies excluded). The density reduced to 196.0 persons per km^2 in 2010. This is significantly higher than the national and regional figures of 103.4 persons per km^2 and 103.0 persons per km^2 respectively. This higher density is attributed to the presence of large water bodies, which occupy one-third of the total land area. The population dynamics of the Municipality may be determined largely by fertility and mortality processes. Persons of Ghanaian parentage constitute a large percentage of the population in the Keta Municipality. There are Ghanaians with dual citizenship in the Municipality, though the proportion is small. Households in the Municipality are predominantly male-headed. The extended family living arrangements dominates in the Municipality. The age-dependency ratio is the ratio of the dependent-age population (those under age 15 and ages 65 and older) to the working-age population (15 to 64 years). The age dependency ratio for the Municipality is about 78 dependents (child and old age) for every 100 people working. This means that 100 persons in the active population group are being depended on by 78 persons in the inactive population group. In relation to the sex structure, there are more males (51.1%) than females (48.9%) who are under 15 years in the Municipality. There are large proportions of children (12.4%) below five years in the Municipality. The population below 15 years (0-14) is 34.6 percent. Population between the ages of 15-19 comprises 11.0 percent of the total population in the Municipality.

Table 6-3: Population By Sex and Age in the Project Communities

Age	Anyanui				Srogbe				Anloga			
	Male	Female	Total	Sex ratio	Male	Female	Total	Sex ratio	Male	Female	Total	Sex ratio
0-4	143	139	282	103	67	79	146	85	1,365	1,307	2,672	104
5-9	162	131	293	124	61	70	131	87	1,215	1,166	2,381	104
10-14	150	131	281	115	67	64	131	105	1,233	1,144	2,377	108
15-19	129	121	250	107	53	58	111	91	1,337	1,238	2,575	108
20-24	93	98	191	95	52	40	92	130	1,081	1,016	2,097	106
25-29	71	90	161	79	45	52	97	87	707	820	1,527	86
30-34	40	65	105	62	42	38	80	111	591	710	1,301	83
35-39	46	62	108	74	37	44	81	84	522	692	1,214	75
40-44	38	72	110	53	28	28	56	100	452	651	1,103	69
45-49	36	45	81	80	22	33	55	67	491	565	1,056	87
50-54	58	69	127	84	21	27	48	78	453	560	1,013	81
55-59	23	50	73	46	9	17	26	53	296	410	706	72
60-64	18	41	59	44	13	22	35	59	252	429	681	59
65-69	15	31	46	48	8	21	29	38	183	330	513	55
70-74	20	36	56	56	6	19	25	32	174	326	500	53
75-79	14	24	38	58	9	5	14	180	134	279	413	48

Age	Anyanui				Srogbe				Anloga			
	Male	**Female**	**Total**	**Sex ratio**	**Male**	**Female**	**Total**	**Sex ratio**	**Male**	**Female**	**Total**	**Sex ratio**
80-84	12	19	31	63	3	6	9	50	82	209	291	39
85-89	5	11	16	45	6	11	17	55	47	116	163	41
90-94	2	5	7	40	2	4	6	50	28	66	94	42
95+	-	1	1	-	2	4	6	50	9	36	45	25
Total	**1,075**	**1,241**	**2,316**	**87**	**553**	**642**	**1,195**	**86**	**10,652**	**12,070**	**22,722**	**88**

Source: Ghana Statistical Service, 2010 Population and Housing Census

6.5.2 Fertility

The fertility rate for the Municipality is 3.1 children per woman age 15-49, which is slightly lower than the regional rate of 3.4 children per woman. The numbers of male and female children ever born are 85,330 and 86,365 respectively and children who survived are 69,440 (81.4%) males and 72,347 (83.8%) females respectively. The crude death rate for the Municipality is 12.3 per 1,000 population. This also implies that there are approximately 12 deaths per 1,000 population. The reported under five (age 0-4) male deaths were slightly higher than the female deaths. From age groups 15-19 to 50-54 the proportion of female deaths were higher than male deaths, which may be attributed to maternal deaths. Among those who were born elsewhere in another region, migrants from the Northern, Central and Ashanti region have had the longest stay (20+ years) in the Municipality than migrants from any other region. Even though Total Fertility Rate is relatively low in the Municipality, (3.1 children per woman aged 15-49 years), most women do not have control over their reproductive health especially when it comes to regulating fertility and using contraceptives, there is a need to integrate family life education into school curriculum and out-of-school programs.

6.5.3 Migration

Migration is a socio-economic phenomenon, which is a result of complex mechanisms involving social, psychological, economic, political and institutional determinants. The movement of population in space is incidental to carrying out daily activities in life, such as commuting to and from places of work and travelling for business or for pleasure. These movements are often monitored and analysed for specific purposes. The duration of stay distinguishes the temporary stay from a short stay. However, when such mobility involves a permanent sojourn in the place of destination, it is considered as migration. Migration is therefore defined as a geographical movement involving a change from a usual place of residence over a defined territory beyond a defined period (United Nations, 2012).

The 2010 PHC shows that there are total of 26,960 migrants residing in the Keta Municipality. Out of this number, 14,464 were born elsewhere in the Volta Region, 8,027 percent were born elsewhere in another region, while the rest 4,226 were born outside Ghana. In terms of duration of residence, majority of the migrants (35.3%) have been residing in the Municipality for ten years or more. Besides, amongst those who were born elsewhere in another region, migrants from the Northern, Central and Ashanti region have had the longest stay (20+ years) in the Municipality than any other region recording 23.6%, 21.7% and 20.2% respectively. These migrants can be a potential asset for the district by tapping their skills and using them for the benefits of the district. It can however be a potential problem if they become a liability to the district by engaging in nefarious activities.

6.5.4 Religion & Ethnic Composition

Within the Keta Municipal, the predominant religion is Christianity, which constitutes about 72.8 percent of the population followed by traditional religion 25.4 percent, Muslim 1.0 percent and others, 0.8 percent. However, some people practice Christianity alongside traditional religion. Ethnic Composition of the Keta Municipality is highly homogeneous with Ewes dominating (98.7%) while the other tribes constitute the remaining (1.3%).

6.6 ARCHAEOLOGICAL, HERITAGE & CULTURAL STRUCTURE

Cultural resources and heritage comprise tangible historical/archaeological sites, documents and artefacts together with religious/spiritual sites (sacred sites) and activities important to local communities, customary law, traditional beliefs, values and practices. Keta Municipality is part of Anlo Traditional Council, which has 36 states and headed by a paramount chief, the Awoamefia of Anlo who serves as a symbol of authority among all people in the Municipality. Other chiefs with their own areas of influence assist the Awoamefia in the promotion of peace and stability in the Municipality.

The main festival is the Hogbetsotso, which symbolizes the great exodus of Ewes from their ancestral home, Notsie, to their present abode around the 15th Century. The Hogbetsotso Festival, which is celebrated at Anloga, the traditional home of the Anlos, attains a grand final with a durbar of Chiefs and people amidst pomp and pageantry on the first Saturday of every November. Display of rich cultural values, resource mobilisation for development and peaceful co-existence are prominent issues considered during the occasion.

Experts from the Department of Archaeology & Heritage Studies from the University of Ghana have undertaken a separate archaeological, heritage and cultural study and details of this is provided in a specialist report submitted as part of the ESIA study. The study did not reveal any significant heritage remains that could be directly impacted on by the project. The project site is not located in a designated archaeological priority area nor contains any scheduled ancient monuments, listed buildings or locally listed buildings. There are no listed heritage sites located within the area of the property proposed for the project site. The most common type of archaeological site encountered in the study area were active heritage resources. These include the following:

a) Walled Takpe Vikpe shrine in the project area (See Plate 6-1) near the sea

b) The Mama Blode river/lagoon deity and associated sacred groove (See Plate 6-2)

c) The Hunua Kofi Gborsike Fuidoglo's shrine village at Toviakorpe/Anloga (See Plate 6-3).

The Tunu community at Anyanui are said to also have a deity known as Gbli. Some taboos associated with this deity are:

- Women in their menstruation period do not visit the shrine of the deity.
- Women in their menstruation period do not visit the river side
- Running and diving into the lagoon is a taboo
- Fetching water from the lagoon with a black pot is a taboo
- Hooting is prohibited in the town
- Having sexual intercourse on the bare ground is unacceptable
- They don't engage in economic activities on Thursdays

At the Srogbe project area, an abandoned village/hamlet once called Komiga Kofe or Kpodzi was identified by the study and was characterised by house mounds and remains of palm trees.

Plate 6-1: The walled Takpe Vikpe shrine in the project area near the sea.

Source: Archaeological & Cultural Heritage Impact Assessment: ESIA for Wind Power Project (Anloga, Sroegbe & Anyanui Project Sites), April 2017

Plate 6-2: Mama Blode river/lagoon deity and associated sacred groove

Source: Archaeological & Cultural Heritage Impact Assessment: ESIA for Wind Power Project (Anloga, Sroegbe & Anyanui Project Sites), April 2017

Plate 6-3: Hunua Kofi Gborsike Fuidoglo’s shrine village at Toviakorpe/Anloga

Source: Archaeological & Cultural Heritage Impact Assessment: ESIA for Wind Power Project (Anloga, Sroegbe & Anyanui Project Sites), April 2017

6.7 LAND TENURE SYSTEM

Under the existing arrangement Ghana's land tenure systems, traditional land-owning authorities (stool chiefs, clan heads and skins) hold allodial (absolute ownership) title to land on behalf of their people. Leases and rentals over a satisfactory period for economic/commercial activities are possible and involve permission by the allodial titleholders to use the land. However, the land must revert to the community or the allodial titleholder at the end of the lease or cessation of the activity for which the lease was granted in the first place. Thus, outright ownership of land is still a rare form of land tenure in Ghana.

Ghana's land tenure system impedes the country's socio-economic development, and is completely out of place in a modern, progressive country. The Anloga area of the Volta Region of Ghana presents a classic case of rational environmental resource management, against the backdrop of limited land space, capricious weather conditions, impoverished soils, hydrological perturbations and intense population pressure. Based on a local initiative, the farmers adopted a highly specialised system of horticulture as a sustainable coping strategy to redress the environmental ills. The farming system, involving shallot cultivation, is intricately linked with an elaborate system of land tenure, institutionalised to streamline the individual's usufractory right.

A study in 2001 showed that although a patrilineal inheritance system prevails in the area, pockets of matrilineal system had also evolved, making the inheritance system quite complicated. The religious importance attached to the patrilineal system of inheritance makes the pattern of land holding much skewed in favour of men. However, though women may not be active partners in shallot farming and in transactions pertaining to land, their absolute control over the distribution network of the end-product places them at a pivotal position in the farming system. Investigations into patterns of land tenure, including gender patterns and possible temporal changes, revealed that apart from the inheritance system through which the majority of the people acquire land for farming, other tenure agreements – share cropping, renting, pledging and leasehold also exist. The study concluded that outright land sales have been completely replaced by pledging, whilst sharecropping is gradually giving way to renting, but the general pattern of land tenure in the area had not changed significantly over the last 25 years.[5]

The variety of customary arrangements, combined with some inconsistencies in the procedures for deed and title registration, make it difficult, though not impossible, for potential investors to acquire large parcels of land for large-scale economic activities. This is particularly the case where the activity has a long economic gestation period. In addition, the different traditional ownership structure, in some cases, requires negotiations with a large number of allodial titleholders. Such negotiations can often be protracted, cumbersome, frustrating and expensive.

The current land tenure system constitutes a serious disincentive to investment in Ghana's economy. The lack of several large-scale commercial agricultural projects in Ghana, similar to those existing in some francophone West African countries such as the Ivory Coast, can be partly attributed to the problems associated with acquiring land for economic activities. It is unlikely that serious large overseas investors would be prepared to undertake protracted negotiations, on a one-to-one basis, with several allodial titleholders in order to put together suitable large parcels of land for large-scale commercial agricultural projects. Even where this is possible, investors potentially face the problem of on-going litigation over the legal right of the land they have acquired or leased. It is not uncommon for the rights to land, which has already been leased or rented and compensation duly paid by an investor to one allodial titleholder, to be challenged or disputed by another allodial titleholder. One commonly hears of stories from friends where disputes have arisen when individuals had successfully negotiated parcels of land for residential/commercial construction only to be challenged by other parties, who also claim ownership of, or interest in, the same parcel of land.

Land tenure is a complex subject for the project area where access to land is shaped by Ghana's inheritance systems, tenure arrangements and land-use patterns. Most of the land in the affected areas is held under customary land tenure systems. The land in the affected communities are owned by clans. Clan land is generally not considered for sale as it belongs to those living there, their ancestors and their progeny.

[5] *Jesee sey Ayivor (2001):* Patterns of land tenure in Anloga, Ghana

Land ownership and transfer processes are similar within the all the three communities of Srogbe, Anloga and Anyanui:

- The site at Srogbe is located at 'SALO' along the Dabala - Anloga highway. It is owned by the 'LIKÉ' clan (Dzezizi Branch) who are residence of the Srogbe (Saviotula) township. The administration of the land is done by the Stool Father, the Regent and the elders of the clan.

- The Anloga site is located along the Anloga beach stretch. The location is separated from the main Anloga township by a huge depression which is cultivated during dry season and floods during wet season. The land is owned by the Adzovia clan although sections have been given out to some individuals within the clan. The administration and transfer of the clan land within the community is done by the elders of the clan whilst those that have been acquired by the individuals are handled by the individuals. Except for some fisher folks dragging their boat and net from the sea onto the property, the land is virtually idle.

- At Anyanui, the site is located along the Dzita Anyanui – Tunu road. There are some communities such as Tunu, Gblife and Wededeanu within the catchment area of the project although none of them is likely to be displaced.

The project will necessitate land acquisition resulting in both physical and economic displacement. During the ESIA exercise, various bodies and processes were found to be involved in the land acquisition. The team also identified some legitimate representatives for the acquisition of community lands especially at Anloga and Srogbe. However, we found that the ownership of the affected lands at Anyanui is being contested between two clans, namely the 'Bate' Clan from Anyanui and the 'Klevi' Clan of Dzita and these has to be resolved for the smooth implementation of the project.

6.8 ECONOMIC CHARACTERISTICS

6.8.1 Economic Activity Status

For the Keta Municipality, the economically active population is (63.9%) of which (93.5%) are employed and (6.5%) are unemployed. The proportion of economically active male is 65 percent of which (94.5%) are employed and (5.5%) unemployed whiles that for the female economically active population is 63 percent with (92.7%) employed whiles (7.3%) are unemployed. The economically not active population is (36.1%) with those in full time education recording the highest percentage of (45.4%) and pensioners or retires recording the lowest of 3.8 percent. The proportion of male to female economically not active population for the district is (35%) and (37%) respectively with (60%) of males in full time education almost twice that of females (34.5%) in full time education, (25.1%) are too old/young to work and (24.5%) of females did home duties (household chores) whiles only (10.3%) of males did the same.

Table 6-4 highlights the activity status of the members in the three project communities. Percentage unemployed persons was highest at Anyanui (17.2%), followed by Srogbe (13.6%) and Anloga (4.9%).

Table 6-4: Activity Status of Project Communities

Activity Status	Anloga			Anyanui			Srogbe		
	Male	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**
Economically active	4,724	5,423	10,147	397	527	924	260	317	577
Employed	*4,507*	*5,139*	*9,646*	*337*	*428*	*765*	*235*	*263*	*498*
Unemployed	*217*	*284*	*501*	*60*	*99*	*159*	*25*	*54*	*79*
Economically not active	2,115	3,030	5,145	223	313	536	98	112	210
Total	**6,839**	**8,453**	**15,292**	**620**	**840**	**1460**	**358**	**429**	**787**

Source: Ghana Statistical Service, 2010 Population and Housing Census

6.8.2 Agricultural Activity

The Keta Municipality is mainly an agrarian economy, with the majority of the population engaged in crop farming, livestock keeping, fishing and other agricultural related activities and trading. About the type of agricultural activity, crop farming represents the main type of agriculture activity adopted by the populace in both the urban and rural areas followed by livestock rearing. While fish farming recorded the least type of agricultural activity engaged in by the people. The Municipality is one of the major vegetable producers in the Volta Region. It is well known for its shallots, which are produced in the flood plains along the Angaw and Keta Lagoons and streams. The main shallot producing areas are Anloga, Anyanui, Agbledomi, Dzita, Atorkor, Srogboe, Whuti, Woe and Tegbi. Other vegetables such as okro, tomato and pepper are also extensively cultivated either as pure stands or as intercrops depending upon the season, with the alluvial soils along the lagoons providing ideal sites for their production. The new developed technology of tube well irrigation has given a new impetus in the production levels of previously unknown crops and horticulture in the Municipality.

Maize and cassava are also grown as off-season crops, along the littoral but as main season crops in the northern parts of the Municipality. Coconut is also cultivated along the littoral even though it is no more the main source of income for the people as it used to be some years ago as a result of the Cape St Paul Wilt Disease, which appeared in the Municipality in the Woe area around 1932 and devastated large numbers of trees and still causing havoc. Fishing is carried out in the sea, lagoons and rivers. Several types of fishing gears are used for fishing in the sea. These include beach seine, Ali, Polo, Watsa, Set nets and Drift gill nets. Some of these fishing gears have proved to be inappropriate and efforts are being made to regulate them. Shrimps, Oysters and other edible bivalves are harvested from water bodies. Livestock production is a secondary vocation to most farmers in the Municipality. The Municipality is very popular for rearing ducks and geese. Local poultry (fowls) are also kept on free range. A few women keep turkeys, while pigeons are pastimes for the wealthy men in the society. Few farmers keep improved poultry. Poultry is abundant in commercial towns along the littoral where the demand is highest. Sheep and goats are also found in most homes and are fed on household waste.

A wide range of small-scale industrial activities which are owned and managed mainly by sole proprietors has been identified in the Municipality and employs about 13% of the labour force. The agro-based: fish processing, cassava processing, the mining: quarry, exploitation of salt and sand winning, wood-based: carpentry, standing brooms, textile: dressmaking, kente weaving, service: hairdressing, vehicle repair/fitting mechanics, radio/TV mechanics, masonry, ceramics, pottery.

Vegetables and cassava are the main farming activities taking place on some parts of the proposed project sites as shown in **Plate 6-4** and **Plate 6-5**. Fishing activities take place at the shores of the proposed site. Some sailors dock their wooden canoes at the seashore and drag their nets from one side to another along the site. The residents of Srogbe and Anyanui also engages in fishing and crab trapping activities on the lagoon. Table 6-5 shows agriculture and non-agriculture households in the three project communities. The proposed sites are also a grazing field for livestock. Mangroves and other plant species in the proposed project site are used as cooking fuel (firewood) and gardening. Grass/straw used for roofing homes, craft and weaving can also be obtained at the Srogbe site. Again, the mangroves play a primary production role in providing nutrients for prawns and juvenile fish in the lagoon. In addition, some herbs are harvested from the vegetation on the proposed sites, which is used for medicinal purposes. Moreover, there is potential for tourism and recreation, the proposed sites are located around communities situated on a lower coast strip with a great potential of beach development, massive tourist during festivals in addition to the slope of the beaches and fine sand at the shores, which provides a beautiful view of the towns by the sea. Many leisure activities can be developed.

Plate 6-4: Cassava Farm

Plate 6-5: Vegetable Farm

Plate 6-6: Canoes belonging to fishermen at Anloga

Plate 6-7: Some fishing activities at the Anloga beach near the project site

Table 6-5: Agriculture & Non-Agriculture Households in Project Communities

Households in agriculture	Anyanui		Anloga		Srogbe	
	Number	Percent	Number	Percent	Number	Percent
Agriculture household	281	49.7	2,521	43.6	49	14.6
Non-agriculture household	284	50.3	3,260	56.4	287	85.4
Total	**565**	**100.0**	**5,781**	**100.0**	**336**	**100.0**

Source: Ghana Statistical Service, 2010 Population and Housing Census

6.8.3 Occupation

Data on employment sector of employed persons 15 years and older in the Keta Municipal in 2010[6] is shown in Table 6-6. Almost 35 percent of the employed population 15 years and older in the Municipality are engaged as skilled agricultural, forestry and fishery workers (34.8%). This is followed by craft and related trades workers (25.4%) and services and sales workers accounting for 21.8 percent. Clerical support workers and technicians and associate professionals recorded the lowest with (1%) and (1.2%) respectively. The employment characteristics of the population indicate employment in low skills among the employed population that are mostly self-employed without employees. Such employment hardly generates employment for others. Its been noted that there is therefore the need to create jobs for the economically active group since they form a majority of the population in the Municipality.

Table 6-6: Employed population 15 years and older by occupation and sex

	Both sexes		Male		Female	
Occupation	Number	Percent	Number	Percent	Number	Percent
Total	57,674	100.0	26,096	100.0	31,578	100.0
Managers	1,317	2.3	331	1.3	986	3.1
Professionals	2,642	4.6	1,558	6.0	1,084	3.4
Technicians and associate professionals	675	1.2	444	1.7	231	0.7
Clerical support workers	570	1.0	408	1.6	162	0.5
Service and sales workers	12,572	21.8	1,596	6.1	10,976	34.8
Skilled agricultural forestry and fishery workers	20,070	34.8	14,445	55.4	5,625	17.8
Craft and related trades workers	14,628	25.4	4,815	18.5	9,813	31.1
Plant and machine operators and assemblers	1,781	3.1	1,715	6.6	66	0.2
Elementary occupations	3,406	5.9	772	3.0	2,634	8.3
Other occupations	13	0.0	12	0.0	1	0.0

[6] *Source*: Ghana Statistical Service, 2010

Data on employment sector of persons 15 years and older by sex in the three project communities in 2010 is shown in Table 6-7.

Table 6-7: Employment sector of persons 15 years and older by sex in project communities, 2010

Employment status	Anloga			Anyanui			Srogbe		
	Male	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**
Employee	743	422	1,165	62	22	84	79	15	94
Self-employed without employee(s)	2,684	3,620	6,304	265	360	625	94	196	290
Self-employed with employee(s)	247	181	428	8	22	30	15	8	23
Casual worker	219	185	404	1	-	1	34	17	51
Contributing family worker	532	545	1,077	-	11	11	4	20	24
Apprentice	49	161	210	1	13	14	8	7	15
Domestic employee (Househelp)	27	21	48	-	-	-	1	-	1
Other	6	4	10	-	-	-	-	-	-
Total	**4,507**	**5,139**	**9,646**	**337**	**428**	**765**	**235**	**263**	**498**

Source: Ghana Statistical Service, 2010 Population and Housing Census

6.8.4 Tourism Potential and Development

As a low lying coastal plain with the highest point only 53 metres above sea level interspersed with lagoons, creeks and mangrove forests, the Keta Municipality offers a great potential for tourism development in the country. The main tourists' sites in the municipality include:

- ✓ Breeding of Sea Turtles: The Beach or the Coastline between Anloga and Dzita and much especially around Dakordzi and Akplorwotorkor records a lot of Seasonal Sea Turtles which come on-shore to lay eggs for hatching. The scene is so interesting attractive to watch during the months of August, September and October.

- ✓ Lagoons: The lagoons also provide calm water bodies for cruising and other water sports. Three major lagoons are found in the Municipality, namely Keta, Angaw and Avu. The Keta Lagoon is the largest in the country and has several islands such as Seva, Dudu and Xevi Kpodzi (bird sanctuary). The lagoons offer opportunities for angling since they are rich in tilapia, mudfish and others such as crabs, shrimps and scallop.

- ✓ Mangrove Swamps: Along the main Angaw, Avu and part of Keta lagoon are very extensive stretches of mangrove swamps. Opportunities exist for visitors to cruise through the mangrove forest or to study its ecology.

- ✓ Ramsar Site: The Anlo- Keta wetlands have been designated Ramsar Site because it provides sanctuaries for several birds including migratory and resident ones, especially water fowls. It is said that the Anlo- Keta Ramsar Site is at the crossroad of several thousands of migratory birds that fly the Mediterranean and the South-Atlantic flyway. Some of the birds which nest, rest, feed and breed there include the various types of terns, gulls and pelicans. There is, therefore, the great need for the construction of bird watching towers to attract more tourists into the Municipality.

- ✓ Sandy Beaches: The Keta Municipality is blessed with several kilometres of very clean and unique golden beaches in the country which can offer places of relaxation to tourists. The beaches drenched in brilliant sunshine have sands ranging from fine to coarse grained types. The coconut clad sandy beaches are interspersed with bare sandy surfaces stretching from Azizanu to Dzelukope near Keta.

- ✓ Festivals: The main festival is the Hogbetsotso, which symbolizes the great exodus of Ewes from their ancestral home, Notsie, to their present abode around the 15th Century. The Hogbetsotso Festival, which is celebrated at Anloga, the traditional home of the Anlos, attains a grand final with a durbar of Chiefs and people amidst pomp and pageantry on the first Saturday of every November.

During such festivals, religious cults are displayed through some magical performances. Such cults include the Korku and Yewe cults. One interesting feature is to see the members of Korku cult cut themselves without effect with sharp knives.

- ✓ Fort Prinzenstein: This Danish Fort build in 1784 at Keta is one of the most spectacular relics of colonialism in the Municipality. It played a key role in the infamous triangular slave trade involving West Africa, England and North America. Efforts need to be made to save this important historical monument from total destruction by sea waves and to preserve it as an important tourist resort. The Keta Sea Defense Project has greatly saved the Fort from further destruction and still has a story to tell.

- ✓ Atorkor Slave Market: In addition to Keta, Atorkor was the second slave market in the Municipality. The trade was masterminded by one Ndorkutsu. A monument was raised in the area where this wicked activity took place. The Keta Municipal Assembly intends to convert the place into an important tourist resort. A beginning has been made with the construction of a sculpture showing a slave dealer giving orders to slaves with a whip.

- ✓ Anlo Military Headquarters, Tsiame: This is yet another important tourist spot where the Anlos during their historical wars gathered to plan war strategies against their enemies. It is located at Tsiame, north of Keta and at that very spot today, stands a grove, which tourists can visit.

6.8.5 Oil & Gas Development in the Keta Basin

The Keta Basin has been known for oil and gas potentials for centuries but had not seen any major activity to tap the oil and gas resources of the area. The basin is also known for mining of salt, tourism, vegetable farming and aquaculture. Currently, an exploration agreement is in place for the exploration in the Keta basin for oil and gas. Because of this opportunity, efforts are underway to create awareness for fishermen and the public on oil and gas exploration in the

Municipality. The need to build capacity to take advantage of the employment opportunities of this development by the community members is underway.

6.9 EDUCATION & LITERACY

Keta Municipality has various educational institutions which cater for different categories of the school going population. These include institutions for pre-school, basic, primary and secondary education in the Municipality and grouped into the 10 educational circuits for effective supervision. These are Abor-Tsiame, Anloga, Anyako-Afiadenyigba, Atiavi-Hatorgodo, Dzelukope-Vui, Dzita-Anyanui, Keta, Shime, Srogboe-Kome and Tegbi-woe. Of these 10 circuits, Keta, Dzelukope-Vui, Tegbi-Woe, Anloga and Abor-Tsiame are urban oriented while the rest are rural. There are 354 schools in the Municipality, which was made up of 120 Pre-schools (90 public and 30 private), 120 Primary schools (88 public and 32 private), 97 Junior High schools (77 public and 20 private), 12 Senior High/Technical Schools (10 public and 2 private), 5 Technical/Vocational (1 public and 4 private) and Health Assistants (Clinical) Training School.

About 76 percent of persons 11 years and older are literate. Out of the total population 11 years and older who are literate, 52 percent constitutes the male population while the rest (48%) constitutes the female population aged 11 years and older. Some renowned educational facility within the municipality includes the Keta Senior High School, which is one of the best secondary schools in the country. Other institutions include the Keta Business School, Anloga Technical Institute, among others. About 88.7 percent are enrolled in basic school, 9.0 percent in secondary/senior high school, 0.9 percent in vocational/technical/commercial school, and 0.8 percent in tertiary institutions. The educational level persons 3 years and older in the three project communities is shown in Table 6-8.

Table 6-8: Educational level persons 3 years and older in the project communities

Category	Anloga			Anyanui			Srogbe		
	Male	Fem.	Total	Male	Fem.	Total	Male	Fem.	Total
Nursery	311	303	614	7	11	18	7	13	20
Kindergarten	590	563	1,153	110	86	196	33	36	69
Primary	2,730	2,989	5,719	303	321	624	173	194	367
Junior Senior School	1,771	1,915	3,686	199	196	395	134	120	254
Middle School	1,232	1,119	2,351	98	63	161	69	43	112
Senior Secondary School	919	726	1,645	42	21	63	20	15	35
Secondary	227	144	371	13	4	17	4	2	6
Vocational/Technical/Commercial	475	268	743	11	9	20	9	10	19
Post middle / secondary certificate	186	169	355	26	8	34	2	-	2
Post-secondary diploma	263	127	390	13	6	19	8	5	13
Bachelor degree	171	55	226	8	-	8	3	1	4
Post graduate (Cert., Diploma, Masters, PHD, etc.,)	26	7	33				3	-	3
Total	**8,901**	**8,385**	**17,286**	**830**	**725**	**1,555**	**465**	**439**	**904**

6.10 HEALTH PROFILE

6.10.1 Health Status

Malaria remains a public health concern, as it is the leading cause of morbidity in Ghana and continues to be the topmost diseases that affect majority of the people in the Municipality. Malaria trend in the Municipality has been increasing over years ranging from 59,561(31.4%) in 2012 to 78,276 (41.2%) in 2013 followed by upper respiratory tract infection representing 27,168 (14.4%) in 2012 to 32,389 (17.1%) in 2013. .

6.10.2 HIV/AIDS

The HIV prevalence in Ghana, over the years, describes Ghana's epidemic as generalized according to World Health Organisation classification. There has been a steady decline of HIV prevalence since 2003 when the country recorded 3.6% among antenatal clients. The prevalence among pregnant women in 2014 was 1.6%. With respect to regional HIV prevalence in 2014, Eastern Region recorded the highest prevalence in the country whilst Northern region recorded the lowest. The prevalence rate in the Volta Region in 2014 was 2.2% (GAC, 2014). The Ghana Statistical Service medium projection assuming the impact of AIDS indicates that the country's population will increase from 18.91 million in 2000 to 30.2 million in 2025 and if this trend continues, the population will reach about 32.0 million in 2030, with an average annual growth rate of about 1.88%. In this case, the urbanization rate is expected to increase from 43.75% in 2000 to 62.94% in 2025 and about 63.4% in 2030.

The Keta Municipality has also been affected by the generalized HIV/AIDS epidemic in Ghana. Just like most parts of Ghana, the epidemic has grown steadily until its current state. Because sero- prevalence surveys have not been carried out in the general population, data on actual prevalence and incidence is lacking; the number of HIV and AIDS cases seen at the various service provision points gives a crude indication of the state of the epidemic.

Two problems generally arise from the use of these figures:

- ✓ Under-reporting of both HIV infected persons and AIDS cases to hospital
- ✓ Use of non-disaggregated data on HIV and AIDS cases seen: this is constrained by over-reporting by inclusion of persons from outside the district seeking care in the municipality and persons from the municipality seeking care outside the district; problems with double counting and other aspects of data quality notwithstanding.

Females tend to be bearing a disproportionate portion of the burden. The productive age group 20-39 years followed by 40-60 years' account for the majority of cases; however, HIV infection among young children due mostly to mother to child transmission is also a reality to be dealt with.

6.10.3 Maternal Death

In the Keta Municipal, maternal deaths in 2013 were nine (9) (2/1000LB) from the two hospitals in the municipality. This was an increase over 2012 performance of seven (7) maternal deaths, which represented (1/1000LB). Out of the nine (9) deaths that occurred, 8 have been audited. Keta Municipal hospital recorded 4 deaths and Abor Hospital recorded 5 deaths (Measured in 100,000). The following were some of the causes of the deaths: PPH due to Ruptured Uterus (1), Eclampsia/Acute with acute renal failure (2), Severe Anaemia with SCD (1), Septicaemia due to Unsafe Abortion (2), Abruption Placenta (1), and PPH (1).

6.11 VULNERABILITY, EXCLUSION AND EMPOWERMENT

More women in particularly the rural areas play caregiver roles or become household heads on whom the survival and development of the household depends. Meanwhile they do not claim ownership to properties and rites and are not privileged to play lead roles nor contribute in the decision-making process domestically, community wise and politically. Women and therefore the children they cater for are therefore vulnerable to hardships, crises and natural shocks and are more often than not relegated to the background economically and socially subjecting them to all forms of violence and abuse.

6.12 PERSONS WITH DISABILITY (PWD)

Persons with disabilities (PWD) have been defined as those who are unable to or are restricted in the performance of specific tasks/activities due to loss of function of some part of the body because of impairment or malformation (Ghana Statistical Service, 2012). As a result, PWDs face a wide range of life challenges because disability, in whatever form or type, can reduce an individual's ability to function to his/her full potential. Disability can limit an individual's full participation in many activities in life. Estimates from the World Health Organisation (WHO) estimates that there are more than 600 million PWDs in the world, of which approximately 80 percent live in low-income countries (Ayiku, 2012). The 2010 PHC indicated that for the

Keta Municipality, 10,632 persons with disability was recorded representing 7.2 percent of the total Municipal population. Females with disability were slightly higher than males. Table 6-9 shows the various types of disabilities in the three project communities.

Table 6-9: Types of Disability in the Project Communities

Type of disability	Anyanui			Srogbe			Anloga		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Sight	10	12	22	13	33	46	174	304	478
Hearing	12	7	19	7	15	22	44	99	143
Speech	18	10	28	3	5	8	56	63	119
Physical	32	24	56	16	19	35	95	146	241
Intellectual	19	7	26	2	9	11	110	207	317
Emotional	47	58	105	16	16	32	124	209	333
Other forms of disability	2	1	3	2	5	7	16	25	41
Total	**140**	**119**	**259**	**59**	**102**	**161**	**619**	**1,053**	**1,672**

Disability is now considered a societal development issue because of its direct relationship to poverty. The development of a nation depends on the important contributions of not only a segment of the population but on the collective contributions of every individual, including PWDs. To this extent, government and civil society organizations in recent years have made progress in addressing disability issues, resulting in some positive gains in improving the lives of PWDs in Ghana. Notable among these is the Persons with Disability Act, 2006, (Act 715). The Act deals with issues such as rights, employment, education, transportation, housing facilities, effective health care, adequate medical rehabilitation services, generation and dissemination of relevant information and participation of PWDs in cultural activities. Pursuant to the passage of the Disability Act 2006 (Act 715), the National Council on Persons with Disability was established in line with Article 41 of the Persons with Disability Act. Additionally, the Ghana Shared Growth and Development Agenda (2010 -2013) Volume 1, also includes the development and implementation of an action plan to fulfil the provisions of the Persons with

Disability Act and the development of targeted social interventions for PWDs (National Development Planning Commission).

6.13 SOCIAL SERVICES

6.13.1 Health Services

The municipality can boast of about 33 health facilities, which provide various levels of services as shown in Table 6-10. The two hospitals have a total bed state of 200. There are four permanent doctors in the Municipal hospital and three doctors in the Catholic Mission hospital. While preventive services are free, access to health services have been greatly enhanced by the Municipal Wide Mutual Health Insurance Scheme.

Table 6-10: Health facilities in Keta Municipal

Facility type	Number
Hospital	2
Health centres (public)	11
Health centre (mission)	1
Private clinic (general services)	3
Private maternity	3
Functional CHPS zone	6
RCH centre	1
CHPS zone yet to be operationalised	6
TOTAL	**33**

Source: Keta Municipal Health Directorate

There is a health centre situated at the western end of Anloga about 1.5miles from the town and lies on the southern part of the main road from Keta to Anyanui. The Anyanui Health Centre has a catchment area population of 13,732 people with fourteen communities and nine outreach sites. The centre provides 24 hours service comprising general, OPD, Family life, Child health, Family planning, Counselling & Testing services for HIV. Besides the presence of these medical facilities, some indigenous residents also rely on herbal and traditional medication. Herbalists and some traditionalists rely on herbs and divine intervention for the medicinal needs of their clients

6.13.2 Telecommunication Systems and Uses

Information and Communication Technologies (ICT) have become important tools in today's knowledge-based information society and economy. This role of ICT in an emerging economy such as Ghana's, has been widely recognized at various levels. The recognition is reflected in actions such as the development and deployment of a national ICT infrastructure, institutional and regulatory framework for managing the sector, promoting the use of ICT in all sectors of the economy, implementing e-governance in all government institutions and the construction of a National Data Centre as well as Regional Innovation Centres.

The Keta Municipality is well endowed with communication networks. These include Mobile phones and fixed lines from many communication networks including MTN, VODAFONE, ZAIN, KASAPA, TIGO and GLO. Ghana Post has post office as well as courier services. Again, there are two (2) Radio Stations in the Municipality namely, Jubilee Radio and Hogbe FM and these can be used for communication purposes for the project. While 41.9 percent of persons aged 12 years and older in the Municipality reports that they own mobile phones only six percent of them use the internet. The rate of ownership of desktop/laptop by households is very low. **Table 6-11** shows mobile phone ownership by sex in the three project communities.

Table 6-11: Mobile Phone Ownership By Sex in the Project Communities

Anyanui			
	Male	Female	Total
Yes	278	271	549
No	441	642	1,083
Total	*719*	*913*	*1,632*
Srogbe			
Yes	205	192	397
No	189	286	475
Total	*394*	*478*	*872*
Anloga			
Yes	4,042	4,140	8,182
No	3,506	4,976	8,482
Total	**7,548**	**9,116**	**16,664**

6.13.3 Road Network

Within the Keta Municipality, the first-class road (74.8km) traverses the coast from Havedzi through Keta-Anloga-Dabala to join the main Accra-Aflao road. Road Network has 74.8km of first class, 30.05km second class and 52.30km of third class road. The northern section of the Municipality between Abor and Anyako is accessible by second class road. The Keta-Aflao stretch of road which was completely destroyed by sea erosion between Keta and Horvi has now been constructed under the Keta Sea Defence Project by the Central Government. Settlements in the north of the Municipality (Abor-Atiavi-Hatorgodo axis) are linked mostly by second-class roads and are complemented by feeder roads.

The middle and southwestern sections of the Municipality (Angaw and Klomi lagoon basin) are poorly accessible mainly by third class roads and footpaths. Generally, the Municipality is relatively more accessible as indicated by a relatively highroad density of 194.7 meters/km^2. This mode of transport is used for passenger and cargo services, passenger buses and mini-buses with a seating capacity of 16-40 are used for these services. Truck services are used to carry mainly tomatoes, shallots, salt and fish to outside the Municipality while manufactured goods and foodstuffs like rice, yams, maize and building materials are imported.

6.13.4 Water Transport

Lagoon transport, though important is poorly developed. In the case of water transport the services are privately owned. Non-motorized local canoes are used to transport goods and people across the lagoons. Another setback is the seasonal fluctuations in the water level, which render movement very slow and even cumbersome. The siltation of the lagoon has also generally reduced the water level. The major routes are Anyako/Seva-Anloga, Afiadenyigba-Keta-Anloga, Atiavi-Keta-Anloga, and Alakple/Kodzi/Fiahor-Keta-Anloga. The seasonal drying up of the lagoon makes water transport unreliable and time consuming as opposed to road transport (over 90 per cent of the population use road transport regularly).

6.13.5 Households

It has long been established that man's most basic needs are food clothing and shelter. Housing is both a social good, providing core security for households, neighborhoods, societies and communities and an economic good stimulation growth and development. The total number of houses in the Municipality is 30,309 with 15,164 located in the urban and 15,145 in the rural areas. The number of households in the Municipality is 37,705. The average numbers of persons per household is 1.2, which is the same as the regional average and higher than national average of 7.1.

The population per house for the urban areas (5.1) is relatively lower than the rural areas (4.5). The commonest type of dwelling units occupied by households in the district is compound houses. On the average, compound house accounts for more than half (47.5%) of all dwelling units in the Municipality, followed by separate houses which forms (39.2%) of all occupied dwellings. Semi-detached houses form the third commonest type of occupied dwellings, constituting 6.8 percent. Dwellings in tents, kiosks, containers and shops constitute small proportions of occupied dwellings. **Table 6-12** indicates the types of dwellings in the three project communities.

The quality of life of the people in the Municipality depends largely on the type of houses they live in, access to potable water, education, health, electricity, and adequate sanitary facilities among others. The data shows, however, that access to these facilities tends to be poor and non-existent in some homes and communities.

Table 6-12: Types of Household dwellings in the three project communities

Type of dwelling	Anyanui		Srogbe		Anloga	
	Number	Percent	Number	Percent	Number	Percent
Separate house	391	69.2	132	39.3	2,268	39.2
Semi-detached house	23	4.1	24	7.1	267	4.6
Flat/Apartment	1	0.2	6	1.8	232	4.0
Compound house (rooms)	147	26.0	146	43.5	2,610	45.1
Tent	3	0.5	2	0.6	9	0.2
Huts/Buildings (same compound)	-	-	7	2.1	176	3.0
Huts/Buildings (different compound)	-	-	9	2.7	88	1.5
Improvised home (kiosk/container, etc)	-	-	1	0.3	9	0.2
Living quarters attached to office/shop	-	-	5	1.5	41	0.7
Uncompleted building	-	-	4	1.2	79	1.4
Other	-	-			2	0.0
Total	**565**	**100.0**	**336**	**100.0**	**5,781**	**100.0**

6.13.6 Water and Sanitation

In the Keta Municipality, greater majority of the households (40.5%) rely on pipe-borne outside dwelling. The proportion of urban (50.4%) is almost twice to rural (28.8%) for pipe-borne outside dwelling. About 9 percent of households have pipe-borne inside dwelling. The 2010 Population and Housing Census Report shows the different methods of solid waste disposals in the municipality. Close to 50 percent of the population disposed of their solid waste by dumping them in public dump or open space (48%) and disposing by burning (18.7%) whiles (13.5%)

buried their waste. **Table 6-13** shows the various sources of drinking water in the three project communities. Pipe borne outside dwelling is the most popular source of drinking water in all three communities.

Table 6-13: Drinking Water Sources in Project Communities

Drinking water	Anyanui		Srogbe		Anloga	
	Number	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Pipe-borne inside dwelling	25	4.4	18	5.4	605	10.5
Pipe-borne outside dwelling	287	50.8	169	50.3	3,193	55.2
Public tap/Standpipe	62	11.0	72	21.4	167	2.9
Bore-hole/Pump/Tube well	-	-	-	-	86	1.5
Protected well	-	-	18	5.4	841	14.5
Rain water	-	-	1	0.3	3	0.1
Bottled water	1	0.2	4	1.2	3	0.1
Satchet water	2	0.4	45	13.4	287	5.0
Unprotected well	188	33.3	9	2.7	574	9.9
Protected spring	-	-	-	-	18	0.3
Tanker supply/Vendor provided	-	-	-	-	1	0.0
Unprotected well	-	-	-	-		
Unprotected spring	-	-	-	-	2	0.0
River/Stream	-	-	-	-	1	0.0
Total	**565**	**100.0**	**336**	**100.0**	**5,781**	**100.0**

Sanitation disposal of both liquid and solid household waste, toilet and bathing facilities is very poor in the district. It appears that expenditure on solid waste disposal and drainage is rarely seen as forming part of a portfolio of investments in public health. Rather, it is generally perceived by decision makers as comparable with other investments such as roads or public transportation, which are not considered to be public health interventions. Sewage disposal should be planned as a major health intervention. Its linkage to financial sustainability of the National Health

Insurance Scheme (NHIS) needs to be explored given that several diseases are linked to poor sanitation.

The proportion using public toilets is also quite high. The district initiatives to construct them as revenue-generating units and this might explain the pervasive use of public toilets in spite of the unhygienic conditions of most the facilities. Actually, the district has a big role to play in the provision of adequate public toilet facilities and maintaining their hygiene. Almost one in ten dwelling units does not have access to any toilet facilities and household members use the bush/beach and open fields. Laws requiring property owners to provide toilet facilities in houses should be enforced by the district and should apply to owner-occupier households.

6.13.7 Access to Utilities and Household facilities

The main source of lighting for most housing units in the Keta Municipality is kerosene lamp (53.1%) with followed by electricity (41.8%) and flashlights/touch (2.9%). The main source of fuel for cooking for most households in the municipality is wood (42.2%), charcoal is used by almost 41 percent of households whiles 12 percent uses gas. About 43 percent (43.4%) of households in the Municipality has no toilet facilities, the urban to rural ratio is (37.6%) and (50.2%) respectively. (29.1%) of households rely on public toilets (WC, KVIP). Almost 44 percent of households have their own bathroom for exclusive use, shared separate bathroom in the same house (16.1%) and shared open cubicle (15.7%). There is the need to continue exploring non-traditional sources of energy and supporting initiatives aimed at addressing the lighting needs of off-grid households by making safe, affordable, durable, and environmentally sustainable lighting available to the masses through solar and other means. There is potential to expand solar energy to accelerate economic growth and the district or government needs to invest more time and money to make solar energy more available and affordable.

7. IDENTIFICATION OF KEY ISSUES

7.1 OVERVIEW

As indicated, the socio-economic impact assessment has involved a series of stakeholder consultations including that with community members and elders, landowners, traditional authorities and heads of key governmental agencies. In addition to this, we organised a stakeholder forum in October 2016 where we invited the public and state agencies for a briefing on the project. At these consultations, the project team explained the findings of the outcomes from the various independent studies and Table 5-1 outlines the stakeholders' perceptions and needs arising out of these engagements.

Based on the issues raised at the project briefings, status quo conditions of the study area and the nature of the proposed development, the key socio-economic issues of concern can be summarised as follows:

- Employment Opportunities;
- Changes in Land Use
- Compensation for Loss Property
- Risk to Public Safety and Health
- Ecotourism Potential
- Improvement in Infrastructure
- Impact on Oil and Gas Development in the Keta Basin
- Environmental Challenges
- Change Management

A synopsis of these issues are provided below:

7.2 EMPLOYMENT OPPORTUNITIES

Employment for locals has been one of the key issues of concern to all parties during the stakeholder engagements. The Chiefs expressed the need for their community members to benefit from the expected employment opportunities under the project. The issue of local content be considered critically and local labour should be considered during recruitment. Specifically, the community members should be the first to benefit from menial works such as security, masons, labourers, etc.

The Client explained that its Local Content Policy will be applicable to the project and the contractor will be required to consider locals for recruitment. This project will bring in employment opportunities for the local inhabitants. Some of the workforce could be sourced from the communities where the project is located. Low to medium skilled workers such as construction workers (Masons, carpenters and steel benders), drivers and cooks abound in some of these communities. Again, there is the likelihood of an indirect employment through suppliers and other complementary industry such as transport, hotelier among others. In addition, the possibility of a skill transfer or skill training for the local recruits will positively influence the local economy

The Client will subsequently explain to the contractor to consider this proposal from the community. However, this will be dependent on the skill set available within the community and what is required to successfully execute the project.

7.3 CHANGES IN LAND USE

The implementation of the project will lead to a permanent loss of land by the locals who mostly depend on such resources for a living. The project will necessitate land acquisition and both physical and economic displacement. This will result in loss of livelihood for landowners and farmers who utilise the land for agricultural and other socio-economic activities. The residents indicated that they had been informed by the Chiefs and land owners that the project would be developed near their village soon, and therefore they should not carry out anymore constructions of any permanent structures.

7.4 COMPENSATION FOR LOSS PROPERTY

The proposed project would affect Land and property owners, especially farms, and this should be compensated according to the existing Government of Ghana compensation regulations and procedures. Some other business activities may be suspended during the construction stage but will be restored with the completion of project construction. Such activities may also be entitled to be paid compensation because on their business activities. In addition, various request as compensation for deity and pacification rights prior to project implementation have also been made.

Acquisition of lands is to be done after the project site has been properly demarcated and the total area clearly determined. Currently, there is anxiety about compensation by landowners and this has to be critically looked at and properly addressed. The community heads of Tunu and Gblife Community, all in Anyanui, requested that if land is to be acquired, VRA should endeavour to pay adequate compensation for loss of farmlands and crops. The traditional Heads of Anloga indicated that they had been briefed on the project by the Client's personnel and has been promised in advance payment of 30% for lands to be acquired.

Ownership of the affected lands at Anyanui is being contested between two clans, namely the 'Bate' Clan from Anyanui and the 'Klevi' Clan of Dzita. During the consultations, the Bate believed they are the true owners of the land as a result they are not happy that the Klevi clan has been consulted for the release of the land for the project instead of the Bate Clan. Both the Klevi Clan of Anyanui and the Traditional Heads of Srogbe requested for a quick negotiation for the acquisition of their land and the payment done promptly. The Client has requested the Bate Clan to resolve the land ownership issues with the Klevi Clan so that compensation would be paid to the rightful owner. Meanwhile, it is only when the rightful is determined that any money can be issued, thus, any delay in the resolving the land ownership will also result in compensation payment delays.

Indeed, in response to the BID, some individuals also have expressed concern about possible lease agreements that may have been entered into between VRA and some landowners. There is therefore the need for ensuring that landownership issues are cleared for smooth project implementation.

The Client recognises that compensation issues are key to the success of the project and is developing a "**Compensation Action Plan"** to adequately address this concern. The Client will have to demarcate lands and explain the modalities and time for compensation payment as soon as possible in order not to create any antagonism with the landowners. This will be done after the project site has been properly demarcated and the total area clearly determined. Property valuation will be done, and payment effected in line with requirements of the Lands Commission. To facilitate compensation payments, Landowners are urged to have a proper land title document to their property. The Client will also conduct further checks to determine the true owners of the land before compensations are paid.

7.5 RISK TO PUBLIC SAFETY AND HEALTH

Various stakeholders raised concerns that the possible influx of migrant workers may result in increased sexual activities, which may result in escalation of sexually transmitted diseases and unwanted pregnancies as well as increased pressure on infrastructure, services (such as healthcare) and roads, particularly with the establishment of informal settlements. The resultant effect of increased unwanted pregnancies may include increase in abortion, school dropout rate, broken homes among others. Additional traffic and transport from huge haulages may result in accidents and injury to the community members.

Coinciding with the influx of migrant workers is typically a raise in demand for goods and services during the construction period, which can result in a rapid expansion in supply chain businesses operating in the area. This will result in increases in formal employment and informal labour. Officials from the Health Services Directorate advised that accidents, robbery and baby delivery mostly happen during the nights, thus generation of electricity is very important to the health service. It was good the Client is looking at alternative sources of power to supplement current supply as inadequate power supply is affecting health delivery in the district especially for storage of drugs.

7.6 ECO TOURISM POTENTIAL

The siting of the project will attract more tourists to the proposed project location and the potential spillover effect of tourist to explore the rich culture, traditions, festivals, beaches and other existing tourist site and the potential to invest in tourist related infrastructure. The Local Government Authority is therefore urged to consider boosting the ecotourism potential to be realised from the development of the project. It must be noted that this will be the role of the Keta Municipality and therefor there is the need to start considering its impact in the Municipal developmental agenda. This issue was discussed to enable the Keta Municipality factor this their developmental plans following the completion of the project.

Another key issue was for workers to respect their traditions and observe festivals. It was therefore important that this be made known to the contractor for adherence. The workers and the entire team should be adequately briefed on these traditional rights and festivals. Issues related to the allowable activities on the land about of do's and don'ts as required by their taboos needs to be respected by project contractors.

7.7 IMPROVEMENT IN INFRASTRUCTURE

Many of the stakeholders requested for the enhancement of existing infrastructure as part of the project development. Indeed, they made various request for the project to contribute to improving roads and providing health and educational facilities. The construction of the wind farm is likely to lead to improvement in infrastructural facilities such as access roads, water and electricity supplies for the affected communities. At the national level, it is apparent that the implementation of the Wind Power Project will have positive impact on the Country's long-term development agenda as laid out by the Client with the goal of improving the power situation in the country.

At completion, the wind power project is projected to add an extra 100MW – 150MW into the country's national grid. This will go a long way in enabling the country realize the planned incremental power supply in the country. In principle, this will augment the country's plan to accelerate rural electrification programme in the different parts of the Country. The result is an attendant multiplier effect on socio-economic benefit likely to arise from power supply. Execution of the project presents the country with a prospect to depend less on the costly fuel powered options and steering in a period of green energy with less environmental problems.

Stakeholders also raised the issue that the development on the Akosombo Dam has negatively affected the socio-economic life of the people of Keta, and therefore there was concern that there was the need to assure them that wind power project will not affect it. In view of this, the Keta Municipal expects other packages such as scholarships and provision other social amenities for the people. The Client made it known that the level of impact associated with hydropower is very different from that of the wind power. Currently, the Keta Municipality currently benefits from VRA's Corporate Social Responsibility Program due to the presence of the Akosombo Dam within the locality and this be expanded now the VRA is implementing another power project in the locality.

7.8 IMPACT ON OIL & GAS DEVELOPMENT IN THE KETA BASIN

As indicated, currently an exploration agreement is in place for the exploration of oil and gas in the Keta basin. The EPA in their review comments indicated that the location of the wind power project falls within the Keta Basin where seismic activities are ongoing for oil and gas development and there was the need to determine the compatibility of the two projects. VRA and the Ghana National Petroleum Corporation will therefore have to work together to address this issue.

7.9 ENVIRONMENTAL CHALLENGES

One of the key concerns was the project to mitigate the impact on birds, as the project is located close to the Keta Lagoon Complex Ramsar site, which is known to harbour significant number of birds. Again, it was noted that during the constructional phase, the wastes that would be generated if not collected and safely disposed of, are likely to pose environmental problems to the surrounding communities. Other environmental effects of concern were the effect of noise, dust, and traffic movements on economic and leisure amenities during the construction stage.

The Client noted that a detailed EIA study was underway, and this would look at these impacts and propose mitigation measures to address them. Associated impacts like noise and shadow flicker would be investigated and the siting of the turbines will be done to mitigate these. In addition, the execution of the project presents the country with a prospect to depend less on the costly fuel powered options and steering in a period of green energy with less environmental problems.

7.10 CHANGE MANAGEMENT

A major concern raised by the stakeholders was that the project implementation seems to delay, and this is causing anxiety amongst the affected landowners. This was one of the main issues by the Keta Municipality. This is because landowners are now unavailable to take major decisions on how to utilise their lands, as they are now aware that the Client intends to acquire them for the project. Various investors have also expressed interest, however as this is a state project and the impact is national on nature, it is considered as priority. It is therefore important the Change management's issues especially with respect to project timelines and duration should be communicated expeditiously to stakeholders.

The Client explained that projects development in the power sector is quite laborious and requires very forms of studies to come to a final decision on exactly what is to be done. It is therefore important that land owners and the municipality in general to exercise some patience since a project of such magnitude requires several processes including the Wind Measurement and ESIA before actual construction. The Client will however endeavour to keep the stakeholders and landowners informed on project status for planning purposes.

8. HIGH LEVEL ASSESSMENT OF IMPACT/RISKS AND IDENTIFICATION OF MANAGEMENT ACTIONS

Key socioeconomic issues of concern raised by the public as well as through field investigations have been highlighted under Chapter 4 of this report. The potential social, economic, health and public safety related impacts likely to be associated with the Project from site preparation to its operational phase are listed and detailed out in the following sections.

8.1 POSITIVE IMPACTS OF PROPOSED PROJECT

The VRA has currently developed a 5-10 year Renewable Energy generation target of 164.5 MW comprising 150MW of wind power and 14.5MW of solar power. This is in line with the National Renewable Energy Law and takes cognisance of the local and export demands as well as system constraints. The object of this law is to promote the sustainable development and utilization of RE resources for electricity and heat generation. The goals of the renewable energy sub-sector are to increase the proportion of renewable energy in the total national energy mix and ensure its efficient production and use.

The support for renewable energy projects is guided by the need to address climate change as well as a rationale that Ghana has a very attractive range of renewable resources, particularly solar and wind and that renewable applications are in fact the least-cost energy service in many cases - and more so when social and environmental costs are considered. The proposed project will have significance positive environment impacts when compared to other forms of power production including the thermal power production, which involves the burning of fossil fuel.

The major positive impacts of the project will include stabilization of electricity in Ghana, potential for carbon market, promotion of economic growth in the country, increased employment in the project area among other positive benefits. The ratings of the significance of these positive impacts are outlined in Table 8.1 and the rationale for arriving at these ratings provided in the corresponding texts. Measures have been also proposed for implementation to enhance these positive impacts.

8.1.1 Stabilization of Electricity

8.1.1.1 Operational Phase

Developing the wind power facility to feed the national grid with about 76MW of power will contribute to creating a stable and reliable power supply base and solving the serious domestic power supply volatility experienced in Ghana over recent years. Again, the current primary energy generation sources in Ghana have experienced serious limitations due to low water levels and oil and gas supply constraints. Consequently, wind facility coming on stream by 2020 will provide broader electricity supply market space as well as optimize the power generation portfolio and improving generation mix and power supply stability and reliability in Ghana.

The wind facility is envisaged to contribute significantly to addressing potential power demand and supply growth in-balance and deficit soon, as it will play a significant role in the stabilization of power situation in the country during the operational phase. Stabilisation of electricity can be described to be definite and has a high positive impact on the country (+16) as it will lead to improvement of environment and individual livelihoods for the entire country during the 25 years of its operations.

8.1.1.2 Enhancement Measures

To ensure continuous availability of electricity, the following enhancement measures are proposed:

- Regular and routine maintenance of wind power facilities.
- Capacity building of operational and maintenance staff for the purposes of developing their efficiency.
- Development of policy options that supports competitive markets with equitable rate structures.
- Provide reliable electricity supply with a socially acceptable level of local or large-scale outages;
- Develop a system to allow a smooth transition in the architecture and operation of the present power system;

- Operations and maintenance activities are environmentally benign; and socially equitable.

8.1.2 Potential for Carbon Market

8.1.2.1 Operational Phase

Developing a renewable energy resource will lessen the need to use fossil fuels such as coal. Wind power generation does not require fuel for turbine operation, and has no emissions directly related to electricity production. As such, operations of wind turbines do not produce CO_2, SO_2, NOx or particulate matter or any other form of air pollutant. Thus, one of the direct benefits that Ghana will enjoy by developing its renewable energy resources such as this is the avoidance of generation of Greenhouse Gases (GHG).

In June 2015, VRA notified the UNFCCC of this wind power facility and plans taken to prepare a Project Design Document to identify its carbon savings for carbon trading under the Clean Development Mechanism (CDM). However, the process stalled due to suspension of CDM application. Currently however, the wind power projects have been included as part of the Ghana's Nationally Determined Commitments to help the country achieve its legally-binding targets of reducing greenhouse gases for the period 2020 - 2030 following the signing and ratification of the Paris Agreement by the country. The inclusion of the project as part of the nationally determined commitments can be described as definite and has a high positive impact (+16) as it will lead to improvement of environment due to low carbon emissions and individual livelihoods for the entire country during the 25 years of its operations.

8.1.2.2 Enhancement Measures

It is important that to enhance the contribution of the wind power project to reduction of greenhouse gases and its contribution to climate change impacts, there should be regular and routine maintenance of wind power facilities for continuous operations of the plant to ensure it displaces energy sources from fossil fuels.

8.1.3 Promotion of Economic Growth

8.1.3.1 Operational Phase

This project will play a significance role in stimulating economic growth in Ghana. The power input will contribute significantly to the Ghana's Electrification Programme, which has potential to promote spin-off effects on rural economy. The project also has power export potential to the neighbouring countries, especially Togo. Today the energy situation in Ghana is unsatisfactory as evidenced by the frequent unplanned power outages, an important circumstance which slows down the economic development in the country. Power produced by this project will largely change this situation.

Currently, nearly 43% of the power capacity in Ghana is based on hydropower at Akosombo, Akuse and Bui, with about 56% being thermal based[7]. Over the last ten years or so, the country has paid a heavy price for over reliance on hydropower. The country from 2011 to 2015 undertook load shedding between 400 and 700 Megawatts of power during off-peak and peak periods, respectively due to a shortfall in production. The crisis came about because of poor water levels in the three dams (Akosombo, Kpong and Bui), the lack of gas flow from the West Africa Gas Pipeline in Nigeria to thermal plants in Ghana for production as well as the breakdown of some plants. The crisis took a toll on industry, businesses and domestic consumers. In the 2013 World Bank Enterprise Survey on Africa, the widespread, poor electricity supply was mentioned as one of the biggest barriers to growth in Ghana's economies, and a hindrance to many multinational investors. The World Bank[8] has indicated that electricity is the second most important constraint to business activities in the country and that Ghana lost about 1.8% of GDP during the 2007 power crisis.

Reduction of hydropower production during the dry spells was compensated by increasing the power production of the diesel plants and of course rationing of power. This increased the cost of power production. ISSER[9], in its 2014 study[10] also indicates that on the average, the country is

[7] National Energy Statistics, 2006-2015, Energy Commission, April 2016

[8] World Bank, Energizing Economic Growth in Ghana: Making the Power and the Petroleum Sectors Rise to the Challenge, February 2013

[9] ISSER is Institute of Statistical Social and Economic Research

losing production worth about US$ 2.1 million per day (or, US$ 55.8 million per month) just being caused by the power crisis alone and that the country lost about US$680 million in 2014 translating into about 2% of GDP due to the power crisis. It further indicated that firms that do not have access to sufficient electricity have lower output/sales, and that not having sufficient electricity lowers firm's annual sales by about 37-48%. These experiences have underscored the need to diversify the power sources in Ghana and this is what the project will achieve during its operations.

The project has the potential of reducing the cost of the power. This is because the power generated from the project will cost far less than from any other existing sources on the long-term as its production cost will not increase thereafter. In effect, this implies that the project has the potential to usher the country into a low-power tariff regime in the end. This has not only a positive effect on the cost of the energy production but will also lead to economic gains through improved competitiveness.

Again, the proposed project may also offer potential economic benefits at the local level through ecotourism as well as the procurement of goods and services. Road enhancement will occur due to the wind power installations and associated facilities to support these developments. Some local businesses' will benefit from the influx of migrant workers due to an increase in trade of a variety of products, including agricultural, fishing, services, recreational activities, amongst others.

The impact of the project in the promotion of economic growth during the 25 years of its operations can be said to be medium positive (+9) as it is national and of long term in nature and definite.

8.1.3.2 Enhancement Measures

The following enhancement measures are proposed:

[10] Electricity Insecurity and its impact on Micro and Small Businesses in Ghana, Charles Ackah, Senior Research fellow, ISSER, University of Ghana, 2015.

- Ensure stably priced electricity for consumers to promote local businesses.
- Payment of taxes to Government for national developments.
- Provide job opportunities for locals and nationals to enhance their economic development.
- Landowner lease and project revenue payments as part of Corporate Social Responsibilities to enhance local economy.
- Promote ecotourism potential of the wind power project to enhance local development and revenue generation.

8.1.4 Increased Employment

8.1.4.1 Constructional Phase

Initial consultation with the residents revealed that they are aware of the imminent commencement of the project, which is very close to their location. The residents expressed positive feedback about the commencement of this development and the Project as being beneficial for their local economy. When asked about how they believe these developments will benefit them economically, they indicated that the commencement of the construction of such projects would bring opportunities for employment, which could continue during their operation. Some of the women expressed their positive attitude towards the developments as they see them as opportunities for them to engage in petty trading and food vending with the construction workers on site. This, they hope, will improve their livelihoods financially and enable them to pay for their children's education. The residents indicated that they had been informed by the Chiefs and land owners that the project would be developed near their village soon, and therefore they should not carry out anymore constructions of any permanent structures.

The Project has the potential to create jobs in the local area both directly and indirectly during the construction phase. As indicated, this project will bring in employment opportunities for the local inhabitants. Direct job opportunities will be available for high calibre professionals including engineers, mechanics and consultants. It is, however, unlikely that the local community will benefit from this calibre of specialised job market. Of greater relevance to the local community will be job opportunities involving unskilled and semi-skilled labour especially during the rehabilitation of the roads and the construction of the wind park and staff buildings.

It is expected that the project will create approximately 50 direct construction employment opportunities over this period (i.e. 8 skilled, 18 semi-skilled, and 24 low skilled). Construction crews will constitute mainly skilled and semi-skilled workers. Unskilled jobs will be offered mainly to the local people particularly during the construction phase. About 10 VRA support staff will be present in addition to the above. About 5 expatriate workers are expected to be on site.

During the road rehabilitation and construction phases of the project, over 50 members of local communities in the project area will be hired by the project as drivers, masons, loaders, carpenters, cooks, security personnel and other assorted personnel. Indirectly the project will create opportunities for self-employment in the project area especially during the rehabilitation of the roads and the construction of the wind park facility. Since the project will require local materials for the above project activities, the local community stand to benefit from their engagement in several activities including the making of ballast, collection of sand, cutting of building stones, making of concrete blocks and transportation of goods and building materials. Other employment opportunities in the project area will spring from spin-off activities including trade, accommodation, and supply of goods and services to both the skilled and unskilled labour.

In addition to direct benefits from the employment of residents, the proposed project may also offer potential economic benefits through the procurement of goods and services. It is assumed that most of this procurement will be at a regional or national level due to shortages in suitable industry and service providers in the social study area. Some local businesses' will benefit from the influx of migrant workers due to an increase in trade of a variety of products, including agricultural, fishing, services, recreational activities, amongst others. Nonetheless, the price of food and other goods sold in the surroundings of the site may increase due to this influx of workers. It is expected that this impact will however be limited to the construction phase.

Increased income generating opportunities will be experienced at a national, regional and more local level to varying scales, causing different degrees of economic growth. However, most of employment during construction is likely to be relatively short-term and significant employment opportunities for local communities may be limited due to the low levels of education, skills and limited experience and training opportunities that the local people have. This can result in a large percentage of skilled and semi-skilled workforce being sourced on a temporary or permanent basis from outside of the local community.

Receptors in the Social Area of Influence (AoI) that may be able to make the most of these opportunities are those who have received some experience of formal employment, gained basic education or learned English language skills. Typically this may be youthful males who have received some education, have experience working for the government or other international companies, or who have learnt some English. It should be noted that at the local level the overall lack of education, skills and capacity means that vulnerability is high, meaning a large majority would be ill equipped to maximise benefits.

Construction of the project will lead to a positive impact on the employment of the area and region. During the constructional phase, this project will create job opportunities in the project area and beyond, including the international community. Local labour sources and local resources will be utilised where possible. It is expected that many of the workers will either originate from the neighbouring area or be staying in houses and apartments in nearby communities. The impact of employment created during construction will be definite and is considered a positive effect from the project. The local community will benefit from job opportunities for the semi-skilled and unskilled cadres who will form the bulk of the labour force, thus the project has the potential to lead to economic development and therefore of medium positive (+10) impact.

8.1.4.2 Enhancement Measures

- Measures are to be designed and adhered to regarding employment and workforce policies to mitigate environmental, health and social impacts that are associated with the influx of formal and informal workers by the Contractor.
- Design and adhere to employment and workforce policies
- Local employment and sourcing policies are to be used to give priorities to people within the three project communities and the Keta Municipality and this must be done in line with VRA Local Content Policy.

- Announcement of job opportunities must be made via both the electronic and print media. Announcements must be in English and the local dialects since a large proportion of the populace in the project area have no formal education.
- Food vendors from the local communities must be encouraged to sell their food to workers at designated place at within the project site.
- The Contractors' workforce should procure food stuff and fish from the local communities, thus providing a source of income for such communities.
- The local communities therefore must be encouraged to earn their income through the sale of cooked food to workers.
- Apply relevant national policies, labour laws and codes concerning employment conduct
- Institute appropriate grievance mechanisms to address concerns of both workers and the public
- Appoint a Community Liaison Officer as a designated point of contact for the community.
- Prepare Labour Management Plan as part of HSE Plan for the construction phase.
- Supply the workers with STD prevention devices including the male and female condoms
- Put in place a worker grievance mechanism including monitoring and resolving of such concerns.
- Put in place mechanisms to deter the work force from engaging in activities which has the potential of causing conflict with the communities
- Put in place suitable measures to maintain a healthy environment for the labour force.

8.1.4.3 Operational Phase

Approximately 20 technical persons on shift basis shall be hired for operations at the wind farm and power plant during operational phase. This number will be in addition to those engaged at site for security and administrative duties expected. At this stage in the project development, the origin of these workers is unknown. Other employment opportunities in the project area will spring from spin-off activities including trade, accommodation, and supply of goods and services to both the skilled and unskilled labour and those to be associated with the tourism potential of the project.

The socio-economic environment of the social study area is characterised by a low degree of livelihood productivity with some degree of diversity. The study showed low levels of educational achievement and capacity within the project area. From the household survey it is determined that majority of household respondents have only reached 2nd cycle and primary school. During the operational phase, it is assumed that many beneficiaries for employment will be educated Ghanaians with experience in the power sector who can provide a swift response to labour requirements with minimum training. Based on the baseline conditions it is assumed that very few of these types of candidates will be available from within the local area. As a result, employment benefits are expected to be experienced mainly by beneficiaries from nearby urban centres such as Accra and Tema. Looking at the numbers involved, the potential intensity on employment is low, national and of long-term duration and definite and is described as medium positive (+9) in nature.

8.1.4.4 Enhancement Measures

The enhancement measures outlined under the constructional phase is also very pertinent to the operational phase. In addition, eensuring continuous electricity availability will help manufacturing sectors which are often constrained by a lack of reliable power to produce more, consume more inputs from other sectors, and hence create additional employment.

Table 8-1: Ratings of Project Associated Positive Impact

Aspect/ Impact Pathway	Nature of Potential Impact/ Risk	Status	Spatial Extent	Duration	Consequence/ Intensity	Probability	Reversibility	Irreplaceability	Significance		Confidence Level
									Without Enhancement	*With Enhancement*	
CONSTRUCTIONAL PHASE											
Job Creation	Increase in Employment Opportunities	Positive	International	Temporal	Medium	Definite	High	Replaceable	Medium	High	High
OPERATIONAL PHASE											
Electricity Availability	Stabilization of Electricity	Positive	National	Long Term	High	Definite	Low	Moderate	High	High	High
Climate Change	Contribution Towards National Determined Commitments	Positive	National	Long Term	High	Definite	Low	High	High	High	High
Economic Growth	Promotion of Economic Growth	Positive	National	Long Term	Medium	High	Low	Moderate	Medium	Medium	Medium
Job Creation	Increase in Employment Opportunities	Positive	National	Long Term	Low	Definite	Low	Moderate	Medium	Medium	Medium

8.2 NEGATIVE IMPACTS ON PROPOSED PROJECT

Although this project will realise tremendous economic benefits and other positive impacts as outlined above, it will also have negative effects on the socio-economic environment. The socio-economic negative impacts of the project will be triggered mainly by challenges in land acquisition and compensation issues, land use and quality as well as the increased population in the project area following the commencement of the installation of proposed wind power project. As the local community and other people from outside the project area respond to employment opportunities, the project area will witness an increase in human population in this remote area. This influx of people is likely to lead to many negative socio-economic impacts including cultural contamination, health issues, increased insecurity and community conflicts, challenges of labour force management, increased accidents from traffic and transport and occupational hazards. A summary of the assessment of the various impacts are outlined in Table 8-2 and the rationale for arriving at these decisions provided in the subsequent texts.

8.2.1 Impact on Land Use

8.2.1.1 Construction Phase

There is a significant development of the land in communities affected by the project. These includes residential houses, commercial centres (markets), churches and schools. However, much of the areas covered by the project traverses' natural vegetation, wetlands and swamps. The proposed sites are also a grazing field for livestock. Mangroves and other plant species in the proposed project site are used as cooking fuel (firewood) and gardening. Grass/straw used for roofing homes, craft and weaving can also be obtained at the Srogbe site. Again, the mangroves play a primary production role in providing nutrients for prawns and juvenile fish in the lagoon. In addition, some herbs are harvested from the vegetation on the proposed sites, which is used for medicinal purposes.

As indicated, the project will necessitate land acquisition resulting in both physical and economic displacement. A Right of Way of 200m, 100 m each side of a wind turbine will be acquired with respect to the Anloga site, however, that for Anyanui and the Srogbe site will be 120 m, i.e., 60 metres on each side. In addition, land for the substation as well as a right of way of 30m will be acquired with the associated 66 Km 161 kV Transmission line. A total of 482.16 acres (refer to Table 6-2) or 1.95km^2 of land is estimated to be required for the project within the project communities Anloga, Srogbe and Anyanui. This represents 0.2% of the total available land area of 724km^2 in the Keta Municipal. The land to be affected by the implementation of the proposed project has the following categories of land-uses, agricultural lands, potential agricultural lands or fallow agricultural lands. Land for the project site has been surveyed and is to be acquired. The demarcation of the land for the project would result in some potential effects on land-use characteristics such as hunting as well on the fauna within the project environment, however, on a minimal basis. The major activity requiring mitigation is the land-use as this ultimately leads to loss of land for hunting and possible land-use conflicts.

Constructional activities could lead to a direct impact of physical displacement of residential communities (with or without legal entitlement) or economic displacement from key activities such as fishing or farming, because of the development and associated infrastructure and this can plunge households into poverty and / or dislocate communities severing extended support networks such as childcare. If located on land impacted by the project, the people and houses will need to be relocated to make way for the project and new land or alternative means of subsidence or livelihood generating activities may be required. The acquisition of the project enclave has direct impact to adversely affect land tenure and ownership and land-use planning characteristics, as land will have to be acquired from some individuals, communities and/or stools. These are negative because the lands will be lost to the community members, however, there will be the opportunity to embark on some specific farming/economic activities, which will be agreed upon with the Client.

The significance rating of the impact on land use is said to be **HIGH NEGATIVE** (-13). The potential intensity of this impact is high and negative as various people will lose their lands and livelihood. The spatial extent of the impact will be specific only to the project site, however, the duration of the impact will be long term but irreversible as the land will be acquired and its uses will be restricted from then on.

8.2.1.2 Mitigation

Land ownership structures and land-use characteristics will change within the affected area. This potential adverse effect on land ownership and land-use requires mitigation measures to minimize the impact on individuals and the community. Under the Local Government Act, 1993 act 462, the Town and Country Planning Department will be responsible for the overall planning and development control within its jurisdiction and will be responsible for the integration of social, economic and physical development of the project area. The Town & Country Planning will also have to demarcate the area and map out accordingly.

To maintain harmony among various communities in the project area, there will be a dire need to raise awareness about the project. Of special importance is awareness about project benefits that different communities stand to gain. The project management should, however, guard against raising expectations that cannot be met. All communities need to be kept abreast of all project development activities and should sufficiently be consulted on all matters that concern them.

The project should engage a neutral person who is accepted by all the communities in the project area to interact with communities, raise awareness on the project activities and to resolve any conflicts that may arise between the project and the communities involved. VRA is considering various alternatives available to ensure that minimal land is utilised for the project as well as avoiding lands that are under litigation.

With the successful implementation of the above recommended mitigation, the high negative significance of this impact is expected to decrease to low.

8.2.1.3 Operational Phase

Most households within the social study area have high level of dependency and communal use of lands where families and individuals are engaged in subsistence farming. Subsistence cropping is not a controlled activity by any authority. Farmers with authority from landowners use portions of lands for farming. As indicated, the land to be affected by the implementation of the proposed project has the following categories of land-uses, agricultural lands, potential agricultural lands or fallow agricultural lands. Due to land acquisition, farming activities may now be restricted during the operational phase, as the acquired land will now be used for wind power operations involving regular monitoring of the performance of the wind turbine generators (WTGs) and minor maintenance carried out when required as well as annual maintenance of the WTGs. The Project will be operational 24 hours a day, seven days a week with the proposed operational period of the Project being 25 years.

This impact to land access is definite and of medium term duration as farmers may return to use the lands once wind turbines are installed. The loss to access of lands for subsistence farming will also affect income generation ability by residents. The impact of loss of income or lowered income generation is definite and will occur in the medium term. Roads in the study area will also be enhanced because of the project development and thus may enhance the landscape and enhance investments.

All degraded areas resulting from the road rehabilitation and wind park construction activities including the quarries, borrow pits, cuts and fills and other disfigured surfaces in the project area and environs, need to be landscaped and suitable grass, shrubs and trees planted to blend with the environment. The presence of the wind park facility in otherwise an unspoilt natural environment is likely to be visually intrusive to some people. It has the potential to attract observers from the normal scenery. It is therefore necessary to paint the turbine, mast, blades and other components with colours that blend with the environment especially shades of pale green, brown and gray in order to further reduce visual intrusion in the project area. It may, however, be noted that the wind park is not an ordinary sight and being a novelty, could be appealing to a wide cross-section of local community, other Ghanaians and even foreign visitors. Indeed, it could as well be a local attraction drawing many observers from beyond the project area. The area could however become a tourist attraction due to the physical presence of the wind turbines infrastructure. This provides opportunity for establishment of recreational and entertainment facilities in the project area to support this new development.

The significance rating of the impact on land use is said to be **MEDIUM NEGATIVE** (-9). Land use restrictions will be definite during operations will be definite. However, the land acquired may be available for limited farming activities. The potential intensity of this impact is medium and negative. The spatial extent of the impact will be specific only to the project site. The duration of the impact will be long term and irreversible as the land will be acquired and its uses will be restricted from then on.

8.2.1.4 Mitigation

Resettlement and livelihood restoration activities will be formulated as sustainable development activities that at least restore but aim to improve the standards of living and long-term wellbeing of the affected persons. This will include a consideration of existing land uses and recreational activities within the vicinity of the site, local tourism activities, employment generation and any indirect economic effects arising from the proposed Wind Power Project.

With the successful implementation of the above recommended mitigation, the medium negative significance of this impact is expected to decrease to low.

8.2.2 Impacts on Land Quality

8.2.2.1 Constructional Phase

Contamination of ground and groundwater at the development site may be present because of past releases. However, as the site is a greenfield development, these risks are considered low. Possible sources of contamination associated with construction work may include spills, leaks, or deliberate discharges of oil or fuel. Other substances may include raw materials, fluids, intermediate produces, wastes and effluents. Dredged material may contain contaminants. As such, substances will be in small quantities, the intensity of any such contamination may be direct, low, and reversible.

The significance rating of the impact of the project on land quality during the constructional phase can be described as VERY LOW (-0.75). Substances that will have the potential for ground and groundwater contamination will be small quantities, the intensity of any such contamination may be direct, negative and low and reversible. The spatial extent of the impact will be specific only to the project site. The duration of the impact will be temporal and reversible. The probability of the impact on land quality is low.

8.2.2.2 Mitigation

The design of the facility to good practice standards will aim to prevent such releases and minimise the potential consequences such that any effects should be insignificant. Clearing and grading of access and corridor tracks of the wind turbines and the excavation of foundation and tower base areas will be limited to the minimum area requirements. Other measures for minimizing erosion and managing excavated materials, wastewater from excavations and accidental spillage of oil, fuel and paints are valid for the prevention of ground and ground water quality.

With the successful implementation of the above recommended mitigation, the very low negative significance of this impact is expected to remain very low.

8.2.2.3 Operational Phase

When the Project is completed, the areas surrounding new installations will be reinstated to their former state. The construction compound will be removed after construction and the area reinstated. Operation and maintenance (O&M) of wind farms is different from O&M of conventional power plants. To run conventional power plants, the purchase of fuel (or coal or gas etc.) is necessary. In case of failures, the machines will stop and do not produce energy - but do also not consume fuel anymore; therefore, the loss of revenue is limited. It is different with wind farms. The “fuel” is the wind. It is free of charge, but is fluctuating; therefore, the aim is to run the WTG as much as the wind speed is in a meaningful level. It is expected that operational activities of the wind power facilities will not have any direct impact on the quality of the land.

The significance rating of the impact of the project on land quality during the operational phase can be described as VERY LOW (-0.75). Substances that will have the potential for ground and groundwater contamination will be small quantities, the intensity of any such contamination may be direct, negative and low and reversible. The spatial extent of the impact will be specific only to the project site. The duration of the impact will be temporal and reversible. The probability of the impact on land quality is low.

8.2.2.4 Mitigation

As in the constructional phase, the design of the facility to good practice standards during the operational phase will also aim to prevent such releases and minimise the potential consequences such that any effects should be insignificant. Other measures for minimizing spillage of oil, fuel and paints are valid for the prevention of ground and ground water quality.

With the successful implementation of the above recommended mitigation, the very low negative significance of this impact is expected to remain very low.

8.2.3 Impacts on Land Acquisition

8.2.3.1 Constructional Phase

The project will necessitate land acquisition and both physical and economic displacement of. It is hoped that physical displacement for associated facilities can be avoided as much as possible. Again, some land acquisition and economic displacement is anticipated for the Rights of Way (ROW) for the access roads and associated transmission lines. During the study, some legitimate representatives for the acquisition of community lands especially at Anloga and Srogbe were identified. However, ownership of the affected lands at Anyanui is being contested between two clans, namely the ‘Bate’ Clan from Anyanui and the ‘Klevi’ Clan of Dzita. If not mitigated appropriately and early, resettlement impacts can cause great controversy and result in significant public objections, time delays and considerable cost overruns for the project. The Client will need to properly manage this through sensitization and information sharing.

Vegetables and cassava are the main farming activities taking place on some parts of the proposed project sites. Fishing activities take place at the shores of the proposed site. Some sailors dock their wooden canoes at the seashore and drag their nets from one side to another along the site. The residents of Srogbe and Anyanui also engages in fishing and crab trapping activities on the lagoon. The proposed sites are also a grazing field for livestock. Mangroves and other plant species in the proposed project site are used as cooking fuel (firewood) and gardening. Grass/straw used for roofing homes, craft and weaving can also be obtained at the Srogbe site. Again, the mangroves play a primary production role in providing nutrients for prawns and juvenile fish in the lagoon. In addition, some herbs are harvested from the vegetation on the proposed sites, which is used for medicinal purposes.

There will be no physical displacement of residential communities (with or without legal entitlement) because of project activities. However, economic displacement from key activities such as fishing or farming because of the development and associated infrastructure can plunge households into poverty and / or dislocate communities severing extended support networks such as childcare. If not mitigated appropriately and early, resettlement impacts can cause great controversy and result in significant public objections, time delays and considerable cost overruns for the project.

The significance rating of the impact of the project on compensation during the constructional phase can be described as High Negative (-13). Land acquisition and economic displacement will require compensation, and this is definite. PAPs to be impacted are currently being enumerated and the property cost under valuation in collaboration with the Lands Commission. The intensity of this impact can be said to be high, negative and direct. The spatial extent of the impact will be specific to the people within the project site. The duration of the impact will be long term and irreversible and will last during the lifetime of the project. There is a definite probability of the impact on occurring.

8.2.3.2 Mitigation

The project requires the acquisition of land for the development of the wind power projects in the various areas. Baseline socio-economic surveys has been undertaken to confirm potential for residence and farming or other economic activity sites on the project area and provide a cut-off date against opportunistic settlers moving into the area. During the study, it was determined that due to economic displacements and lands to be acquired; there will be need for compensation as part of the proposed project. To minimize the adverse effects of the land acquisition on individuals, communities and/or families or clans a detailed survey of project-affected persons is being carried out as part of the ESIA for the purposes of compensation payment. Prompt, adequate and fair compensation will be paid to all project-affected persons before the start of constructional activities.

As part of the process, VRA shall engage the Land Valuation Division of the Ghana Lands Commission (Ho Office) to determine the compensation to be paid for the crops and any other identified infrastructure within the site. Cognisance has been taken of IFC PS5 and consultations are ongoing with the Property Affected Persons (PAPs). Currently, project-affected persons (PAPs) are being engaged in a meaningful manner, and to provide opportunity for their participation in the planning and execution of resettlement programs. In view of this, the client is considering involuntary compensation as an integral part of project design, and subsequently deal with resettlement issues from the earliest stages of project preparation. A "***Compensation Action Plan***" report is under preparation by the same Land Valuation Division and the Client, to ensure that the PAPs were compensated properly.

Alongside the valuation and compensation process, there is the legal administration of land acquisition that must be undertaken. Those to be considered are the Local Government Service Act, 2003 Act 656, Lands Commission Act (2008) Act 76, State Lands (Amendment) Act (2005) Act 586, and the State Lands Regulations (1962) LI 230. The new Lands Commission Act (2008) Act 76 provides for the management of public lands and other lands and for related matters and the Commission will to assist in the execution of, a comprehensive programme for the registration of title to lands to facilitate compensation payment to land owners.

Thus, the land acquisition procedures are to be carried out in accordance with national regulations. This entails the Client communicating with the Ministry of Lands and Natural Resources to apply for land for the specific project. Then the Public and Vested Lands Management Divisions (PVLMD) in the region initiates proceedings by establishing a committee which reviews the site and advises if land chosen conflicts with any existing developments or land transaction underway. With approval of the land and an interim valuation certificate to estimate compensation, the Ministry will formally notify authorisation to acquire the designated lands in the public interest.

In a project of this magnitude where the developer must contend with the acquisition of a large area of land, involuntary resettlement of displaced local communities becomes a thorny issue. In such cases, the donors would prefer that the developer follow the guidelines contained in the World Bank (WB) Operational Policy on Involuntary Settlement (OP 4.12) in the resettlement of the project-affected persons (PAPs) as well as the IFC Performance Standard 5: Land Acquisition and Involuntary Resettlement. The WB guidelines recognize that involuntary resettlement brought about by development projects, if unmitigated, is likely to cause severe economic, social and environmental risks. The policy addresses direct economic and social impacts that are caused by the involuntary taking of land, resulting in:

a) Relocation or loss of shelter;

b) Loss of assets or access to assets; and

c) Loss of income sources or means of livelihood, whether the affected persons must move to another location.

The Bank's policy advocates that where feasible, involuntary resettlement should be avoided or minimized. In addition, the resettlement must be conceived and executed as a sustainable development program, providing sufficient investment resources to enable persons displaced by the project share in project benefit. In this case persons displaced must be:

a) Meaningfully consulted and should have opportunity to participate in the planning and execution of the resettlement;

b) Compensated for their losses at full replacement cost prior to civil works;

c) Assisted with the move and supported during the transitional period in the resettlement site; and

d) Assisted in their effort to improve their former living standards, income earning capacity and production levels or at least to restore them.

To adhere to both national and internationals requirements, the "***Compensation Action Plan***" would seek to achieve the following:

- To determine the compensation and resettlement strategy in accordance with the local Laws and Regulations of both Ghana and World Bank guidelines on involuntary resettlement;

- To compensate Project-Affected Persons (PAPs) fully and fairly for all assets lost permanently or temporarily, this means timely payment of full replacement value prior to construction;

- To ensure that only PAPs who meet agreed eligibility criteria will be entitled to compensation and relocation measures;

- To ensure that lack of legal rights to land and assets occupied or used will not preclude a PAP from entitlement to resettlement and compensation measures;

- To assist PAPs in proportion to impact, recognizing the special needs of vulnerable populations; i.e. widows, orphans, HIV/AIDS victims, elderly people and handicapped people;

- To ensure that PAPs who lose income-generating resources are assisted in their efforts to improve their livelihoods and standards of living or at least restore them, in real terms, to pre-project levels;

- To disclose the proposed mitigation measures to the local community prior to resettlement and conduct ongoing consultation with affected communities during the resettlement process and afterwards;

- To provide a grievance procedure whereby local people can lodge concerns and complaints regarding the resettlement;

- To consult with Project-Affected Persons (PAPs) in a meaningful manner, and to provide opportunity for their participation in the planning and execution of resettlement programs;

- To facilitate a smooth integration with the host communities;

- To ensure that pre-construction and actual construction work on each particular affected site will not commence until PAPs have been satisfactorily compensated and/or relocated.

Our initial investigations revealed that, before one can enter the land for any physical development at Srogbe, a traditional rite must be performed, and this must be addressed. Owners of the shrines encountered within the project area have agreed to carry out of certain traditional/customary rites if the project will affect them. It is expected that requirements for various pacifications for entering onto lands in the project area as indicated by the landowners will be outlined in the CAP for the project. Out of respect for the sensibilities of the owners and the communities, the items for the rites is not discussed here. VRA should do all within its means to ensure that these rites are successfully carried out and prompt and adequate compensation paid when it becomes necessary to impact on these community properties. VRA should however endeavour to align the project activities to avoid these community properties prior to the commencement of construction activities.

It is expected that project activities connected with the road rehabilitation will not displace local communities in the project area or any section traversed by the earmarked access roads. The proposed road rehabilitation will follow the current Right of Way (ROW) for the existing road and therefore, there will virtually be no displacement of local people and destruction of property.

With the successful implementation of the above recommended mitigation, the high negative significance of this impact is expected to decrease to low.

8.2.3.3 Operational Phase

As indicated, a "Compensation Action Plan" report is under preparation to ensure that the PAPs are compensated properly prior to project development. From experience, land ownership issues are expected to persist during the operational phase of the project. In cases, where property owners could not be traced after all efforts have been made during the constructional phase additional efforts will be made during the operational phase to locate such people.

Outstanding payments will be effected during this phase. The significance rating of the impact of the project on compensation during the operational phase can be described as Medium Negative (-7.0). Land acquisition and economic displacement will require compensation. PAPs to be impacted are to be paid prior to project development. The intensity of this impact can be said to be medium low, negative, direct and irreversible. The spatial extent of the impact will be specific to the people within the project site

8.2.3.4 Mitigation

A "***Compensation Action Plant***" report is under preparation by to ensure that the PAPs were compensated properly. It is expected that its implementation would continue during the operational phase. Further, VRA should put in place appropriate grievance mechanisms to address concerns of both workers and the public as part of a wider Stakeholder Engagement Plan enabling community concerns to be documented and resolved in a timely fashion. The Client should effect prompt payment of outstanding compensation and continue to institute appropriate grievance mechanisms to address concerns of both workers and the public should continue to be put in place.

With the successful implementation of the above recommended mitigation, the medium negative significance of this impact is expected to decrease to very low.

8.2.4 Impacts on Labour and Working Conditions

8.2.4.1 Constructional Phase

It is envisaged that the client will employ as many people as possible from the surrounding local villages and towns. Workers will be hired for periods lasting from a few days (for specific construction tasks) to the full extent of the construction period. Peak employment is estimated to be 6 months. Temporary camps will not be required to house the workforce. The Client is advised to hold discussions with the house owners in order to determine if the facilities will be suitable for senior level workers.

Productivity has been known to deteriorate on construction sites due to labour unrest, leading to a negative impact on the cost and quality of construction as well as the livelihood and morale of workers. Wages, bonus and other compensation disputes remains the main reason for work stoppages and accounting for working days lost. Given the important role of labour productivity and industrial action to workers and to the economy, there is the need for the client to play an increasingly active role in mitigating the damages resulting from industrial action.

EPC companies, contractors, and subcontractors usually have contracts with a defined work scope, duration, start date, and other parameters to base their estimate. A change in a project scope of any kind usually means there will be associated productivity impacts that can be attributed to inefficiencies as well. Often, the design is incomplete or changes are made that will impact the original estimate. The original project may have been planned for partial execution in wet weather and other inefficiencies; however, the changes will probably constitute additional impacts and inefficiencies.

One key example is owners will very often demand the same completion date, despite the added work scope. This may require overtime, second shift work, rework, additional crafts, and many other impacts to the original plan and estimate. This increase in person-hours, constraints, and other resources would affect the cost and schedule. Another impact that may occur is the need for new or additional material, constraints, and equipment, which affect the sequence, duration, and schedule of work packages. There could also be an increase in idle time of workers waiting on material. Such changes may cause work force increases and work areas to be overcrowded with workers who now need to share and occupy the same workspace, scaffolding, or equipment with other crafts, causing a further drop in productivity.

The significance of the impact on labour and working conditions during constructional phase is Low Negative (-3). The potential intensity if this impact occurs is described as medium negative, site specific and temporal in nature and probable to occur, if relevant measures are not put in place.

8.2.4.2 Mitigation

The Client should apply relevant national policies, labour laws and codes concerning employment conduct as discussed under Section 4.4 to regulate behaviour of workers in the local communities. Measures should be designed and adhered to regarding employment and workforce policies to mitigate environmental, health and social impacts that are associated with the influx of formal and informal workers by the Contractor. Local employment and sourcing policies are to be used to give priorities to people within the project affected areas.

The Client should put in place appropriate grievance mechanisms to address concerns of both workers and the public as part of a wider Stakeholder Engagement Plan enabling community concerns to be documented and resolved in a timely fashion. The Client should appoint a Community Liaison Officer as a designated point of contact for the community. Ensure that the community understands that this person is a point of contact for the project and that they can have access to him/her always, that they act as means of communication with the project management and are a potential source of conflict resolution with the project as well. This Community Liaison Officer should be integrated into the management of the grievance mechanism process.

The Client should prepare a Labour Management Plan as part of their Health, Safety & Environmental (HSE) Plan for the construction phase. This should cover maximising employment opportunities for the project within the local communities, managing expectations, and reducing the potential for influx into the area during the construction. The Plan will also aim to take into account vulnerable groups such as women. The Plan will include for job training and capacity building during the construction activities.

This influx of workers will be limited for the Project, with clear recruitment and employment policies put into place. The Project will aim to reduce the influx of workers by:

a) Making clear that there will be no recruitment of workforce “at the gate”, clearly advertising the formal recruitment process, hence discouraging an influx of opportunistic in-migrants; and

b) Work in conjunction with local authorities, municipalities, village Chiefs and their staff to discourage settlement of opportunistic in-migrants.

It is understood that no temporary accommodation will be provided or constructed for the workforce. If, however camps are developed, they will need to be designed and operated by the contractor in accordance with the requirements set by IFC PS2 and the relevant guidelines within the guidance document Workers' Accommodation: Processes and Standards: A Guidance Note by IFC and the European Bank for Reconstruction and Development (EBRD).

In order to maintain a healthy environment for the labour force, the project management should put in place suitable measures to clean the environment associated with labour camps. This will include proper disposal of human waste. The Client needs to put in place mechanisms for the collection of all wastes generated (solid wastes, organic wastes, food remains, garbage etc.), in the labour camps, segregate the various wastes and arrange for subsequent disposal through either efficient incineration or disposal in a sanitary landfill.

With the successful implementation of the above recommended mitigation, the low negative significance of this impact is expected to decrease to very low.

8.2.4.3 Operational Phase

Approximately 20 technical persons on shift basis shall be hired for operations at the wind farm and power plant during operational phase. This number will be in addition to those engaged at site for security and administrative duties expected. Other employment opportunities in the project area will spring from spin-off activities including trade, accommodation, and supply of goods and services to both the skilled and unskilled labour. Increased income generating opportunities will be experienced at a national, regional and more local level to varying scales, causing different degrees of economic growth. It is assumed that the majority of beneficiaries will be educated Ghanaians with some experience in the power sector who can provide a swift response to labour requirements with minimum training. Based on the baseline conditions it is assumed that very few of these types of candidates will be available from within the local area.

The socio-economic environment of the social study area is characterised by a low degree of livelihood productivity with some degree of diversity. The study showed low levels of educational achievement and capacity within the project area. From the household survey it is determined that majority of household respondents have only reached 2nd cycle and primary school. As a result, this benefit is expected to be experienced mainly by beneficiaries in urban centres such as Accra.

Receptors in the Social Area of Influence (AoI) that may be able to make the most of these opportunities are those who have received experience of formal employment, gained basic education or learned English language skills. Typically, this may be youthful males who have received some education, have experience working for the government or other international companies. It should be noted that at the local level the overall lack of education, skills and capacity means that vulnerability is high, meaning a large majority would be ill equipped to maximise benefits. Experience has shown that such situations usually causes the community members to be peeved that others have been successful, with its subsequent negative attitudes to the project and the workers that have been engaged. Vandalism sometimes results from such ill feelings.

Any labour unrest or community vandalism or attack during the operational phase will result in project shut down and loss of 75MW of power to the national grid, and its subsequent impact on the economy.

The significance of the impact on labour and working conditions during operational phase is Medium Negative (-6.5). The potential intensity if this impact occurs is described as medium negative, national and temporal in nature and probable to occur, if relevant measures are not put in place.

8.2.4.4 Mitigation

Mitigation measures proposed for the constructional phase will be same as the operational phase.

With the successful implementation of the above recommended mitigation, the medium negative significance of this impact is expected to decrease to very low.

8.2.5 Impact on Historical & Cultural Heritage Resources

Constructional Phase

Cultural resources and heritage comprise tangible historical/archaeological sites, documents and artefacts together with religious/spiritual sites (sacred sites) and activities important to local communities, customary law, traditional beliefs, values and practices. It should be noted that the assessment of impacts and development of mitigation actions for some cultural features cannot be wholly segregated from other social impact assessments and there will be overlap in some mitigation actions. The sensitivity of a cultural feature to direct impacts reflects the level of importance assigned to it. This is the product of a number of factors, including for features of present day cultural value: its current role; its cultural or sacred associations, its aesthetic value; association with significant historical events or traditions and its role as a sacred site or local landmark; and in addition, for those of heritage value, its potential as a resource of archaeological data.

The significance of an impact, either direct or upon setting (indirect), on a site is assessed by combining the magnitude of the impact and the sensitivity of the site. The impacts will either be:

- ✓ **Direct impact** involving physical damage to cultural features or disruption to customary law, practice and tradition. Any direct impacts on tangible features will be permanent and irreversible

- ✓ **Indirect impact** including visual impact on cultural features, influences the appreciation of the inter-relationship between these sites, impacts on the relationship of a site to the wider landscape and impacts on significant views from and to sites.

Construction activities and land take has the potential to impact on areas of cultural heritage. Potential impacts that may disturb or damage on cultural heritage or historical resources may arise from site digging for construction. Potential impacts on archaeology may relate to the possibility for disturbance, removal or destruction of archaeological deposits during construction activities. Specific activities with the potential to affect archaeology may include the excavations of foundations and piling. Archaeological relics could be delivered to the site at any time during the life of the site, but the occurrence will be seldom and random. This is high priority only initially. Proposed development works or longer-term effects of an operational development may affect archaeological heritage that was not identified prior to the commencement of development works.

The main impacts relate to areas of ground excavation required for construction purposes e.g. lay down areas of work camps, new access roads, etc. As with any project site, there is a potential for previously unrecorded cultural sites to lie within. As all unknown cultural heritage will be sub-surface it is only direct impacts arising from disturbance that could occur. Disturbance within the project area following operation could potentially occur during the excavation works of building facilities, infrastructure, pipelines and the installation of fencing for other works. As the value of archaeological resources is predicated on their discovery within a specific geological host unit, construction of the proposed project could result in a net gain to the science of paleontology by allowing fossils that would not otherwise have been found to be recovered, identified, studied, and preserved.

As indicated, Archaeological, heritage and cultural studies have been concluded by experts from the Department of Archaeology & Heritage studies from the University of Ghana and the report outlined various sites of importance that needs to be considered during project implementation. The project area including the actual area impacted by the road construction and the wind park siting has so far not been reported to have any cultural property including archaeological discoveries. The project site is not located in a designated archaeological priority area nor contains any scheduled ancient monuments, listed buildings or locally listed buildings. There are no listed heritage sites located within the area of the property proposed for the project site.

Various heritage sites identified for consideration includes:

a) Deity called Takpe Vikpe which is a walled male deity located on the shore within the project area about 10 meters away from the sea.

b) Female deity called Mama Blode of a river/lagoon by the project area. It is also associated with a sacred forest near the river.

c) Fenced household/village located about 100m to the east of the project area and 50 m from the sea at Anloga that serves as a shrine containing many deities (eg. Madugu, Klamor, Korshie, Anyigbator, Dzakpa, Azor and Tsingeli) which are often consulted by interested supplicants.

d) Deity tree by the lagoon belonging to people of Whutti Sroegbe

e) Deity known as Apim located along the sea and belonging to the Dzezizi branch of the Like clan

The proposed project has the potential to impact on the cultural landscape. Some notable cultural taboos were documented in the project that needs to be observed to minimize its impact. It was indicated that hooting is prohibited on the shore of Anloga. In addition, red dresses or colors are prohibited around the area.

The Tunu community at Anyanui also has a deity known as Gbli. Some taboos associated with this deity are:

- Women in their menstruation period do not visit the shrine of the deity.
- Women in their menstruation period do not visit the river side
- Running and diving into the lagoon is a taboo
- Fetching water from the lagoon with a black pot is a taboo
- Hooting is prohibited in the town
- Having sexual intercourse on the bare ground is unacceptable
- They don’t engage in economic activities on Thursdays

As indicated earlier, people of Whutti Sroegbe have a deity which is a tree by the lagoon. The Dzezizi branch of the Like clan also have a deity known as Apim and it is also located along the sea. More importantly, Whuti lands are owned by three clans namely; Bate, Adzorvia and Like. According to the stool father, a number of ritual items for the pacification of the stool will be expected before the commencement of work and signing of the lease. However, all of these deities are not in the project area, but could be of significance depending on how the locals raise issues.

The impact of the proposed project on the cultural landscape is expected to occur during the construction phase. The significance of the impact on historical and cultural heritage during the constructional phase is Low Negative (-2.5). There will be no direct impact on historical and cultural heritage resources even though various sites have been identified. Looking at the type of resources identified, the intensity of this impact can be said to be medium low. The spatial extent of the impact will be local. The duration of the impact will be temporal and will last during the construction period with a probability of occurring.

8.2.5.1 Mitigation

Under the study, various pacification rites have been discussed with the various caretakers and these shall be subjected to negotiations during implementation to pave way for constructional activities to commence. Such information should be included in the "Compensation Action Plan" for the study. In addition, the Client should put in place a procedure for chance finds. As with any project site, there is a potential for previously unrecorded cultural sites to lie within. Disturbance within the project area could potentially occur during the excavation works of building facilities, infrastructure, pipelines and the installation of fencing for other works. An appropriate watching brief will be implemented to ensure that in the case of unearthing important archaeological finds during excavation, the following procedure, which is derived from the National Museum Decree 1969, (NLCD 387), for dealing with all such finds, shall be triggered.

In the event of any significant finds, the Client should implement a suitable programme of mitigation agreed upon with the Archaeology Department of the University of Ghana and the National Museums Board. Again, the project contractor should brief all site workers on sensitive cultural issues onsite as part of the workforce "Code of Conduct" training.

With the successful implementation of the above recommended mitigation, the low negative significance of this impact is expected to decrease to very low.

8.2.5.2 Operational Phase

There are no documented sites of archaeological, historical, or cultural significance at the proposed plant site and in its vicinity as stated earlier. Only very limited ground or excavation works are expected during the operational phase of the project. It is therefore not anticipated that there will be any impact on such resources during this phase. However, as indicated, there may also be impacts upon unknown sites during any excavation work during this phase.

The significance of the impact on historical and cultural heritage during the operational phase is Very Low Negative (-0.75). Looking at the type of resources identified and the rural landscape to one characterized by electrical infrastructure, the intensity of this impact can be said to be low. The spatial extent of the impact will be site specific. The duration of the impact will be temporal and with low probability of occurring.

8.2.5.3 Mitigation

Under the study, various pacification rites have been discussed with the various caretakers and these shall be subjected to negotiations during implementation to pave way for constructional activities to commence. In addition, the Client should put in place a procedure for chance finds. As with any project site, there is a potential for previously unrecorded cultural sites to lie within. Disturbance within the project area could potentially occur during the excavation works of building facilities, infrastructure, pipelines and the installation of fencing for other works. An appropriate watching brief will be implemented to ensure that in the case of unearthing important archaeological finds during excavation, the following procedure, which is derived from the National Museum Decree 1969, (NLCD 387), for dealing with all such finds, shall be triggered.

In the event of any significant finds, a suitable programme of mitigation agreed upon with the Archaeology Department of the University of Ghana and the National Museums Board should be implemented. Again, all site workers will be briefed on sensitive cultural issues onsite as part of the workforce "Code of Conduct" training.

With the successful implementation of the above recommended mitigation, the very low negative significance of this impact is expected to remain very low.

8.2.6 Impacts on Community, Health, Safety and Security

8.2.6.1 Constructional Phase

Health and safety requirements are key aspects for any developmental project, which is seeking for international lending or loan financing. According to IFC Performance Standard 2, "*economic growth through employment creation and income generation should be accompanied by protection of the fundamental rights of workers"*. Occupational health and safety is contained under section 23 of the IFC PS 2 and requires that, "*the client will provide safe and healthy work environment, taking into account inherent risk in this particular sector and specific classes of hazards in the clients works areas including physical, chemical, biological and radiological hazards"*. The requirements and conditions of this standard are applied to the development of this project.

In Ghana, there is not an abundance of health and safety regulations, however, the practice is promoted under the Factories, Shops and Offices Act of 1970 (Act 328), the Ghana National Fire Service Act, 1997 (537) and the Workmen Compensation Act, 1987 (PNDL 187). Nevertheless, the promotion of health and safety practices on projects of this nature is discussed in many government document and national guidelines. These standards, laws and guidelines, will protect workers during the project construction and operation period.

Implementation of the project will increase volume of human and motor traffic. Increase in human and motor traffic will be aggravated by the transportation of construction materials and proposed wind plant accessories and other equipment required to install the wind park facility from Tema. This is likely to result in a higher risk of accidents occurring, and relocation of facilities to allow for smooth transportation.

During the implementation of the road rehabilitation and wind park construction phases, several activities including vehicular transport, operation of heavy machineries and blasting of hard rock in quarries have potential for accidents risks among both the project workers and the local community. Factors that may exacerbate this situation are inadequate appropriate working gear for project workers including the helmets, overalls, boots and gloves.

The road rehabilitation, construction of the wind power facilities, and other project activities may lead to creation of stagnant water bodies in quarries, borrow pits and depressions created during the construction works. Although water collected in the depressions may be a respite for pastoral animals, the resultant stagnant water bodies are likely to be suitable habitats for the breeding of mosquitoes that is the disease vector for malaria.

There will be the potential for increased road traffic accidents from increased construction traffic, right from transportation of materials from Tema. The risks of accidents and injury will mainly concern the construction workers. During construction, non-local employees are typically employed on a ‘single’ basis, they will not come with their families. Often, they can be housed close to the construction sites either in purpose built accommodation of within the nearby communities, which will most be likely in this case. Health hazards due to dust, noise and equipment soot can be minimized by daily water sprinkling on all dusty working areas and keeping machinery regularly and properly serviced / tuned by the contractor.

The project is located off the coast of Keta in the Keta Municipality. From the social surveys conducted, most common illness in the various communities are; malaria, cholera, diarrhoea and headaches. Except for headaches, significant number of persons in household has suffered the effect from one of these diseases illness. Malaria is spread by the Anopheles mosquito, which breeds in water spools and chocked gutters. Cholera is an acute illness caused by the ingestion of food and water contaminated with bacterium. The prevalence of these diseases is because of poor sanitary conditions within the areas. From the study, it was identified that sanitation conditions are poor and in some areas, no proper waste management system was identified. With the significant potential influx of workers to the project area, it is expected that communicable diseases will increase among workers through interaction with local communities and vice versa.

Migration will occur to the surrounding areas as there is an opportunity for employment. Coinciding with the influx of migrant workers is typically a raise in demand for goods and services during the construction period which can result in a rapid expansion in supply chain businesses operating in the area. This will result in increases in formal employment and informal labour. This expansion may result in migration into the area. The impacts that may arise from the presence of migrant and/or expatriate employees largely comprise the following:

a) Inappropriate behaviour and lack of respect for local leadership and cultural norms on the part of expatriate workers;

b) Conflict resulting in part from resentment by skilled nationals and residents if they perceive that expatriates have been hired into jobs for which they are suitably qualified;

c) Disruption of local communities with an increase in crime and anti-social behaviour;

d) Spread of transmissible diseases including HIV/AIDS both within the workforce and between the workforce and the local community;

e) Resentment of non-local nationals by residents if they are perceived to have taken jobs that could be successfully filled by local people, or due to non-integration with the local community; and

f) Increased local demand for consumer goods and housing with resulting encouragement for improved supply resulting in financial hardship and benefits for local people; and,

g) Increased pressure on infrastructure, services (such as healthcare) and roads, particularly with the establishment of informal settlements.

The significance rating of the impact of the project on community health, safety and security can be described as Medium Negative (-9.0). The intensity of this impact can be said to be high with local to regional influence. The duration is temporal and reversible with a high probability to occur.

8.2.6.2 Mitigation

The Client should develop Health and safety measures related to the working conditions as part of the Health and Safety Plan prior to the commencement of construction works. This plan should include recommendations and measures to protect the surrounding villages / communities during this phase of the Project. Aspects to be covered in this Plan include:

a) Barricading the working areas;

b) Health and safety training for all employees;

c) Health and safety training on the use of chemical and hazardous materials

d) Provision of the appropriate Personal Protective Equipment (PPE);

e) Traffic management plan and driver training;

f) Accident prevention monitoring;

g) Training in the use of all equipment;

h) Safeguards of environmental pollution of water resources;

i) Safeguards in hazardous materials handling and transportation;

j) First Aid access and communications; and

k) Emergency Preparedness Plan and Emergency Response Procedures.

In addition, health education about communicable diseases will be undertaken as part of the induction training for workforce members. This will include health education on STIs as well as diseases such as malaria. As such, provision would be made for education awareness of communicable diseases within the wider community. Induction training will be undertaken for construction and operation personnel covering aspects such as health, safety and environmental and cultural awareness.

There will be an influx of people during construction, although this will be minimised via the Labour Management Plan. Such influx or in-migration can result in an increase in the wealth in the project area, however, this can also lead to negative impacts on the surrounding villages/communities. This is because the project may also experience the influx of night-time (sex) workers to the area, which may result in the increase in sexually transmitted infections and HIV cases. Regarding the influx of commercial sex workers into project area following the project activities, the project should be prepared for an increase in the prevalence of HIV/AIDS.

To prevent the spread of HIV/AIDS in the project area, the developer and other stakeholders including the administration, community leaders, opinion leaders, and other stakeholders must organize and support education programmes to increase awareness and change public attitudes towards HIV/AIDS and other sexually transmitted diseases (STDs). To protect the project workers, there will be a need for the project developer to supply the workers with STD prevention devices including the male and female condoms.

Worker grievance mechanism will be put in place for both construction and operation so that workers can raise reasonable workplace concerns and for the monitoring and resolving of such concerns. All personnel will be informed of this mechanism at the time of being hired. In addition, a complaint redress committee should be formed to receive and facilitate resolution of concerns and grievances about the socioeconomic concerns raised by individuals or groups from the project affected communities. This is so because in spite of best efforts, there is a possibility that the individuals / communities affected by the project will be dissatisfied with the measures adopted to address the adverse impacts of the project and addressing the grievances at the root level will ensure the timely and successful implementation of the project.

The main functions of the committee will be as follows:

- To provide a mechanism for aggrieved persons to report on problems arising because of project activities.

- To facilitate and prioritize the grievances of project affected persons that needs to be resolved.

- To ensure reporting to the aggrieved parties about the developments regarding their grievances and the decision of the project authorities.

To ensure that the committee provides a solution to the grievances, the committee should be headed by the Project Engineer with representation from professionals with background in Social Work, Economics, Land Administration and Law. The community should also involve an impartial representative from the communities, district or municipal officers, traditional, religious and community leaders.

The project management should also put in place mechanisms to deter the work force from engaging in cutting of trees for fuel wood, charcoal burning, and building material and for any other purposes, which has the potential of causing conflict with the communities. This will deter the labour force from unnecessary cutting and trampling of vegetation and enhance the protection of the scanty natural vegetation of the project area. To maintain a healthy environment for the labour force, the project management should put in place suitable measures to clean the environment associated with labour camps. This will include proper disposal of human waste. The Client needs to put in place mechanisms for the collection of all wastes generated (solid wastes, organic wastes, food remains, garbage etc.), in the labour camps, segregate the various wastes and arrange for subsequent disposal through either efficient incineration or disposal in a sanitary landfill.

With the successful implementation of the above recommended mitigation, the medium negative significance of this impact is expected to decrease to very low.

8.2.6.3 Operational Phase

Health and occupational hazards associated with the proposed project are cross cutting issues, which may occur in the project area due to a combination of several project processes including influx of workers, creation of ponding conditions, increased human and motor vehicle traffic and operations of the installed wind park facility. Public safety, Occupational safety and health hazards associated with the project are extremely significant and must be the first priority of site management as they pose potential threat to the safety and health of the workers. These hazards could be from falling and/or swinging objects, potential collapse of towers due to rainstorms or vandalism, falling from heights and snakebites.

Due to the nature of technology involved, the wind park operation and maintenance activities will be minimal. Nevertheless, there are potential occupational hazards with regard to work force engagement in both daytime and/or night-time activities albeit on a small scale. The nature of occupational hazards will include:

- ✓ Machine/equipment injury risk;
- ✓ Occupational noise and vibration;
- ✓ Fire risk;
- ✓ Risk of exposure to electro-magnetic radiation;
- ✓ The risk of electrical shock; and
- ✓ Miscellaneous hazards.

The significance rating of the impact of the project on community health, safety and security can be described as Low Negative (-2.25). Considering the number of workers involved at this stage, the intensity of this impact can be said to be Medium, the spatial extent of the impact will be local, the duration of the impact will be long term and reversible there is a low probability of the impact occurring.

8.2.6.4 Mitigation

Operation of the plant could have an impact on the public and workers through general operation activities and because of accidental spills and fires. During the construction, operation and decommissioning phases of the proposed project, the Client will mainly adopt the IFC Occupational Health and Safety (OHS) Guidelines for wind energy projects in the prevention of accidents, containment of health hazards and management of security and fire outbreaks among other contingencies in the project area. Appropriate warning signs will also be provided at the site where there is a risk to health and safety. The design of the substation includes mechanisms for ensuring the highest standard of safety and protection. A comprehensive fire detection and protection system will be installed to cover all equipment on site that could constitute a fire risk.

Even though the communities within the project area is a relatively peaceful area, land rights and acquisition issues usually become fraught with insecurity problems. This was experienced during the ESIA process where the consultant's specialists were attacked by a mob for being suspected trespassers on the land. The Client should therefore take precautions to beef up the security of the wind park and the staff quarters. There will be a need to hire services of the local guards. However, the local guards will need to be reinforced by a more professional security force from the leading security firms in Ghana. In addition, an alarm system should be installed as a backup for the above outlined security measures. Even more important, the project management should cultivate harmonious co-existence between itself and the local communities in the project area.

As stated in Section 6.13.7 of this report, the main source of fuel for cooking for most households in the municipality is wood and charcoal, also made from wood. Any increased population in the project area will make high demand of fuel wood resources. There is therefore a need for the provision of alternative source of energy during the implementation of the project to ensure that uncontrolled utilization woody resources does not take place in the project area. In addition, there will be a need to explore more efficient ways of making charcoal through efficient kilns and saving energy with efficient stoves such as the Gyampa Stoves. The project should encourage the local population through support of the relevant local CBOs to conserve the plant resources including participation in planting of trees and mangrove rehabilitation in the project area.

With the successful implementation of the above recommended mitigation, the low negative significance of this impact is expected to decrease to very low.

8.2.7 Traffic and Transport Impacts

8.2.7.1 Constructional Phase

The shipping port would be Tema and from there the transport distance to the sites would be around 160 km for Anloga. The main part of the route is on the N1 (Accra - Aflao road). The routes are shown in Plate 8-1[11]. The existing road network reaches close to the selected sites and only very few kilometres of access roads have to be built new for reaching the selected sites. Additionally, there is a small water crossing near Anloga and some turnings in the villages and settlements around Anloga may require the removal of existing small buildings. As an alternative to passing the villages, the construction of a new bypass road is under consideration.

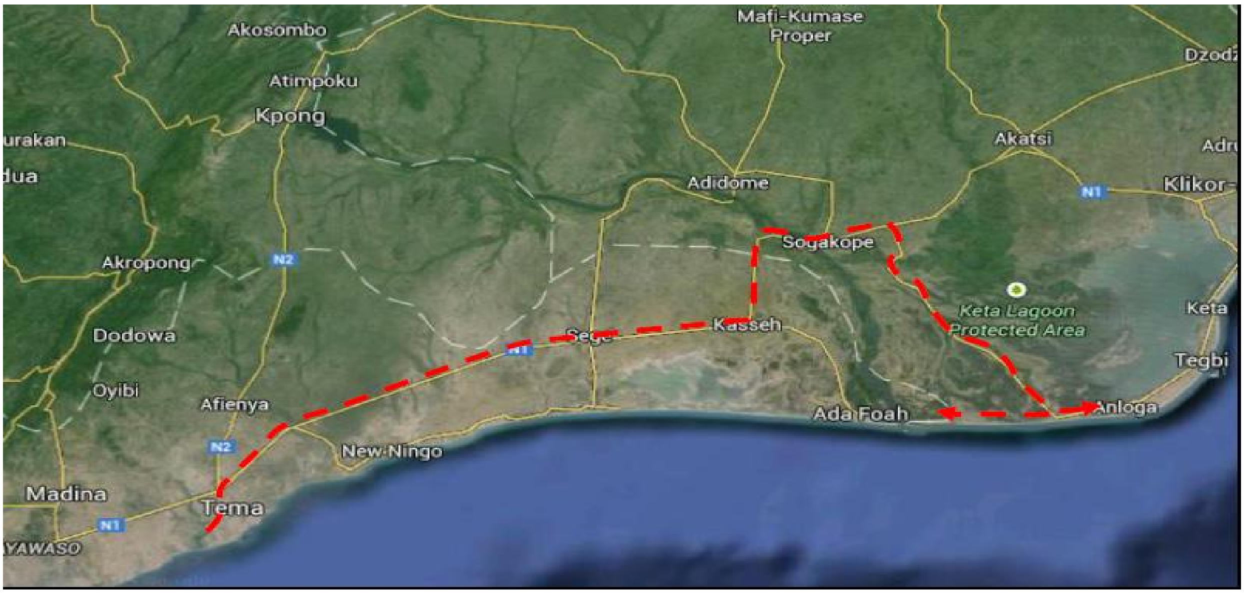

Plate 8-1: Project Transport Route

All roads are to be reviewed four (4) months before the start of the project. Work will commence with improvement of the access road connecting the site with the national Accra – Aflao Highway N1. Any dirt road to the identified sites will require widening, spreading gravel and compaction to upgrade/ build to a standard that is suitable for the 60-foot flat-bed trucks in good weather conditions. Lay-bys will be built at suitable points for ease of crossing. The roads within the project area shall be suitably compacted / strengthened to withstand the onset of torrential

[11] *Source*: Draft Feasibility Study for Anloga Wind Farm, August 2015

surface flow and land submergence/inundation. Since the entire project area is flat, road gradient will not be an issue. A truck test is to be performed after the road works are done.

The proposed sites are well served by public transport; the local bus service known as the Metro Mass, as well as short-hub transport, popularly known as “Tro-tro”, as well as taxis runs several times on the route. However, encroachment and traffic load on the designated road are not considerably heavy. Hence, traffic congestion during the construction phase will not be a major issue. However, suitable temporal segregation of traffic will be undertaken, in order to ease the load of traffic in the project area. Due to local movements/traffic inside villages, the proposed roads are to be crossed during night-time and all access roads within villages must be clear to allow the transports.

Equipment, supplies and personnel will move in and out from the site using the access road and the Accra – Aflao NI Highway. WTG components will require delivery via specialised heavy goods vehicles, which would be escorted along the public highway and upgraded access tracks. Heavy vehicles carrying the wind turbines and necessary equipment will operate from the Tema Port and take the link road to the NI Highway for onward journey to project sites site by the dirt road which will be upgraded to take the heavy load of towers (~162 tons), rotor blades (~60 tons), turbines (Nacelle ~82 tons), machinery and equipment. Analysis of the difficulties to be encountered on these routes has been performed and recommendations have been made on how to overcome them. Within this context, the access to the site of along the N1 shows no major obstacles, only small works are necessary at roundabouts and turnings to assure sufficient space without electricity poles, traffic signs, etc.

The site will receive many truckloads of fill material, construction materials daily for the constructional period. Concrete plant and some material (cabling, cement etc.) will be transported to the site via normal articulated heavy goods vehicles. Aggregate for tracks and foundations will be sourced from off-site quarries in proximity to the Project therefore no borrow pits are proposed. Building materials supply to the site would be frequent for sand, stones, cement, and blocks, especially during early stages of the construction period. In addition to this are the equipment and machinery, and this would be delivered to be project site, via road to the project sites.

The roadway and entrance/exit design, driver safety, and roadworthiness of the trucks are all important issues, as is the need to contain all garbage, trash and fluids in the load. In terms of total traffic generated by the construction phase, daily movements will be low. Transport of equipment and material would not require any specialised vehicles and would be highly minimal and therefore and does not have any impacts on the project. Administrative measures would have to be put in place to stagger the delivery of construction equipment and materials to the port sites.

There will also be traffic created by many of the workers who will drive to the site each day to work. The requirement will only be for the delivery of workers at the start and end of each day and the construction materials during the working day, both to the depots and to the construction sites.

There can be serious disruptions to local traffic and also accidents during the construction period. The significance rating of the impact of the project on community health, safety and security can be described as Medium Negative (-9.0). This may be as a result from the transportation of machinery and materials from Tema to the project site and the intensity of this impact can be described as high with both local and regional influence. It will be temporal and reversible in nature with a high probability of occurring.

8.2.7.2 Mitigation

The Client should develop a Traffic Method Statement (TMS) for the construction phase with the aim of minimizing disturbance to the nearby residents, industrial workers and general road users. The TMS will govern vehicle movements in and out of the site. The TMS will include, amongst other things details of signage requirements, transportation times etc. In addition, a health and safety management plan for all operating vehicles and machines.

To reduce/avoid any potential impacts in relation to traffic, the Client should ensure that:

- Local authorities are involved in defining optimum project traffic routes and times for transit;
- Defensive driving training will be provided to drivers;

- Speed limits will be enforced for heavy good vehicles and workforce transportation vehicles;
- The provision of site vehicle maintenance to ensure technical failures do not occur;
- Avoid densest areas of traffic, if possible, through planning and channelling of traffic.
- Install traffic safety signage at vantage points along access routes with the project sites. Install traffic calming measures (speed bumps and rumble strips) to slow traffic down where heavy vehicles cross or enter busy roads. Install traffic calming measures (speed bumps and rumble strips) to slow traffic down where heavy vehicles cross or enter busy roads.
- Engage communities on road risk and educate them through constant communications, road signals as well as with communications with the local authorities and community leaders
- Improve and enhance community sensitization on road traffic accidents within the project area.
- Install speed control limits for the project and ensure all vehicles comply with the site driving regulations.
- Develop and implement a “No Drinking” “No Alcohol” policy on site during both construction and operation. Monitor all vehicles and ensure they have a “No Alcohol” sticker. The same must be done for all construction equipment and machines. Monitor all vehicles and ensure they have a “No Alcohol” sticker. The same must be done for all construction equipment and machines.
- Conduct periodic and routine alcohol checks for all site drivers and site workers.

The Client should ensure coordination with the Ghana Highway Authority and Department of Urban Roads to minimise interference between installation and operation following guidelines of the “Road Reservation Management: Manual for Coordination” (June 2001). The Client should give a Notice of Work as outlined in Appendix 1 of the manual and this should be accompanied by a sketch of the location plan. Thus, in all cases, where the project will affect public roads due notification to the public and appropriate authorities (GHA, Urban Roads and/or Keta Municipality) will be given as required.

With the successful implementation of the above recommended mitigation, the medium negative significance of this impact is expected to decrease to very low.

8.2.7.3 Operational Phase

Currently, the road conditions of project area are in a very poor state. In order to facilitate smooth transportation of wind power equipment, the project will improve access roads to the wind turbines at the project site. The rehabilitated road will improve communication in the project area and promote economic activities. There may be some alterations in the existing road traffic movements associated with the operational phase of the project, however, in the long term, once the proposed power station is operational, the traffic generated will be small, and will not contribute significantly to the existing traffic volumes in the area. The additional traffic generated by the development can be accommodated by spare capacity in the existing highway network.

Approximately 20 technical persons on shift basis shall be hired for operations at the wind farm and power plant during operational phase. These staff will work a shift pattern, which combined with car sharing would result in a small increase of the order of about 5 vehicles arriving in any day. The increase in traffic would therefore be barely detectable within the day-to-day variation in the project area. As such, the operation of the wind power plant will not have a material impact on the operation of the existing roads. The operational phase of the scheme is not expected to have any significant impact on road safety. Severance, vibration, visual intrusion, driver delay will not be a significant impact. Nor will the operational phase of the project have a detrimental effect on pedestrian amenity.

The significance rating of the impact of the project on traffic and transport during project operations can be described as VERY LOW (-1.5). Taking account of the low overall total traffic movement that will occur, impacts are predicted to be low. The spatial extent of the impact will be local. The duration of the impact will be during the operational duration and long term and there is a low probability of the impact on occurring.

8.2.7.4 Mitigation

The Traffic Method Statement (TMS) developed for the construction phase will continue to be used for the operational phase. The TMS aims at minimizing disturbance to the nearby residents, industrial workers and general road users. In the long term, once the proposed power station is operational, the traffic generated will be small, and will not contribute significantly to the existing traffic volumes in the area Due to the reliability of such new plant, requirements for maintenance will be minimised, limiting the number of site visits necessary by maintenance staff. Car sharing will be encouraged. The additional traffic generated by the development can be accommodated by spare capacity in the existing highway network.

With the successful implementation of the above recommended mitigation, the very low negative significance of this impact is expected to remain very low.

8.3 POTENTIAL CUMULATIVE IMPACTS

Cumulative impacts are impacts on the environment that result when the effects of implementing the project's activities are added to the effects of other past, present and reasonably foreseeable future actions. Cumulative impacts are important because impacts of individual projects may be minor when considered in isolation but quite significant when the projects are viewed collectively cumulative impacts with existing and planned facilities may occur during construction and operation.

Currently there are no wind power projects in Ghana. However, in future the coastal area in the Volta and Greater Accra Regions are likely to be associated with the establishment of other wind power projects. There is the potential for cumulative effects to occur when considering the Project in conjunction with other operational wind farms in the area or those consented or in planning. The nearest for a similar wind power project will be the 76.5MW Wind Power Project 2 (Wokumagbe and Goi) to be in Wokumagbe and Goi communities in the Ada West District in the Greater Accra Region also belonging to the Client and those being implemented by one Upwind International AG in different stages of development within the same vicinity.

Cumulative impacts from operation of project will need to be considered in relation to the proposed developments.

At a national level, the impacts of the project as a whole had been considered in the context of effects on the national economy and compliance with national policy. The project will make a significant contribution to national energy policy by moderating Ghana's dependence on fuel based energy. It will also provide stable and economic energy supplies, enhancing the sustainability of existing industry in the country.

None of the wind farms is yet to be built and hence the socio-economic effects of each at the regional level are yet to be realised. Cumulative benefits are likely to result through land rent, community funding, employment and associated indirect impacts. When considering the proposed developments in conjunction with the Project, there is the potential for further benefits resulting from local employment and community funding. Should construction occur concurrently then temporary effects on recreational activities may be noted. As identified previously, measures will be employed during construction to minimise nuisance caused to users of local roads, for example cyclists and walkers. With mitigation in place, it is envisaged that cumulative impacts would be overall of low and of negligible significance.

From the wind feasibility studies for the project, the coastline of the Keta Municipal is well endowed with potential extractable wind power. Therefore, the prevailing suitable wind attributes in the area are likely to attract other developers to install wind park facilities near the project area. A situation where other wind development projects are established close to the project area, will lead to cumulative and long-term impacts in the project area, far beyond what has been predicted for this project. If this happens, the country in general and the project area are likely to be beneficiaries of cumulative positive impacts of the additional wind park facilities including further improvement in transportation, provision of employment and social benefits and enhancement of economic growth. However, increased projects close to the project area may enhance the negative impacts including loss habitats and biodiversity, increased pressure on natural resources, increased insecurity and unplanned settlements, visual intrusion and increased pollution among other negative impacts. In addition, the likely increase in incidences of HIV/AIDS and increased cultural contamination among the local community in the impacted area are likely to cause long-term and cumulative social impacts if no attempts are carried out to contain the situation at an early stage of project development.

8.4 IMPACTS OF PROJECT DECOMMISSIONING

Generally, the disposal of the turbine components during project de-commissioning has the potential to affect the environment. However, this may not be the case for the project area. It is likely that the turbine will be dismantled and re-exported, since 88% (by weight) of the turbine can be re-used. This means that the environment is spared extra extraction of non-renewable resources. However, there will be wasted energy used to break down the turbine from the project site. In addition, de-commissioning activities will cause some minor negative impacts on the flora and physical environment of the project area. Following the de-commissioning of the turbines, buildings belonging to the project will either be acquired by the Government or other selected stakeholders in the project area. It is important to note that the proposed wind farm will be in the project area for a long time. It is expected that after 20-25 years; new wind mills will replace the old ones. The project buildings will last about 50 years before they are replaced.

The project is expected to have similar impacts as the construction phase during decommissioning phase. Key negative impacts will be on Land Quality, Community, Health, Safety and Security as well as Traffic & Transport and the ratings of these impacts are outlined under Table 8-2. Mitigative measures proposed for the constructional phase for these impacts also pertains to the decommissioning phase.

Table 8-2: Ratings of Project Associated Negative Impact

Aspect/ Impact Pathway	Nature of Potential Impact/ Risk	Status	Spatial Extent	Duration	Consequence/ Intensity	Probability	Reversibility	Irreplaceability	Significance		Confidence Level
									Without Mitigation	*With Mitigation*	
CONSTRUCTIONAL PHASE											
Land Use	Loss of land for personal and commercial use	Negative	Site Specific	Long Term	High	Definite	Low	Moderate	High	Low	Medium
Land Quality	Land pollution	Negative	Site Specific	Temporal	Low	Low	High	Low	Very Low	Very Low	Medium
Land Acquisition	Loss of Properties	Negative	Site Specific	Long Term	High	Definite	Non-reversible	High	High	Low	High
Labour & Working Conditions	Reduction in productivity	Negative	Local	Temporal	Medium	Probable	High	Low	Low	Very Low	Medium
Historical & Cultural Heritage Resources	Destruction / loss of Historical & Cultural Heritage Resources	Negative	Local	Temporal	Medium Low	Probable	High	Low	Low	Very Low	Medium
Community, Health, Safety and Security	Injury to public	Negative	Regional	Temporal	High	High Probable	High	Low	Medium	Very Low	Medium
Traffic & Transport	Increase in traffic and road accidents	Negative	Regional	Temporal	High	High Probable	High	Low	Medium	Very Low	Medium

Aspect/ Impact Pathway	Nature of Potential Impact/ Risk	Status	Spatial Extent	Duration	Consequence/ Intensity	Probability	Reversibility	Irreplaceability	Significance		Confidence Level
									Without Mitigation	*With Mitigation*	
OPERATIONAL PHASE											
Land Use	Permanent loss of land for personal and commercial use	Negative	Site Specific	Long Term	Medium	Definite	Low	High	Medium	Very Low	Medium
Land Quality	Land pollution	Negative	Site Specific	Temporal	Low	Low probable	High	Low	Very Low	Very Low	Medium
Land Acquisition	Loss of Properties	Negative	Site Specific	Long Term	Medium Low	Definite	Non-reversible	High	Medium	Very Low	High
Labour & Working Conditions	Reduction in productivity	Negative	National	Temporal	High	Probable	High	Low	Medium	Very Low	Medium
Historical & Cultural Heritage Resources	Destruction / loss of Historical & Cultural Heritage Resources	Negative	Site Specific	Temporal	Low	Low	Low	Moderate	Very Low	Very Low	High
Community, Health, Safety and Security	Injury to public	Negative	Local	Medium	Medium	Low	High	Low	Low	Very Low	Medium
Traffic & Transport	Increase in traffic and road accidents	Negative	Local	Long	Low	Low	High	Low	Very Low	Very Low	High
DECOMMISSIONING PHASE											
Labour & Working	Reduction in	Negative	Local	Temporal	Medium	Probable	High	Low	Low	Very Low	Medium

Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence/ Intensity**	**Probability**	**Reversibility**	**Irreplaceability**	**Significance**		**Confidence Level**
									Without Mitigation	***With Mitigation***	
Conditions	productivity										
Community, Health, Safety and Security	Injury to public	Negative	Regional	Temporal	High	High Probable	High	Low	Medium	Very Low	Medium
Traffic & Transport	Increase in traffic and road accidents	Negative	Regional	Temporal	High	High Probable	High	Low	Medium	Very Low	Medium
Land Quality	Land pollution	Negative	Site Specific	Temporal	Low	Low	High	Low	Very Low	Very Low	Medium

9. CONCLUSION & RECOMMENDATIONS

9.1 CONCLUSION

Today the energy situation in Ghana is unsatisfactory as evidenced by the frequent unplanned power outages, an important circumstance which slows down the economic development in the country. Power produced by this project will largely change this situation. Nearly 43% of the power capacity in Ghana is based on hydropower. Over the last thirty years or so, the country has paid a heavy price for over reliance on hydropower due to poor rainfalls into the Volta Lake leaving power rationing in its wake. Reduction of hydropower production during the dry spells was compensated by increasing the power production of the diesel plants and of course rationing of power. This increased the cost of power production.

Comprehensive execution of the proposed wind power project will have far-reaching effects nationally and in the project area. This project will play a significance role in stimulating economic growth in Ghana. The power input will contribute significantly to the Ghana's Rural Electrification Programme, which has potential to promote spin-off effects on rural economy in Ghana. The project also has power export potential to the neighbouring countries including Togo and Benin as well as La Cote D'Ivoire. The extents of the predicted environmental and socio-economic impacts have been carefully examined at various stages of the project planning.

Based on the issues raised at the project briefings, status quo conditions of the study area and the nature of the proposed wind power project, the following socio-economic impacts are anticipated:

- Land Use
- Land Quality
- Traffic & Transport
- Compensation for Loss Property
- Labour & Working Conditions
- Historical & Cultural Heritage Resources

- Community, Health, Safety & Security

These identified impacts could be positive and negative. The project benefits are at both national and local levels. At the national level, the project benefits will include:

a) Diversification of power sources - Implementation of the project presents Ghana with an opportunity to rely less on the expensive fossil fuel fired powered alternatives;

b) Promotion of renewable energy and reduction of carbon dioxide equivalent for use in mitigating the country's emission commitments. The proposed project will achieve CO_2 emission reduction by replacing electricity generated by fossil fuel fired power plant connected to the national grid.

c) Stabilization of electricity access and reduction of power outage in Ghana - At its completion, the project is expected to add an extra 75 MW of power into the country's national grid. This will bolster the country's plan to expedite rural electrification programs in different parts of the country. The end result is an attendant multiplier effect on the socio-economic parameters of the whole country and stable power supply network;

d) Reduction of the cost of the power - The power generated from the project will cost far less than from any other existing sources on the long-term as its production cost will not increase thereafter. In effect, this implies that the project has the potential to usher the country into a low-power tariff regime in the end. This has not only a positive effect on the cost of the energy production but will also lead to economic gains through improved competitiveness;

At the local level, the positive benefits include:

a) Employment opportunities for the local community during the construction and operation phases of the project (e.g. masons, carpenters, cooks and indirect spins-off, such as livestock and fish trade, ecotourism, etc.);

b) The rehabilitation of existing road networks will facilitate the transportation of livestock and fish products to external markets;

c) The project will provide human and financial assistance in the development of health and education facilities through Corporate Social Responsibility by the Client in order to improve health conditions and literacy of local community, especially the marginalized groups, the women and the youth.

Against the above positive benefits brought about by the project, there will be some negative socio-economic impacts emanating from both the construction and operation activities of the wife power project, some of which are:

a) Economic displacement due to acquisition of land of an area of about 482.16 acres of land.

b) Visual intrusion because of project facilities such as the wind turbines,

c) Contamination of local culture due to influx of construction employees,

d) Increased conflicts and insecurity within the community,

e) Exploitation of natural resources,

f) Increased incidences of diseases such as HIV/AIDS

g) Potential challenges and impacts of labour force management, and

h) Increased accidents and occupational hazards.

9.2 RECOMMENDATIONS

Various recommendations have been proposed for the client to implement to ensure that proposed associated socioeconomic benefits are realised and impacts mitigated. Key amongst them include:

a) Design the wind power facility to good practice standards aiming at preventing releases and minimising its potential consequences such that any effects would be insignificant.

b) Keeping all communities abreast of all project development activities and they should sufficiently be consulted on all matters that concern them.

c) Preparation of a “**Compensation Action Plan**” in order to minimize the adverse effects of the land acquisition on individuals, communities and/or families or clans to ensure that the PAPs are compensated properly.

d) Development of a suitable programme of mitigation in the event of any significant chance finds in consultation with the Archaeology Department of the University of Ghana and the National Museums Board.

e) Application of relevant national policies, labour laws and codes of concerning employment conduct and local employment and sourcing policies are to be used to give priorities to people within the project affected areas.

f) Preparation of a Labour Management Plan as part of their Health, Safety & Environmental (HSE) Plan for the construction phase.

g) Provision of alternative source of energy during the implementation of the project to ensure that uncontrolled utilization woody resources does not take place in the project area. In addition, there will be a need to explore more efficient ways of making charcoal through efficient kilns and saving energy with efficient stoves such as the Gyampa Stoves.

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11. APPENDICES

Appendix 1: Background Information Document for the Wind Power Project

Appendix 2: Scoping Notice

Appendix 3: Pictures from Project Briefings

APPENDIX 1:

BACKGROUND INFORMATION DOCUMENT FOR THE WIND POWER PROJECT

APPENDIX 1 - SOCIO-ECONOMIC IMPACT ASSESSMENT STUDY

INTRODUCTION

The Volta River Authority in Ghana (hereinafter referred to as VRA) was established in 1961 with the main focus of the company being the generation and supply of electricity for domestic use in Ghana. VRA works with landowners, project developers, technology providers, regulators and investors to source and develop energy projects. Currently, the Government of Ghana has formulated a Renewable Energy (RE) Policy which aims to have 10% of Ghana's electricity needs come from RE by 2020. Subsequently, the Government passed a RE law in November 2011 to provide the necessary legal and regulatory framework to promote the sustainable development and utilization of RE resources for electricity and heat generation.

In line with this legislation, VRA has set a 5-10 year Renewable Energy (RE) generation capacity target taking into consideration the local and export demand as well as the current system's energy constraints. VRA's RE Development Programme Phase 1 (REDP1) aims at developing about 164 MW of installed renewable energy capacity before 2020. The program consists of three components, namely (a) a 150 MW Wind Power Project (Phase 1) (b) a 14 MW Solar Power Project (Phase 1), and (c) Renewable Energy Planning & Development Integration into the current energy plan.

VRA proposes to construct and operate two wind energy facilities as follows:

- 75MW Wind Power Project 1 (Anloga Extension) located at Anloga, Anyanui & Srogbe communities in the Keta Municipal in the Volta Region (Site A)
- 75MW Wind Power Project 2 (Wokumagbe and Goi) located in Wokumagbe and Goi communities in the Ada West District in the Greater Accra Region (Site B)

In accordance with the requirements of the Environmental Assessment Regulations, 1999 (LI 1652) and as outlined in the Environmental Impact Assessment (EIA) Guidelines for the Energy Sector, Volume 1, dated August 2010, the construction of wind energy facilities exceeding 20 hectares or exceeding an installed capacity of 15MW falls into the category for which an EIA Study is required. Seljen Consult and the Council for Scientific & Industrial Research (CSIR), a South African research council, have been appointed to undertake the ESIA process for the proposed projects.

An integrated Public Participation Process (PPP) will be undertaken for the proposed projects. Two separate Scoping Reports and two separate Environmental and Social Impact Assessment (ESIA) reports will be submitted to the Environmental Protection Agency (EPA) for decision-making.

WIND ENERGY FACILITIES

The proposed ***75 MW Wind Power Project 1*** will cover an area of approximately 177.46 ha (Site A). Site A is located east of the flat Volta River delta near the communities of Anloga, Srogbe and Anyanui on the coast in the Keta Municipality in the Volta Region. The electricity generated at the proposed ***Wind Power Project 1*** will be evacuated via a newly constructed 69/33 kV substation onsite and will be connected to the grid via a 69 kV overhead transmission line of approximately 37 km from the onsite substation to the Sogakofe Substation.

The proposed ***75 MW Wind Power Project 2*** will cover an area of approximately 193.31 ha (Site B). Site B is located within the Wokumagbe and Goi communities in the Ada West District of the Greater Accra Region. The electricity generated at the proposed ***Wind Power Project 2*** will be evacuated via a newly constructed substation onsite and will be connected to the grid via a new dedicated High Voltage transmission line to the existing grid.

STUDY AREA

The study area for the Scoping and Environmental & Social Impact Assessment consists of sites at Anloga, Srogbe and Anyanui communities for the 75MW *Wind Power Project 1* and Wokumagbe and Goi communities for the *Wind Power Project 2* which are 424 and 470 ha, respectively (Figure 1 and 2 below).

Figure 1 – Locality Map for the Proposed Development of 75 MW Wind Power Project 1 at Anloga, Srogbe and Anyanui (Anloga Extension) in the Keta Municipal, Ghana.

Figure 2 – Locality Map for the Proposed Development of 75MW Wind Power Project 2 at Goi and Wokumagbe in the Ada West District, Ghana.

WHAT DOES THE BACKGROUND INFORMATION DOCUMENT TELL YOU?

This Background Information Document (BID) provides you, as an Interested and Affected Party (I&AP), with the background information on the proposed projects as follows;

- A description of the ESIA and Public Participation Processes that will be undertaken for the proposed projects; and
- Details on how to register as an Interested and Affected Party (I&AP) to indicate your interest in the projects and receive further information.

If you register as an I&AP, there will be opportunities for you to be involved in the Scoping and ESIA Processes through receiving information, registering your interest on the project database, raising issues of concern and commenting on reports. Inputs from I&APs, together with the information and assessment provided by the Environmental Assessment Practitioner and relevant specialists, will assist the Environmental Protection Agency Board with their decision-making in terms of whether to grant or refuse an environmental permit for the proposed projects.

What do the projects entail?

The 75MW Wind Power Project 1 (Anloga Extension) and 75MW Wind Power Project 2 (Wokumagbe and Goi) will each consist of the main components listed below. The components and their dimensions will be discussed in the Scoping and the ESIA Reports that will be produced for each facility:

- Wind Energy Facilities
  - Wind turbines
  - Building infrastructure
  - Offices;
  - Operational control centre;
  - Warehouse/workshop;
  - Ablution facilities; and
  - Converter station.
- Associated Infrastructure
  - Electrical infrastructure (including transmission lines and substations);
  - Access roads;
  - Internal gravel roads;
  - Fencing;
  - Operation and Maintenance Area;
  - Laydown Area;
  - Stormwater channels; and
  - Water pipelines.

ENVIRONMENTAL AUTHORISATION

The applicable regulations that would be triggered in the context of the proposed projects are:

- The Constitution of the Republic of Ghana, 1992
- Environmental Protection Agency Act, 1994 (Act 490)
- Environmental Assessment Regulations 1999, LI 1652
- Renewable Energy (RE) Act, Act 832 of 2011
- Factories, Offices and Shops Act (1970) Act 328
- The Ghana Civil Aviation Act 678, 2004
- Road Traffic Acts, 2004, Act 683
- National Road Safety Commission Act 567 of 1999
- Road Traffic Offences Regulations, 1974 (Li 952).
- Ghana Civil Aviation Regulations (GCAR) part 1, LI 1818
- Labour Act No (2003) Act 651
- Labour Regulations, 2007 (LI 1833)
- New Lands Commission Act (2008) Act 767
- State Lands Regulations (1962) LI 230
- National Museums Decree (1969) NLCD 387
- National Land Policy, 1999
- National Biodiversity Strategy for Ghana, 2002
- Wetland Management (Ramsar Sites) Regulations LI 1999
- National Wetlands Conservation Strategy, 1999

The list of relevant regulations will be refined during the course of the Scoping and ESIA Processes, and other regulations triggered may be removed or added as applicable. The applicable project activities require environmental permit from the Environmental Protection Agency. The Scoping and ESIA Process needs to show the potential impacts of the proposed developments on the biophysical, social and economic environment. The steps in the Scoping and ESIA Process are outlined below.

Scoping and ESIA Process

The Scoping and ESIA Process being implemented can be summarised as follows:

Stage 1: Environmental Scoping:

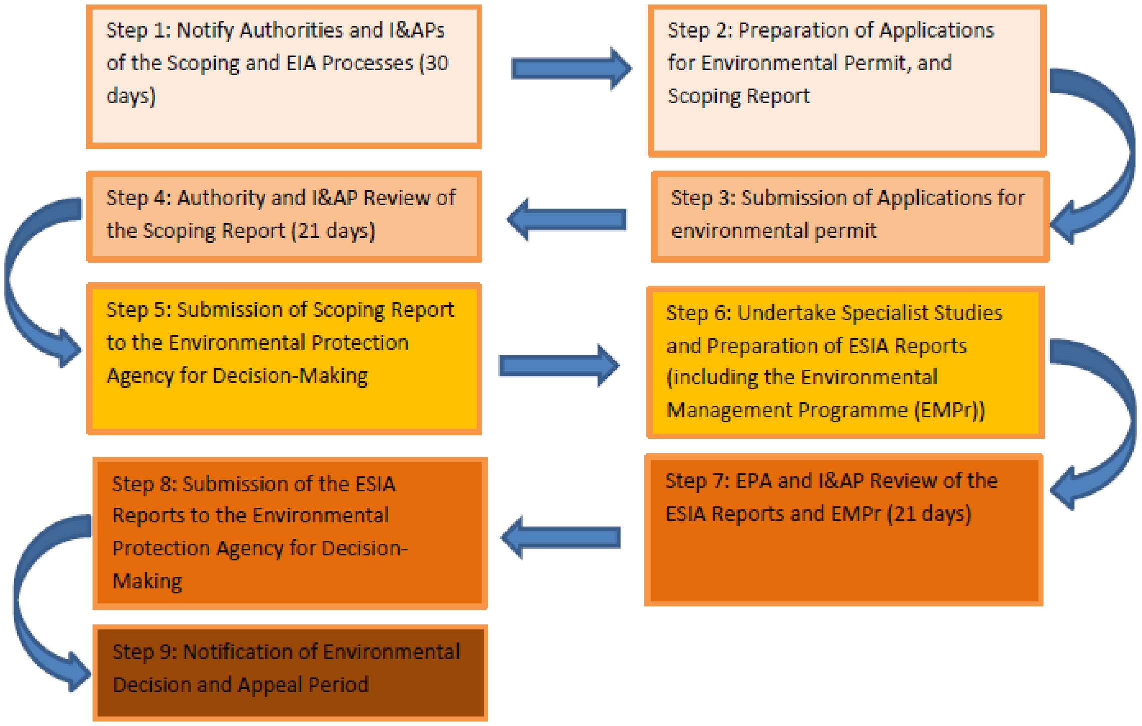
This Scoping Process is being planned and conducted in a manner that is intended to provide sufficient information to enable the authorities to reach a decision regarding the scope of issues to be addressed in the ESIA, and in particular to convey the range of specialist studies that will be included as part of the Environmental Impact Reporting Phase of the ESIA, as well as the approach to these specialist studies.

Stage 2: ESIA:

One of the purposes of this stage of the ESIA Process is to undertake specialist investigations to address the issues of concern that have been raised and identified through the Scoping Process. The following specialist studies have been identified, at this stage, to form part of the ESIA Phase of the proposed projects:

- Ecological Survey & Habitat Assessment Study;
- Historical Resources & Cultural Heritage Assessment;
- Landscape & Visual Intrusion Assessment;
- Aviation & Communication Impact;
- Compensation Action Plan;
- Noise and Flicker Impact Assessment

Public participation process



How can you get involved?

1. By responding to our invitation to register as an interested and affected party for this project.
2. By mailing or faxing a Comment and Registration Form to the Seljen Consult Limited (contact details provided below).
3. By telephonically contacting the Seljen Consult Limited if you have a query, comment, or require further project information.
4. By reviewing the various reports within the stipulated comment periods provided.
5. By attending any feedback meetings, which may be held during the review period.

Contact us:

To register as an I&AP, please complete the Comment and Registration Form included with this BID and kindly return to:

Name	Email	Mobile
Kofi Gatu	seljencon@gmail.com	+233-20-843-4557 / +233-24-206-3391
Dr. James Kojo Adomako	jadomak@yahooc.com	+233-20-818-0362 / +233-54-434-0346
Frank Cudjoe	cudjoefrank@yahoo.com	+233-50-973-8415 / +233-24-280-7339

Postal Address:
Seljen Consult Limited, P. O. Box AT 140, Achimota-Accra. Ghana-West Africa

REGISTRATION AND COMMENT SHEET:

Should you have any queries, comments or suggestions regarding the proposed 75MW Wind Power Project 1 (Anloga Extension) and 75MW Wind Power Project 2 (Wokumagbe and Goi) being developed by the Volta River Authority respectively in the Keta Municipality and Ada West Districts in Ghana, please note them below and return this sheet to:

Name	Email	Mobile
Kofi Gatu	seljencon@gmail.com	+233-20-843-4557 / +233-24-206-3391
Dr. James Kojo Adomako	jadomak@yahooc.com	+233-20-818-0362 / +233-54-434-0346
Frank Cudjoe	cudjoefrank@yahoo.com	+233-50-973-8415 / +233-24-280-7339

Please formally register me as stakeholder and provide further information and notifications during ESIA process		Yes	No
I would like to receive my notifications by:	Fax	Post	Email

Comments:

Please fill-in your contact details below for the project database:

Title & Name			
Organisation			
Telephone		**Fax**	
Mobile Phone		**Email**	
Postal Address			

Name	**Signature**	**Date**

SELJEN CONSULT	**Thank you for the Participation**	CSIR our future through science

MARCH 2016

APPENDIX 2: SCOPING NOTICE

36 Visit www.graphic.com.gh Daily Graphic, Tuesday, August 9, 2016.

SCOPING NOTICE

The Volta River Authority (VRA) intends to construct and operate two wind energy facilities as follows:

A. 75MW Wind Power Project 1 (Anloga Extension) located at Anloga, Anyanui & Srogbe communities in the Keta Municipal in the Volta Region

B. 75MW Wind Power Project 2 (Wokumagbe and Goi) located in Wokumagbe and Goi communities in the Ada West District in the Greater Accra Region

Notice of the proposed wind energy facilities is hereby served for public information, as required under the procedures for the conduct of EIA in accordance with Regulation 15 (1) of LI. 1652.

Any person(s) who have an interest, concern, or special knowledge relating to potential environmental effects of the proposed undertaking may contact or submit such concerns, etc., to:

The Chief Executive	AND	The Executive Director
Volta River Authority		Environmental Protection Agency
P. O. Box MB 77, Accra		P. O. Box M 326, Accra
Tel No: +233-302-664941-9		Tel No: +233-302-664697/8
Fax: +233-30-2662610		Fax No: +233-302-662690
Email: corpcomm@vra.com		Email: info@epa.gov.gh

Not later than 15th September, 2016

PUBLIC NOTICE

WARNING AGAINST SALE/PURCHASE & ENCROACHMENT OF LANDS WITHIN THE VOLTA GORGE PROTECTION ZONE

The Volta River Authority wishes to inform the General Public that by the Volta River Development Act (1961) Act 46, it is mandated to plan, execute, manage and ensure the protection of the lake side area of the Akosombo Dam.

In furtherance to this, the entire Volta Gorge measuring approximately 5,149.29 hectares has been designated as a protection zone hence no development can be carried out in this area without express permission from the Authority.

The said land is bounded on the West Bank of the dam by the Adjena, Anyaase, Dasaase, Pese, Gyakiti, Sawa townships, on the East Bank by Mpakadan, Anum and Dodi in the Akwamu, Anum and Boso Traditional Areas in the Asuogyaman District in the Eastern Region of the Republic of Ghana, on the North East by the Dodi Stool Land on the North West by the Pese Stool land on the South East by the Akosombo Dam and the South West by the Adjena Stool and.

The Authority hereby warns all prospective land purchasers to desist from purchasing lands within the Gorge Area as no development would be permitted. Any person who commences development activity will be prosecuted and the project demolished.

Persons who do not adhere to this directive do so at their own risk.

For further enquiries, please contact:

The Director, Real Estate & Security Department, VRA on 0302675168/0302660078 or the 8th Floor of the Heritage Tower Building, Ambassadorial Area, Accra from 8:00a.m. to 4:00p.m. during working hours.

VOLTA RIVER AUTHORITY

APPENDIX 3: PICTURES FROM PROJECT BRIEFINGS

CONSULTATIONS WITH LANDOWNERS

CONSULTATIONS WITH HEADS OF KETA MUNICIPAL ASSEMBLY

CONSULTATIONS WITH CHIEF AND ELDERS OF SROGBE

CONSULTATIONS WITH CHIEF OF ANYANUI

CONSULTATIONS WITH ELDERS OF GBLIFE-ANYANUI

CONSULTATIONS WITH BARTEH CLAN OF ANYANUI

MEETING WITH TOGBE GASU AND LANDOWNERS OF THE ANLOGA PROJECT SITE

CONSULTATION WITH MEETING WITH ELDERS OF XORSEKORDZI COMMUNITY

STAKEHOLDERS' FORUM

SPECIALIST CURRICULUM VITAE

1.0 PERSONAL DATA

Contact Address:	P. O. Box AT 427, Achimota, Accra
Mobile Number:	0208434557
Email:	kofigatu@gmail.com
Profession:	Environmental & Social Impact Practioner

2.0 SUMMARY PROFILE

Kofi Gatu has an educational background in Environmental Psychology, Human Resource Management and Local Government Administration, and now with over 10 years' experience in Environmental Assessments, primarily in the Leadership and integration functions. In this role, Kofi has conducted several research/data collation for input into several ESIAs for companies in order to strengthen their green credentials in the marketplace and protect the environment. His various roles have included stakeholder mapping/engagement, community mobilisations, identification and quantification of socio-economic issues, including legal implications for both project/property affected persons.

Kofi joined Moses Consulting Limited, an Environmental Consultancy firm , in 2007 as an Associate Consultant providing specific input into the coordination of Environmental Scoping, Environmental Impact Assessment (EIA) studies, Environmental Auditing as well as the production of Environmental Management Plans (EMP) and Environmental Progress Reports, as part of compliance of relevant regulatory bodies and organizations.

In 2009, Kofi joined Seljen Consult Limited as Technical Director of the company. His various roles and responsibilities has now gained him immense expertise in project design and management, proposal development, social survey, establishments of grievance mechanism/ resolutions, scientific/environmental research involving data collection and analysis, stakeholder analysis and their appraisal for input into ESIA reports, including facilitating the processes of acquiring Environmental Protection Agency permits and certificates.

Kofi is now proficient in application of sustainable development concepts and the use of both local (AKOBEN Rating) and International Standards Organisation (ISO) Principles (ISO 9,000, 14,000 & OHSAS 18,000) for effective management of the environment and the qualitative production of goods and services for clients, especially in the extraction, utilities, processing, recycling, mining, manufacturing and production in line with both Ghanaian and international safeguard requirements, such as the IFC, World Bank, Equator Principles, etc.

3.0 EDUCATION

2012- 2014:	MA in Local Gov't Administration and Organization: Institute of Local Government
2010 -2012:	MSc. Environmental Psychology: University of the Rockies, Denver Colorado-USA
2006-2008	Bachelor in Business Studies Management (Human Resources Managements): Wisconsin International University College
2002 -2005:	BA Psychology with Philosophy: University of Ghana

4.0 EMPLOYMENT RECORD

Employer:	Seljen Consult Limited
Period:	January 2009 – Till Date
Position:	Technical Director
Job Functions:	Project Design & Management, Proposal Development, Coordinating activities for acquisition of Environmental permits for clients.
Employer:	Moses Consulting Limited
Period:	July 2007 - January 2009
Position:	Associate Consultant
Job Functions:	Conducting Environmental Scoping, Environmental Impact Assessment (EIA) studies, Environmental Auditing/Due diligence as well as the production of Environmental Management Plans (EMP) and Environmental Progress Reports, for clients as part of compliance of relevant regulatory bodies and organizations.

RECENT CONSULTANCY ASSIGNMENTS:

1. Preliminary Environmental Assessment for Achimota-Mallam Transmission Line Upgrade Project, Ghana Grid Company Limited, March 2012

2. Environmental & Social Impact Assessment for the Construction of Community Senior High School Project , Ministry of Education –World Bank Funded Project in the Greater Accra, Eastern and Volta Regions, September to December 2014.

3. Health Impact Assessment for Romex Mining Resources, Amoamang, Upper Denkyera West District. November 2013

4. Preliminary Environmental Assessment for Prestea-Bogoso Transmission Line Upgrade Project, Ghana Grid Company Limited, March 2012 (in progress)

5. Proposed 401 Eastern Corridor Transmission Line, GridCo

6. Environmental & Social Impact Assessment (ESIA), P.W. Ghana Limited Quarry Project, Shai Hill, Feb 2014

7. Environmental & Social Impact Assessment (ESIA), P.W. Ghana Limited Estate Airport Project

8. Preliminary Environmental Assessment, Volta River Authority Water Restructuring Project, selected Resettlement Communities

9. Environmental & Social Impact Assessment, Community Water & Sanitation Water Restructuring Project, Asutsuare.

SPECIALIST DECLARATION

I, Kofi Gatu, as the appointed independent specialist, hereby declare that I:

- I act as the independent specialist in this application;
- I perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the any Acts, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Acts, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- I realise that a false declaration is an offence

Signature of the Specialist:

Name of Specialist: Kofi Gatu

Date: September 30, 2017

Environmental & Social Impact Assessment

for the proposed development of a Wind Energy Facility in Anloga Extension (WPP1)

APPENDIX 2:

Terrestrial Ecology Impact Assessment Study

TERRESTRIAL ECOLOGY IMPACT ASSESSMENT:

Scoping and Environmental and Social Impact Assessment for the proposed Development of the 76MW Wind Power Project situated at Anloga, Srogbe & Anyanui (Anloga Extension) in the Volta Region of Ghana

Report prepared for:	*Report prepared by:*
Seljen Consult Limited P. O. Box AT 140 Achimota-Accra Ghana-West Africa CSIR – Environmental Management Services P O Box 320 Stellenbosch, 7599 South Africa	Dr. James Kojo Adomako Department of Botany University of Ghana P. O. Box LG 55 Legon Tel: 054-434-0346 Email: jadomako@ug.edu.gh

DECEMBER 2017

EXECUTIVE SUMMARY

Dr James Kojo Adomako was appointed by Seljen Consult Limited to conduct an assessment of the potential impacts on Terrestrial Ecological resources that might occur through the proposed construction, operation and decommissioning of a 76 Megawatt (MW) Wind Energy Facility in Anloga Extension (WPP1) areas in the Greater Accra region, Ghana. Two layout alternatives were considered in this study.

The aim of the study was to identify the presence of terrestrial flora and fauna species and sensitive areas in the study area and to inform the Environmental Management Plan (EMP) developed as part of this ESIA to assist VRA in managing the discovered ecological resources in a responsible manner, to protect and preserve them.

The following three main vegetation types were encountered in the study areas:

- Coastal grassland and thicket
- Estuarine mangrove
- Lagoon margin

Seventy-four (74) species belonging to 43 families and 69 genera were identified in the study area. The family represented by the greatest number of species was Gramineae with 8 species. This was followed by Cyperaceae and Rubiaceae with 6 species each. All other families recorded were represented by less than 6 species.

The mangrove habitat is composed of *Rhizophora Sp, Avicennia germinans* and *Conocarpus erectus* which are listed as Least Concern by IUCN but show decreasing population trends globally. The Thicket vegetation harbours species such *as Ritchiea reflexa* (Gold star species), *Sansevieria liberica* and *Uvaria chamae* which are restricted to the coastal scrub and thicket vegetation zones of Ghana. These habitats are therefore critical.

Some of the fauna that are known to occur in the area enjoy some level of protection under Ghana's wildlife laws. The rare Sitatunga (*Tragelaphus spekii*) is known to exist in the Keta lagoon complex. Also of significance are the Nile monitor (*Varanus niloticus*), and several snake species.

The key impacts (medium significance without mitigation) identified during this assessment are as follows:

Construction phase

- Potential loss of protected and listed species associated with the clearing of vegetation.
- Removal of mangrove vegetation and brackish water swamp vegetation lagoon margin can cause intense evaporation of water body and destruction of habitats.
- Compacting of soils leading to death and displacement of some faunal and microbial species as well as to the competition of some plant species over others.
- Harsh chemical control measures may be used which might have negative impacts on non-target plant species and the environment.
- Disturbance of fauna during construction activities and opportunistic animal species may benefit from the construction activities.

Operation phase

- Noise, Accidents and Disturbance of fauna during the operation of the proposed wind turbines.

The above impacts are anticipated to be of low significance following the effective implementation of key recommended mitigation measures. All other impacts on flora and fauna associated with the construction, operation and decommissioning of the proposed project have been assessed to be of low/very low significance without and with mitigation measures. Both layouts (preferred and alternative layout) are anticipated to lead to the same level of impacts.

The following key management actions are recommended to be implemented:

- Where possible, species of conservation concern are to be identified prior to construction and adequate measures taken to protect them. Such species could be translocated to safe areas in the project area or their propagules collected and replanted outside the project impact areas.

- Ensure that camp sites, lay down areas and other temporary areas are located in areas of low sensitivity and that they are clearly demarcated
- Demarcate construction and no go areas and keep clearing to a minimum.
- Ensure a rehabilitation and re-vegetation programme is effectively implemented.
- Compile and implement an invasive or alien species management programme.
- Construction of new tracks should be kept to the barest minimum and the use of existing roads should be encouraged.
- Mechanical control should be used for all vegetation clearing.
- Minimised compaction by minimising the number of passes of heavy trucks to and from the project sites.
- Adopt a faunal rescue plan and prohibit hunting/poaching activities.
- Ensure a good housekeeping during construction activities and all vehicles at the site should adhere to a low speed limit.

The preferred layout is recommended since the alternative layout would not lead to any significant reduction of the anticipated impacts.

LIST OF ABBREVIATIONS

CITES	Convention on international trade in endangered species of wild flora and fauna (Appendices, 1975)
EI	Economic Index
GHI	Genetic Heat Index
IUCN	International Union for Conservation of Nature
kV	Kilo Volts
MW	Mega Watts
NWC	National wildlife conservation regulations (Schedules, 1995)
PI	Pioneer Index
VRA	Volta River Authority

GLOSSARY

DEFINITIONS	
Alien Invasive species	These are species whose introduction and/or spread outside their natural past or present distribution threaten biological diversity
CITES Appendix 1	Threatened species which cannot be traded in
CITES Appendix 2	Species for which levels of trade are limited
NWC Regulations Schedule 1	The hunting, capturing or destroying of these species is prohibited at all times
NWC Regulations Schedule 2	The hunting capturing or destroying of these species is absolutely prohibited between 1st August and 1st December of any season. The hunting, capturing or destroying of any young animal, or adult accompanied by its young, of these species is absolutely prohibited at all times
Duration	The timeframe during which the risk/impact will be experienced
Economic Index	EI reflects the degree to which economic species occur in a sample
Endangered	In danger of extinction, and survival unlikely if the causal factors continue operating

DEFINITIONS	
Flora	Flora is the plant life occurring in a particular region or time, generally, the natural occurring or indigenous (native plant life)
Genetic Heat Index	GHI is a score reflecting how much of a biodiversity hotspot a sample of vegetation is. GHI is calculated in terms of the concentration of globally significant species in the sample, weighted by the degree of rarity
Indeterminate	Known to be “Endangered” or “Vulnerable”, but there is not enough information to say which category is appropriate
Least Concern	Does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened
Magnitude	The anticipated severity of the impact
Pioneer Index	PI reflects the degree to which pioneer species occur in a sample
Pioneer species	Hardy species which are the first to colonize previously disrupted or damaged ecosystems, beginning a chain of ecological succession that ultimately leads to a more bio diverse steady-state ecosystem.
Probability	The chance of the impact/risk occurring
Rare	Small localised world populations, and therefore at risk, but are currently not “Endangered” or “Vulnerable”
Significance	Will the impact cause a notable alteration of the environment?
Spatial extent	The size of the area that will be affected by the risk/impact
Species	A group of living organisms consisting of similar individuals capable of exchanging genes or interbreeding.
Vulnerable	Believed likely to move to “Endangered” category, if the causal factors continue operating

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TERRESTRIAL ECOLOGY IMPACT ASSESSMENT

1. INTRODUCTION & METHODOLOGY

Dr James Kojo Adomako was appointed by Seljen Consult Limited to conduct an assessment of the potential impacts on Terrestrial Ecological resources that might occur through the proposed construction, operation and decommissioning of a 76 Megawatt (MW) Wind Energy Facility in Anloga Extension (WPP1) (Figure 1) areas in the Volta region, Ghana.

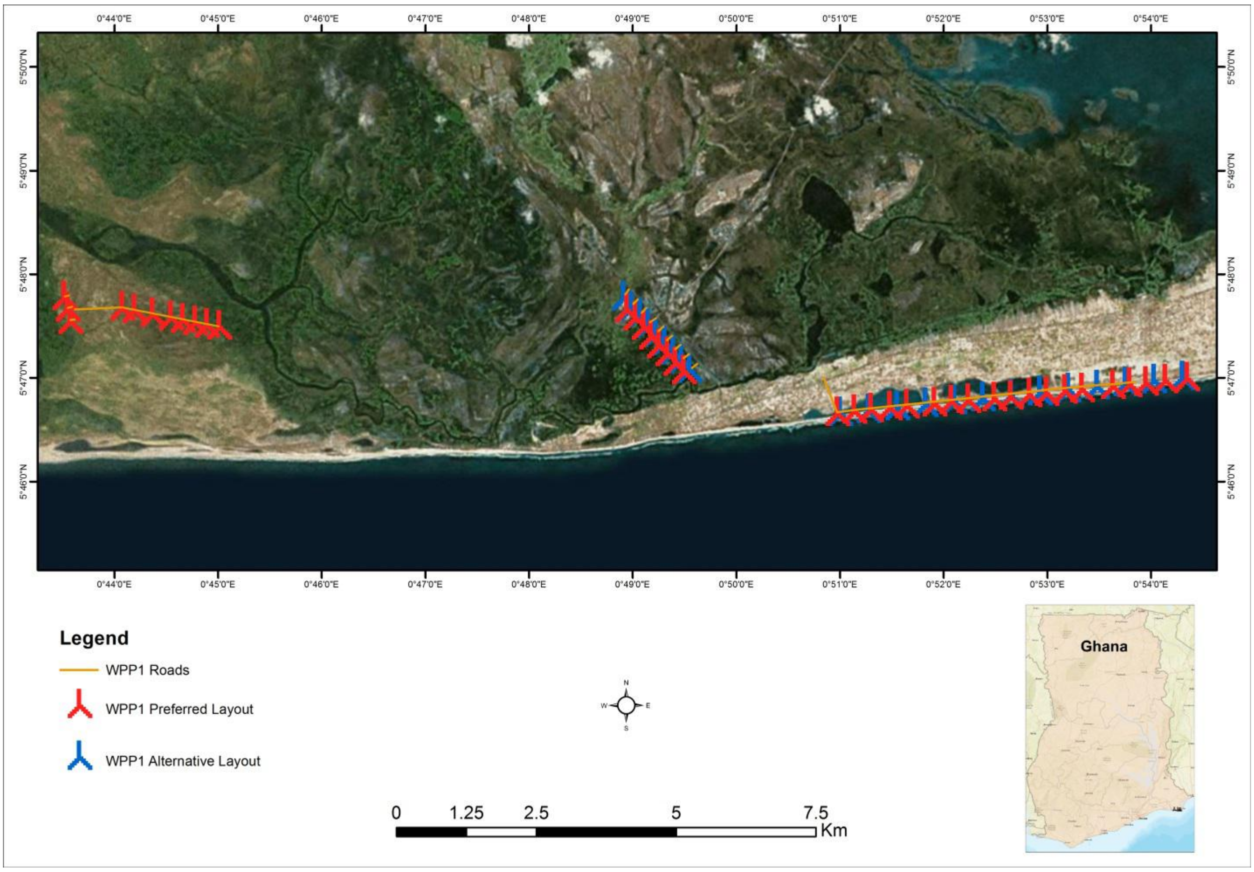

Figure 1: Location of the site for WPP1 with preferred and alternative layouts

The aim of the study was to identify potential terrestrial flora and fauna species and sensitive areas that may occur in the study area. This study aims to inform the ESIA in the development of a comprehensive Environmental Management Plan (EMP) to assist VRA in managing the discovered ecological resources in a responsible manner, to protect and preserve them.

2. TERMS OF REFERENCE

The assessment of the current ecological status of the proposed project site as well as impacts associated with the proposed project was undertaken in line with IFC PS 6 and World Bank OP 4.04. The scope of work was based on the following broad Terms of Reference which have been specified for this specialist study:

- List the prominent plant species (trees, shrubs, grasses and other herbaceous species of special interest) present for vegetation unit and ecosystem delimitation and determine the spatial distribution of native vegetation patches across the site.

- Identify plant and animal/fauna species (including bats) of conservation importance; which could possibly occur at the site.

- Assess impacts of the proposed wind development on terrestrial ecology, including loss of habitat and habitat fragmentation, potential risks for erosion, impacts on potential ecological corridors, loss of ecosystems services, etc.

- Make recommendation on the suitability of the proposed site for the project regarding the extent of impacts on ecology.

3. PROJECT DESCRIPTION

Any aspect of a development that disturbs the ground (e.g. foundations, roads, trenches and superstructures (e.g. wind turbines, buildings, fences)) would introduce impacts on terrestrial ecology. This project referred to as WPP1 will have the following main components which will impact on terrestrial ecology:

- **Wind turbine area**
  - Wind turbines;
  - Hard standing areas
- **Building Infrastructure:**
  - Offices;
  - Operational and maintenance control centre;
  - Warehouse/workshop;
  - Ablution facilities;
  - Converter/Inverter stations;
  - On-site substation building; and
  - Guard Houses.
- **Associated Infrastructure**
  - Access roads;
  - Internal gravel roads;
  - Fencing;
  - Storm water channels; and
  - Temporary work area during the construction phase (i.e. laydown area).

Detailed project descriptions can be found in Chapter 3 of this ESIA report.

4. APPLICABLE LEGISLATION AND PERMIT REQUIREMENTS

Table 1 briefly describes the legislation and permit requirements pertaining to fauna, flora and its related resources in Ghana, and how it applies to the proposed project.

Table 1: Policy and Legal Frameworks applicable to this project

Policy and Legal Framework	Summary of Core Requirements	Relation to Project
Biodiversity Strategies and Action Plan, 1998	An action plan to ensure sustainable use of the country's biological resources as enshrined in the Convention on Biological Diversity.	This project may cause the loss of some biological resources at the construction phase and should thus be guided by this Action plan.
Economic Plants Protection Act, 1979	An Act to provide for the prohibition of the destruction of specified plants of economic value and for related matters.	Destruction of economic plants listed in this framework during the construction phase of this project will be an offence.
Environmental Assessment Regulation, 1999, LI 1652	An Act which ensures that all projects conform to Environmental safety regulations of Ghana	This project may have a short to long term impact on the local and regional environment; hence should be regulated by the provisions of this Act.
Pesticide Control and Management Act, 1996	An Act to provide for the control, management and regulation of pesticides in Ghana and to provide for related matters.	This project should be guided against the use of pesticides.
Rivers Act, 1903	An Act to regulate the use of certain rivers and to provide for related matters.	Gallery vegetation of river bodies in and around the project site should be protected in compliance to the rivers Act.
Timber Resource Management Regulations, 1998	An Act which regulates how timber resources are accessed and used.	Destruction of timber resources in any forest reserve in relation to this project without permit will be an offence to the Republic of Ghana.
Wild Animals Preservation Act 1961 (Act 43)	An Act to consolidate and amend the law relating to wild animals, birds and fish and to continue the observance of the Convention signed at London on nineteenth day of May, 1900.	Required in this project to protect habitats of wild animals.
Wildlife Conservations Regulations, LI 685, 1971 (and Amendments)	A legislative instrument for restrictions on wildlife destruction and hunting, game licencing and export of game and trophy.	The project should be guided against the destruction of habitats of wild animals and the killing of animals listed in the wholly or partly protected category of this legal framework.

5. METHODOLOGY

The methodology used in this study to determine the potential impacts of the proposed wind facility and associated infrastructures on terrestrial ecology included:

- a desktop study; and
- a field survey.

5.1 LITERATURE SURVEY AND INFORMATION SOURCES

A literature review was conducted to access existing information on the flora and fauna of the project area and to ascertain the broad vegetation types of the study area. The literature consulted included Taylor (1960), Hutchinson and Dalziel (1954-72) and Hall and Swaine (1981).

5.2 FIELD SURVEY

The following objectives were set for the field survey:

- To determine the spatial distribution of native vegetation patches across the site.
- To determine the presence of faunal species
- To record GPS locations of Sample point positions.
- To determine critical terrestrial ecological features that would be affected negatively by the proposed project.

5.2.1 Flora inventory

A reconnaissance walk along access routes crisscrossing the study area and along the external boundaries was undertaken to obtain an overview of the extent, topography and complexity of the vegetation. A rapid assessment of vascular plant species was conducted in the proposed site for

WPP1 near the communities of Anloga, Srogbe and Anyanui on the coast in the Keta Municipality in the Volta Region. Due to the low diversity in the project area, the sample sweep method (large circular quadrats – 20m radius) was used. A total of twelve 20 m radius sweep sample plots (7 plots in Anloga, 6 plots in Srogbe and 8 plots in Anyanui) were studied at the proposed project site (Table 2). The locations of the sample plots are shown in Figure 2 below.

Table 2: Coordinates and elevations of sampling locations

Sample number	Coordinates
ANLOGA	
A1	Lat N 5.783033; Long 0.899678
A2	Lat 5.784303; Long 0.899223
A3	Lat 5.782216; Long 0.893457
A4	Lat 5.783388; Long 0.893454
A5	Lat 5.782239; Long 0.88242
A6	Lat 5.781515; Long 0.88278
SROGBE	
B1	Lat. 5.802684; Long 0.811177
B2	Lat 5.800958; Long 0.811958
B3	Lat 5.801151; Long 0.810827
B4	Lat 5.799749; Long 0.808675
B5	Lat 5.795516; Long 0.805467
B6	Lat 5.791953; Long 0.805131
ANYANUI	
C1	Lat 5.803827; Long 0.726517
C2	Lat 5.801594; Long 0.727287
C3	Lat 5.800936; Long 0.725271
C4	Lat 5.800883; Long 0.723509
C5	Lat 5.795467; Long 0.728145
C6	Lat 5.794208; Long 0.726196

Figure 2: Sample plot locations

Specimens of species that could not readily be identified in the field were identified in the Ghana Herbarium, in Accra. Nomenclature follows the Flora of West Tropical Africa (Hutchinson and Dalziel, 1972). The conservation status of the species encountered were defined using the IUCN category and the star rating system adopted in the Forest Reserves of Ghana Geographic Information Exhibitor manual (Hawthorne, 1995) (Table 3).

Table 3: IUCN Star Rating categories

Rating	Description
Black Star species	Species rare internationally and at least uncommon in Ghana; urgent attention to conservation of populations needed
Gold Star species	Fairly rare internationally and/or locally
Blue star species	Widespread internationally but rare in Ghana or vice-versa
Scarlet star species	Common, but under serious pressure from heavy exploitation
Red Star species	Common, but under pressure from exploitation
Pink Star species	Common and moderately exploited. Also non-abundant species of high potential value
Green Star species	No particular conservation concern, common in Ghana

The proportions of species in the various categories were estimated and used in commenting on the conservational significance of the area.

The Bioquality of the study area was assessed using the Genetic Heat Index (GHI), the Economic Index (EI) and the Pioneer Index (PI), allowing prioritising the sites for various land uses (Box 1) (Hawthorne & Abu-Juam, 1995).

- A high Genetic Heat Index signifies that the area is of greater conservation priority and relatively rich in rare species such that loss or degradation of the area would represent a highly significant decline of genetic resources from the world and in Ghana in particular.

- A high Economic Index signifies that the area of the sample has a high priority for greater protection from, or at least more fine-grained control of, exploitation.

- A high Pioneer Index signifies that the area is well populated with pioneer species. Samples plots dominated by pioneer species are usually disturbed areas at the onset of ecological succession.

Box 1. Calculation of GHI, PI & EI

$$\mathbf{GHI} = \frac{[(BkS \times BkW) + (GS \times GW) + (BuS \times BuW)]}{N} \times 100$$

where:

BkS = Number of Black star species

BkW = Weight applicable to Black star species

GS = Number of Gold star species

GW = Weight applicable to Gold star species

BuS = Number of Blue star species

BuW = Weight applicable to Blue star species

N = Total number of species in a sample

NB. Black, Gold & Blue star weights are: 27, 9, 3 respectively

$$\mathbf{PI} = \frac{[(Pioneers \times Pw) + (NPLDs \times NPLDw)]}{N} \times 100$$

where:

Pw = Pioneer weight

NPLDw = NPLD weight

N = Total number of species in a sample

NB. Pioneer and NPLD weights are 2 & 1 respectively

$$\mathbf{EI} = \frac{[(SC \times SCw) + (RD \times RDw) + (PK \times PKw)]}{N} \times 100$$

where:

SC = Number of Scarlet star species

RD = Number of Red star species

PK = Number of Pink star species

SCw = Scarlet star weight

RDw = Red star weight

Pkw = Pink star weight

N = Total number of species in a sample

NB. Scarlet, Red and Pink star weights are: 3, 2 & 1 respectively

5.2.2 Faunal inventory

Four main methods were used in the faunal survey:

- direct/opportunistic observation,
- identification of animal spoors,
- interviews, and
- desk surveys of available literature (Hughes & Barry, 1969; Serle et al., 1992; Delany & Happold, 1979; Kingdon, 1987; Hughes, 1988; Haltenorth & Diller, 1988; Larsen, 1994).

Direct/opportunistic observation involved recording any animal sightings or animal trails while driving or walking within the project area. Transect walks to spot animal spoors (any sign left by a living animal, such as feeding sites, regular pathways, tracks, footprints, faecal pellets, nests, etc.) were also undertaken. Some individuals in villages within the project area were also interviewed to gather information about the fauna of the area. The interviews focused mainly on the various animals that commonly occurred in the area and their relative abundance.

5.3 ASSUMPTIONS AND LIMITATIONS

As a result of the use of random sweep sampling method, minor outliers within the site may not have been evaluated. The random sampling method, if correlated to topography and other aspects, is however a robust method of evaluating habitat across a large area. Upon the finalisation of the detailed design of the proposed project, an evaluation of the final footprint should be undertaken (subsequent to the issuing of an Environmental Permit (should one be granted for the proposed project) and upon completion of the detailed engineering prior to the commencement of construction).

6. DESCRIPTION OF THE AFFECTED ENVIRONMENT

6.1 GENERAL VEGETATION OF THE STUDY AREA

The project area lies in the coastal guinea savanna zone, which stretches from the east of Accra to the Western tip of Nigeria. This coastal guinea savanna zone interrupts the Upper Guinea forest ecosystem which occupies the coastal region of West Africa. The extent and quality of the Upper Guinea forest have declined considerably in response to human influences, notably growth of cities and agriculture.

The existing natural vegetation of the project area is a mosaic of Coastal Thicket and Grassland as well as Lagoon margin and Estuarine Mangrove. The sand bar above the highwater mark has a narrow stretch of Coastal Strand Vegetation.

At the Anloga site, the existing vegetation is a patchy and degraded coastal strand and thicket vegetation on the sandbar (Plate 1). Some of the species encountered in the strand are *Cyperus maritimus, Remirea maritima, opuntia vulgaris, Ipomoea pes-caprae* and *Diodia vaginalis*. The thicket clumps associated with the strand have species such as *Chrysobalanus orbicularis, Flacourtia flavescence, Sansevieria liberica* and *Azadirachta indica* (Plate 2). Vegetable cultivation (Pepper, shallots, okra) occurs beyond the sandbar (Plate 3).

Plate 1: Patchy strand vegetation on sandbar at Anloga

Plate 2: Poorly developed thicket clumps on the sandbar at Anloga

Plate 3: Vegetable (Onion and Pepper) farm in low lying area beyond the sandbar at Anloga

The existing vegetation at the Srogbe site consists of expansive brackish water swamp (Plate 4), dominated by *Cyperus articulatus* and *Typha domingensis*, with scattered mangrove and thicket. The mangrove vegetation is composed of *Rhiziphora sp*, *Avicennia germinans*, *Conocarpus erectus*, *Paspalum vaginatum* and *Acrostichum aureum* (Plate 5). The well drained areas at the site have degraded thicket vegetation with species such as *Azadirachta indica*, *Zanthoxylum xanthoxyloides*, *Borassus aethiopum*, *Cassytha filiformis*, *Elaeis guineensis* and *Ritchiea reflexa* (Plate 6).

Plate 4: Brackish water swamp with expansive coverage of *Cyperus articulatus* at Srogbe

Plate 5: Grassland with isolated clumps of *Rhizophora* sp.

Plate 6: Grassland with thicket clump dominated by *Borassus aethiopum* at Srogbe site

The Anyanui site consists of grassland and thicket vegetation (Plate 7) as well as mangrove. A woodlot and a sacred grove (Plate 8) are located within the project site. The woodlot is composed of mainly *Acacia mangium*. The grassland and thicket is composed of species such as *Sporobolus pyramidalis, Imperata cylindrica, Panicum maximum, Securinega virosa, Dialium guineense, Byrsocarpus coccineus, Flacourtia flavescens, Allophyllus africanus* and *Waltheria indica*. The mangrove vegetation and brackish water swamp is composed of species such as *Typha doimngensis, Acrostichum aureum, Avicennia germinans, Rhizophora sp., paspalum vaginatum, Cyperus ariculatus* and *Sesuvium portulacastrum* (Plate 9). The mangrove swamps are sensitive habitats that require conservation action. Some species such as *Ritchiea reflexa* have restricted habitat which is threatened in Ghana.

Plate 7: Grassland with thicket on well-drained soils at Anyanui

Plate 8: Sacred grove at Anyanui

Plate 9: Mangrove swamp with *Paspalum vaginatum* (foreground), *Acrostichum aureum* (mid ground) and *Rhizophora sp*. (background).

6.2 FLORISTIC COMPOSITION OF THE STUDY SITES

74 species belonging to 43 families and 69 genera were identified in the study area. The family represented by the greatest number of species was *Gramineae* with 8 species. This was followed by *Cyperaceae* and *Rubiaceae* with 6 species each. All other families recorded were represented by less than 6 species. In all, leguminous families (*Caesalpiniaceae*, *Mimosaceae* and *Papilionaceae*) had a combined total of 7 species.

A list of all the plant species along with their families, life form, Star rating and IUCN status encountered in the study areas is presented in Table 4.

Table 4: Plant species encountered in the Study Sites

SPECIES	FAMILY	LIFE FORM	STAR RATING	IUCN STATUS
Abrus precatorius	Papilionaceae	Climber	Green	NA
Acacia mangium (E)	Mimosaceae	Tree	NE	NA
Acrostichum aureum	Pteridaceae	Herb	NE	LC
Agave sisalana	Asparagaceae	Herb	NE	NA
Allophyllus africanus	Sapindaceae	Tree	Green	NA
Amaranthus spinosus	Amaranthaceae	Shrub	NE	NA
Andropogon gayanus	Gramineae	Herb	NE	NA

SPECIES	FAMILY	LIFE FORM	STAR RATING	IUCN STATUS
Annona senegalensis	Annonaceae	Tree	NE	NA
Avicennia germinans	Avicenniaceae	Tree	NE	LC
Azadirachta indica	Meliaceae	Tree	NE	NA
Bambusa vulgaris	Gramineae	Tree	Green	NA
Borassus aethiopum	Palmae	Tree	NE	NA
Bridelia ferruginea	Euphorbiaceae	Tree	NE	NA
Byrsocarpus coccineus	Connaraceae	Shrub	NE	NA
Carissa edulis	Apocynaceae	Tree	NE	NA
Carpolobia lutea	Polygalaceae	Shrub	Green	NA
Cassytha filiformis	Lauraceae	Climber	NE	NA
Catharanthus rosea	Apocynaceae	Shrub	NE	NA
Chassalia kolly	Rubiaceae	Shrub	Green	NA
Chrysobalanus orbicularis	Rubiaceae	Shrub	Green	NA
Coccoloba uvifera	Polyganaceae	Tree	NE	NA
Cocos nucifera	Palmae	Tree	NE	NA
Commelina erecta	Commelinaceae	Herb	Green	LC
Conocarpus erectus	Combretaceae	Shrub	NE	LC
Cynodon dactylon	Gramineae	Herb	NE	NA
Cyperus articulates	Cyperaceae	Herb	NE	LC
Cyperus distans	Cyperaceae	Herb	NE	LC
Cyperus maritimus	Cyperaceae	Herb	NE	NA
Cyperus rotundus	Cyperaceae	Herb	NE	NA
Dialium guineense	Caesalpiniaceae	Tree	Green	NA
Dichrostachys cinerea	Mimosaceae	Shrub	NE	LC
Diodia scandens	Rubiaceae	Climber	Green	NA
Diodia vaginalis	Rubiaceae	Herb	NE	NA
Drypetes sp.	Euphorbiaceae	Tree	NE	NA
Ehretia cymosa	Boraginaceae	Tree	Green	NA
Elaeis guineensis	Palmae	Tree	Pink	NA
Ficus elastic	Moraceae	Tree	Blue	NA

SPECIES	FAMILY	LIFE FORM	STAR RATING	IUCN STATUS
Flacourtia flavascens	Flacourtiaceae	Tree	Green	NA
Fuirena umbellate	Cyperaceae	Herb	NE	LC
Gossypium hirsutum	Malvaceae	Shrub	NE	NA
Grewia carpinifolia	Tiliaceae	Climber	Blue	NA
Heteropogon contortus	Gramineae	Herb	NE	NA
Imperata cylindrica (E)	Gramineae	Herb	NE	NA
Indigofera hirsuta	Papilionaceae	Shrub	NE	NA
Ipomoea pes-caprae	Convolvulaceae	Climber	NE	NA
Jasminum dichotomum	Oleaceae	Climber	Green	NA
Lonchocarpus sericeus	Papilionaceae	Tree	NE	NA
Mangifera indica	Anacardiaceae	Tree	NE	DD
Millettia thonningii	Papilionaceae	Tree	Blue	NA
Morinda lucida	Rubiaceae	Tree	Green	NA
Newbouldia laevis	Bignoniaceae	Tree	Green	NA
Opuntia vulgaris	Cactaceae	Tree	NE	NA
Paspalum vaginatum	Gramineae	Herb	NE	LC
Passiflora foetida	Passifloraceae	Climber	NE	NA
Pentodon pentandrus	Rubiaceae	Shrub	NE	LC
Philoxerus vermicularis	Amaranthaceae	Herb	NE	NA
Phoenix reclinata	Palmae	Tree	NE	NA
Remirea maritima	Cyperaceae	Herb	NE	NA
Rhizophora mangle	Rhizophoraceae	Tree	NE	LC
Ritchea reflexa	Capparaceae	Climber	Gold	NA
Sansevieria liberica	Agavaceae	Herb	Blue	NA
Scoparia dulcis	Scrophulariaceae	Shrub	NE	NA
Secamone afzelii	Asclepiadaceae	Climber	Green	NA
Securinega virosa	Euphorbiaceae	Shrub	NE	NA
Sesuvium portulacastrum	Aizoaceae	Herb	NE	NA
Sporobolus pyramidalis	Gramineae	Herb	NE	NA
Sporobolus virginicus	Gramineae	Herb	NE	NA

SPECIES	FAMILY	LIFE FORM	STAR RATING	IUCN STATUS
Thespesia populnea	Malvaceae	Tree	NE	NA
Typha domingensis	Typhaceae	Herb	NE	LC
Uvaria chamae	Annonaceae	Climber	Blue	NA
Vernonia colorata	Compositae	Tree	Green	NA
Vitex doniana	Verbanaceae	Tree	NE	NA
Waltheria indica	Sterculiaceae	Shrub	NE	NA
Zanthoxylum xanthoxylioides	Rutaceae	Tree	NE	NA

Note: LC – least concern; NA – Not yet assessed; NE – Not evaluated; (E) – Exotic species

Phoenix reclinata and *Acacia mangium* were the most frequent species occurring in nearly 43 – 48% of the samples studied. *Acacia mangium* is an exotic species which is commonly planted in woodlots because it is a fast-growing species.

6.2.1 IUCN category of plant species

Most of the species (82.43%) have not been yet assessed by the IUCN. 16.22% of the species is of least concern and 1.35% is Data deficient (Table 5). Although the conservation status of *Avicennia germinans* (Black mangrove), *Rhizophora mangle* (Red mangrove) and *Conocarpus erectus* (Silver-leaved Buttonwood) are of least concern (Table 4), their population trend is decreasing internationally.

Table 5: Distribution of IUCN status in the flora

IUCN Status	Frequency	%
Least concern (LC)	12	16.22
Data deficient (DD)	1	1.35
Not yet accessed (NA)	61	82.43
Total	74	100.00

6.2.2 Star Rating

The majority of the species (68.92%) has not yet been evaluated (NE) in terms of the star rating system. Green, Blue, Gold and Pink star species followed with 21.62%, 6.76% and 1.35% and 1.35% respectively (Table 6).

The Gold star species (Fairly rare internationally and/or locally) encountered in this study was *Ritchiea reflexa*. The Blue star species (Widespread internationally but rare in Ghana or vice-versa) encountered in this study includes *Sansevieria liberica*, *Ficus elastica*, *Grewia carpinifolia*, *Millettia thonningii* and *Uvaria chamae.*

Table 6: Distribution of star rating in the flora

Star Rating	Frequency	%
Green	16	21.62
Blue	5	6.76
Gold	1	1.35
Pink	1	1.35
Not evaluated	51	68.92
Total	74	100.00

6.2.3 Invasive Alien species

The invasive alien species encountered in this study was *Imperata cylindrica.*

6.2.4 Bioquality analysis

The following indexes have been evaluated for the proposed project sites for WPP1:

- The Genetic Heat Index (GHI) value calculated for the project site at Anloga was 43.3 (Table 7). This implies that the site is a hot spot for globally rare plant species, i.e. the area is relatively rich in species threatened in Ghana by overexploitation. Destruction of the vegetation for construction purposes can therefore result in the loss of such species in the area. In particular, *Ritchiea reflexa*, a Gold star species (Fairly rare internationally and/or locally) was encountered at Anloga. On the other hand, Anyanui and Srobge recorded low GHI values thus raising no conservation concerns.

- Economic Index (EI) values for all three sites were generally low ranging from 0.9 to 2.5 (Table 7). This implies that all three areas are generally low in the occurrence of Economic plants.

- The Pioneer Index (PI) values of WPP1 sites range between 69 and 87.9 (Table 7). Such high PI values indicate that the sites are well populated with pioneer species. During secondary succession, pioneer species are first to arise. This implies that the area has been disturbed and thus has few or no primary species.

WPP1 sites were found to be poor in species richness (Table 7) but some have sensitive sites such as the mangrove and lagoon margin, which may be affected during the construction phase.

Table 7: Bioquality analysis of the project sites

Location	Species Richness	PI	EI	GHI
Anyanui	51	78.0	1.2	5.4
Srobge	30	69.0	2.5	16.7
Anloga	33	87.9	0.9	43.4

6.2.5 Classification of habitat types

The habitat types present in the project impact areas are presented in Table 8. Anloga has a strand and thicket vegetation on the sandbar which habours some species of conservation concern (viz., *Ritchiea reflexa* and *Sansevieria liberica*). Thus, it is an area of high sensitivity. Srogbe and Anyanui have significant mangrove habitats which provide ecosystem services and economic benefits to the people. Harvesting of mangrove resources has led to some degradation of the habitat.

Table 8: Classification of sites in terms of habitats

Classification	Community		
	Anloga	**Srogbe**	**Anyanui**
Habitat type	Natural habitat (Strand vegetation)	Natural habitat (Mangrove swamp / Dry Lagoon)	Natural habitat (Mangrove forest/ Thicket clump/seasonally wet reed swamp)
Current State	Partly degraded	Partly degraded	Partly degraded
Importance	Hosting *Ritchiea reflexa* (Fairly rare internationally and/or locally) *Sansevieria liberica* (Blue star plant species i.e., Widespread internationally but rare in Ghana or vice-versa).	Gallery to Srogbe water body	Gallery to water body as well as site for seasonal floods.
Status	High sensitivity	Moderate sensitivity	Moderate sensitivity

6.3 FAUNA

The viable wildlife populations of Ghana support a growing eco-tourism industry to complement the nation's strong cultural and historical attractions. Most of the wildlife is however found in the protected areas which are probably the only safe refuge for them against illegal hunting and habitat degradation from industrial activities.

The terrestrial fauna of Ghana includes relatively small animals living in primary or secondary vegetation. These include frogs, toads, snakes and mice as well as smaller antelope species such as bushbuck. Notable among the mammals in Ghana are forest elephant, Red River Hog, and Leopards. The Primates species include Senegalese bush baby, Bosman's potto, Mona monkey, Spot-nosed monkey, and Black-and-white colobus. There are over 230 species of birds and 600 butterfly species. Reptiles are also fairly represented.

With the decrease in fish catches in recent years, the hunting of wild animals for sale and consumption of bushmeat has increased sharply. As a result the biomass of terrestrial wildlife species has dramatically declined in most coastal areas of Ghana (World Bank 2006; Brashares *et* *al.* 2004). Recent increase in coastal development has also resulted in declines in wildlife species and their habitats.

The WPP1 project area lacks significant wildlife resources because of extensive agricultural and human settlement developments.

Based on the information gathered from the various methods and desktop analysis, Table 8 presents a faunal list of the study area. A number of the species known to occur in the area are of both national and global (IUCN, CITES) conservation significance (Anon, 1986).

Table 9: List of Fauna present in the study area

	Phylum	Class	Order	Family	CITES (1975) /National conservation status (NWC Regulations, 1995)	IUCN status
INVERTEBRATES/ INSECTS						
Achatina sp. (Snail)	Mollusca	Gastropoda (Snails)			No data available	No data available
Archachatina sp.	Mollusca	Gastropoda (Snails)			No data available	No data available
Julus sp. (Millipede)	Arthropoda	Myriapoda			No data available	No data available
Graphium policenes	Arthropoda	Insecta (Insects)	Lepidoptera (Butterflies)	Papilionidae	No data available	No data available
Papilio cypraeophila	Arthropoda	Insecta (Insects)	Lepidoptera (Butterflies)	Papilionidae	No data available	No data available
Papilio demodocus	Arthropoda	Insecta (Insects)	Lepidoptera (Butterflies)	Papilionidae	No data available	No data available
Acraea sp.	Arthropoda	Insecta (Insects)	Lepidoptera (Butterflies)	Nymphalidae	No data available	No data available
Bematistis sp.	Arthropoda	Insecta (Insects)	Lepidoptera (Butterflies)	Nymphalidae	No data available	No data available

	Phylum	Class	Order	Family	CITES (1975) /National conservation status (NWC Regulations, 1995)	IUCN status
Bicyclus sp.	Arthropoda	Insecta (Insects)	Lepidoptera (Butterflies)	Nymphalidae	No data available	No data available
Catacroptera cloanthe	Arthropoda	Insecta (Insects)	Lepidoptera (Butterflies)	Nymphalidae	No data available	No data available
Charaxes sp.	Arthropoda	Insecta (Insects)	Lepidoptera (Butterflies)	Nymphalidae	No data available	No data available
Cymothoe sp.	Arthropoda	Insecta (Insects)	Lepidoptera (Butterflies)	Nymphalidae	No data available	No data available
Danaus chrysippus	Arthropoda	Insecta (Insects)	Lepidoptera (Butterflies)	Nymphalidae	No data available	No data available
Euphedra sp.	Arthropoda	Insecta (Insects)	Lepidoptera (Butterflies)	Nymphalidae	No data available	No data available
Zonoceros variegatus	Arthropoda	Insecta (Insects)	Orthoptera (Grasshoppers)		No data available	No data available
Palthothyreus sp.	Arthropoda	Insecta (Insects)	Hymenoptera (Ants, Bees)		No data available	No data available
AMPHIBIANS						
Xenopus tropicalis (Clawed Toad)	Cordata	Amphibia	Anura (Salientia)	Pipidae (Clawed Toads)	No data available	No data available
Afrixalus dorsalis (Leaf folders)	Cordata	Amphibia	Anura (Salientia)	Hyperoliidae	No data available	No data

	Phylum	Class	Order	Family	CITES (1975) /National conservation status (NWC Regulations, 1995)	IUCN status
						available
Afrixalus laevis	Cordata	Amphibia	Anura (Salientia)	Hyperoliidae	No data available	No data available
Afrixalus nigeriensis	Cordata	Amphibia	Anura (Salientia)	Hyperoliidae	No data available	No data available
Hyperolius baumanni (Reed frogs)	Cordata	Amphibia	Anura (Salientia)	Hyperoliidae	No data available	No data available
Hyperolius bobirensis	Cordata	Amphibia	Anura (Salientia)	Hyperoliidae	No data available	No data available
Hyperolius concolor	Cordata	Amphibia	Anura (Salientia)	Hyperoliidae	No data available	No data available
Hemisus guineensis (Shovel-nosed Frog)	Cordata	Amphibia	Anura (Salientia)	Hemisisdae (Shovel-nosed Frogs)	No data available	No data available
Dicroglossus occipitalis (Common Frog)	Cordata	Amphibia	Anura (Salientia)	Ranidae (Frogs)	No data available	No data available
Hylarana albolabris (Common Frog)	Cordata	Amphibia	Anura (Salientia)	Ranidae (Frogs)	No data available	No data available
Hylarana occidentalis	Cordata	Amphibia	Anura (Salientia)	Ranidae (Frogs)	No data available	No data available

	Phylum	Class	Order	Family	CITES (1975) /National conservation status (NWC Regulations, 1995)	IUCN status
Phrynobatrachus accraensis (Puddle Frogs)	Cordata	Amphibia	Anura (Salientia)	Ranidae (Frogs)	No data available	No data available
Bufo maculatus	Cordata	Amphibia	Anura (Salientia)	Bufonide (True Toads)	No data available	No data available
Bufo regularis (Common Toad)	Cordata	Amphibia	Anura (Salientia)	Bufonide (True Toads)	No data available	No data available
Geotrypetes seraphini (Caecilian)	Cordata	Amphibia	Apoda (Gymnopiona)	Caecilidae (Leg-less Amphibians)	No data available	No data available
REPTILES						
Pelomedusa subrufa (Marsh Terrapin)	Cordata	Reptilia	Chelonia (Testudinata)	Pelomedusidae	S.2	*
Pelusios gabonensis (Gaboon Terrapin)	Cordata	Reptilia	Chelonia (Testudinata)	Pelomedusidae (Side-necked Terrapins)	S.2	*
Pelusios niger	Cordata	Reptilia	Chelonia (Testudinata)	Pelomedusidae (Side-necked Terrapins)	S.2	*
Kinixys erosa (Sweigger's Hingeback)	Cordata	Reptilia	Chelonia (Testudinata)	Testudinidae (Hinge-back Land Tortoises)	C.2 S.2	*
Kinixys homeana (Hinged Tortoise)	Cordata	Reptilia	Chelonia (Testudinata)	Testudinidae (Hinge-back Land	C.2 S.2	*

	Phylum	**Class**	**Order**	**Family**	**CITES (1975) /National conservation status (NWC Regulations, 1995)**	**IUCN status**
				Tortoises)		
Trionyx triunguis (River Turtle)	Cordata	Reptilia	Chelonia (Testudinata)	Trionychidae (Soft-shelled Turtles)	S.2	*
Agama agama (Agama/Rainbow Lizard)	Cordata	Reptilia	Squamata (Lizards and Snakes)	Agamidae	No data available	No data available
Agama paragama [sylvanus]	Cordata	Reptilia	Squamata (Lizards and Snakes)	Agamidae	No data available	No data available
Mabuya perrotetii (Pink Bellied Skink)	CordataReptiles	Reptilia	Squamata (Lizards and Snakes)	Scincidae (Skinks)	No data available	No data available
Chamaeleo gracilis (Chameleon)	Cordata	Reptilia	Squamata (Lizards and Snakes)	Chamaeleonidae (Chameleons)	C.2	*
Ancylodactylus spinicollis	Cordata	Reptilia	Squamata (Lizards and Snakes)	Gekkonidae (Geckos)	No data available	No data available
Hemidactylus brookei (Common House/Brooke's Gecko)	Cordata	Reptilia	Squamata (Lizards and Snakes)	Gekkonidae (Geckos)	No data available	No data available
Hemidactylus fasciatus (Banded Gecko)	Cordata	Reptilia	Squamata (Lizards and Snakes)	Gekkonidae (Geckos)	No data available	No data available
Lygodactylus conraui	Cordata	Reptilia	Squamata (Lizards and Snakes)	Gekkonidae (Geckos)	No data available	No data available
Lygodactylus picturatus	Cordata	Reptilia	Squamata (Lizards and Snakes)	Gekkonidae	No data available	No data

	Phylum	Class	Order	Family	CITES (1975) /National conservation status (NWC Regulations, 1995)	IUCN status
				(Geckos)		available
Varanus niloticus (Nile Monitor)	CordataReptiles	Reptilia	Squamata (Lizards and Snakes)	Varanidae (Monitors)	C.2 S.2	*
Amphisbaena muelleri (Worm Lizard)	Cordata	Reptilia	Squamata (Lizards and Snakes)	Amphisbaenidae (Leg-less/Worm Lizards)	No data available	No data available
Typhlops caecatus (Blind Snake)	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Typhlopidae (Blind/Glass Snakes)	No data available	No data available
Typhlops punctatus (Spotted Blind/Glass Snake)	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Boidae (Boas / Pythons)	No data available	No data available
Python sebae (African/Rock Python)	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Colubridae (Typical snakes)	C.2	*
Apparallactus modestus	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Colubridae (Typical snakes)	No data available	No data available
Atractaspis aterrima	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Colubridae (Typical snakes)	No data available	No data available
Philothamnus carinatus (Green Tree Snake)	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Colubridae (Typical snakes)	No data available	No data available
Psammophis phillipsi (Olive Grass	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Colubridae (Typical	No data available	No data

	Phylum	Class	Order	Family	CITES (1975) /National conservation status (NWC Regulations, 1995)	IUCN status
Snake)				snakes)		available
Thelothornis kirtlandii (Twig/Vine/Bird Snake)	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Colubridae (Typical snakes)	No data available	No data available
Dendroaspis. viridis (Green/Tree Mamba)	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Elapidae (Cobras and mambas)		No data available
Naja melanoleuca (Black-and-white Cobra)	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Viperidae (Vipers and Adders)	No data available	No data available
Atheris chlorechis (Green Tree Viper)	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Viperidae (Vipers and Adders)	No data available	No data available
Atheris squamigera	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Viperidae (Vipers and Adders)	No data available	No data available
Bitis gabonica (Gaboon Adder/Viper)	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Viperidae (Vipers and Adders)	No data available	No data available
Bitis nasicornis (Rhinoceros Viper)	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Viperidae (Vipers and Adders)	No data available	
Causus maculatus (Night Adder)	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Viperidae (Vipers and Adders)	No data available	No data available
MAMMALS						

	Phylum	Class	Order	Family	CITES (1975) /National conservation status (NWC Regulations, 1995)	IUCN status
Crocidura spp. (White-toothed Shrews)	Cordata	Mammalia	Insectivora	Soricidae (Shrews)	No data available	No data available
Eidolon helvum (African Fruit Bat)	Cordata	Mammalia	Chiroptera	Pteropodidae	S.2	*
Hypsignathus monstrosus (Hammer headed Bat)	Cordata	Mammalia	Chiroptera	Pteropodidae	S.2	*
Perodicticus potto (Common/Bosman's Potto)	Cordata	Mammalia	Primates	Loridae	C.2 S.1	*
Galago senegalensis (Senegal Galago/Bush Baby)	Cordata	Mammalia	Primates	Galagonidae	C.2 S.1	*
Galagoides demidoff (Lesser/Dwarf Galago)	Cordata	Mammalia	Primates	Galagonidae	S.1	*
Epixerus ebi (Red-headed forest Squirrel)	Cordata	Mammalia	Rodentia	Sciuridae	No data available	No data available
Funisciurus anerythrus (Redless Tree Squirrel)	Cordata	Mammalia	Rodentia	Sciuridae	S.2	*
Funisciurus leucogenys (Orange-headed Tree-Squirrel)	Cordata	Mammalia	Rodentia	Sciuridae	S.2	*
Funisciurus pyrrhopus (Cuvier's Fire-footed Tree-squirrel)	Cordata	Mammalia	Rodentia	Sciuridae	S.2	*
Paraxerus poensis (Small Green/Bush	Cordata	Mammalia	Rodentia	Sciuridae	No data available	No data

	Phylum	**Class**	**Order**	**Family**	**CITES (1975) /National conservation status (NWC Regulations, 1995)**	**IUCN status**
Squirrel)						available
Cricetomys gambianus (Gambian/Pouched Giant Rat)	Cordata	Mammalia	Rodentia	Muridae	S.2	*
Mus spp. (Common Mice)	Cordata	Mammalia	Rodentia	Muridae	No data available	No data available
Thryonomys swinderianus (Cutting Grass/Cane Rat)	Cordata	Mammalia	Rodentia	Thryonomidae (Grasscutters)	No data available	No data available
Atilax paludinosus (Marsh Mongoose)	Cordata	Mammalia	Carnivora	Herpestidae	S.2	*
Tragelaphus scriptus (Bushbuck)	Cordata	Mammalia	Artiodactyla	Bovidae	S.2	*
Tragelaphus spekii gratus (Sitatunga)	Cordata	Mammalia	Artiodactyla	Bovidae	S.1 LC	No data available

Note:* Fauna of local, national or international conservation significance

+ Fauna observed or whose presence was confirmed through interviews

E – Endangered, LC – Least Concerned, Vu – Vulnerable, R - Rare

[C.1] … CITES Appendix 1; [C.2]… CITES Appendix 2

[S.1] NWC Regulations Schedule 1; [S.2] NWC Regulations Schedule 2

7. IDENTIFICATION OF KEY ISSUES

7.1 KEY ISSUES IDENTIFIED

The key potential issues identified during the study are as follows:

Construction phase

- Permanent loss of vegetation cover and potential loss of listed/rare plant species associated with the turbines footprint and new access roads during construction is expected.

- In swampy areas, there may be the need to pump out water from the excavations and this would further increase erosion from surface runoff and increase sediment flow in-to nearby water bodies. Increased erosion risk would be likely to result due to the loss of plant cover and soil disturbance created during the construction phase. This may impact downstream riparian and wetland habitats if a lot of silt enters the drainage systems.

- Removal of mangrove vegetation will cause the exposure of water bodies to direct sunlight thus increasing the rate of evaporation.

- Clearing of vegetation and compaction of soils could lead to death and displacement of some faunal species.

- Impact on plants due to the release of fine particulate matter or sediment into the environment.

- Harsh chemical control measures for weed and pest control may be used which might have negative impacts on non-target plant species and the environment.

- Introduction of alien (sometimes invasive) species of biodiversity to the area in and around the wind facility.

- Presence and operation of construction machinery on site. This will create a physical impact as well as generate noise, pollution and other forms of disturbance at the site.

Operational Phase

- Alteration of micro-climate.

- The operation of the facility may generate noise and disturbance which may deter some fauna from the site as well as impact the activities of others within the site.

- Maintenance activities such as vegetation clearing may impact the biodiversity of the site if not conducted in a sensitive manner.

- Loss of connectivity and habitat fragmentation may result if fauna avoid the area or cannot move through the area on account of the presence of the facility.

Decommissioning

Decommissioning is assumed to entail the removal of the hard infrastructure from the facility and the rehabilitation of the cleared and disturbed areas. The following impacts are likely to be associated with this phase of the development:

- Increased erosion risk due to the loss of plant cover and soil disturbance created during the decommissioning phase. This may impact downstream riparian and wetland habitats if a lot of silt enters the drainage systems. The disturbance would also be likely to increase the vulnerability of the area to alien plant invasion.

- Presence and operation of machinery on site. This will create a physical impact as well as generate noise, pollution and other forms of disturbance at the site.

- Impacts on fauna during decommissioning activities.

8. ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

8.1 CONSTRUCTION PHASE

A high level of disturbance is likely to occur for the duration of the construction phase. Such disturbance will relate to vegetation clearing, excavation, noise and general anthropogenic influences associated with the building of the facility on site. This may include the cutting and removal of vegetation for the establishment of new internal gravel roads (a permanent transformation) and the cutting and trampling of vegetation at the proposed location for the wind turbines and laydown areas.

8.1.1 Loss of vegetation and protected/listed species due to the clearing of vegetation

The clearing of vegetation for roads, turbine foundations and crane pads will lead to disturbance of the area and loss of biological diversity, including the potential loss of globally/locally rare species. Gold star species such as the *Ritchea reflexa* was encountered at Anloga. On the other hand, Anyanui and Srobge recorded low GHI values thus raising no conservation concerns. Increased human presence can lead to poaching, illegal plant harvesting and other forms of disturbance such as fire.

The impact of the development on vegetation would be of local extent, but of high intensity given the high sensitivity of the Anloga site (presence of *Ritchea reflexa* species) for both alternatives. The impact is assessed to be long-term as the majority of cleared areas are required for roads and other infrastructure and will not be rehabilitated. The probability of the loss of vegetation is definite as clearing of the vegetation is required ahead of construction and the probability of impacting a protected/listed or rare species is rated as probable.

Given the above, the loss of vegetation and protected/listed or rare species due to the clearing of vegetation is anticipated to be of medium significance without mitigation for both the proposed and the alternative layouts as the Gold Star species is present in Anloga which will be impacted for both alternative layouts.

Mitigation

Although the WPP1 site is poor in species richness, the following key mitigation measures are recommended to be implemented by the project applicant:

- Undertake a walk through the site while doing micro-sitting of the turbines to avoid species of concern as much as possible.
- Undertake a pre-construction walk through the site to identify species of concern that can be translocated if necessary
- Ensure that construction staff has attended an environmental awareness training to ensure that basic environmental principles are adhered to.
- Demarcate areas that will need to be cleared and keep clearing areas to a minimum.
- Demarcating and labelling no-go areas in proximity to the development footprint, such as sensitive areas
- No listed/protected or rare plant may be dislocated or disturbed without the permission of the environmental manager
- Ensure that camp sites, lay down areas and other temporary areas are located in areas of low sensitivity and that they are clearly demarcated
- Mangrove revegetation and tree planting should be undertaken to reverse the decline in the vegetation cover of the project footprint.
- Lost biodiversity on the disturbed area should be restored through planting of appropriate trees and shrubs and protection of fauna species and their habitat.
- The GoG quarantine inspection and procedures should be followed to ensure that invasive or alien species do not enter the area.
- Construction of new tracks should be kept to the barest minimum and the use of existing roads should be encouraged. Track routes should be selected in such a way as to minimize any damage to farms and crops.
- Mechanical control should be used for all vegetation clearing.
- Removal of stream bank vegetation (especially bamboo/mangrove) must be avoided as much as possible.

- Cutting of trees must be done by a certified timber contractor, and strictly in line with the prescribed safety guidelines. The landing area of falling trees should be carefully selected to minimize damage to farms. Adequate warning should be given to ensure that public safety is not compromised.
- Clearing of vegetation should be minimised to the project area

With the successful implementation of the above recommended mitigation, the medium significance of this impact is expected to decrease to low for both preferred and alternative layouts.

8.1.2 Increase in potential erosion during the clearing of vegetation

Vegetation clearing and soil disturbance will lead to an increase in soil being exposed, which may leave the disturbed areas vulnerable to erosion. This may impact downstream wetland habitats if a lot of fine particulate matter or sediment enter into the environment. In addition, the construction of many hard surface areas for roads, laydowns, etc. will generate water run offs which can also increase erosion risks of surrounding areas. However, most parts of the site contain a high proportion of grass within the vegetation and grasses should increase in density rapidly within wetter areas and should in most instances help to prevent erosion in areas receiving runoff.

Given the above, impacts associated with erosion have been assessed to be of local extent, short term duration and medium intensity for both preferred and alternative layouts. The probability that erosion and associated impacts do occur is probable and the significance is therefore anticipated to be low, without mitigation.

The following mitigation measures are recommended:

- A rehabilitation and re-vegetation plan should be developed prior to construction.
- Regular monitoring of the site during construction for erosion problems.
- Topsoil should be removed and stored separately and should be reapplied where appropriate as soon as possible in order to encourage and facilitate rapid regeneration of the natural vegetation on cleared areas.
- Establishment of revegetation in exposed areas

- Erosion management plan should be considered right from construction phase.

With the successful implementation of the above recommended mitigation, the low significance is expected to decrease to very low for the preferred and the alternative layout.

8.1.3 Removal of mangrove vegetation and brackish water swamp vegetation can cause intense evaporation of water body and destruction of habitats

The mangrove vegetation and brackish water swamp is composed of species such as *Typha doimngensis, Acrostichum aureum, Avicennia germinans, Rhizophora sp., Paspalum vaginatum, Cyperus ariculatus* and *Sesuvium portulacastrum*. The mangrove swamps are sensitive habitats that require conservation action. Aside from protecting water bodies from intense evaporation, mangrove vegetation serves as habitats and brooding sites for brackish and freshwater organisms. This medium rated impact is expected to affect footprint of local extent. Mangrove forest can be replaced through replanting. There is almost 25% chance of removing a few mangroves in the proposed wind power project site.

The duration of this impact of removing the mangrove vegetation is expected to be long term unless mitigation strategies are adopted.

Without mitigation, the negative impact is anticipated to be of medium significance for both preferred and alternative layouts.

The following mitigation measures are recommended:

- Mangrove revegetation
- Avoiding destruction of mangrove swamp where possible

With the successful implementation of the above recommended mitigation, the significance of this impact is expected to decrease to low for both preferred and alternative layouts

8.1.4 Impacts on fauna and flora due to compaction of soils by traffic and through the use of compactors

Depending upon the nature of soils (particle size, clay and mineral content etc.) changes in habitat form may arise within the site in the long term as plant species that are tolerant of or prefer particular soils benefit at the expense of other species which are less tolerant. The intensity of this impact has been rated as high due to the fact that the impact will eventually lead to reduction in biodiversity. Moreover, in the situation where invasive alien species benefit, they will enjoy rapid growth at the expense of economic and rare plants in the project footprint.

Soil compaction can also lead to the death and displacement of some faunal and microbial species. This probable impact is expected to be long term and spread to about 10 km away from the project site.

Without mitigation, this negative impact is anticipated to be of medium significance for both preferred and alternative layouts.

The following mitigation measures are recommended:

- The number of passes of heavy trucks to and from the project sites should be regulated and minimised.

With the successful implementation of the above recommended mitigation, the significance of this impact is expected to decrease to low for both preferred and alternative layout.

8.1.5 Impact on plants due to the release of fine particulate matter or sediment into the environment

The clearing of vegetation for roads, turbine foundations and crane pads during the construction phase will result in the release of fine particulate matter which is likely to settle on plant surfaces. The particles impair respiration by blocking the stomata through which gaseous exchange occur. Furthermore, the particles reduce the surface area available for chlorophyll to trap solar energy for photosynthesis. The intensity of this impact is rated medium due to the fact that inefficiencies in respiration and photosynthesis can result in weakening and death of plants. Moreover, microorganisms and fauna that survive on such plant leaves will be displaced. There is also the likelihood of changing the visual morphology of plants in the project footprint.

However, this is a temporal impact that which can be reversed by rainfall as long as excavation activities ceases.

The impact of the settlement of particulate matter on the leaf surfaces of plants would be of local extent (<10 km), the probability of particulate matter settling on plant surfaces is probable. Without mitigation, the negative impact is anticipated to be of low significance for both preferred and alternate layouts.

The following additional mitigation measures are recommended:

- Artificial wash off can remedy the impact
- Excavation activities should not be carried out during high wind speed moment of the day. This will reduce the extent of spread of the particulate matter in the project footprint. Minor trenches and holes should be dug manually to reduce the release of particulate matter.

With the successful implementation of the above recommended mitigation, the significance of this impact is expected to decrease to very low for the preferred and the alternative layout.

8.1.6 Weed and pest control

Harsh chemical control measures may be used which might have negative impacts on non-target plant species and the environment.

Weed and pest control chemicals are usually in sprayable form, making them easier to soak into undesired plant foliage and animals. The intensity of this impact is rated medium due to the fact that chemical drift can result in damage to none target economical or rare plants and animals. Over time, the vegetation of the project site and its footprint will change as a result of residual chemicals in the soil. Chemical usage in weed and pest control is probable and long term activity that will last throughout the construction and operation phases of the project. The damage caused by chemicals usually has low reversibility.

Without mitigation, the negative impact of chemical weed and pest control is anticipated to be of medium significance for the preferred and alternative layout.

The following mitigation measures are recommended:

- Mechanical weed control should be used instead of chemical weed control
- Avoid the use of chemicals in the control of pests, rodents, snakes etc. around the project site and settlement areas.
- In situations where chemical control is inevitable, adopt spot application strategy in chemical application instead of the broadcast method in other to minimize exposure to non-targeted plants and animals.

With the successful implementation of the above recommended mitigation, the significance of this impact is expected to decrease to very low for the preferred and the alternative layout.

8.1.7 Introduction of alien (sometimes invasive) species of biodiversity to the area in and around the wind facility

During the construction phase, the introduction of exotic vegetation or the invasion of disturbed areas by exotic vegetation through either a physical vector (e.g. machinery, vehicles etc.) or more "natural" dispersion vectors (e.g. wind, avian dispersion) is probable.

The changes in vegetation as a result of the introduction of invasive alien species will last for long. However, the impact is expected to be contained within 10 km off the project site. The intensity is rated low due to the fact that the area is already degraded. Only a few native plants were identified during the survey. Pioneer index ranged between 69.0 and 87.9 (suggests the high number of pioneer species growing in the area).

Without mitigation, the negative impact is anticipated to be of low significance for the preferred layout and low significance for the alternative layout.

The following mitigation measures are recommended:

- Inspection of all persons and machinery before entry to the site
- Quarantine and elimination of all suspected carriers of invasive alien species
- Use only plants and seed collected on-site for revegetation.

With the successful implementation of the above recommended mitigation, the significance of this impact is expected to remain low for both preferred and the alternative layout.

8.1.8 Impacts on fauna during construction activities

The intensity of the negative impact on fauna during the construction phase is rated as medium. This is because there is high probability of ousting of fauna through disturbance and human presence. Opportunistic animal species may benefit from the construction activities; in particular the exclusion of predators from the site may benefit former prey species which will take refuge within the area, skewing populations and predator – prey relations.

Another impact on fauna during the construction phase is that of lighting during late and early hours during construction. This may result in the death, injury and relocation of several animals inhabiting the project area. Increased human presence can also lead to poaching, illegal plant harvesting and other forms of disturbance such as fire

The short term effect of the impacts is expected to be localized extent with a low chance of reversibility.

Without mitigation, the negative impact is anticipated to be of medium significance for the preferred and alternative layout. This phase is however transient and during the operational phase, levels of disturbance and activity will be considerably reduced.

The following mitigation measures are recommended:

- Faunal rescue plan should be adopted
- Hunting activities should follow the Wildlife Act
- All vehicles at the site should adhere to a low speed limit.
- No litter, food or other foreign material should be thrown or left around the site and should be placed in demarcated and fenced rubbish and litter areas.

With the successful implementation of the above recommended mitigation, the medium significance of this impact is expected to decrease to low for the preferred and alternative layout.

8.2 OPERATION PHASE

The Operation phase is less impactful on the flora and fauna. Access roads to turbines would be maintained as well as vegetation controlled in the immediate vicinity of the turbines.

8.2.1 Alteration of micro-climate

Changes in wind speed and wind direction during operation may affect the flight of migratory birds. Dispersion of fruits and seeds, photoperiod, pollination, fruit formation and morphology of plants may be affected by the changes in micro-climate induced by the wind turbines during operation.

The status of the indirect impact is rated as neutral with a local spatial extent and long-term duration. The intensity of the impact is rated as low. The probability of the impact is assessed as probable. Without mitigation, the indirect impact is anticipated to be of low significance for the preferred layout and very low significance for the alternative layout.

The following mitigation measures are recommended:

- Monitoring plan for native plants the project footprint.
- Relocation of affected rare species.

With the successful implementation of the above recommended mitigation, the significance of this impact is expected to remain to very low for the preferred and the alternative layout.

8.2.2 Impact on fauna during the operation of the wind turbines

Although activity at the site is likely to be relatively low during operation, some impact on fauna may still occur as a result of personnel present on site as well as the operation of maintenance vehicles. Direct interactions between the turbines and terrestrial fauna are likely to be low. The operation of the facility will generate noise and disturbance which may deter some fauna from the site as well as impact the activities of others within the site. The operation of turbines and wind blades can cause injuries and deaths to flying birds in the vicinity (refer to Appendix 3 Birds Impact Assessment study). This localized impact will persist as long as the project is in operation with probability of 50%. Hence the intensity of this impact is rated as high. The reversibility of this impact is very low.

Without mitigation, the negative impact is anticipated to be of medium significance for both preferred and alternative layouts.

The following mitigation measures are recommended:

- Provision of critter paths within the fencing should be considered in the design.
- Promote and support faunal presence and activities within the proposed PV facility by prohibiting hunting, trading and consumption of bush meat in the project sites
- Access to the site should be strictly controlled.
- All vehicles at the site should adhere to a low speed limit and any fauna on roads should receive right or way or can be moved off the road in the direction that the animal was moving in the case of slow-moving fauna such as tortoises.
- Any chemical spills at the site should be handled in the appropriate manner as determined by the nature of the spill.

With the successful implementation of the above recommended mitigation, the significance of this impact is expected to decrease to low for both, the preferred and alternative layouts.

8.2.3 Impact on flora during maintenance activities.

Maintenance activities such as vegetation clearing will impact the biodiversity of the site if not conducted in a sensitive manner. This a site specific impact with long term duration. Probability of occurrence is 75%, however, lost species can be replaced through replanting. The intensity is rated as medium since it involves the possible loss of species and habitats.

Without mitigation, the negative impact is anticipated to be of low significance for both preferred layout and alternative layouts.

The following mitigation measures are recommended:

- Avoid broadcast spraying of chemical herbicides during vegetation clearance
- Uproot and burn invasive alien species ones spotted
- Replant native rare plants in buffer zones to prevent extinction.

- Minor vegetation clearance should be done manually.

With the successful implementation of the above recommended mitigation, the significance of this impact is expected to decrease to very low for both preferred and alternative layouts.

8.2.4 Loss of connectivity and habitat fragmentation may result if fauna avoid the area or cannot move through the area on account of the presence of the facility.

The presence of the facility and the associated transformation of intact vegetation, would pose a threat to the connectivity of the landscape and the ability of fauna and flora to respond to environmental change. The potential severity of the disruption is to a large extent related to the surrounding vegetation and the contrast between the natural vegetation and the hardened surfaces of the facility. In the current context, the extent of disruption of landscape connectivity is likely to be low as the site is disturbed.

In the long-term the facility is not likely to create significant local or regional population-level impact as it is likely that sufficient numbers of individuals would be successfully moving about the landscape to prevent spatial fragmentation of their populations. The impact of the facility on the fragmentation of the landscape is likely to be of local extent, low intensity and low significance.

The following mitigation measures are recommended:

- Minimising the development footprint wherever possible.
- Revegetation of all cleared and bare areas created by the facility with local species.
- Key mitigation measures proposed by the specialist include:
- Fences and other structures which impede faunal movement should be avoided where possible

8.3 DECOMMISSIONING PHASE

8.3.1 Exotic weed invasion as a consequence of abandonment of site and cessation of weed control measures

Exotic weed invasion is a likely consequence the removal of wind turbines. Decommissioning of site will see increased disturbance of the land and therefore increased susceptibility to exotic weed invasion.

The spatial extent of this impact is local with medium-term duration. The consequence and probability of the impact are respectively rated as moderate and probable. The reversibility and irreplaceability of the impact are respectively rated as high and low. The significance of the impact without mitigation is rated as low. Significance without mitigation is low. Significance with mitigation is low.

Mitigation:

- Lost biodiversity on the disturbed area should be restored through planting of appropriate trees and shrubs.
- The GoG quarantine inspection and procedures should be followed to ensure that invasive or alien species do not enter the area.
- The landing area of falling turbines should be carefully selected to minimize damage to vulnerable plants and human lives. Adequate warning should be given to ensure that public safety is not compromised.
- Mitigation would include monitoring of the land and redress of exotic weeds found present on site.

8.3.2 Exposed soil increases erosion risks

Increased erosion risk due to the loss of plant cover and soil disturbance created during the decommissioning phase. This may impact downstream riparian and wetland habitats if a lot of silt enters the drainage systems. The disturbance would also be likely to increase the vulnerability of the area to alien plant invasion.

Given the above, impacts associated with erosion have been assessed to be of local extent, short term duration and medium intensity for both preferred and alternative layouts. The probability that erosion and associated impacts does occur is probable and the significance is therefore anticipated to be low, without mitigation.

The following mitigation measures are recommended:

- Establishment of revegetation in exposed areas
- Construction of proper permanent drainage system

With the successful implementation of the above recommended mitigation, the low significance is expected to decrease to very low for the preferred and the alternative layout.

8.3.3 Impacts on fauna

The presence and operation of machinery on site will create a physical impact as well as generate noise, pollution and other forms of disturbance at the site.

In addition, increased human presence can lead to poaching, illegal plant harvesting and other forms of disturbance such as fire.

The short term effect of the impacts is expected to be localized extent with a low chance of reversibility.

Without mitigation, the negative impact is anticipated to be of low significance for both preferred and alternative layouts.

The following mitigation measures are recommended:

- Faunal rescue plan should be adopted
- Hunting activities should follow the Wildlife Act
- All vehicles at the site should adhere to a low speed limit.
- No litter, food or other foreign material should be thrown or left around the site and should be placed in demarcated and fenced rubbish and litter areas.

8.4 CUMULATIVE IMPACTS

Cumulative impacts on the flora and fauna, if other projects of similar nature are constructed in the area, would be significant. The implementation of the mitigation measures outlined below would reduce the significance level to very low.

8.4.1 Cumulative impact 1: Reduced ability to meet conservation obligations & targets

The loss of unprotected vegetation types on a cumulative basis from the broad area may impact the countries' ability to meet its conservation targets, particularly the Gold Star index vegetation.

Mitigation measures inherent to the project design include:

- Preconstruction walk-through of the facility, especially the roads and turbine locations to ensure that sensitive habitats are avoided.
- Minimise the development footprint as far as possible.

As there are no other large development projects in the project's area of influence, the cumulative impact for both alternatives is thus assessed to be of low significance.

8.4.2 Cumulative Impact 2: Impact on the disruption of broad-scale ecological processes

The presence of the facility and associated infrastructure could potentially contribute to the disruption of broad-scale ecological processes such as dispersal, migration or the ability of fauna to respond to fluctuations in climate or other conditions. There are no other renewable energy facilities in the broad area the cumulative impact of these on habitat loss and the broad scale disruption of landscape connectivity is currently not a concern.

Mitigation measures inherent to the project design include:

- Preconstruction walk-through of the facility, especially the roads and turbine locations to ensure that sensitive habitats are avoided.
- Minimise the development footprint as far as possible.

Key mitigation measures proposed by the specialist include:

- Stringent construction-phase monitoring of activities at the site to ensure that mitigation measures are adhered to and that the overall ecological impact of the development is maintained at a low level.
- The use of structures which may inhibit movement of fauna, such as mesh and electric fencing should be avoided as far as possible.

As there are no other large development projects in the project's area of influence, the cumulative impact for **both alternatives** is thus assessed to be of **low** significance.

9. IMPACT ASSESSMENT SUMMARY

The assessment of potential impacts and recommendation of mitigation measures as discussed above are collated in Tables 10 to 12 below.

Table 10: Direct impacts assessment summary table for the Construction Phase for the preferred and alternative layout

CONSTRUCTION PHASE												
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence/ Intensity**	**Probability**	**Reversibility**	**Irreplaceability**	**Potential Mitigation Measures**	**Significance**		**Confidence Level**
										Without Mitigation	***With Mitigation***	
Vegetation clearance	Loss of habitat and listed/rare species	Negative	Site and Local	Long-Term	High	Probable	Low	Low	• Any unwarranted destruction of vegetation and habitats beyond the designed wind park should be discouraged. • Lost biodiversity on the disturbed area should be restored through planting of appropriate trees and shrubs and protection of fauna species and their habitat. • Undertake a pre-construction walk through the site to identify species of concern that can be trans located if necessary • Mechanical control should be used for all vegetation clearing. • No listed/protected or rare plant may be dislocated or disturbed without the	Medium	Low	High

CONSTRUCTION PHASE												
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence/ Intensity**	**Probability**	**Reversibility**	**Irreplaceability**	**Potential Mitigation Measures**	**Significance**		**Confidence Level**
										Without Mitigation	***With Mitigation***	
									permission of the environmental manager • Cutting of trees must be done by a certified timber contractor, and in line with the prescribed safety guidelines.			
	Increase in potential erosion during the clearing of vegetation	Negative	Local	Short term	Medium	Probable	Moderate	Moderate	• A rehabilitation and revegetation plan should be developed as part of the EMP • Regular monitoring of the site during construction for erosion problems. • Topsoil should be removed and stored separately and should be reapplied where appropriate as soon as possible in order to encourage and facilitate rapid regeneration of the natural vegetation on cleared areas.	Low	Very low	High

CONSTRUCTION PHASE												
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence/ Intensity**	**Probability**	**Reversibility**	**Irreplaceability**	**Potential Mitigation Measures**	**Significance**		**Confidence Level**
										Without Mitigation	***With Mitigation***	
									• Erosion management plan			
	Removal of mangrove vegetation and brackish water swamp vegetation lagoon margin can cause intense evaporation of water body and destruction of habitats.	Negative	Local	Long-Term	Medium	Highly Probable	Moderate	Low	• Mangrove revegetation • Avoiding destruction of mangrove swamp where possible	Medium	Low	High
Movement of Heavy Trucks and laying of concrete floors	Compacting of soils leading to death and displacement of some faunal and microbial species as well as to the competition of some plant	Negative	Site specific	Long-term	Medium	Highly Probable	High	Low	• The number of passes of heavy trucks to and from the project sites should be regulated.	Medium	Low	Medium

CONSTRUCTION PHASE												
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence/ Intensity**	**Probability**	**Reversibility**	**Irreplaceability**	**Potential Mitigation Measures**	**Significance**		**Confidence Level**
										Without Mitigation	***With Mitigation***	
	species											
	Impact on plants due to the release of fine particulate matter or sediment into the environment	Negative	Local	Short-term	Medium	Probable	High reversibility	Moderate	• Artificial wash off using a sprinkler. • Excavation activities should not be carried out during high wind speed period of the day. This will reduce the extent of spread of the particulate matter in the project footprint. • Minor trenches and holes should be constructed manually in order to reduce the release of particulate matter.	Low	Very low	High
Weed and Pest control	Harsh chemical control measures may be used which might have negative impacts on non-target plant species	Negative	Site specific	Long-term	Medium	Low probability	Low	Moderate	• Mechanical control should be used for all vegetation clearing. • Avoid the use of chemicals in the control of pests, rodents, snakes etc around the project site and settlement areas.	Medium	Very low	High

CONSTRUCTION PHASE												
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence/ Intensity**	**Probability**	**Reversibility**	**Irreplaceability**	**Potential Mitigation Measures**	**Significance**		**Confidence Level**
										Without Mitigation	***With Mitigation***	
	and the environment.								• In situations where chemical control is inevitable, adopt spot application strategy in chemical application instead of the broadcast method in other to minimize exposure to non-target plants and animals.			
Transportation of people, materials and equipment	Introduction of alien (sometimes invasive) species of biodiversity to the area in and around the wind facility	Negative	Local	Long-term	Low	Probable	Low	Moderate	• Inspection of all persons and machinery before entry to the site • Quarantine and elimination of all suspected carriers of invasive alien species • Use only plants and seed collected on-site for revegetation	Low	Low	High
The clearing of vegetation and ousting of fauna through construction activities	Disturbance of fauna and opportunistic animal species may benefit from the construction	Negative	Local	Long-Term	High	Probable	Low	Low	• Faunal rescue plan should be adopted • Hunting activities should follow the Wildlife Act - All vehicles at the site	Medium	Low	High

CONSTRUCTION PHASE												
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence/ Intensity**	**Probability**	**Reversibility**	**Irreplaceability**	**Potential Mitigation Measures**	**Significance**		**Confidence Level**
										Without Mitigation	***With Mitigation***	
	activities								should adhere to a low speed limit. - No litter, food or other foreign material should be thrown or left around the site and should be placed in demarcated and fenced rubbish and litter areas			

Table 11: Impact assessment summary table for the Operational Phase for preferred and alternative layout

OPERATIONAL PHASE												
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence/ Intensity**	**Probability**	**Reversibility**	**Irreplace-ability**	**Potential Mitigation Measures**	**Significance**		**Confidence Level**
										Without Mitigation	***With Mitigation***	
Alteration of micro-climate	Changes in temperature, wind direction and speed	Neutral	Local	Long-Term	Medium	Probable	High	Low	• Monitoring of plant populations and replanting of native rare plants in buffer zones	Low	Very low	Medium
Impact on fauna during the operation of the wind turbines.	Noise, Accidents and Disturbance	Negative	Local	Long-Term	High	Probable	Low	Very Low	• Provision of critter paths within the fencing should be considered in the design. • Promote and support faunal presence and activities within the proposed PV facility	Medium	Low	High

OPERATIONAL PHASE												
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence/ Intensity**	**Probability**	**Reversibility**	**Irreplace-ability**	**Potential Mitigation Measures**	**Significance**		**Confidence Level**
Impact on flora during maintenance activities.	Loss of biodiversity and habitats	Negative	Site-specific	Long-Term	Medium	Probable	Low	Moderate	• Avoid broadcast spraying of chemical herbicides during vegetation clearance • Uproot and burn invasive alien species ones spotted • Replant native rare plants in buffer zones to prevent extinction. • Minor vegetation clearance should be done manually.	Low	Very low	High
Operation of the wind turbines	Loss of connectivity and habitat fragmentation may result if fauna avoid the area or cannot move through the area on account of the presence of the facility	Negative	Local	Long- term	Low	Probable	Low	Low	• Minimising the development footprint wherever possible. • Revegetation of all cleared and bare areas created by the facility with local species.	Low	Low	

Table 12: Decommissioning Phase Impact assessment summary table for preferred and alternative layout

DECOMMISSIONING PHASE												
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence / Intensity**	**Probability**	**Reversibility**	**Irreplace-ability**	**Potential Mitigation Measures**	**Significance**		**Confidence Level**
										Without Mitigation	***With Mitigation***	
Exotic weed invasion as a consequence of abandonment of site and cessation of weed control measures	Habitat and species change	Negative	Local	Medium-Term	High	Probable	Low	Low	• Lost biodiversity on the disturbed area should be restored through planting of appropriate trees and shrubs. • The GoG quarantine inspection and procedures should be followed to ensure that invasive or alien species do not enter the area. • Mitigation would include monitoring of the land and redress of exotic weeds found present on site	Low	Low	High
Exposed soil increase in erosion	Habitat and species population change	Negative	Local	Short-term	Medium	Probable	Medium	Low	• Establishment of lawn in exposed areas • Establishment of lawn in exposed areas • Construction of proper permanent drainage system	Low	Very low	Medium

DECOMMISSIONING PHASE												
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence / Intensity**	**Probability**	**Reversibility**	**Irreplace-ability**	**Potential Mitigation Measures**	**Significance**		**Confidence Level**
										Without Mitigation	***With Mitigation***	
	Impacts on fauna during construction decommissioning activities	Negative	Local	Short term	Medium	Probable	Low	Low		Low	Very Low	Medium

10. CONCLUSIONS AND RECOMMENDATIONS

The study identified the mangrove and thicket vegetation as critical habitats that would be impacted by the project through clearance. The thicket has species such *as Ritchiea reflexa*, which is of conservation concern in Ghana. Furthermore, some fauna would be dislodged or destroyed with the implementation of the project. The soil would be compacted and as such could prevent natural regeneration after temporary facilities are removed.

Wind energy facilities are diffuse and distributed across a broad area and the footprint from an ecological perspective is considerably greater than the extent of transformation. Nevertheless, the areas of the site consist of plant communities with relatively low floral diversity.

The major impacts associated with the development are likely to occur during the construction phase. A large amount of physical disturbance and activity will occur during construction and effective management of associated impacts would be a key element in reducing the overall impact of the development. The key mitigation measures identified in this report include the following basic activities, which are detailed in the report:

- Careful pre-construction micro-siting of the infrastructure of the development.
- Preconstruction walk-through of the development footprint to locate species and habitats of conservation concern that should either be avoided or translocated prior to construction.
- Stringent construction-phase monitoring of activities at the site to ensure that mitigation measures are adhered to and that impacts such as erosion and alien plant invasion are managed before that become serious impacts that may be difficult to control.
- Minimising the footprint of the development as much as possible, with particular emphasis on rehabilitation of disturbed areas with local species.
- Ensure a rehabilitation and re-vegetation programme is effectively implemented.

- Adopt a faunal rescue plan and prohibit hunting/poaching activities.

- Ensure a good housekeeping during construction activities and all vehicles at the site should adhere to a low speed limit

During the course of the ESIA process, the turbine layout has been adapted to accommodate the various sensitivities identified in the various specialist studies. This has been a critical element in reducing the overall impact of the development. A similar approach should be adopted with regards to the associated infrastructure such as roads and underground cabling.

It is recommended that as far as possible, species of conservation concern are identified and adequate measures taken to protect them. Such species could be translocated to safe areas in the project area or their propagules collected and replanted outside the project impact areas.

The preferred layout is recommended since the alternative layout would not lead to any significant reduction of the anticipated impacts.

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CURRICULUM VITAE OF JAMES K. ADOMAKO (DR.)

Full Name: James Kojo Adomako (Dr.)
Profession: Ecological Specialist
Date of Birth: August 28, 1961
Nationality: Ghanaian
Contact Address: Department of Botany, University of Ghana, P. O. Box LG 55, Legon
Tel: 054-434-0346
Email: jadomako@ug.edu.gh

Membership of Professional Body:

Ghana Science Association

Key Qualifications:

Dr. James Kojo Adomako is a botanist by profession and currently has a Ph.D. in ecology. He has undertaken various floral and faunal surveys, including that of fresh and marine water and which he has presented at various workshops and conferences. His research work in the field of ecology is extensive and has over 50 research papers to his name. He has worked as an individual consultant to many environmental consultancy firms during which he conducted ecological studies and provided recommendations on impacts and mitigation measures as a result of project development.

As terrestrial ecologist, Dr. Adomako has been responsible for the specific inputs into many environmental and scientific assignments some of which are indicated below:

- Consultant for WWF-International on the Biodiversity Convention, 1992-1994
- National Expert on Mangroves for the GEF Gulf of Guinea Large Marine Ecosystem Project 1997-1999

- Mapping of sudd vegetation on the Kpong head pond, Volta River Authority 1998-99
- Consultant Ecologist on the under listed Environmental Impact Studies
- Environmental Audit of small scale mining operations in Ghana, GTZ/Minerals Commission, 1993
- Dunkwa Environmental Audit, L&W of South Africa/SGMC
- Environmental impact studies for Aplaku and Nungua septage treatment projects, AY&A Consult, 1998
- Environmental impact studies for the Kwabenya Landfill Project, AY&A Consult, 1998
- Studies on the Underlying Causes of Deforestation and Forest Degradation in Ghana, ICA-Ghana, 1998
- Ecological Baseline Studies for Korle Lagoon, Scott Wilson Kirkpatirck & Co.Ltd, 1998-1999
- Kotoka International Airport runway expansion project, AY&A consult,1999
- Prestea-Obuasi transmission Line Right-of-Way, Refast, VRA, 2000
- Winneba water supply expansion project, AY&A,2000
- Aboadze-Tema transmission line Right-of-Way extension project, Refast Lines/VRA, 2002
- West Africa Gas Pipe Line Project, ESL/ICF Consulting, 2002-2003
- Floral Survey of the Biodiversity Component of the NRMP, Forestry Commission/ERML, 2001-2002
- Ex-Post Project Studies of 4 GEF-SGP funded Projects in Ghana, Global Environment Fund, 2004 - 2005.
- Tamale water supply Expansion project, AY&A Consult, 2006
- Ethnobotanical Survey in Inland Valley Sites, Inland Valleys Rice Development Project, GOG/AfDB/MoFA, 2006-2008 (Team Leader)

- EIA and EMP for Oil Palm Project, Dekel Oil, Abidjan Cote D'Ivoire, 2008

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Education:

a. PhD Botany (Ecology), University of Ghana, 2004,
b. Certificate (Diatom Taxonomy), University College London, 1998
c. MPhil Botany (Ecology), University of Ghana, 1991
d. BSc. (Hons) Botany with Zoology, University of Ghana, 1986

Employment Record:

Year:	**February 2001 to date**
Employer:	University of Ghana
Position:	Senior Lecturer
Responsibilities:	Teaches courses in Plant Ecology, Anatomy of Seed Plants, Conservation and Environmental Studies
Year:	**September 1992 - February 2001**
Employer:	University of Ghana
Position:	Lecturer
Responsibilities:	Teaches courses in Plant Ecology, Anatomy of Seed Plants and Conservation
Year:	**1986 – 1988**
Employer:	University of Ghana
Position:	Teaching Assistant
Responsibilities:	Assisting lecturers in practical assignment and course work in botany studies

Languages:

Languages:	**Speaking**	**Reading**	**Writing**
English	Excellent	Excellent	Excellent
Akan	Excellent	Excellent	Excellent
Ga	Excellent	Excellent	Excellent

SPECIALIST DECLARATION

I, **DR. JAMES KOJO ADOMAKO**, as the appointed independent specialist, hereby declare that I:

- I act as the independent specialist in this application;
- I perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- Regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of any Acts, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Acts, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing – any decision to be taken with respect to the application by the competent authority; and – objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I have ensured that information containing all relevant facts in respect to the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- All the particulars furnished by me in this specialist input/study are true and correct; and
- I realize that a false declaration is an offence

Signature of the specialist:

Name of the specialist: Dr. James Kojo Adomako

Date: February 19, 2017

Environmental & Social Impact Assessment

for the proposed development of a Wind Energy Facility in Anloga Extension (WPP1)

APPENDIX 3:

Bird Impact Assessment Study

ORNITHOLOGICAL IMPACT ASSESSMENT:

Scoping and Environmental and Social Impact Assessment for the proposed Development of the 76MW Wind Power Project situated at Anloga, Srogbe & Anyanui (Anloga Extension) in the Volta Region of Ghana

Report prepared for:	*Report prepared by:*
Seljen Consult Limited P. O. Box AT 140 Achimota-Accra Ghana-West Africa CSIR – Environmental Management Services P O Box 320 Stellenbosch, 7599 South Africa	Dr Erasmus Henaku Owusu P. O. Box LG 67, Legon, Accra-Ghana erasmus67@yahoo.com or ehowusu@ug.edu.gh

DECEMBER 2017

EXECUTIVE SUMMARY

This study aims at assessing the potential impacts on avifauna associated with the proposed construction, operation and decommissioning of a 76 Megawatt (MW) Wind Energy Facility (WEF) ("WPP1") in Anloga Extension areas in the Volta Region, Ghana. It will also inform the development of a comprehensive Environmental Management Plan (EMP) to assist Volta River Authority (VRA) in managing the impacts on avifauna in a responsible manner.

On the whole the proposed sites for the power project have been highly modified by subsistence agriculture and perennial inundation of most of the marshy areas. Although some bird species of national conservation concern, mainly raptors belonging to the family *Accipitridae* were recorded at the site, these were not significant and other species recorded are common and widespread in Ghana as well within their geographic range. The key impacts associated with WEFs and birds are:

Construction phase:

- Habitat Destruction,
- Disturbance and Displacement

Operation Phase

- Collision with turbines
- Disturbance and displacement
- Disruption of bird movements

Decommissioning Phase:

- Disturbance and Displacement

Birds have proven to be resilient to most habitat changes, but impacts from developments such as wind turbines could have significant consequences on bird populations, particularly, vulnerable species. In general the study did not record any species or an ecological entity whose presence at both preferred and alternative layouts should preclude the development of the proposed project as both have similar potential impacts with regards to avifauna.

The main impacts on avifauna identified as part of this study include disturbance associated with habitat destruction during the construction phase as well as disruption of local bird movement patterns and collision with turbines during the operational phase, which will remain of medium significance with mitigation measures. The other impacts on avifauna have been assessed to be of low significance following the effective implementation of recommended mitigation measures. Both layouts (preferred and alternative layout) are anticipated to lead to the same level of impacts.

The key mitigation measures proposed in the study include:

- A pre-construction monitoring programme is recommended, particularly during the migration months where higher bird activity would be recorded. 24 hour-a-day monitoring during the three months September, October and November should be undertaken. Such real-time monitoring should be continued throughout the life of the facility to allow modification of the wind turbine operational regime in response to the presence of significant numbers of these birds.
- The review of monitoring data and results should strive to identify sensitive locations, including turbines that may require additional mitigation. If unacceptable impacts are observed (in the opinion of the bird specialist and independent review), the specialist should conduct a literature review specific to the impact (e.g. collision and/or electrocution) and provide updated and relevant mitigation options to be implemented. As a starting point for the review of possible mitigations, the following may need to be considered:
    - Assess the suitability of using deterrent devices to reduce collision risk (e.g. DTBird© and ultrasonic/radar/electromagnetic deterrents for bats)

    - Identify modification options to turbine operation to reduce collision risk if absolutely necessary and if other methods are not achieving the desired results (e.g. temporary curtailment or shut-down on demand).

LIST OF ABBREVIATIONS

ABBREVIATION	MEANING
CEMP	Construction Environmental Management Plan
CSIR	Council for Scientific & Industrial Research
dB	Decibels
ECO	Environmental Control Officers
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme
ESIA	Environmental & Social Impact Assessment
HV	High Voltage
IBA	Important Bird Area
IUCN	International Union for the Conservation
km	kilometre
kV	kilovolts
m	metre
MV	medium voltage
MW	Megawatt
PA	Protected Area
SCL	Seljen Consult Limited
S/S	substation
sp.	species
VRA	Volta River Authority
WEF	Wind Energy Facility
WPP 2	Wind Power Project 2

GLOSSARY

DEFINITIONS	
Barrier effect	Phenomenon where bird movement is stampeded by barrier between feeding areas and breeding areas, thus affected productivity and populations.
Vulnerable species	A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for vulnerability (see Red List Categories and Criteria Booklet for details), and it is therefore considered to be facing a high risk of extinction in the wild.
Refugia habitat	Remnants of habitat within a matrix of land use options that serve as refuge for species once their usual colonising site is altered.
Biome and Range Restricted species	Birds whose global distributions are restricted to the Guinea-Congo Forest block and the Upper Guinea Forest.

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ORNITHOLOGICAL IMPACT ASSESSMENT

1. INTRODUCTION

Dr. Erasmus Owusu from The University of Ghana and Mr Patrick Morant from the Council for Scientific and Industrial Research were appointed to conduct an assessment of the potential impacts on avifauna associated with the proposed construction, operation and decommissioning of a 76 Megawatt (MW) Wind Energy Facility (WEF) ("WPP1") in Anloga Extension areas in the Volta Region, Ghana (Figure 1). Dr Andrew Agyekumhene (Site Manager of the Muni-Pomadze Ramsar Site, Wildlife Division, Forestry Commission) was also contracted to undertake a field survey during November 2017.

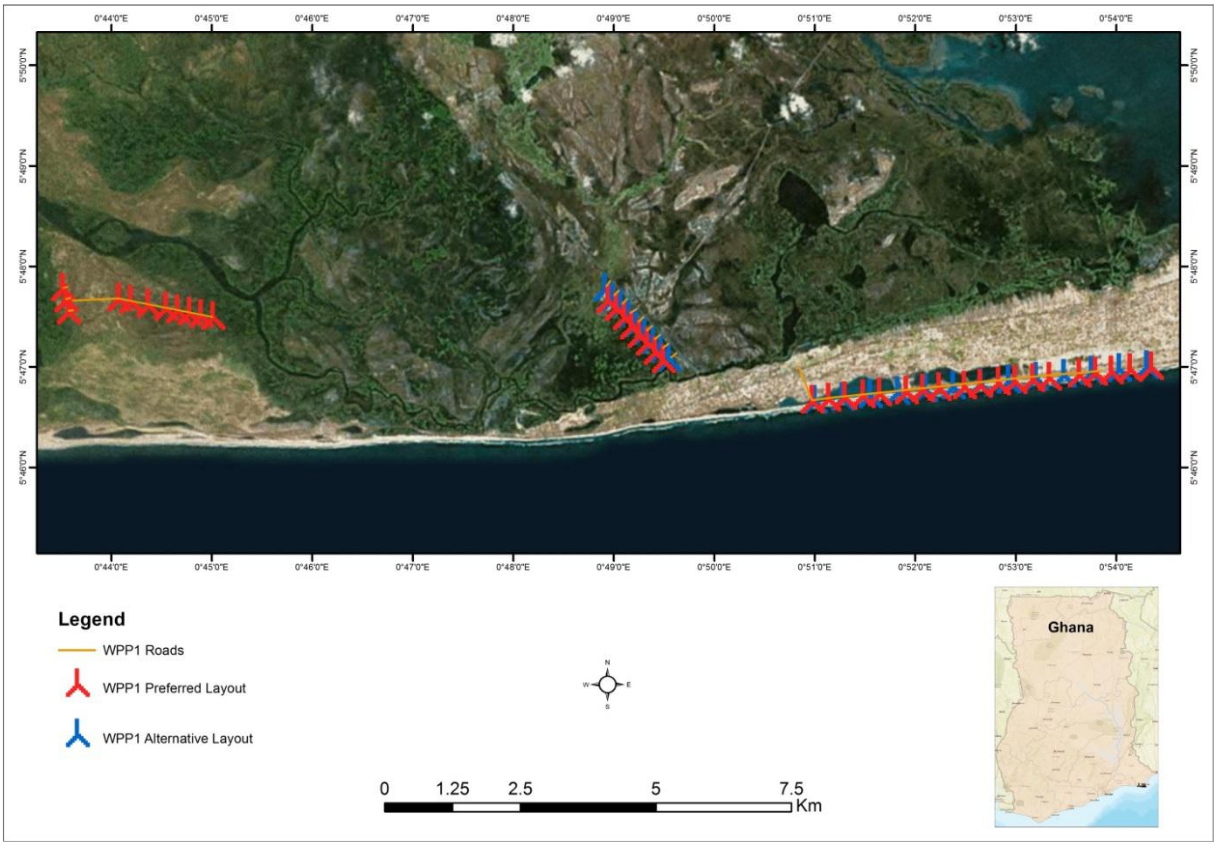

Figure 1: Location of the site for WPP1 with preferred and alternative layouts

This study aims to inform the Environmental & Social Impact Assessment (ESIA) in the development of a comprehensive Environmental Management Plan (EMP) to assist Volta River Authority (VRA) in managing the impacts on avifauna in a responsible manner.

2. TERMS OF REFERENCE FOR SPECIALIST STUDY

Birds are present in almost every habitat type. In Ghana, the avifauna constitutes a significant and important component of the fauna resources of all ecological zones. In many cases, birds have been used in identifying priority areas for biodiversity action (Conservation International, 1999, BirdLife International, 1998) and have proved to be reliable indicators of terrestrial biological richness and environmental conditions (Stattersfield, *et al.*, 1998). Although they may not provide an ideal early warning signal of environmental deterioration; a change in bird population, species diversity and composition in a given habitat over a period of time is often indicative of ecological changes.

The Scope of Work is based on the following broad Terms of Reference, which have been specified for this specialist study:

- Undertake an ornithological survey to assess the biodiversity value of avifauna within the project area;
- Identify the potential threats to the identified bird species within the various phases of the project and prescribe interventions to mitigate identified issues;
- Provide inputs into the "Ecological Survey & Habitat Assessment Study" Report by preparing an "Ornithological Impact Assessment Report".

This Bird Impact Assessment report has been compiled based on the information and data collected during the Scoping phase as well as four days of field observations in the month of October and November 2017. The Bird Impact Assessment Report contains the following:

- A description of the existing environment with regards to bird species and their habitats. Those bird species which are most likely to occur on site or be impacted upon as a result of the proposed development must be identified and described.

- A description of the potential impacts of the proposed facility on bird species.

- Recommendations for the management and mitigation of impacts.

The results of this analysis should be used to:

Inform the final turbine layout (or where the layout cannot be finalized within the ESIA, the assessment should be used to define no go areas and areas that should be sufficiently buffered).

Assess the significance of the potential impact of the proposed project alternatives and related activities - with and without mitigation - on avifaunal species and communities (with regards to potential disturbance, displacement, habitat loss and mortality through collision), including consideration of the spatial and temporal extent of these impacts.

Inform actions that should be taken to prevent or, if prevention is not feasible, to mitigate negative impacts during the planning, construction and operational phases of the development.

Inform the nature and extent of monitoring required during and post-construction

Highlight whether the proposed development is fatally flawed and should not be recommended for approval.

2.1 ASSUMPTIONS

Some assumptions included:

- Most species in the areas would be detected;
- Larger species would easily be detected and identified; and
- This study assumes that the information sources used are accurate and reliable.

2.2 LIMITATIONS

The major limitations encountered included:

- Monitoring programmes need to sample a wide set of environmental variables on site and this was not possible for the study. The length of time allocated for the study of bird species abundance and richness in an area is largely influenced by the time (season) of study (in this case dry season, where most of the vegetation had been burnt)
- Estimation of the flight height with no reference points against which to judge this is difficult and subjective
- The presence of the observers on site is certain to have an effect on the birds itself. For example during walked transects, certain bird species will flush more easily than others, certain species may sit undetected, certain species may flee, and yet others may be inquisitive and approach the observers. Likewise with the vantage point counts, it is extremely unlikely that two observers sitting in position for three hours will have no effect on bird flight. Some species may avoid the vantage point position, because there are people there, and others may approach out of curiosity. In almost all data collection methods large bird species will be more easily detected, and their position in the landscape more easily estimated.

3. PROJECT DESCRIPTION

Birds have proven to be resilient to most habitat changes, but impacts from developments such as wind turbines could have significant consequences on bird populations, particularly vulnerable species. Such impacts could result from habitat loss associated with the construction of all components of the proposed facility and direct strikes on the turbines; barrier effects; and noise generated during the operation phase. The following main components of the proposed development may have impacts on avifauna:

- ***Wind turbine area:***
  - Wind turbines; and
  - Hard standing areas;
- ***Building Infrastructure:***
  - Offices;
  - Operational and maintenance control centre;
  - Warehouse/workshop;
  - Ablution facilities;
  - Converter/Inverter stations;
  - On-site substation building; and
  - Guard Houses.
- ***Associated Infrastructure:***
  - Access roads;
  - Internal gravel roads;
  - Fencing;
  - Stormwater channels; and
  - Temporary work area during the construction phase (i.e. laydown area).

The proposed project will include 38 individual wind turbines with an approximate generation capacity of 2 MW each for the preferred layout and 22 wind turbines of 3.45 MW for the alternative layout. The a hub height of up to 95 m and a rotor diameter of 110 m for the preferred layout and hub height of 112 m and rotor diameter of 136 m for the alternative layout. A detailed description of the proposed project can be found in Chapter 3 of the ESIA report.

4. APPLICABLE LEGISLATION AND PERMIT REQUIREMENTS

The main domestic legislations governing wildlife in Ghana include:

1. Wild Animals Preservation Act, 1961 (Act 43) as variously amended;
2. Wildlife Conservation Regulation, 1971 (LI 685) as variously amended;
3. Wildlife Reserve Regulation, 1971 (LI 710) as variously amended;
4. Wetland Management (Ramsar Sites) Regulation 1999.

The Wild Animals Preservation Act, 1961 (Act 43) was subsequently amended by the Wild Animals Preservation (Amendment) Law, 1983 (PNDCL 55), and Forestry Commission Act, 1999 (Act 571). The main provisions of this Act include:

- It gives the Government the right to establish Protected Areas (PAs);
- It regulates hunting and trade in wild animals; including birds and trophies;
- It restricts the import and export of trophies without certificate;
- It prohibits certain methods of hunting;
- It contains five Schedules (of animals and birds) which provides various degrees of protection;
- It gives game officers the police powers of arrest;
- It provides indemnity to game officers for acts performed in good faith;
- It provides the institutional framework for management and conservation of wildlife, vested in Wildlife Division of Forestry Commission;
- It empowers the Sector Minister to make regulations for the administration of the Act; and
- It provides for sanctions in the event of non-compliance;

This law amends the five (5) Schedules provided under Act 43 and replaces them with three (3) new Schedules.

The Wildlife Conservation Regulations, 1971 (LI 685), as variously amended

- This law amends the five (5) Schedules provided under Act 43 and replaces them with three (3) new Schedules.
- Schedule I deals with animals that are under complete protection at all times (i.e. throughout the year). It is forbidden to hunt, capture or destroy any of the species contained in this Schedule. Examples include Chimpanzees, lions, and elephants.
- Schedule II provides for animals that are under complete protection between 1st August and 1st December and those protected at all times when accompanied by their juvenile members. Examples include the Mona monkey, spotted hyenas, crested porcupines and tree bears.
- Schedule III deals with animals under complete protection between 1st August and 1st December. This Schedule further includes:
    - The prohibition of certain methods of hunting, such us using fires;
    - It provides for the acquisition of game licenses for hunting of wild animals;
    - Enforcement of the law(s) entrusted to staff of the Wildlife Division;
    - The seizure of any equipment or apparatus in possession of any person who has contravened the law;
    - Permits required for the export of any animal and trophy;
    - Killing in defense of person(s); and
    - The provision of sanctions for breach of any of the provisions under the law.

The Wildlife Reserves Regulations, 1971 (LI 710), as variously amended, includes the following main provisions:

- To provide for the creation of national parks, game production reserves, strict nature reserves and wildlife sanctuaries;
- To provide for rules and regulations on entry;
- To prohibit certain activities within wildlife PAs
- To provide for the protection of plant and animal life therein; and
- It provides sanctions in events of non-compliance.

Table 1 briefly describes the legislation and permit requirements pertaining to avifauna and its related resources in Ghana, and how it applies to the proposed project.

Table 1: Core requirements of applicable legislation and their relation to the project

Policy and Legal Framework	Summary of Core Requirements	Relation to Project
The Wildlife Conservation Regulations, *1971 (LI 685) as variously amended*	All species in schedule I of the regulation are wholly protected throughout the year	The cattle egret and the yellow-billed kite and all raptors belonging to the family *Accipitridae* that were recorded in the project area, are fully protected. Hence any activity that would be undertaken would need to ensure that such species are not negatively impacted
Wetland Management (Ramsar Sites) Regulations 1999	Under this regulation, no person shall through his/ her activities 1) pollute ant water, 2) use poison, chemicals, explosives or any prohibited method for fishing, 3) the use of seine nets or other nets with mesh size below 25 mm; 4) do any other act that has or likely to have an adverse effect on the environment	The affected area falls within the Keta Lagoon complex Ramsar Site and therefore activities undertaken within the area are regulated. The aspect of the regulation that is directly connected to the project has to do with restriction on hunting, capture, harm or deliberately disturb any wild animals, including roosting, breeding and nesting birds.
The Wild Animals Preservation Act, 1961 (Act 43)	1) gives the Government the right to establish protected areas 2) regulation of hunting and trade in wild animals; including birds and trophies 3) iii)To provide for sanctions in the event of non-compliance.	The Keta Lagoon complex as Ramsar site is also a protected area under the management of the Forestry Commission through the Wildlife Division of Ghana

5. METHODOLOGY FOR ASSESSMENT OF IMPACTS

In order to assess the potential impacts, a standard field survey was conducted to determine, inter alia, the avian species composition of the selected sites. These included direct and indirect field observations and a combination of appropriate study methods.

5.1 AVIFAUNA

The initial field observations included two standard methods, transect and point counts. The two methods were selected based on the following;

a) The habitat of the proposed site is generally uniformly coastal savanna, with clear views for observing birds. Along the coast, lagoons that are documented habitat for migratory water birds exist.

b) Point counts using distance bands enable the estimation of species abundance and density.

The species list would be augmented by opportunistic observations. The method for bird identification and nomenclature followed that of Borrow and Demey (2001). Bird surveys were carried out in all the major representative habitat conditions. Major habitat types and site condition were predetermined using the current vegetation maps of the sites.

It is important to note that either method provides a quick and effective means of assessing the avifauna composition in different micro-habitat types. For the transects, counts were carried out every 200 m along footpaths and other access ways at the sites. Counts were carried out between 6:30 am and 10:00 am, and between 4:00 pm and 6:00 pm for four days per site, to ensure the complete species list has been exhausted. For each point of count, focus notes were taken on movement patterns of the flocks with respect to the proposed wind farm location and which species were involved.

The procedure for the point counts which was undertaken in patches, fell outside of the main transect and ensured that the species list would be exhausted. Hence the data was used to enrich the species list. Since the primary purpose of the study was to identify and document the presence of bird species at the site, no distance limits were set for observations and, hence, any bird seen or heard anywhere in and around the site will be identified and recorded with the aid of telescopes and binoculars.

In addition to the above, filed surveys along the Anloga beach where turbines are proposed, were conducted by Dr Andrew Agyekumhene (Site Manager of the Muni-Pomadze Ramsar Site, Wildlife Division, Forestry Commission) for four days during the month of October and November 2017. The Vantage Point (VP) survey was used in the assessment. The survey comprised a series of watches from a fixed location to quantify the flight activity of birds at the proposed development site. The selection of vantage points (number and locations) was based on field conditions (e.g. size of area, topography etc). The surveys were conducted in the early morning and early evening to cover the periods when birds are most active.

The information that was collected on each survey day include:

- Survey start and end time
- Cloud cover
- Wind speed (using the Beaufort scale)
- Wind direction
- Visibility
- Bird species
- Flight height band of bird
- Time of bird at flight height band
- Bird activity at each flight height band

Mortality counts involved observations around each of the meteorological masts that have been installed on the sites to ascertain whether there were any signs of collision.

5.2 DATA ANALYSIS

Bird species recorded at the sites will be grouped according to their family using the appropriate authorities and checklists, in this case, Borrow and Demey (2010). Global conservation and national protection status of each species will be assessed using the International Union for the Conservation of Nature (IUCN) Red List of Threatened species (IUCN, 2012). The assessment of national protection status was based on the Ghana Wildlife Conservation Regulation 1971 (LI 685), where all species listed in **Schedule I** of the Wildlife Conservation Regulation are accorded full protection or wholly protected. Other measures of conservation significance such as Biome and Range Restriction (Bibby, *et al.,* 1992; Stattersfield, *et al*., 1998) were used to consolidate the knowledge of conservation status of various species. Biome and Range Restricted species are birds whose global distributions are restricted to the Guinea-Congo Forest block and the Upper Guinea Forest. This attribute is important in any baseline study, in view of the rapid rate of disappearance of the Guinea - Congo Forest of West and Central Africa.

6. DESCRIPTION OF THE AFFECTED ORNITHOLOGICAL ENVIRONMENT

6.1 VEGETATION AND BIRD MICRO-HABITATS

The vegetation on the site which falls within the Keta Municipality in the Volta Region comprises coastal savannah scrub. This primarily consists of wooded areas of mainly neem trees, scattered mango and palm trees. The land is generally flat with few undulating slopes. The primary land use observed during the survey is crop farming for watermelons and other vegetables such as pepper and okra. The whole landscape is farmed using raised beds. Cattle grazing were observed across the study landscape with significant levels of fuel wood collection. The nature of the habitat with regards to farming makes it conducive for birds as it offers a very good area for foraging particularly for granivorous bird. The flat and windy nature is also ideal for raptors such as the Yellow-billed Kite to soar and hunt for prey. The mangroves at Anyanui offer refugia habitat for certain bird species, particularly, the herons. Internationally, the study area falls within the Keta Lagoon Complex which is designated as a Ramsar Site and an Important Bird Area (IBA) (Ntiamoa-Baidu *et al*, 2001). Some key micro habitats include patches of mangroves (Figure 2) and old farmlands.

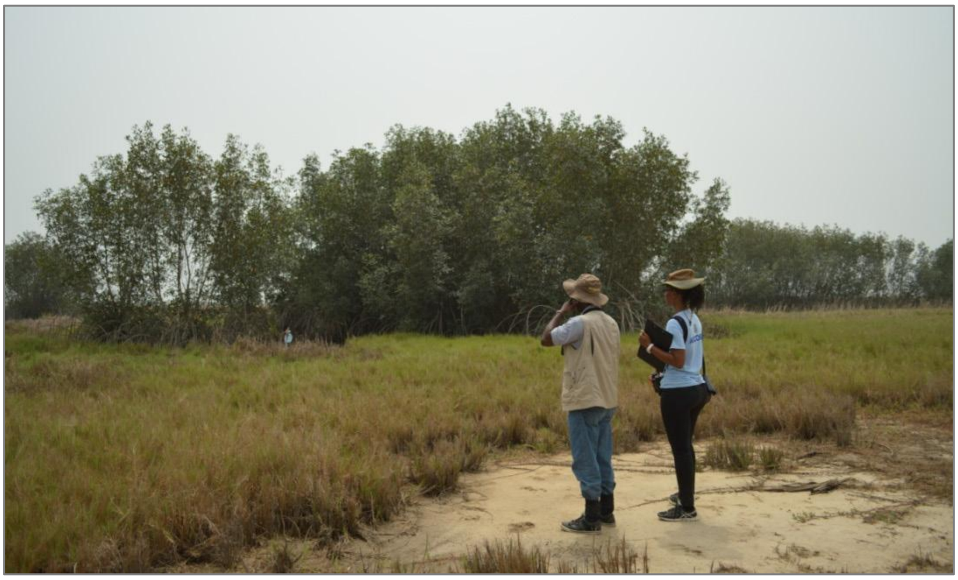

Figure 2: Patches of mangroves at Anloga

6.2 AVIFAUNAL COMMUNITY

A list of species of that is likely to be impacted (Table 2) has been generated based on the abundance of the species, the flight patterns, and habitat preferences. All the species listed are "Least Concern" on the IUCN Red List, hence their populations can be considered to be at low risk. The listing here is therefore based on commonness and the risk of high probability of encountering wind turbines and obstructions from access roads etc.

Table 2: Terrestrial Bird Species of Concern based on flight patterns and habitat preference

Species	Rational	Conservation Status National
CONSTRUCTION PHASE		
Common Bulbul	Clearance of habitat leading to displacement. Mid canopy bird.	Common, no special protection
Vinaceous Dove	Clearance of habitat leading to displacement	Common, no special protection
Village Weaver	Clearance of habitat leading to displacement	Common, no special protection
Yellow-crowned Gonolek	Clearance of habitat leading to displacement	Common, no special protection
Zitting Cisticola	Clearance of habitat leading to displacement	Common, no special protection
Black-crowned Tchagra	Clearance of habitat leading to displacement	Common, no special protection
Brown Babbler	Clearance of habitat leading to displacement. Gregarious and could be easily trapped	Common, no special protection
Bronze Mannikin	Clearance of habitat leading to displacement. Usually in large flocks in mid canopy	Common, no special protection
Northern Red Bishop	Clearance of habitat leading to displacement	Common, no special protection
Black-rumped Waxbill	Clearance of habitat leading to displacement	Common, no special protection
Black-billed Wood Dove	Clearance of habitat leading to displacement	Common, no special protection
African Wattled Lapwing	Clearance of habitat leading to displacement	Common, no special

Species	Rational	Conservation Status National
CONSTRUCTION PHASE		
		protection
Northern Grey-headed Sparrow	Clearance of habitat leading to displacement	Common, no special protection
Red-eyed Dove	Clearance of habitat leading to displacement	Common, no special protection
Yellow-billed Shrike	Clearance of habitat leading to displacement	Common, no special protection
Tawny-flanked Prinia	Clearance of habitat leading to displacement	Common, no special protection
OPERATION PHASE		
Yellow-billed Kite	Flight pattern increases its collision potential	Wholly protected
Purple Glossy Starling	Flight pattern increases its collision potential	Common, no special protection
Pied Crow	Flight pattern increases its collision potential	Common, no special protection
Western Grey Plantain-eater	Flight pattern increases its collision potential	Common, no special protection
Barn Swallow	Flight pattern increases its collision potential	Common, no special protection
White-throated Bee-eater	Flight pattern increases its collision potential	Common, no special protection
African Grey Hornbill	Flight pattern increases its collision potential. Medium sized bird with mid canopy movement	Common, no special protection

Besides the terrestrial bird species listed in Table 2 above, five species of terns (Grimes, 1977) and at least three species of waders (Delany *et al.*, 2009) could be affected by the proposed Anloga project. These two groups can be expected to forage and roost along the coastline. The terns hunt for fish in the inshore waters whereas the waders feed on invertebrates in the swash zone.

Grimes (1977) used radar to track the terns moving from their fishing grounds to inland roost sites on saltpans near Accra. The tern species are the Black *Chlidonias nigra*, Royal *Sterna maxima*, Sandwich *S. sandvicensis,* Common *S. hirundo* and Roseate *S. dougalli.* These terns are present during the boreal (Northern Hemisphere) autumn (September - December) during their southwards migration down the west coast of Africa. Upwelling, which occurs in autumn, results in shoals of fish, mainly sardine *Sardinella aurita* moving inshore where they are preyed upon by the terns. In spring no upwelling occurs and the terns travel northwards to their breeding grounds via a different route thus are not likely to be present in the Anloga area in significant numbers.

Delany *et al.* (2009) list three species of waders, Common Ringed Plover *Charadrius hiaticula*, White-fronted Plover *C. marginatus*, and Sanderling *Calidris alba,* that could be present in the Anloga area throughout the boreal winter from autumn to spring. These birds forage along the shore when sea conditions permit but will move inland to feed in shallow wetlands when the sea conditions are too rough.

Both these tern and wader species can be expected to roost on the beach at Anloga or on island in the wetlands and thus are at risk from collision with the wind turbine blades. Terns in particular, based on the experience of Grimes (1977) may fly inland to roost after dark thereby exacerbating the risk of collision.

The surveys undertaken for the ESIA only indicated the presence of few terns and no waders. It is therefore possible that the Anloga coast may not support significant numbers of these birds (Table 3). Results from previous surveys at the Keta Ramsar site (Appendix 14.1) and from field observations in similar wetlands (Ramsar sites) shows that the numbers of birds fluctuate considerably over the years. This could have accounted for the much lower of birds observed during the survey undertaken during the peak arrival season in November 2017. In addition, the birds usually aggregate more around the lagoon than on the beach front, which could also contribute to the lower number of birds observed.

However, the surveys undertaken as part of this ESIA were too few in number and limited in scope and thus may not have provided representative data on these birds. Ideally 24 hour-a-day monitoring during the three months September, October and November should be undertaken to clarify the situation. Such real-time monitoring should be continued throughout the life of the facility to allow modification of the wind turbine operational regime in response to the presence of significant numbers of these birds.

Table 3: Bird species observed during the second field survey (November 2017)

List of Species	Conservation Status National (WCR, 197, LI 685)
Black Shouldered Kite	Completely protected
Common Tern	Partly protected
Long-tailed Cormorant	Partly protected
Sandwich Tern	Partly protected
Western Reef Egret	Completely protected
Yellow-billed Kite	Completely protected

An extensive list of common waterbird species and their abundance on coastal Ramsar Sites, including Keta Ramsar Site, as obtained in a single count in January 2017 can be found in Appendix 4 of the Wetland Impact Assessment Report. (Appendix 6 of this ESIA Report).

7. IDENTIFICATION OF KEY ISSUES

7.1 KEY ISSUES IDENTIFIED DURING SCOPING

The following key issues related to avifauna have been identified during the ESIA process:

Construction phase

- *Habitat Destruction:*

A certain amount of natural habitat will be altered and removed during the construction of the proposed facility. Building a new wind farm can therefore affect birds if the turbines are put up in an area that is frequently used directly by the birds. This may lead to the displacement of birds from the proposed site. However, the magnitude of the impact will depend on the conservation status of the species concern.

- *Disturbance and Displacement:*

Noise and human presence associated with construction activities may disturb birds in the surrounding areas. Other disturbances include burning and flashing of birds in an attempt by local community members to prevent them from destroying grain and pepper farms. New wind farms can act as a barrier for birds and lead to behaviour and flight pattern changes. For example, some wind farms could create a barrier between feeding areas and breeding areas, thus affecting productivity and populations. Equally, wind farms can also fragment habitats used by one bird species, making the two smaller pieces of habitat less useful. Regular maintenance of access routes and associated clearing of vegetation may also cause habitat fragmentation.

Operation phase

- *Disturbance and Displacement:*

Wind turbine blades create noise that can affect the ability of birds to communicate with one another. According to the U.S. Fish and Wildlife Service, a 3 decibel (dB) increase in sound from turbines can reduce the distance across which birds are able to communicate by 30 %. An increase in 10 dB reduces the distance by 90 %. The turbine noise can also cause long-term hearing damage in some bird species.

- Disruption of bird movements:

Wind turbines may also pose a physical barrier to the movement of birds across the landscape, which may induce alterations to their migration paths, and it may cause an increase in the distances that birds have to traverse, as well as increase their energy expenditure and potentially prevent movement of birds to ecologically important areas such as ephemeral wetlands.

- Collision with wind turbines:

This involves the direct strike of birds with wind turbine, killing them instantly. It is on record that songbirds/passerines, which are common in the project area, are susceptible to collisions. Birds are most susceptible to being hit by a wind turbine blade when the wind farm is in their migration corridor and when the bird is flying at low elevations, which can happen during bad weather.

The number of birds impacted by collision is influenced by a number of factors, including:

- Number of birds in the vicinity of the WEF;
- The species of birds present and their flying patterns and behaviour; and
- The turbine layout, height and size of the rotor swept area.

Large birds with poor manoeuvrability are generally at greater risk of collision with structures, and species that habitually fly at dawn and dusk or at night are perhaps less likely to detect and avoid turbines (e.g. cranes arriving at a roost site after sunset, or flamingos flying at night) (Jenkins *et al*. 2015). Collision risk may also vary for a particular species, depending on age, behaviour and stage of annual cycle (Drewitt & Langston 2006).

The precise location of a wind farm site can be critical. Soaring species may use particular topographic features for lift (Barrios & Rodriguez 2004; De Lucas et. al. 2008) or such features can result in large numbers of birds being funnelled through an area of turbines (Drewitt & Langston 2006). Birds also lower their flight height in some locations, for example when following the coastline or crossing a ridge, which might place them at greater risk of collision with rotors.

The size and alignment of turbines and rotor speed are likely to influence collision risk; however, physical structure is probably only significant in combination with other factors, especially wind speed, with gentle winds resulting in the highest risk (Barrios & Rodriguez 2004; Stewart et. al. 2007). De Lucas et. al. (2008) found that turbine height and higher elevations may heighten the risk (taller/higher = higher risk), but that abundance was not directly related to collision risk, at least for Eurasian Griffon Vulture Gyps fulvus.

Decommissioning Phase

- *Disturbance and Displacement:*

Activities occurring during the decommissioning phase, such as traffic and noise, may have similar impacts on avifauna as in the construction phase. Birds that may have utilised the electrical infrastructure for nesting may be vulnerable to disturbance impacts, particularly if the nests are disturbed or removed during the dismantling of infrastructure.

7.2 KEY ISSUES IDENTIFIED DURING THE PUBLIC CONSULTATION PROCESS

Based on the comments raised by Interested and Affected Parties (I&APs) during the presentation of the scoping report on April 13, 2016, the Bird Impact Assessment also needed to address the impacts of the WEF at the location of the Keta Lagoon Ramsar site known to harbour significant number of birds and important migratory birds.

8. HIGH LEVEL ASSESSMENT OF IMPACTS/RISKS AND IDENTIFICATION OF MANAGEMENT ACTIONS

The methodology used to assess the potential impacts on avifauna is detailed in Chapter 2 of the ESIA report. The identified impacts/ risks posed to avifauna during the construction, operation and decommissioning phases are detailed below.

8.1 CONSTRUCTION PHASE

The disturbance normally associated with the construction of a wind farm is temporary. However, this depends on the time taken to construct a wind farm and many other factors, including the scale of the project, the terrain and climate. In the project area, a key activity likely to impact on bird species includes the clearing of vegetation associated with the construction of proposed wind turbines and associated infrastructure, particularly roads, which can adversely alter the habitat quality of birds, but only for short periods, depending on the intensity of other anthropogenic activities that may be stimulated as a result of the creation of access routes. The clearing of vegetation will lead to two main impacts on avifauna in the project:

- Habitat Destruction,
- Disturbance and Displacement

8.1.1 Habitat Destruction

Construction typically takes 9 - 18 months (Kingsley & Whittam, 2005), which is likely to coincide with periods of bird breeding. Construction usually begins with the development of roads, followed by the excavation and pouring of the concrete foundations for the towers. This is followed by digging trenches and the burial of underground electrical cables. Substations and any other buildings are then built; followed lastly by the assembly and testing of the turbines. The erection of a turbine usually takes 1 day. It is envisaged that during the construction phase, clearing of habitat used by birds for food and roosting within the site would result in the displacement of birds (Owusu & Roberts, 2016).

The scale of habitat loss resulting from the construction of a WEF and associated infrastructure depends on the size of the project, but is likely to be small per turbine base i.e. 2 – 5 % of the total development area (Drewitt & Langston, 2006) of a WEF. Therefore, due to the relatively small footprint of the WEF and degraded and altered state of the vegetation in the affected area, in most cases, habitat destruction or alteration due to clearing of natural vegetation is unlikely to be of much significance. Fragmentation of habitat can be an important factor for some smaller bird species. This disturbance could cause certain birds to avoid the entire site, thereby losing a significant amount of habitat effectively. In addition, the aerial habitat which will be lost by birds should be considered.

The destructive impact of the development on bird habitat would be of direct local extent for both alternative and preferred layouts, and permanent as the majority of cleared areas are required for roads and other infrastructure and will not be rehabilitated. The potential intensity of the impact on birds is expected to be Medium for the preferred and alternative layouts, given that there are species of Least Concern in the project area, and the development has the potential to reduce the quality of the environment and result in habitat loss. The probability of the impact on birds is rated as highly probable because of the previously- and currently cultivated nature of different sites within the project area, which attracts birds.

Given the above, the destruction of bird habit due to the clearing of vegetation is anticipated to be of medium significance for the preferred and alternative layout, without mitigation. The significance is predicated to be medium with mitigation for both proposed layouts.

8.1.1.1 Mitigation

Disturbance distances of up to 850 m have been recorded for wintering waterfowl and waders for onshore wind turbines (the distance from wind turbines in which birds are either absent or the population density is less than expected) (e.g. Pedersen and Poulsen, 1991; Kruckenberg & Jaene, 1999; Larsen & Madsen, 2000; Kowallik & Borbach-Jaene, 2001; Hötker, *et al.*, 2006; Madsen & Boertmann, 2008). A distance of 600 m is the maximum reliably recorded distance for the majority of species (Langston & Pullan, 2003; Drewitt & Langston, 2006). Assuming an absence of habituation, a precautionary complete avoidance distance would be in the region of

300 m for wintering waders and wildfowl, with a precautionary displacement distance of 600 m; the expected population reductions would be in the region of 100% within 0 - 300 m and 50% within 300 - 600 m (Owusu & Roberts, 2016). Specific mitigation actions include:

- Buildings (e.g. offices, storage areas etc.) and high traffic areas should be situated in areas that are already disturbed, where possible.
- Minimizing the footprint areas of infrastructure wherever possible, i.e. length and width of roads and the size of hard standing areas, laydown areas, and vehicle turning areas.
- Avoid wholesale clearing of the landscape and only clear areas critical to the project.
- Avoid prolonged disturbance by phasing clearing and ground work activities.
- Utilize existing roads and farm tracks, where possible, and keep road lengths to an absolute minimum. Ring and alternate roads to turbines should be avoided.
- Avoid any off-road driving and unnecessary earth moving, or vegetation damage or removal.
- Any clearing of stands of alien trees on site should be approved first by an avifaunal specialist, since certain raptor species breed in these areas and should not be impacted.
- Any site rehabilitation should use only indigenous plant species.
- Minimise the impact on natural vegetation by keeping staff numbers to a minimum, as well as the number of large vehicles and general vehicular traffic.
- Avoid any development in sensitive zones and no-go areas.
- Environmental Control Officers (ECOs) must oversee activities and ensure that the site specific construction environmental management plan (CEMP) is implemented and enforced;
- The avifaunal specialist should conduct a site walkthrough prior to construction, confirming the final road as well as the final turbine positions, to identify any nests/breeding activity of sensitive species, as well as any additional sensitive habitats within which construction activities may need to be excluded.
- Rehabilitation of all disturbed areas (e.g. temporary access tracks and laydown areas) must be undertaken following construction; and a habitat restoration plan must be developed by a specialist and included within the CEMP.

- Providing wide corridors between clusters of closely spaced turbines, as recommended by Langston & Pullan (2003).
- According to Winkelman (1992), the layout of a wind farm is an important determinant of collision risk, with dense clusters of turbines potentially being less damaging for wintering, feeding and possibly breeding birds, in that it dissuades them from flying amongst the turbines.

8.1.2 Disturbance and Displacement

Certain sensitive species can be impacted by disturbances and noise from staff and construction activities, especially during feeding and breeding periods, which can result in effective habitat loss through a perceived increase in predation risk (Frid & Dill, 2002; Percival, 2005). There are various Species of Concern occurring on the WEF site (see Table 2), which may become displaced, either temporarily (i.e. for some period during the construction activity) or permanently (i.e. never returning to the site). This displacement into less suitable habitat may reduce their ability to survive and reproduce.

This is a negative impact restricted to the construction site (local) and duration is temporary (~1.5 years), limited to the duration of the construction phase. The irreplaceability of the receiving environment is low. The severity of the impact can be mitigated partially, but some disturbance is likely to occur. The consequence of this impact is medium as the environment will continue to function in a modified manner. The significance of the impact is rated as Low for the preferred and alternative layout prior to the application of mitigation measures, and is Low following mitigation.

Impacts on breeding success are anticipated to be of medium intensity on a short term duration. The impact would be highly probable and is therefore rated as medium before mitigation. With the effective implementation of mitigation actions, the impact on breeding success is anticipated to be of low significance.

8.1.2.1 Mitigation

Generally, the spacing between turbines should be greater than 200 m in order to avoid inhibiting bird movement (barrier effect). This recommended distance is also often the amount of spacing required by industry to reduce wake effects of large turbines on neighbouring turbines (Kingsley & Whittam, 2005). However, the wide spacing of turbines, in an attempt to reduce the likelihood of inhibiting bird movement, may potentially increase the area of displacement due to disturbance (Percival, 2001).

Given the open nature of the habitat in this project, with predominantly widespread and common species (of no or least conservation concern), the displacement of such bird species from portions of a wind farm is unlikely to have population consequences. However, the following specific actions are recommended:

- The implementation of a site specific CEMP is required, which must provide an appropriate and detailed description of how construction activities must be conducted. During construction, all contractors are to adhere to the CEMP and should apply good environmental practice.
- The avifaunal specialist should conduct a site walkthrough prior to construction, confirming the final road alignment, as well as the final turbine positions, to identify any nests/breeding/roosting activity of sensitive species, as well as any additional sensitive habitats and no go areas. These results may inform the final construction schedule, including reducing the construction time, scheduling activities around avian breeding and/or movement schedules, and lowering levels of associated noise.
- Where necessary and under the supervision of an avifauna specialist, nests and roost sites should be removed from the turbine cluster area prior to construction.
- Access routes and layout areas should, as much as possible, be devoid of farmlands which serve as feeding grounds for most of the bird species encountered.
- A precautionary disturbance distance of 1 km should be implemented around wader habitat.
- Minimise the number of staff on site, as well as the number of large vehicles and general vehicular traffic.

- Sensitive zones and no-go areas (e.g. nesting sites) which must be avoided must be demarcated.

8.2 OPERATIONAL PHASE

The development of new wind farms can affect birds because of the "barrier effect" it has on birds. This happens when the new wind farm causes birds to change their behaviour to avoid flying through the developed area. This affects bird movement patterns and, potentially, their eventual displacement. For example, some wind farms could create a barrier between feeding areas and breeding areas, thus affecting productivity and populations. Obstruction of the flight path for certain bird species, particularly raptors and large flocks, is therefore a major concern in the industry. Other impact sources include the regular maintenance of access routes through clearing of vegetation, thereby causing habitat fragmentation. This can also affect birds if the turbines are put up in an area that is frequently used directly by the birds. However, the magnitude of the impact depends on the rarity of the habitat type. During the operational phase, the main impacts on avifauna include:

- Collision with turbines
- Disturbance and displacement
- Disruption of bird movements

8.2.1 Collision with Wind Turbines

The average mortality rate from turbines in Europe fall within the average range of 6.5 and 1.6 bird per turbine per year in North America 1.6 (Rydell *et al*. 2012). Not all birds that fly through a WEF at heights swept by rotors automatically collide with blades. Certain bird species have extremely high avoidance rates. A radar study conducted for an off-shore WEF in Denmark showed that less than 1% of bird flights were at risk due to close proximity to the turbines, and it was clear that the birds (in this case; ducks and geese) effectively avoided the turbines (Desholm and Kahlert, 2005). Whilst a lack of data makes current avoidance rates for Ghanaian species unknown, comparisons can be drawn between functionally similar species in order to inform an assessment, for example Verreaux's Eagle with Golden Eagle.

The majority of studies on collisions caused by wind turbines have recorded relatively low mortality levels (Madders & Whitfield, 2006); however this may largely be a reflection of the fact that many of the studied wind farms are located away from large concentrations of birds. It is also noteworthy that many records are based only on finding carcasses, with no correction for carcasses that were overlooked or removed by scavengers (Drewitt & Langston, 2006).

The cautionary approach to assessing this impact is due to the lack of monitoring data as well as the location of the proposed WEF near a designated Ramsar Site.

Bird mortality is a direct, negative impact that can occur over the full duration of the project's lifespan (long-term). It can affect regional populations if, for example, dispersing eagles continue to collide with turbines as they attempt to populate an available territory (sinkhole effect). The consequence of this impact is potentially severe and recent data from wind farms in South Africa (Ralston Paton *et al.*, 2017) demonstrates that mortalities are very likely to occur, and irreversible in terms of the deceased individuals and possibly also irreversible at a population level. The significance of the impact is rated as High prior to the application of mitigation measures, in particular due to the lack of detailed monitoring. With the effective implementation of the recommended management actions, this impact is anticipated to be of medium significance.

8.2.1.1 Mitigation

- Additional pre construction monitoring is recommended, particularly during the migration months where higher bird activity is expected. A 24 hour-a-day monitoring during the three months September, October and November should be undertaken. Such real-time monitoring should be continued throughout the life of the facility to allow modification of the wind turbine operational regime in response to the presence of significant numbers of these birds.

- Develop and implement a carcass search programme for birds during the first 24 months of operation (at the start of operations at the wind farm). It is recommended to make use of webcams.
- Develop and implement a 24 month post-construction bird activity monitoring programme, including thorough and ongoing nest searches and nest monitoring, which mimics the pre-construction monitoring surveys/ walkthroughs as described in Section 8.1.1.1 and 8.1.2.1.
- Frequent and regular review of monitoring data (activity and carcass) and results by an avifaunal specialist to establish the requirement for continued monitoring studies (activity and carcass) throughout the operational and decommissioning phases of the development, i.e. the frequency and scope of surveys can be adjusted as a result of experience gained during the first 2 years (e.g. focus the monitoring programme during the migration period).
- The review of monitoring data and results should strive to identify sensitive locations, including turbines that may require additional mitigation. If unacceptable impacts are observed (in the opinion of the bird specialist and independent review), the specialist should conduct a literature review specific to the impact (e.g. collision and/or electrocution) and provide updated and relevant mitigation options to be implemented. As a starting point for the review of possible mitigations, the following may need to be considered:
    - Assess the suitability of using deterrent devices to reduce collision risk (e.g. DTBird© and ultrasonic/radar/electromagnetic deterrents for bats)
    - Identify modification options to turbine operation to reduce collision risk if absolutely necessary and if other methods are not achieving the desired results (e.g. temporary curtailment or shut-down on demand).
- Nests and roost sites should be removed from the turbine cluster area to reduce raptor flight activity and subsequent possible collisions.
- As much as possible the ponds and pools in close proximity of turbines should be avoided as these serve as water sources for most bird species.

- Turbines should be placed outside of high sensitivity areas, such as ridge edges and nest buffers.
- If it becomes necessary, based on outcomes of the operation monitoring results, regulation of the operation of the turbines so as to reduce collision risks must be employed. If the real-time assessment proves that more collisions are occurring, turbines can be regulated during operations by reducing speed or stopping them of during certain months when we know (from the surveys) that significant numbers of birds move through the project area.
- If permissible by the Ghana Civil Aviation Authority (GCAA), the use of constant lighting on top of turbines should be avoided, as this may disorientate birds in flight. Intermittent lighting should rather be used.

8.2.2 Disturbance and Displacement

Operational activities such as turbine and road maintenance, fencing, etc. and associated noise can lead to the disturbance and displacement of birds, by effectively avoiding the area for feeding or breeding which could result in habitat loss, and ultimately a potential reduction in breeding success (Larsen & Madsen, 2000; Percival, 2005). Turbines may also disrupt bird flight paths, whereby some species may alter their routes to avoid them (Dirksen *et al*., 1998; Tulp *et al*., 1999; Pettersson & Stalin, 2003). While this reduces the chance of collisions it can also create a displacement or barrier effect, as discussed in Section 8.1.2, which could result in an increased energy expenditure and lower breeding success (Percival, 2005).

Raptors are generally fairly tolerant of wind farms, and continue to use the areas for foraging (Thelander *et al*., 2003; Madders & Whitfield, 2006; Ralston Paton *et al*., 2017), and may therefore not be affected by displacement, however this subsequently increases their risk of collision. Maintenance activities can disturb sensitive species occurring on site. Furthermore, species nesting on the project site may be disturbed during routine maintenance.

This negative impact is of potentially Low consequence and has a long-term duration (will continue throughout the operational phase of the project). The Likely disturbance is restricted to local populations and is moderately reversible once the activity ceases. The significance of the impact is rated as low prior to the application of mitigation measures, and as low following mitigation.

8.2.2.1 Mitigation

- The on-site WEF manager (or a suitably appointed Environmental Manager) must be trained by an avifaunal specialist to identify the potential priority species and Red Data species as well as the signs that indicate possible breeding by these species. If a priority species or Red Data species is found to be breeding (e.g. a nest site is located) on the operational WEF, the nest/breeding site must not be disturbed and an avifaunal specialist must be contacted for further instruction.

8.2.3 Disruption of Bird Movements/ Patterns

The movement of birds across the landscape may be physically disrupted by WEFs, which may alter migration routes, increase distances travelled and energy expenditure, and/or block movement to important areas such as ephemeral wetlands or prey sources. The disruption of bird movements is likely to be more significant as a cumulative impact with surrounding developments, and it is difficult to measure and assess; making it difficult to identify appropriate mitigation measures. Although some mitigation may be possible by avoiding placing turbines in obvious flyways and making turbines more visible through lighting; the significance of this impact will remain unchanged.

The disruption of bird movements constitutes a direct, potentially negative regional impact, with long-term effects. However, the impacts will cease as soon as the turbines are removed (highly reversible). The consequence of this impact is considered medium. The significance of the impact is rated as medium prior to the application of mitigation measures, and as medium following mitigation.

8.2.3.1 Mitigation

- The construction of turbines must be avoided within any high sensitivity zones identified through pre-construction monitoring, and

- In order to reduce the possible impact on the movement patterns of nocturnal migratory species, an intermittent and coloured lighting on turbines is preferred, rather than constant white light. (to be confirmed by the Ghana Civil Aviation Authority (GCAA))
- A precautionary disturbance distance of 1km should be implemented around wader habitat.
- As much as possible the ponds and pools in close proximity of turbines should be avoided as these serve as water source for most bird species.

8.3 DECOMMISSIONING PHASE

8.3.1 Disturbance and Displacement

Activities associated with the decommissioning phase, such as traffic and noise, may have similar impacts on avifauna as in the construction phase. Rehabilitation across the whole area affected by the project footprint must be conducted during decommissioning, with special emphasis on managing hazardous areas and the proper disposal of waste materials. This direct impact is site restricted (local) and will last for the length of the decommissioning phase (medium-term). The likely occurrence of this impact can however be mitigated. The impact holds a medium consequence, while the significance is rated as low prior to the application of mitigation measures, and as low following mitigation.

8.3.1.1 Mitigation

- A site specific EMP must provide an appropriate and detailed description of how decommissioning activities must be conducted during this phase. All contractors are to adhere to the EMP and should apply good environmental practice during decommissioning.
- The appointed ECO must be trained by an avifaunal specialist to identify the potential priority species and Red Data species, including any signs that could indicate possible breeding by these species. During audits/site visits, the ECO must pay careful attention to such breeding activities of Red Data species, and should train the construction staff to identify Red Data species, followed by regular questioning of staff as to the regular

whereabouts on site of these species. If breeding of any of the Red Data species is confirmed (e.g. if a nest site is found), decommissioning activities within 500 m of the breeding site must cease, and an avifaunal specialist is to be contacted immediately for further assessment of the situation and instruction on how to proceed.

- Prior to decommissioning, an avifaunal specialist should conduct a site walkthrough, covering the turbine areas to identify any nests/breeding/roosting activity of sensitive species, as well as any additional sensitive habitats. The results may inform the final decommissioning schedule within the proximity of that specific area, including shortening activity times, scheduling activities around avian breeding and/or movement schedules, and lowering levels of associated noise.

8.4 CUMULATIVE IMPACTS

According to Kingsley & Whittam (2005) and Percival (2005) there is little relationship between the scale of a wind farm and the amount of bird mortality that occurs. For examples a large, appropriately sited wind farm may kill fewer birds than a small, poorly sited one. However, in isolation, it is unlikely that small numbers of fatalities per year at a wind farm would be considered significant, unless some of those fatalities were of threatened species, in which case impacts might occur at the population level. It should also be noted that cumulative effects of small numbers of fatalities at two or more wind farms may be sufficient to result in population impacts. As a result when considering potential impact, it is important to consider the average effect of each turbine, the cumulative effect of the total number of turbines and associated structures such as overhead power lines, meteorological masts on a farm, and even the cumulative impact of other wind farms in the range of a bird population, particularly where rare or threatened species occur. (Australian Wind Energy Association 2002; Everaert & Stienen 2007).

With regards to the proposed development at Anloga, it is unlikely there will be any disruption to the wetland hydrology. Also the birds observed in the area are species of no conservation concern as there is the wider landscape with several options available for species to adapt.

In general given that the habitat is an open modified one with predominantly widespread and common species of no conservation concern, the displacement of such bird species from portions of a wind farm is unlikely to have population consequences.

9. IMPACT ASSESSMENT SUMMARY

The assessment of potential key issues, as discussed above, is collated in Table 4 below.

Table 4: Summary table of the direct impacts identified for the Construction, Operational and Decommissioning Phases for the preferred and alternative layouts

Aspect/ Impact Pathway	Nature of Potential Impact/ Risk	Status	Spatial Extent	Duration	Consequences/ Intensity	Probability	Reversibility (of impact)	Irreplaceability (of resource)	Significance		Confidence Level
									Without Mitigation	*With Mitigation*	
CONSTRUCTION PHASE											
Clearing of vegetation	Habitat Destruction	Negative	Local	Permanent	Medium	Highly probable	Moderate	Moderate	Medium	Medium	Medium
Noise and disturbance from construction activities Noise and disturbance from construction activities	Habitat loss and displacement through perceived increased predation risk	Negative	Local	Temporary	Medium	Probable	Moderate	Low	Low	Low	Medium
	Reduced breeding success	Negative	Local	Short term	Medium	Highly Probable	Moderate	Low	Medium	Low	Medium
OPERATIONAL PHASE											
Collisions with wind turbines during operation	Bird mortality	Negative	Regional	Long-term	Very high	Highly probable	Irreversible	Moderate	High due to the low level of confidence	Medium	Low
Disturbance (incl. noise) from maintenance activities	Habitat loss and displacement through perceived increased predation risk	Negative	Local	Long-term	Low	Probable	Moderate	Moderate	Low	Low	Medium
Turbine avoidance	Disruption and alteration of local bird	Negative	Regional	Long-term	Medium	Probable	High	Moderate	Medium	Medium	Low

Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequences/ Intensity**	**Probability**	**Reversibility (of impact)**	**Irreplaceability (of resource)**	**Significance**		**Confidence Level**
									Without Mitigation	***With Mitigation***	
	movement patterns										
DECOMMISSIONING PHASE											
Disturbance (incl. noise) from decommissioning and rehabilitation activities	Habitat loss and displacement through perceived increased predation risk	Negative	Local	Medium-term	Medium	Probable	High	Moderate	Low	Low	Medium
	Reduced breeding success	Negative	Local	Medium-term	Medium	Probable	High	Moderate	Low	Low	Medium
CUMULATIVE IMPACTS											
Clearing of vegetation	Disturbance of avifauna due to habitat Destruction	Negative	Local	Long-term	Medium	Probable	Moderate	Moderate	Medium	Low	Medium

10. CONCLUSION AND RECOMMENDATIONS

On the whole the proposed sites for the power project have been highly modified by subsistence agriculture and perennial inundation of most of the marshy areas. Although some bird species of national conservation concern, mainly raptors belonging to the family *Accipitridae* were recorded at the site, these were not present in significant number and other species recorded are common and widespread in Ghana as well within their geographic range. In general the study did not record any species or an ecological entity whose presence at both preferred and alternative layouts should preclude the development of the proposed project as both have similar potential impacts with regards to avifauna.

The main impacts on avifauna identified as part of this study include disturbance associated with habitat destruction during the construction phase as well as disruption of local bird movement patterns and collision with turbines during the operational phase, which will remain of medium significance with mitigation measures. The other impacts on avifauna have been assessed to be of low significance following the effective implementation of recommended mitigation measures. Both layouts (preferred and alternative layout) are anticipated to lead to the same level of impacts.

The following key recommendations for monitoring are made:

- A pre-construction monitoring programme is recommended, particularly during the migration months where higher bird activity would be expected. A 24 hour-a-day monitoring during the three months September, October and November should be undertaken. Such real-time monitoring should be continued throughout the life of the facility to allow modification of the wind turbine operational regime in response to the presence of significant numbers of these birds.
    - The aim is to establish appropriate monitoring criteria, to verify the predicted impact of the project, and to ensure that any unforeseen impacts are detected and the mitigation adjusted where needed at an early stage. Also the

monitoring plan will ensure that mitigating measures and impacts of the project during construction and operational phases are implemented.

  - Also the monitoring results will provide information on the actual nature and extent of key impacts and the effectiveness of mitigation and benefit enhancement measures put in place and through a feedback mechanism, can be used enhance environmental compliance.

- The recommended monitoring programme will:
  - confirm the location of the proposed turbines in relation to migration routes,
  - estimate the number of birds regularly present or resident within the project area,
  - confirm patterns of bird movement in the vicinity of the proposed project and
  - therefore assess collision risks for key species
- Develop and implement a programme for birds during the first 24 months of operation (at the start of operations at the wind farm).

The review of monitoring data and results should strive to identify sensitive locations, including turbines that may require additional mitigation. If unacceptable impacts are observed (in the opinion of the bird specialist and independent review), the specialist should conduct a literature review specific to the impact (e.g. collision) and provide updated and relevant mitigation options to be implemented. As a starting point for the review of possible mitigations, the following may need to be considered:

- Assess the suitability of using deterrent devices to reduce collision risk (e.g. DTBird© and ultrasonic/radar/electromagnetic deterrents for bats)

- Identify modification options to turbine operation to reduce collision risk if absolutely necessary and if other methods are not achieving the desired results (e.g. temporary curtailment or shut-down on demand).

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12. APPENDICES

Appendix 12.1

Keta Lagoon Complex Survey January 2014

Scientific name	English name	Total Counts	Total Species
Phalacrocorax africanus	Long-tailed Cormorant	282	
Ardea cinerea	Grey Heron	11	
Egretta garzetta	Little Egret	447	
Egretta gularis	Western Reef Egret	216	
Calidris alba	Sanderling	55	
Calidris ferruginea	Curlew Sandpiper	7 992	
Calidris minuta	Little Stint	288	
Charadrius hiaticula	Ringed Plover	954	
Himantopus himantopus	Black-winged Stilt	334	
Limosa lapponica	Bar-tailed Godwit	1	
Numenius phaeopus	Whimbrel	51	
Pluvialis squatarola	Grey Plover	14	
Tringa erythropus	Spotted Redshank	3 205	
Tringa hypoleucos	Common Sandpiper	391	
Tringa nebularia	Greenshank	1 234	
Tringa stagnatilis	Marsh Sandpiper	683	
Tringa totanus	Redshank	21	
Larus fuscus	Lesser Black-backed Gull	1	
Sterna albifrons	Little Tern	184	
Sterna hirundo	Common Tern	85	
Sterna maxima	Royal Tern	119	
Sterna sandvicensis	Sandwich Tern	85	
Alcedo atthis	Common Kingfisher	23	
		16 676	23

Keta Lagoon Complex Survey January 2015

Scientific name	English name	Total Counts	Total Species
Phalacrocorax africanus	Long-tailed Cormorant	1248	
Ardea cinerea	Grey Heron	97	
Ardeola ralloides	Squacco Heron	3	
Egretta alba	Great White Egret	87	
Egretta ardesiaca	Black Heron	196	
Egretta garzetta	Little Egret	436	
Egretta gularis	Western Reef Egret	386	
Egretta intermedia	Intermediate Egret	83	
Actophilornis africana	African Jacana	7	
Calidris alba	Sanderling	225	
Calidris ferruginea	Curlew Sandpiper	3 550	
Calidris minuta	Little Stint	62	
Charadrius dubius	Little Ringed Plover	27	
Charadrius hiaticula	(Common) Ringed Plover	305	
Charadrius pecuarius	Kittlitz's Sandplover	21	
Glareola pratincola	Common Pratincole	49	
Himantopus himantopus	Black-winged Stilt	716	
Limosa lapponica	Bar-tailed Godwit	41	
Numenius arquata	Eurasian Curlew	46	
Numenius phaeopus	Whimbrel	25	
Pluvialis squatarola	Grey Plover	28	
Tringa erythropus	Spotted Redshank	5 755	
Tringa hypoleucos	Common Sandpiper	129	
Tringa nebularia	Greenshank	953	
Tringa stagnatilis	Marsh Sandpiper	30	
Tringa totanus	Redshank	71	
Vanellus spinosus	Spur-winged Plover	5	
Larus fuscus	Lesser Black-backed Gull	18	

Scientific name	English name	Total Counts	Total Species
Rynchops flavirostris	African Skimmer	1	
Sterna albifrons	Little Tern	1	
Sterna maxima	Royal Tern	1	
Sterna sandvicensis	Sandwich Tern	7	
Milvus migrans	Black Kite	187	
Alcedo cristata	Malachite Kingfisher	18	
Ceryle rudis	Pied Kingfisher	231	
		15 045	35

Keta Lagoon Complex Survey January 2016

Scientific name	English name	Total Counts	Total Species
Phalacrocorax africanus	Long-tailed Cormorant	632	
Ardea cinerea	Grey Heron	77	
Ardeola ralloides	Squacco Heron	4	
Egretta alba	Great White Egret	219	
Egretta ardesiaca	Black Heron	166	
Egretta garzetta	Little Egret	954	
Egretta gularis	Western Reef Egret	425	
Calidris alba	Sanderling	517	
Calidris ferruginea	Curlew Sandpiper	5 197	
Calidris minuta	Little Stint	43	
Charadrius dubius	Little Ringed Plover	212	
Charadrius hiaticula	(Common) Ringed Plover	972	
Charadrius marginatus	White-fronted Sandplover	143	
Charadrius pecuarius	Kittlitz's Sandplover	94	
Himantopus himantopus	Black-winged Stilt	505	
Limosa lapponica	Bar-tailed Godwit	3	
Numenius phaeopus	Whimbrel	41	

Scientific name	English name	Total Counts	Total Species
Pluvialis squatarola	Grey Plover	158	
Tringa hypoleucos	Common Sandpiper	227	
Tringa nebularia	Greenshank	500	
Tringa stagnatilis	Marsh Sandpiper	111	
Tringa totanus	Redshank	43	
Chlidonias niger	Black Tern	650	
Larus fuscus	Lesser Black-backed Gull	66	
Sterna albifrons	Little Tern	234	
Sterna dougallii	Roseate Tern	108	
Sterna hirundo	Common Tern	190	
Sterna maxima	Royal Tern	408	
Sterna sandvicensis	Sandwich Tern	411	
Milvus migrans	Black Kite	23	
Alcedo cristata	Malachite Kingfisher	6	
Ceryle rudis	Pied Kingfisher	159	
		13 498	32

CURRICULUM VITAE OF ERASMUS HENAKU OWUSU

PERSONAL

Name:	Dr Erasmus Henaku Owusu
Date of Birth:	30th October 1967
Marital Status:	Married
Nationality:	Ghanaian
Languages:	English (Fluent), French (Read), Akan (Twi-Fluent)
Address:	P. O. Box LG 67, Legon, Accra-Ghana
Mob:	233-24-465-6359
E-mail:	erasmus67@yahoo.com or ehowusu@ug.edu.gh

PROFILE

Dr Erasmus H. Owusu is a Conservation Scientist and a Senior Lecturer at the University of Ghana Legon. He holds a PhD in Biodiversity Management from the University of Kent, Canterbury, UK. Dr Owusu has extensive knowledge of natural resource and environmental conservation in Ghana and Africa with **22 years** functional experience. His areas of expertise include community-based natural resource management; protected areas management & planning; environmental impact assessment as well as monitoring and evaluation of environmental projects. Since the year 2003, he has lectured in Conservation Sciences, Animal Ecology, Wildlife Management, and Wetland Ecology, among others, at undergraduate level. Within the same period he lectured in Advanced Animal Ecology, Human Dimensions of Conservation Science and Ecological Restoration at the graduate level at the University of Ghana. Dr Owusu has published **38 articles comprising 30** in refereed journals, **five (5)** as book chapters and **three (3)** Books. He co-authored the Birds of Ghana and was the project manager of the Important Bird Areas of Africa Project which was funded by the GEF/UNDP. The project surveyed and compiled forest of important biodiversity under his supervision and he co-authored the Ghana chapter of the Important Bird Areas of Africa and Associated Islands which was an outcome of the project. He was part of the core team that established the Kakum National Park in Ghana.

At the international level, Dr Owusu is currently the representative of Western Africa on the Technical Committee of the African Euro-Asian Waterbird Agreement (AEWA-Bonn Germany), and Representative of West Africa on the East Atlantic Flyway Initiative Task Force (UK). He is currently the only African serving as International Jury Member of the Quarry Life Award Programme for Restoration of Degraded Mining Sites of Heidelberg Cement Group, Germany. He was a Member of the Global Council of BirdLife International (UK) from 2008-2009 and served as the Chair of the Council of African Partners of BirdLife International between 2005 and 2006.

SPECIALIST DECLARATION

I, **Dr Erasmus Owusu**........, as the appointed independent specialist, hereby declare that I:

- I act as the independent specialist in this application;
- I perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- Regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the any Acts, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Acts, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- I realise that a false declaration is an offence

Signature of the Specialist: _______ _______________________

Name of Specialist: ___**Dr Erasmus Owusu**_________________

Date: _________________**18th January 2017**________________

Environmental & Social Impact Assessment

for the proposed development of a Wind Energy Facility in Anloga Extension (WPP1)

APPENDIX 4:

Heritage Impact Assessment Study

ARCHAEOLOGICAL & CULTURAL HERITAGE IMPACT ASSESSMENT:

Scoping and Environmental and Social Impact Assessment for the proposed Development of the 76MW Wind Power Project situated at Anloga, Srogbe & Anyanui (Anloga Extension) in the Volta Region of Ghana

Report prepared for:	***Report prepared by:***
Seljen Consult Limited P. O. Box AT 140 Achimota-Accra Ghana-West Africa CSIR – Environmental Management Services P O Box 320 Stellenbosch, 7599 South Africa	*Wazi Apoh (Dr.)* Department of Archaeology and Heritage Studies P. O. BOX, LG 3 University of Ghana Legon -Accra

DECEMBER 2017

EXECUTIVE SUMMARY

Dr Apoh Wazi was appointed by Seljen Consult Limited to conduct an assessment of the potential impacts to archaeological and cultural heritage resources, that might occur through the proposed construction, operation and decommissioning of the 76 Megawatt (MW) Wind Energy Facility (WEF) in Anloga Extension (WPP1).

The primary aims of this assessment are to describe the archaeological and cultural heritage resources baseline, assess the potential impacts on archaeological and cultural heritage resources associated with the proposed WEF and identify effective and practicable mitigation measures to assist VRA in managing the discovered heritage resources in a responsible manner, in order to protect, preserve, and develop them within the framework provided by the National Museums Decree (1969) NLCD 387. Heritage resources are unique and non-renewable; as such any impact on such resources must be seen as an impact that should be mitigated where possible. As the value of archaeological resources is predicated on their discovery within a specific geological host unit, construction of the proposed project could result in a net gain to the science of palaeontology by allowing fossils that would not otherwise have been found to be recovered, identified, studied, and preserved.

The following wide range of places and objects were investigated during the survey:

a) Places, buildings, structures and equipment
b) Places to which oral traditions are attached or which are associated with living heritage;
c) Historical settlements and townscapes;
d) Landscapes and natural features;
e) Geological sites of scientific or cultural importance;
f) Archaeological and palaeontological sites;
g) Graves and burial grounds,
h) Movable objects

Key findings from this study include:

a. Archaeological, heritage and cultural studies undertaken by experts from the Department of Archaeology & Heritage studies from the University of Ghana did not reveal any significant archaeological remains that could be directly impacted on by the project. The most common type of heritage resources encountered in the study area were active heritage resources. These will definitely be highly impacted during the construction phase and include the Hunua Kofi Gborsike Fuidoglo's shrine village at Toviakorpe/Anloga, the walled Takpe Vikpe shrine in the project area near the sea and the Mama Blode river/lagoon deity and associated sacred groove.

b. The proposed project has the potential to impact on the cultural landscape. Some notable cultural taboos were documented in the project that needs to be observed to minimize its impact. It was indicated that that hooting is prohibited on the shore of Anloga. In addition, red dresses or colours are prohibited around the area.

Various recommendations have been proposed for the client to implement to ensure that proposed associated benefits are realised and impacts mitigated. Key actions include:

c. Preparation of a "Compensation Action Plan" in order to minimize the adverse effects of the relocation of the shrines and land acquisition on individuals, communities and/or families or clans to ensure that the PAPs are compensated properly.

d. Development of a suitable programme of mitigation in the event of any significant chance finds in consultation with the Archaeology Department of the University of Ghana and the National Museums Board.

LIST OF ABBREVIATIONS

EP	Environmental Permit
EIA	Environmental Impact Assessment
ESIA	Environmental & Social Impact Assessment
UNESCO	United Nations Education, Scientific and Cultural Organization
GMMB	Ghana Museums and Monuments Board

GLOSSARY

DEFINITIONS	
Heritage	UNESCO's 1972 convention defines heritage as our legacy from the past, what we live with today and what we pass on to the future generations. My perspective is that: It is a complex of inherited tangible and intangible legacies that are usually bequeathed by individuals, families, groups, communities, societies, nations, continents and the globe.
Cultural Resources	The UNESCO 1972 convention views cultural resources as "monuments, groups of buildings and sites with historical, aesthetic, archaeological, scientific, or anthropological value…it can also be cultural practices or sites with extrinsic cultural and socio-economic value.
Chance Finds	Any artefact or cultural material of significant archaeological value that is accidentally encountered in the course of the project.

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ARCHAELOGICAL & CULTURAL HERITAGE IMPACT ASSESSMENT

1. INTRODUCTION

Dr Apoh Wazi was appointed by Seljen Consult Limited to conduct an assessment of the potential impacts to archaeological and cultural heritage resources that might occur through the proposed construction, operation and decommissioning of the 76 Megawatt (MW) Wind Energy Facility in Anloga Extension (WPP1) (Figure 1) areas in the Volta Region, Ghana.

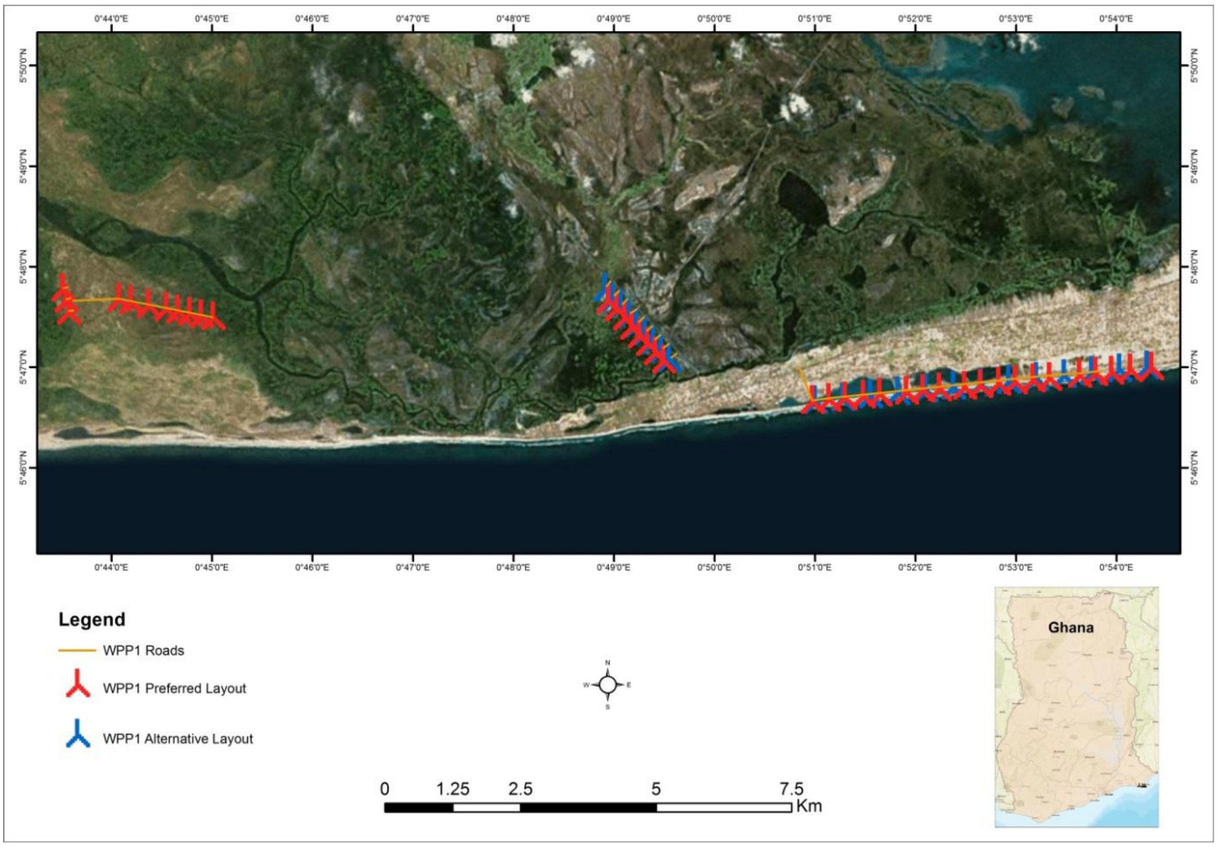

Figure 1: Location of the site for WPP1 with preferred and alternative layouts

The aim of the study is to identify possible archaeological and cultural heritage sites, finds and sensitive areas that may occur within the study area. The Archaeological and Cultural Heritage

Impact Assessment aims to inform the ESIA in the development of a comprehensive Environmental Management Plan (EMP) to assist VRA in managing any discovered heritage resources in a responsible manner, in order to protect, preserve, and develop them.

2. TERMS OF REFERENCE

The purpose of the Archaeological and Cultural Heritage study is to recommend mitigation measures for any heritage resources that would be adversely affected by the proposed development and assist VRA in managing the discovered heritage resources in a responsible manner, in order to protect, preserve, and develop them within the framework provided by the National Museums Decree (1969) NLCD 387. Heritage resources are unique and non-renewable; as such any impact on such resources must be seen as an impact that should be mitigated where possible.

The following wide range of places and objects were investigated during the survey:

i) Places, buildings, structures and equipment
j) Places to which oral traditions are attached or which are associated with living heritage;
k) Historical settlements and townscapes;
l) Landscapes and natural features;
m) Geological sites of scientific or cultural importance;
n) Archaeological and palaeontological sites;
o) Graves and burial grounds,
p) Movable objects

The key impacts and recommendations of this study have been captured in Chapters 6, 7 and 8 of the ESIA report.

3. PROJECT DESCRIPTION

This project referred to as WPP1 will have the following main components which may impact on the archaeology and cultural heritage resources:

- **Wind turbine area:**
  - Wind turbines; and
  - Hard standing areas;

- **Building Infrastructure:**
  - Offices;
  - Operational and maintenance control centre;
  - Warehouse/workshop;
  - Ablution facilities;
  - Converter/Inverter stations;
  - On-site substation building; and
  - Guard Houses.

- **Associated Infrastructure:**
  - Access roads;
  - Internal gravel roads;
  - Fencing;
  - Stormwater channels; and
  - Temporary work area during the construction phase (i.e. laydown area).

Any aspects that disturb the ground (e.g. foundations, roads, trenches) may affect archaeological, palaeontological, cultural heritage resources and graves, while all superstructures (e.g. wind turbines, buildings, fences) would introduce impacts to the cultural landscape.

4. APPLICABLE LEGISLATION AND PERMIT REQUIREMENTS

The National Museums Decree (1969) NLCD 387, the Executive instrument (EI 118) of 1969 and the National Museums Regulation (EI 29) of 1973 provide the guidelines for this study. These legal documents, besides expounding on the duties and regulations of the Ghana Museums and Monuments Board (GMMB), also provide a definition of antiquities, monuments and cultural artefacts and protect a variety of archaeological and cultural heritage resources.

The definitions applicable to the protected heritage resources are as follows:

The National Museums Decree (1969) NLCD 387 indicates under Article 31 that

> ‘Antiquity means an object of archaeological interest or land in which any such object is believed to exist or was discovered, including any land adjacent to such object or land which in the opinion of the Board is reasonably required to maintain the object or the land or its amenities or to provide access thereto, or for the exercise of proper control or management over such object or land; or
>
> Any work of art or craftwork, including any statue, modelled clay figure, cast or wrought iron metal carving, house post, door, ancestral figure, religious mask, staff, drum, bowl, ornament, utensil, weapon, armour, regalia, manuscript or document, if such work of art or craftwork is of indigenous origin and
>
> i) was made or fashioned before the year 1900 or-
>
> ii) is of historical, artistic, or scientific interest and is or has been used at any time in the performance, and for the purpose of, any traditional ceremony.

‘Objects of archaeological interest’ means-

a) any fossil remains of man or of animals found in association with man; or
b) any site, trace or ruin of an ancient habitation, working place, midden or sacred place; or
c) any cave or other natural shelter, or engraving, drawing, inscription, painting or inscription on rock or elsewhere; or

d) any stone object or implement believed to have been used or produced by early man; or
e) any ancient structure, erection, memorial, causeway, bridge, cairn, tumulus, grave, shrine, excavation, well, water tank, artificial pool, monolith, group of stones, earthworks, wall gateway or fortification; or
f) any antique tool or object of metal, wood, stone clay, leather, textile, basket ware or other material which is of archaeological interest

In addition, the above laws provide the foundational rules on the conduct of research on antiquities, protection and conservation as well as the sale and export of antiquities. Section 8(1) The National Museums Decree (1969) NLCD 387 requires that a permit be obtained from the GMMB before the search for any antiquities can begin.

5. METHODOLOGY

The methodology used in this study to determine potential impacts on archaeological, historical and cultural heritage resources associated with the construction and operation of the proposed wind facility consisted of the following approach:

- a desktop study;
- interviews and focus group meetings; and
- a field survey of the existing cultural heritage resources.

The assessment details are summarised as follows:

Type of specialist investigation	The specialist investigation was for an Archaeological and Cultural Heritage assessment
Date of specialist investigation	Field work was completed between 5-9 February and 21 and 25 July 2016
Season, relevance of season	Seasonality has no relevance on the fieldwork completed in relation to heritage resources

The following methods were used to identify historical and cultural heritage resources: archaeological reconnaissance survey, ethnographic study, and visual anthropological field methods and techniques.

5.1 LITERATURE SURVEY AND INFORMATION SOURCES

A survey of available literature was carried out to assess the general heritage context into which the development would be set. This literature included published material, unpublished commercial reports and online material.

5.2 FIELD SURVEY

The WPP1 sites and their alternative site locations were archaeologically assessed in the field from 5-9 February 2016 as well as 21-25 July 2016. The assessment included conducting a reconnaissance surveys in transect at the proposed preferred layout sites to record key ethnographic objects and surface archaeological materials in the project areas. The location of possible archaeological sites and heritage resources were recorded with the use of a GPS. A number of shovel test pits were dug to test some of the sites for buried cultural remains. None of these test pits revealed any buried remains of significant cultural value. The use of video and photographic documentation of sites, objects, landscapes, the built environment, craft production processes, sacred ceremonies, and other tangible lifeways in the project area were also deployed.

5.3 INTERVIEWS AND FOCUS GROUP MEETINGS

Interviews and focus group discussions were held between 5-9 February 2016, to document the heritage resources, cultural practices and oral accounts; including migration and settlement histories of descendant communities in the project areas.

Table 1: Dates and location of interviewees for documentation of heritage resources in the study area

Dates	Location	Interviewees
5/2/16	Community Elder's House	Community Elder of Klevi Clan of Anyanui
5/2/16	Chief Fetish Priest's House;	Community heads of Wededeanu (Anyanui)
5/2/16	Community Meeting Place	Community heads of Tunu (Anyanui)
6/2/16	Reconnaissance Survey of project Site and shrine village at Toviakorpe/Anloga	Hunua Kofi Gborsike Fuidoglo's
6/2/16	Compound of Togbe Gasu, Overseer of Takpe Vikpe Shrine	Togbe Gasu and Clan Elders
7/2/16	Chief's House	Barteh Clan of Anyanui
7/2/16	House of Clan head	Traditional Heads of Anloga
9/2/16	Office of Municipal Coordinating Director	Keta Municipal Assembly
9/2/16	Compound of Sroegbe Stool Father	Traditional Heads of Srogbe
9/2/16	House of Acting Chief	Community heads of Gblife Community (Anyanui)

5.4 LIMITATIONS

5.4.1 Size of the study area and time constraints

Due to the substantial size of the study area, only samples of the area were archaeologically tested to discover buried remains.

6. DESCRIPTION OF THE AFFECTED CULTURAL AND HISTORICAL ENVIRONMENT

The wind farm site is located in three communities in the Keta Municipal, namely Anloga, Srogbe and Anyanui. Keta Municipality is part of Anlo Traditional Council, which has 36 states and headed by a paramount chief, the Awoamefia of Anlo who serves as a symbol of authority among all people in the Municipality. There are other chiefs with their own areas of influence who assists the Awoamefia in the promotion of peace and stability in the Municipality. The main festival is the Hogbetsotso, which symbolizes the purported great exodus of Ewes from their ancestral home, Notsie, to their present abode around the 17th Century. The Hogbetsotso Festival, which is celebrated at Anloga, the traditional home of the Anlos, attains a grand finale with a durbar of Chiefs and people amidst pomp and pageantry on the first Saturday of every November. Display of rich cultural values, resource mobilisation for development and peaceful co-existence are prominent issues considered during the occasion.

Anloga lies to the east of the Volta River and south of the Keta Lagoon. Anloga is the traditional and ritual capital of the 36 traditional states of the Anlo Ewe people. The land is owned by the Adzovia clan although sections have been given out to some individuals within the clan. The administration and transfer of the clan land within the community is done by the elders of the clan while those that have been acquired by the individuals are handled by the individuals.

The site at Srogbe is located at 'SALO' along the Dabala - Anloga highway. It is owned by the 'LIKÉ' clan (Dzezizi Branch) who are residence of the Srogbe (Saviotula) township. The administration of the land is done by the Stool Father, the Regent and the elders of the clan. According to the Regent (Afatsawu Agbavitor), the Stool father (Francis Atsu Lumor), and elders of Sroegbe, the community was first settled by a branch of the Like clan known as the Dzezizi. The people of Whuti Sroegbe celebrate Norvikporgbe festival in addition to Hogbetsotso. They have a war deity call Sri. It is believed that Sroegbe is the corrupted form of the town deity 'Sri'. This deity is a tree by the lagoon. The Dzezizi branch of the Like clan also have a deity known as Apim and it is also located along the sea. The Whuti lands are owned by three clans namely; Bate, Adzorvia and Like.

According to Togbe Gamor II, the divisional chief of Anyanui, the town, Anyanui, was derived from a deity called Mama Gbortonunyanui. On the issue of ownership of the proposed land for the project, he said the project land belongs to the Bate clan. To him, the land in question was acquired from the Klevi by his grandfather. He made mention that at time the Anyanui land was advertised to be sold by the Klevi clan, his rich grandfather who was by then living in Togo was informed so he sent money (cowries) through one Ashigbi to purchase the land. The payment was made to Torgbui Gadagbui, the head of the Klevi clan in about 1750. It is out of benevolence that the Bate Chiefs allowed Torgbui Gadagbui and his people to stay at the far end of the land; at a place called Xorsekordzi.

More importantly, in the words of Torgbe Gamor II, even though it is true that an Anyanui land belongs to the Bate clan, it is a communal property and no single individual reserves the right to its ownership. He is of the view that the advent of this important project led to the rise of multiple claims to the ownership of the Anyanui lands by the Klevi clan. Togbe was quick to mention that a legal tussle regarding the true ownership of the land that was adjudicated at the Ho High Court in 1965, was won by the Bate clan.

There are some communities such as Tunu, Gblife and Wededeanu within the catchment area of the project although none of them are to be displaced. Tunu is about 300 meters to the north of the project site. According to the elders, Tunu used to be a forest area populated with lions and other dangerous animals. Their ancestors who first settled on the land were hunters who used to set traps for game. One of the hunters set a trap in the forest with the mouth facing the present day Tunu and instructed other hunters not to pass where the gun or the trap were set. Since then, the area has been referred to as Tu nu in Ewe; meaning ‘gun mouth’. To put simply, the Tunu Township was named after that hunting phrase. Clans currently settled in Tunu include the Lafeawo, Adzorviawo, Toviawo, and Kleviawo. According to the elders, they don’t pay tribute to the chief of Anyanui but their forebears used to do so because Tunu land belongs to the Anyanui traditional area.

Gblife is a second community in the project area of Anyanui and it is situated by a lagoon. In the wisdom of the elders, Gblife is named after a male deity called Gbli. Even though the deity is domiciled in Tunu, they have a female deity called Kpokpo. The elders made it known to us that

Gblife land was given to the Toviawo clan of Glife by the Bate clan in Anyanui. The Gblife people do not have a chief but a Headman (Amegakpui) and their paramountcy is at Dzita.

7. IDENTIFICATION OF KEY ISSUES

Cultural resources and heritage comprise tangible historical/archaeological sites, documents and artefacts together with religious/spiritual sites (sacred sites) and activities important to local communities, customary law, traditional beliefs, values and practices. It should be noted that the assessment of impacts and development of mitigation actions for some cultural features cannot be wholly segregated from other social impact assessments and there will be overlap in some mitigation actions.

7.1 SENSITIVITY OF THE SITE IN RELATION TO THE PROPOSED ACTIVITY

The sensitivity of a cultural feature to direct impacts depends on the level of importance assigned to it. This is the product of a number of factors, including features of present day cultural value; its current role; its cultural or sacred associations, its aesthetic value; association with significant historical events or traditions and its role as a sacred site or local landmark. For cultural features of heritage value, its potential as a resource of archaeological data will also affect its sensitivity. The significance of an impact, either direct or indirect, on a site is assessed by combining the magnitude of the impact and the sensitivity of the site. The impacts will either be:

- Direct impact: involving physical damage to cultural features or disruption to customary law, practice and tradition. Any direct impacts on tangible features will be permanent and irreversible. Other possible direct impacts include preventing public access, interference with customary ritual practices (e.g., at shrine sites), or those caused by disturbance from noise, vibration, drainage or other changes in hydrology.
- Indirect impact: including visual impact on cultural features, impacts on the appreciation of the inter-relationship between these sites, impacts on the relationship of a site to the wider landscape and impacts on significant views from and to sites.

Also, the lack of observance of intangible cultural taboos associated with the site. Some of these aforementioned issues can be considered direct impacts when the project affects them directly.

Potential impacts on heritage resources may relate to the possibility for disturbance, removal or destruction of archaeological deposits or cultural heritage features during construction activities. Specific activities with the potential to impact archaeology include ground excavations (foundations and piling) required for construction purposes e.g. lay down areas of work camps, new access roads, etc.

As with any project site, there is a potential for previously unrecorded cultural sites to lie within. As all unknown cultural heritage will be sub-surface, it is only direct impacts arising from disturbance that could occur. Archaeological relics could be found on the site at any time during the lifetime of the facility, but the occurrence of archaeological heritage that was not identified prior to the commencement of development works will be seldom and random. This is high priority only during the initial phase of the project. Disturbance within the project area following operation could potentially occur during the excavation works of additional building facilities, infrastructure, pipelines, cable lines and the installation of fencing for other works.

As the value of archaeological resources is predicated on their discovery within a specific geological host unit, construction of the proposed project could result in a net gain to the science of palaeontology by allowing fossils that would not otherwise have been found to be recovered, identified, studied, and preserved.

The project site is not located in a designated archaeological priority area nor contains any scheduled ancient monuments, listed buildings or locally listed buildings. There are no listed heritage sites located within the area of the property proposed for the project site. As indicated, further archaeological, heritage and cultural studies undertaken by experts from the Department of Archaeology & Heritage studies from the University of Ghana did not reveal any significant archaeological remains that could be directly impacted on by the project.

The most common type of heritage resources encountered in the study area and which will be impacted, were active heritage resources. These include the Hunua Kofi Gborsike Fuidoglo's shrine village at Toviakorpe/Anloga (Figure 2), the walled Takpe Vikpe shrine in the project area near the sea (Figure 3) and the Mama Blode river/lagoon deity and associated sacred groove (Figure 4). Table 2 lists the archaeological and cultural heritage resources that have been recorded in the study area during the course of the project.

Figure 2: Hunua Kofi Gborsike Fuidoglo's shrine village at Toviakorpe/Anloga

Figure 3: The walled Takpe Vikpe shrine in the project area near the sea.

Figure 4: Mama Blode river/lagoon deity and associated sacred groove

Table 2: List of cultural heritage resources found during the survey for WPP1 preferred and alternative layouts.

Location	Co-ordinates	Description	Heritage Significance	Suggested Mitigation
1	N05° 47.043’ E000° 53.999’	Toviakorpe (Figure 1). This is a fenced household/village located about 100m to the east of the project area and 50 m from the sea at Anloga. The place also serves as a shrine containing many deities (e.g., Madugu, Klamor, Korshie, Anyigbator, Dzakpa, Azor and Tsingeli) which are often consulted by interested supplicants. According to Hunua Kofi Gborsike Fuidoglo, he anticipates that the execution of the project is likely to disturb the peace of the deities and as a result they can halt the project spiritually.	High	Hunua Fuidoglo indicated that the Toviakorpe land belongs to the Tovia clan. However, he inherited his from his grandmother and eventually bought it from the clan. He is in support of the intended windmill project on the site and will be willing to be relocated provided VRA will procure the same size of land and build a house with the same number of rooms on it for him. He said he has 12 rooms on his compound some of which he uses to accommodate the deities.
2	N05° 46.955’ E000° 53.737’	Takpe Vikpe Shrine (Figure 2). It is a walled male deity located on the shore within the project area about 10 meters away from the sea . According to the sources, these two deities help the community a lot. In case of poor fish catch at sea and in the river, they often perform some rituals for the deity to turn their fortunes around.	High	Togbe Gasu oversees the deity. According to him, the relocation of the shrine is necessary. However, this will involve further spiritual consultations and an elaborate ritual.
3	N05° 47.030’ E000° 52.925’	Mama Blode (Figure 3). It is the deity of a river/lagoon by the project area. It is associated with a sacred forest near the river. According to Togbe Gasu, the Mama Blode deity hates light.	Medium	Since there is a likelihood that floodlights may be used during the construction, the light must not be directed on the river. Also, there will be the need to pacify the deity for her not to disrupt the project or stop the provision of fish for the people.

In addition to the resources within the project area, the people of Whutti Sroegbe have a deity which is a tree by the lagoon. The Dzezizi branch of the Like clan also have a deity known as Apim and it is also located along the sea. More importantly, Whuti lands are owned by three clans namely; Bate, Adzorvia and Like. According to the stool father, a number of ritual items for the pacification of the stool will be expected before the commencement of work and signing of the lease. However, all of these deities are not in the project area and thus will not be impacted by the project.

8. ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

The methodology applied to predict and assess impacts/risks is detailed in Chapter 6 of the ESIA report.

Direct archaeological and cultural heritage impacts during the construction / decommissioning and operation phases are likely to result from a number of project interventions and/or activities:

- Construction Phase:
  - Damage to and destruction of heritage resources.
  - Impacts on cultural landscape
  - Gain to the science of archaeology
- Operations Phase:
  - Impacts on cultural landscape
- Decommissioning Phase:
  - Damage to and destruction of heritage resources.
  - Impacts on cultural landscape

The following section describes the potential impacts during the construction, operations and decommissioning phases and assesses them utilising the impact rating methodology provided by the CSIR. Refer to the impact summary tables for the high level assessment of potential impacts

(Tables 3, 4 and 5). The impacts on archaeological and cultural resources, associated with the construction and operation of the proposed wind facility will be similar for both the preferred and the alternative layout. The significance rating for both alternatives is the same according to the impact rating methodology, the significance of the cultural heritage impacts for the Alternative Layout will be marginally lower.

8.1 CONSTRUCTION PHASE

8.1.1 Disturbance, damage to and destruction of heritage resources

Construction activities have the potential to impact on heritage resources. Potential impacts that may disturb or damage heritage/cultural resources often arise from ground excavation required for construction purposes; e.g. laying down areas of work camps, new access roads, etc. It is anticipated that any known heritage sites located within the final development footprint (refer to Table 1) would be relocated to minimise impacts and any unknown could possibly be physically damaged or, more likely, destroyed when the surface is levelled in preparation for construction. The potential impact or damage to and destruction of heritage resources is predicted to be a negative, direct impact. The impact is rated with a site specific spatial extent and a permanent duration. The intensity and probability of the impacts are respectively rated as high given the significant heritage resources (e.g., Shrines) identified on the site. The reversibility of the impact and irreplaceability of the resource are respectively rated as non-reversible and high. As a result of the high heritage importance in the area, the significance of any impacts is likely to be high. It should, however, be ensured that all works take place within the authorised footprint so as to avoid impacts to any nearby tangible and intangible heritage resources. With effective mitigation including dialogue with community members and compensation and moving the shrines, the impact would be medium.

8.1.2 Impacts to the Cultural Landscape

The proposed project has the potential to impact on the cultural landscape (i.e. impacts on Mama Blode). Some notable cultural taboos were documented in the project area. It was indicated that

that hooting is prohibited on the shore of Anloga. In addition, red dresses or colours are prohibited around the area.

The Tunu community at Anyanui also has a deity known as Gbli. Some taboos associated with this deity are:

- Women in their menstruation period do not visit the shrine of the deity.
- Women in their menstruation period do not visit the river side
- Running and diving into the lagoon is a taboo
- Fetching water from the lagoon with a black pot is a taboo
- Hooting is prohibited in the town
- Having sexual intercourse on the bare ground is unacceptable
- They don’t engage in economic activities on Thursdays

As indicated earlier, people of Whutti Sroegbe have a deity which is a tree by the lagoon. The Dzezizi branch of the Like clan also have a deity known as Apim and it is also located along the sea. More importantly, Whuti lands are owned by three clans namely; Bate, Adzorvia and Like. According to the stool father, a number of ritual items for the pacification of the stool will be expected before the commencement of work and signing of the lease. However, all of these deities are not in the project area and thus will not be impacted by the project. The proposed project will impact the heritage resources identified in section 1.6 of this report for both the preferred and alternative layouts. The proposed project will result in the identified shrines (e.g., Toviakorpe and Takpe Vikpe shrines) being moved and thus affecting the communities ability to observe cultural rites in the project area. Since there is a likelihood that floodlights may be used during the construction, the light must not be directed on the river. Also, there will be the need to pacify the deity, Mama Blode, for her not to disrupt the project or stop the provision of fish for the people. Figure 5 is an illustration of the heritage sites in relation to the proposed project area.

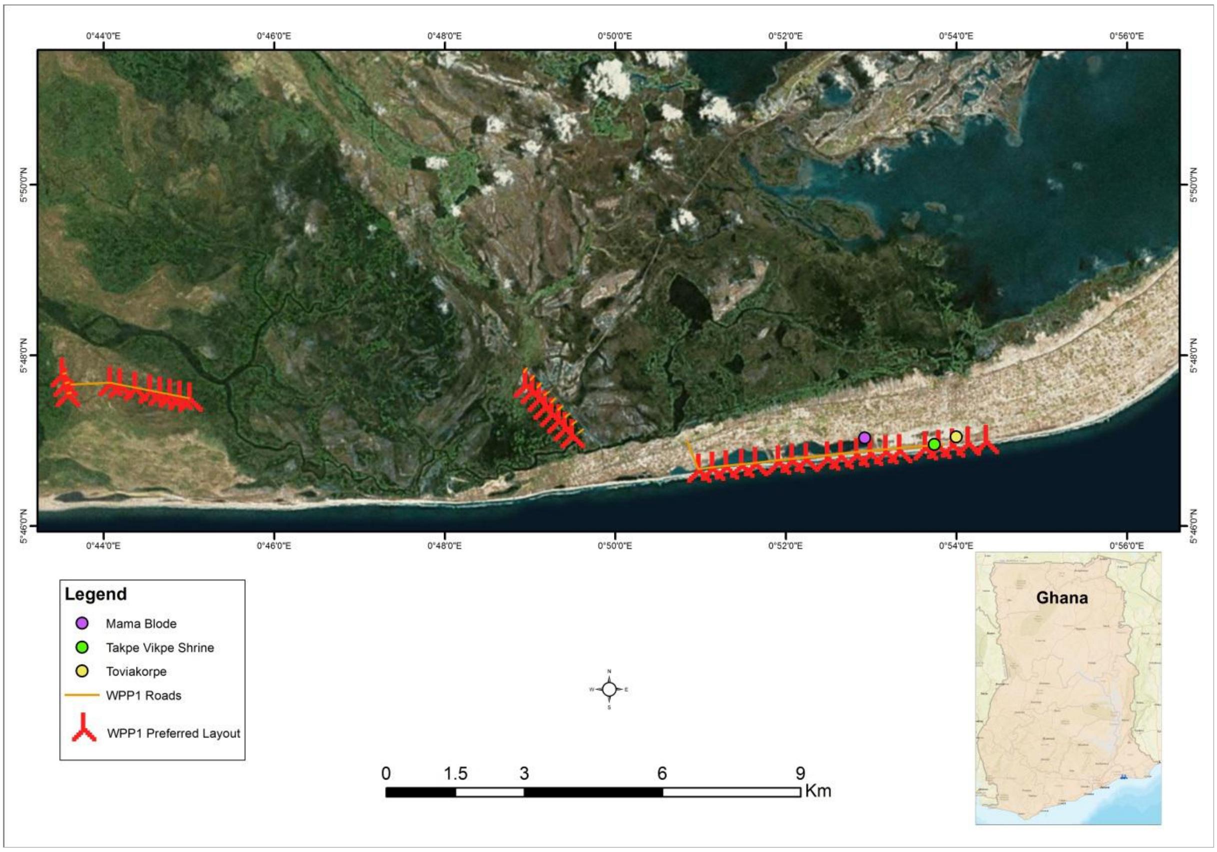

Figure 5: Identified heritage resources in relation to the proposed project site

The impact of the proposed project on the cultural landscape is expected to occur during the construction. These potential impacts are predicted to be negative, direct and indirect with a local spatial extent, and a long-term duration for all phases. The impacts of the proposed project on cultural landscape are anticipated to be of high significance before mitigation and very low after mitigation, if the shrines are relocated.

Effective mitigation measures include dialogue with community members and compensation and moving the shrines.

8.2 OPERATIONAL PHASE

8.2.1 Impacts to the Cultural Landscape

During the operational phase, the addition of wind turbines to the landscape will result in a marked change in its character from a rural landscape to one characterized by electrical infrastructure. Given that the Government of Ghana has commissioned the National Renewable Energy Law which calls for a mix in energy generation sources in Ghana and increased use of renewables, precedent has already been set for electrical development, the intensity of the impact of the proposed project on the cultural landscape is anticipated to be medium. The probability of the impact is rated as very high given the tangible and intangible significance and nature of the cultural resources identified on the site. The reversibility of the impact and irreplaceability of the resource are respectively rated as high and moderate.

The key recommendation associated with this impact is that though the shrines and their current locations are very important to the people, they are prepared to negotiate for their relocation to a new environment for the greater good of Ghana. However, the project must consistently ensure strict observation of the cultural taboos. During the operation phase, the significance of this impact is expected to be high before mitigation and medium after mitigation if the project consistently ensures sensitivity and strict observations of the cultural taboos.

8.3 DECOMMISSIONING PHASE

8.3.1 Impacts to the Cultural Landscape

The impact of the proposed project on the cultural landscape is expected to occur during the decommissioning phases. These potential impacts are predicted to be negative, direct and indirect with a local spatial extent, and a long-term duration for all phases. The impacts of the proposed project on cultural heritage of the site are anticipated to be of very high significance before mitigation and very low after mitigation if the shrines are relocated.

Mitigation measures are for the project applicant to ensure strict observation of cultural taboos and all development occurs in the development footprint.

8.3.2 Damage to and Destruction of Heritage Resources

Removal of infrastructure during decommission activities has the potential to impact on archaeological resources. Potential impacts that may disturb or damage archaeological resources often arise from ground excavation required for decommissioning purposes; e.g. laying down areas of work camps, new access roads, etc. It is anticipated that any heritage sites located within the final development footprint would be physically damaged or, more likely, destroyed when the surface is levelled in preparation for decommissioning if areas that were not disturbed before during construction are disturbed. The potential impact of damage to and destruction of heritage resources is predicted to be a negative, direct impact. The impact is rated with a site specific spatial extent and a permanent duration. The intensity and probability of the impacts are respectively rated as medium. The reversibility of the impact and irreplaceability of the resource are respectively rated as non-reversible and high. As a result of the high heritage importance in the area, the significance of any impacts is likely to be very low.

Mitigation measures are for the project applicant to ensure all development occurs in the development footprint.

8.4 CUMULATIVE IMPACTS

The development of multiple wind energy facilities in the area, will result in many cultural heritage resources (e.g., Hunua Kofi Gborsike Fuidoglo’s shrine village and the walled Takpe Vikpe shrine) being disturbed and /or destroyed over a wide area. Cumulative impacts would be negative and direct in nature. They would occur at the local level and would be permanent. Because the WEF is not in a designated archaeological priority area and that there are no listed sites of high archaeological significance were found within the present study area, the cumulative impact consequence is rated as slight with the probability of impacts being unlikely. There are currently no proposed wind energy facilities in a 20 km distance from the project area.

9. IMPACT ASSESSMENT SUMMARY

The assessment of potential impacts and recommendation of mitigation measures as discussed above are collated in Tables 3 to 5 below.

Table 3: Impact assessment summary table for the Construction Phase for preferred and alternative layout

CONSTRUCTION PHASE												
Direct Impacts												
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Intensity**	**Probability**	**Reversibility of Impact**	**Irreplace-ability**	**Potential Mitigation Measures**	**Significance of Impact and Risk**		**Specialist Confidence Level in Assessment**
										Without Mitigation/ Management	***With Mitigation/ Management (Residual Impact/ Risk)***	
Clearing of site and excavation works	Damage or destruction of heritage resources	Negative	Site	Permanent	High	Definite	Non-reversible	High	Ensure all works occur inside the approved development footprint. Relocate all shrines within the project area	High	Medium	High
Clearing of site and construction of the proposed facility	Impacts to the cultural landscape	Negative	Local	Long term	Medium	Definite	High	Moderate	Ensure strict observation of cultural taboos	High	Very Low	High
Clearing of site and excavation works	Gain to the science of archaeology	Positive	Site	Permanent	Medium	Definite	-	-	Proper documentation and reporting of chance finds	Medium	Medium	High

Table 4: Impact assessment summary table for the Operational Phase for preferred and alternative layout

OPERATIONAL PHASE												
Direct Impacts												
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Intensity**	**Probability**	**Reversibility of Impact**	**Irreplace-ability**	**Potential Mitigation Measures**	**Significance of Impact and Risk**		**Specialist Confidence Level in Assessment**
										Without Mitigation/ Management	***With Mitigation/ Management (Residual Impact/ Risk)***	
The presence of the proposed facility	Impacts to the cultural Landscape	Negative	Local	Long term	Medium	Definite	High	Moderate	Continuous dialogue to key Elders in the community	High	Medium	High

Table 5: Impact assessment summary table for the Decommissioning Phase for preferred and alternative layout

DECOMMISSIONING PHASE												
Direct Impacts												
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Intensity**	**Probability**	**Reversibility of Impact**	**Irreplace-ability**	**Potential Mitigation Measures**	**Significance of Impact and Risk**		**Confidence Level**
										Without Mitigation/ Management	***With Mitigation/ Management (Residual Impact/ Risk)***	
The presence of construction vehicles	Impacts to the cultural landscape	Negative	Local	Long term	Medium	Highly probably	High	Moderate	Ensure strict observation of cultural taboos Ensure all works occur inside the development footprint.	Medium	Very Low	High
Removal of infrastructure	Damage or destruction of archaeological resources	Negative	Site	Permanent	Medium	Unlikely	Non-reversible	High	Ensure all works occur inside the development footprint.	Very low	Very low	High

10. CONCLUSION AND RECOMMENDATION

The project site is not located in a designated archaeological priority area nor contains any scheduled ancient monuments, listed buildings or locally listed buildings. There are no listed heritage sites located within the area of the property proposed for the project site. As indicated, archaeological, heritage and cultural studies were conducted at some of the noted sites by experts from the Department of Archaeology & Heritage studies of the University of Ghana and showed no archaeological remains of significant value.

However other cultural heritage sites of importance that needs to be considered during project implementation include:

a) Deity called Takpe Vikpe which is a walled male deity located on the shore within the project area about 10 meters away from the sea.
b) Female deity called Mama Blode of a river/lagoon by the project area. It is also associated with a sacred forest near the river.
c) Fenced household/village of Toviakorpe located about 100m to the east of the project area and 50 m from the sea at Anloga that serves as a shrine containing many deities (e.g. Madugu, Klamor, Korshie, Anyigbator, Dzakpa, Azor and Tsingeli) which are often consulted by interested supplicants.
d) Deity tree by the lagoon belonging to people of Whutti Sroegbe
e) Deity known as Apim located along the sea and belonging to the Dzezizi branch of the Like clan.

Key impacts are associated with the construction phase. Once built, it is unlikely that the operation of the facility would impact on any areas of cultural interest. Future decommissioning and closure of the proposed new wind energy generating facility would not adversely impact archaeological resources either because the ground disturbed during these activities would have been already disturbed, and impacts mitigated as required, during the construction of the proposed project.

Given that all the activities related to project during the construction, operational and decommissioning stages shall be confined to the designated site, and the nature and magnitude of the activities are too small, when mitigated, the impact on cultural resources will be medium to very low. The identified shrines in the areas surveyed will not be directly affected by construction activities should they be moved. However, it is expected that requirements for various pacification should be outlined in the Compensation Action Plan for the project. There is a chance that other heritage and archeologically resources may be found in the area and construction activities are likely to have an impact on these. Similarly, all chance finds or artefacts of cultural value accidentally encountered in all phase of work must be reported to Ghana Museums and Monuments Board.

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SPECIALIST EXPERTISE

Dr. Wazi Apoh (HOD/Senior Lecturer, Frederick Douglass Scholar)

Department of Archaeology and Heritage Studies

University of Ghana, P.O. Box LG 3,

Legon-Ghana

Date of birth: March 23, 1972; **Sex:** Male;

Languages spoken: English, Ewe, Ga, Dagaare, Twi

Nationality: Ghanaian (Ghana); **Phone**: 0542676293; **E mail** wazital@gmail.com

Educational Background

Doctor of Philosophy Degree in Archaeological Anthropology; conferral date	12-21-2008
Master of Philosophy Degree in Archaeology, University of Ghana, Legon	1999-2001

Publications

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April 2011 Archaeological and Cultural Heritage Baseline Survey/Assessment within the Scantogo project area in Tabligbo, Togo. Report prepared for Golder Associates & Scantogo by Dr. Wazi Apoh, Department of Archaeology and Heritage Studies, University of Ghana.

International Collaborative Research Projects

January 2015-Present: Co-Director of the Gonja Archaeological Project. A collaborative archaeological project between the Department of Archaeology and Heritage studies, University of Ghana, Legon and the Archaeology and Population in Africa laboratory, the University of Geneva, Switzerland.

August-December 2014: Comparative anthropological research on impact of mining on customary law and heritage resources at the Newmont-Akyem and Anglogold Ashanti Obuasi mine impacted communities in Ghana and the Northern Star mine impacted community of Wiluna in Western Australia

<u>Research and Cultural Impact Assessment Projects</u>

May 2014. Consultant Archaeologist for Golder Associates Ghana, Ltd. Engaged in Cultural Impact Assessment at Anglogold Ashanti Tailings Mine Site

December 2012. Engaged in Salvage archaeology at Appolonia-Accra under the Appolonia-City of Light Cultural Heritage Impact Assessment (CHIA) project. Project Commissioned By Appolonia Development Company Ltd (December 2012)

November 2012 Engaged in Salvage archaeology at Takoradi under the King City Cultural Heritage Impact Assessment (CHIA) project. Project Commissioned by King's City Development Company Ltd (November 2012)

02/2011: Consultant Archaeologist for Golder Associates Ghana, Ltd. Engaged in Cultural Impact Assessment at the Scantogo site near Tabligbo in Togo

01/2011-Present: Coordinator of Bui Dam Visual Anthropological Data Collection Phase (Bui Dam Resettlement Project)

11/15/2009-12/17/2010 & 02/24/2010-03/05/2010: Coordinated Bui Dam Salvage Archaeology Project as part of the Environmental, Social and Cultural Impact Assessment Project.

5/26/2003-7/31/2008: Worked as a Senior Research Aide in the Public Archaeology Facility (PAF) of the Dept. of Anthropology, Binghamton University under Dr. Nina Versaggi (Director). Cultural Resource Management duties include: site surveys, excavations and laboratory processing and analysis of archaeological data from New York State.

SPECIALIST DECLARATION

I, DR WAZI APOH, as the appointed independent specialist, hereby declare that I:

- I act as the independent specialist in this application;
- I perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the any Acts, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Acts, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- I realise that a false declaration is an offence

Signature of the Specialist: ________________________________

Name of Specialist: DR WAZI APOH

Date: January 20, 2017

Environmental & Social Impact Assessment

for the proposed development of a Wind Energy Facility in Anloga Extension (WPP1)

APPENDIX 5:

Aviation & Communication Impact Assessment Study

AVIATION AND COMMUNICATION IMPACT ASSESSMENT:

Scoping and Environmental and Social Impact Assessment for the proposed Development of the 76MW Wind Power Project situated at Anloga, Srogbe & Anyanui (Anloga Extension) in the Volta Region of Ghana

Report prepared for:	*Report prepared by:*
Seljen Consult Limited P. O. Box AT 140 Achimota-Accra Ghana-West Africa CSIR – Environmental Management Services P O Box 320 Stellenbosch, 7599 South Africa	*Emmanuel Hayford* *P.O. Box KU 68* *Winneba* *Contact: +233 24 4687326* *Email:emmanuelhayford@gmail.com*

DECEMBER 2017

EXECUTIVE SUMMARY

Emmanuel Hayford was appointed by Seljen Consult Limited to conduct a specialist study on the potential impacts on aviation associated with the proposed construction, operation and decommissioning of the 76 Megawatt (MW) Wind Energy Facility in Anloga Extension (WPP1) in the Volta region, Ghana. Two layout alternatives were considered in the Aviation Impact Assessment.

The Ghana Civil Aviation Authority (GCAA), the Government Agency responsible for aviation regulation and air navigation services, requires all prospective wind turbine developers to submit an aviation safety impact assessment. This document describes the available baseline aviation data, the potential impact of the proposed wind turbine development on aviation safety (air traffic management, airport airspace safeguarding and the general safety of air navigation installations). The assessment took into consideration issues related to the protection of the Airport Airspace Obstruction and Safeguarding, Communication, Navigation and Surveillance and Air Traffic Management of both the Kotoka International Airport (KIA) and the future Prampram International Airport.

The aviation safety impact assessment revealed the following:

- The proposed WEF in Anloga Extension is not anticipated to affect the navigable airspace, in accordance with the Ghana Civil Aviation Authority (GCAA) standards,

- The proposed wind farm will not impact upon aircraft operations to and from Accra (Kotoka International Airport) as well as from the future Prampram Airport

- Flights operating under the Visual Flight Rules (VFR) should not be affected by the proposed wind farm as these flights are required to be conducted at a minimum height of 500 ft above ground level outside populous areas and will be above the level of the turbines.

- The structures will be sufficiently conspicuous by day, and at night, local en-route lowest safe altitudes (LSALTs) will provide clearance required for flights under the Instrument Flight Rules (IFR) and night operations under the Visual Flight Rules (Night VFR).

It is not anticipated to have any impacts on aviation safety during the construction and decommissioning phase. The only identified impact during operation phase is that of the interference with communication, Navigation and Surveillance. This impact is anticipated to be of very low significance for both the preferred and the alternative layouts.

LIST OF ABBREVIATIONS

ABBREVIATION	MEANING
ATC	Air Traffic Control
APPROX	Approximately
CAA	Civil Aviation Authority
CNS	Communication, Navigation and Surveillance
DOC	Document
EPA	Environmental Protection Agency
Ft	Feet
GA	General Aviation
GCAA	Ghana Civil Aviation Authority
GCARs	Ghana Civil Aviation Regulations
GPS	Global Positioning System
ICAO	International Civil Aviation Organization
ILS	Instrument Landing System
IFR	Instrument Flight Rules
KIA	Kotoka International Airport
KM	Kilometer
LOS	Line of Sight
M	Meter
MW	Mega Watts
NM	Nautical Mile
OLS	Obstacle Limitation Surface
PANS- OPS	Procedures for Air Navigation Services–Operations
PSR	Primary Surveillance Radar
SSR	Secondary Surveillance Radar
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
VRA	Volta River Authority
WGS	World Geodetic System

GLOSSARY

DEFINITIONS	
Aerodrome	A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft. An aerodrome includes but is not limited to the following: airport, airstrip, heliport, helistop, vertiport, gliderport, seaplane base, ultralight flightpark, manned balloon launching facility, or other aircraft landing or take off area.
Navigable airspace	The airspace above the minimum altitudes of flight prescribed by the Regulations and includes airspace needed to ensure safety in the take-off and landing of aircraft.
Wind farm	A group of wind turbines in the same location used to produce electricity. A large wind farm may consist of several hundred individual wind turbines and cover an extended area of hundreds of acres of land.

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AVIATION AND COMMUNICATION IMPACT ASSESSMENT

1. INTRODUCTION

Emmanuel Hayford was appointed by Seljen Consult Limited to conduct an assessment of the potential impacts on aviation safety, associated with the proposed construction, operation and decommissioning of the 76 Megawatt (MW) Wind Energy Facility in Anloga Extension (WPP1) in the Volta region, Ghana (Figure 1).

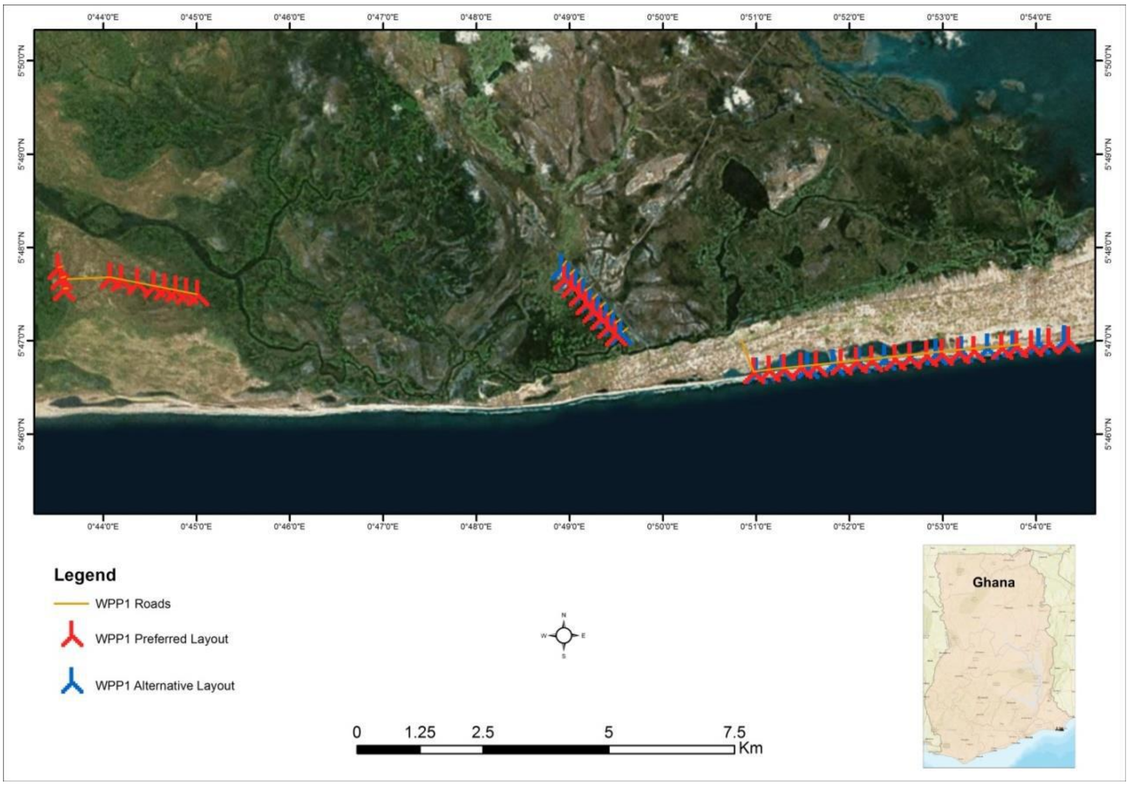


Figure 1: Location of the site for WPP1 with preferred and alternative layouts

This study aims at informing the Environmental and Social Impact Assessment (ESIA) in the development of a comprehensive Environmental Management Plan (EMP) to assist VRA in managing any aviation impacts.

2. TERMS OF REFERENCE

The purpose of the specialist study was to undertake an aviation safety impact assessment and to identify various cross sectional issues that are likely to impinge on aviation safety and efficiency, as well as, recommending appropriate interventions to mitigate potential issues, if any, for the benefit of the country.

The Scope of Work is based on the following broad Terms of Reference, which have been specified for this specialist study:

- Review of Civil Aviation Legislative Framework regarding installation of highrise structures
- Conduct a literature review
- Consultation with relevant aviation stakeholders
- Field survey and compilation of data
- Detailed analysis of new and existing data
- Conduct an Obstruction evaluation for Obstacle Limitation Surfaces
- Conduct an Obstruction evaluation for PANS-OPS Surfaces
- Determine the potential interference with CNS Signals
- Develop Alternative Intervention Schemes
- Determine management actions for possible Risk of Intrusions into the Protected Airspace of Airports
- Determine management actions for possible Risks of Interference to CNS Signals
- Develop information materials for client's use at public hearing and public workshops about the project regarding the impacts on aviation.

The key impacts and recommendations of this study have been captured in Chapters 6, 7 and 8 of the ESIA report.

3. PROJECT DESCRIPTION

In Ghana, all structures higher than 10 metres above ground level must be assessed and registered as potential obstacles to aviation. Given that the proposed wind turbines for WPP1 have hub heights that range between 95 m (plus 55 m rotor radius) to 112 m (plus 68 m rotor radius) for the preferred layout and alternative layout, these could present a potential impact to aviation.

The preferred and alternative layouts can be seen in Figure 1 above. Details on the project description can be found in Chapter 3 of the ESIA report.

4. APPLICABLE LEGISLATION AND PERMIT REQUIREMENTS

Standards and guidelines established by the Ghana Civil Aviation Authority (GCAA) and the International Civil Aviation Organization (ICAO) stipulate suitable distances/dimensions for any proposed development in the vicinity of aerodromes. These guidelines are used to ensure wind farms that may pose a threat to aviation are not erected in the vicinity of airports and proposed airports. ICAO Annex 14 specifically addresses the issue of wind turbines. These standards have been implemented in Ghana by the Ghana Civil Aviation Act 678 of 2004 (GCAAct) and Part 27 (the Airports (Protection of Airspace)) of the Ghana Civil Aviation (Aerodrome) Regulations (GCAR), 2011, L.I. 2004.

Under the provisions of the GCAAct 678 of 2004 and the Part 27 of the GCARs of 2011 (L.I. 2004), the GCAA is the competent authority that approves or refuses the erection of structures on or near an aerodrome as well as proposed future aerodrome. If deemed necessary, the GCAA, in coordination with the Metropolitans, Municipals and District Assemblies (MMDAs), can order the removal of high rise structures which are classified as an obstruction or a hazard to aircraft operations by the Authority.

The GCAR Part 27 promulgates the requirements to be met in relation to obstacles and hazards and establishes standards for determining obstructions to air navigation. It requires the proponent of a proposed structure to notify the GCAA of their intention to erect any structure anywhere in the country and to provide the proposed height and location coordinates of the structure.

In accordance with the GCAR Part 27, the Authority's Safety Inspectors shall determine after conducting an aeronautical assessment that a high-rise structure is, or will not be hazardous to aircraft operation. The GCAA shall subsequently direct the proponent to light or mark the hazard in accordance with the Manual of Standards (MOS) – Aerodromes Advisory Circular Obstacle Marking and Lighting.

If a wind turbine is found to penetrate a defined airspace surrounding an airport, it will be defined as an obstacle and shall be dealt with in accordance with the requirements set out in the GCAR Part 27 and that of the Manual of Standards (MOS), – Aerodromes.

The Ghana Civil Aviation Authority, under the legislative instruments protecting civil aircraft safety, also protects the interests of the Ghana Air Force (GAF) aircraft operations. This is done in coordination with the GAF.

According to international (ICAO) standards, aviation operations may be conducted at a height of 150 m (500 feet) above ground level, and lower if these can be carried out without being a hazard or nuisance to persons or property on the ground. Any obstacle protruding above this height is thus considered a danger to aviation.

4.1 GHANA CIVIL AVIATION AUTHORITY (GCAA) POLICY

The GCAAct emphasizes the need for conserving the navigable airspace for aircraft; preserving the integrity of the national airspace system; and protecting air navigation facilities from either electromagnetic or physical encroachments that would preclude normal operation A structure is therefore considered to have an adverse aeronautical effect if it exceeds the obstruction standards of the GCAR, and/or is found to have physical or electromagnetic radiation effect on the operation of air navigation facilities, unless the obstruction evaluation study determines otherwise.

If a structure is found to have a significant adverse impact, a "hazard" determination will be issued and will establish whether the proposed development would be a hazard to air navigation or not. The outcome of an evaluation of a proposed construction or alteration may be one of the following:

- object will exceed a standard but will not be a hazard to air navigation; or
- object will exceed a standard and will be a hazard to air navigation

However, in most cases, the GCAA works with the proponent until the conditions are met for a "no hazard" determination.

4.2 OBSTRUCTION STANDARDS

There are established standards for determining obstructions to air navigation as well as Industry best practices; including the Ghana Civil Aviation Regulation (GCAR) Part 27, Aerodrome Manual of Standards (MOS) and Ghana Civil Aviation guidelines. These apply to existing and proposed manmade objects, objects of natural growth and terrain. The standards apply to the use of navigable airspace by aircrafts and to existing air navigation facilities, such as an air navigation aid, airport, airway, instrument approach or departure procedure, or approved off airway route. Additionally, those standards apply to a planned facility or use, or a change in an existing facility or use.

The GCAA conducts aeronautical studies to determine the impact of a proposed structure, an existing structure that has not yet been studied by the GCAA, or an alteration of an existing structure on aeronautical operations, procedures, and the safety of flight. These studies include evaluating:

1. The impact on present and future arrival, departure, and en-route procedures for aircraft operating under visual flight rules and any possible changes in those operations and procedures that would eliminate or alleviate the conflicting demands;

2. The impact on present and future arrival, departure, and en-route procedures for aircraft operating under instrument flight rules and any possible changes in those operations and procedures that would eliminate or alleviate the conflicting demands;

3. The impact on existing and planned public use aerodromes;

4. Airport traffic capacity of existing public use aerodrome and public use aerodrome development plans received before the issuance of the final determination;

5. Minimum obstacle clearance altitudes, minimum instrument flight rules altitudes, approved or planned instrument approach procedures, and departure procedures;

6. The potential effect on operations of ATC radar, direction finders, ATC tower line-of-sight visibility, and physical or electromagnetic effects on air navigation, communication facilities, and other surveillance systems;

7. The aeronautical effects resulting from the cumulative impact of a proposed construction or alteration of a structure when combined with the effects of other existing or proposed structures and any possible changes in the proposal that would eliminate or alleviate the conflicting demands.

An obstruction evaluation study shall identify:

a) the effect the proposed development would have:

   i. on existing and proposed public-use and military airports and/or aeronautical facilities.

ii. on existing and proposed visual flight rule (VFR)/instrument flight rule (IFR) aeronautical departure, arrival and en-route operations, procedures, and minimum flight altitudes.

iii. regarding physical, electromagnetic, or line-of-sight interference on existing or proposed air navigation, communications, radar, and control systems facilities.

iv. on airport capacity, as well as the cumulative impact resulting from the structure when combined with the impact of other existing or proposed structures

b) the nature of marking and/or lighting on the development

The GCAR Part 27 states that all forms of development, which are beyond 10 nm and is 46 m (150 ft) or higher requires regulatory clearance. The proposed WEF exceeds this recommended height as the proposed hub heights range from 95 m to 126 m for the preferred and alternative layout will be above the recommended threshold of the GCAA (height of 46 m).

4.3 NOTICE REQUIREMENTS FOR CONSTRUCTION OR ALTERATION

Each applicant proposing any kind of construction, including wind turbines, shall apply to the GCAA for an obstruction evaluation and the granting of airspace safety permits for wind turbine developments (wind farm)/wind monitoring tower installations.

5. METHODOLOGY

The methodology used for this study consisted of the following approach to determine potential impacts on aviation (aircraft navigable airspace as well as aerodrome operations and expansion) from the proposed construction and operation of wind turbines:

- A Literature review
- Consultation with key stakeholders
- A field survey and
- A detailed analysis.

Further details on the above methodology can be found below.

5.1 LITERATURE REVIEW

In order to address the objectives of the study, a comprehensive literature review was conducted. The purpose of the literature review was to understand the unique features of wind turbine impact, background information on the project and the site, current and proposed aerodromes and CNS installations across the country and other factors that are likely to influence decision making.

5.2 CONSULTATION WITH STAKEHOLDERS

Project stakeholders are individuals and organizations that have interest and can influence the project from different perspectives. Since the objective of the assignment identified various cross sectional issues that are likely to impinge on aviation safety, the aviation consultant identified relevant stakeholders in the aviation community and determined the requirements and expectations. Table 1 below lists the stakeholders consulted and the nature of consultation.

Table 1: Stakeholder consultation

Name	Organisation	Date	Nature of consultation
Peter Akewetey	GCAA	3/03/2016	Face-to-face
Isaac Otu	GACL	23/03/2016	Face-to-face
James Narh Lawerteh	Assemblyman	4/04/2016	Face-to-face
Gilbert Akaba	Ag. District Coordinating Director	4/04/2016	Face-to face
Emmanual Andoh	NCA	21/04/2016	Telephone call

5.3 FIELD SURVEY AND COMPILATION OF DATA

The aviation consultant carried out a number of surveys and gathered field data to identify elements that will aid the aviation risk assessment process. Field surveys were carried on both proposed project locations from 2nd to 4th February, 2016. This visit was done to ascertain the situation on ground and some of the key elements that were looked at include grade aerodrome sites, geographic coordinates of wind turbines (WGS 84), accurate elevation data, air traffic route characteristics, radar coverages and line-of-sight. Brief reconnaissance visits were undertaken to affiliate with the conditions at the project site. Introductory meetings were held with the client's representatives to rationalise emerging issues from the reconnaissance for smooth execution of the project during the field survey, confirmation of site coordinates and physical characteristics/data of the proposed wind turbine project area using hand held global positioning system (GPS) and the coordinates were plotted on google earth and geographic information system (GIS).

5.4 DETAILED ANALYSIS

A full scale obstruction evaluation and airport airspace analysis (OE/AAA) was performed to ensure that the effect of each turbine is taken into consideration. Details of the OE/AAA are as follows:

- Obstruction evaluation (Airport Obstacle Limitation Surfaces)
- Obstruction evaluation (PANS-OPS Obstacle Identification Surfaces)

Also, potential Interference with CNS Signals was assessed in detail to create a balance for safe coexistence of the wind farm and airport.

Site data was compared with information from the Ghana Civil Aviation Authority (GCAA) standards and international best practices, including lighting guidance on wind turbines. An evaluation and analysis of all aviation activities related with the proposed site was considered and topographical maps, approach charts (including consideration of airspaces/navigation warnings-prohibited, restricted and danger areas) were reviewed.

6. DESCRIPTION OF THE AFFECTED AVIATION ENVIRONMENT

The proposed wind farm project site is located on the south-eastern portion of Kokota International Airport (KIA) and the proposed Prampram Airport as can be seen in Figure 2. The preferred and alternative layout turbine have hub heights which range from 95 m to 126 m respectively, however the largest turbine being considered in this study has a maximum height of 150 m above ground level. As these proposed wind turbines could cause hazard to aircraft navigable airspace, GCAA must be notified for assessment of the risk this proposed structure may pose to civil aircraft operation.

The current aviation infrastructures available at KIA include, but are not limited to, very wide omnidirectional range (VOR) radar, outer marker beacon, middle maker beacon, inner marker beacon, localizer and glideslope. These facilities are located at more than 100 km from WPP1. The proposed future Prampram Airport is closer, approximately 80 km from the proposed wind turbine project sites (WPP1).

The airport master plan showing a comprehensive study of the Prampram airport and describing the short, medium, and long-term development plans was not available at the time of this study. As such, technical decisions concerning siting of airport infrastructure like radars is not certain. Figure 2 below illustrates the location of the KIA and the location of the proposed PramPram airports in relation to the study sites.

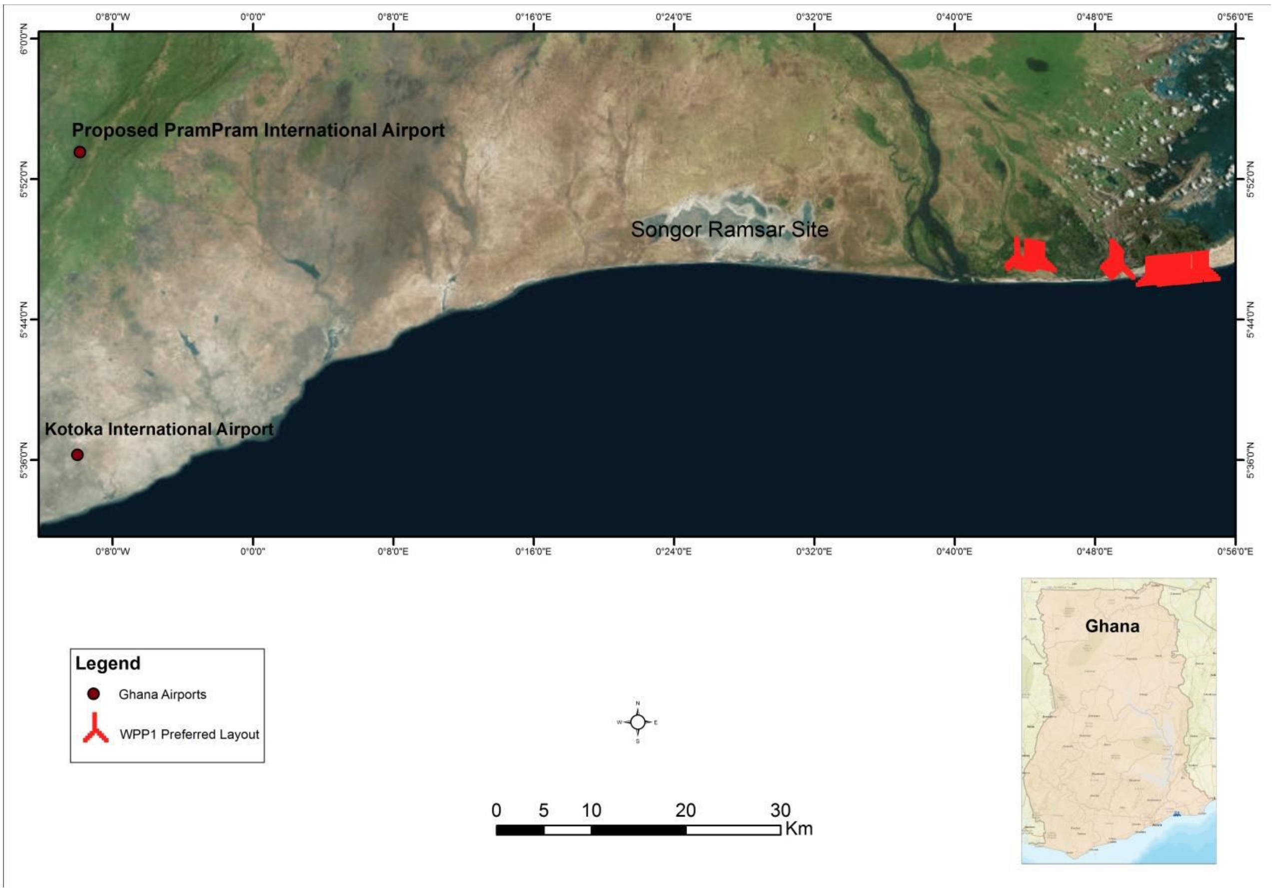


Figure 2: Location of the KIA and the proposed PramPram airports in relation to the study sites.

7. IDENTIFICATION OF KEY ISSUES

Potential key issues related to civil aviation include turbines presenting a physical obstacle to Air Navigation, interference with Communication as well as Navigation and Surveillance (CNS) signals and impact on Air Traffic Control Operations. Moreover, the greatest risk to aviation is linked to the cumulative effects of large scale developments in areas that are sensitive in terms of aviation.

The potential impacts of wind turbines on surveillance and navigation equipment are predominantly caused by the energy transmitted by the radar and returned by the turbines. The returned energy can result in the false detection of aircraft (i.e. clutter) or create blind spots behind wind facilities. In severe cases, the amount of returned energy can saturate the radar receiver and result in the radar system not being able to make any further detection. In terms of civil aviation this impact is most pronounced on the primary radar systems at major aerodromes. Such systems can be affected by any development in radio line of sight (which is generally 20% further than optical line of sight) and is thus dependent on the height of the turbine and the terrain. The size (i.e. rotor diameter) and distance from the radar station further determines the magnitude of the impact. It is generally unlikely for this impact to occur if development is further than 35 km from the radar station.

The key potential aviation issues identified during the study regarding the impacts are described below:

7.1 NAVIGATION FACILITIES (RADAR)

The wind farm would have no effect on navigation facility installations of the KIA and the proposed Prampram International Airport, since the proposed wind turbine site is beyond 15 km from the KIA and from the general proposed airport location in accordance with the recommendations provided in ICAO's Guidance Material on Managing Building Restricted Areas, which is applicable to any obstacle.

Experiences from other airports across the globe can be assessed and adopted to manage this issue, should any navigation systems be constructed near the project in future.

7.2 EFFECTS ON RADIO NAVIGATION AIDS (COMMUNICATION, NAVIGATION AND SURVEILLANCE)

Ground based radio navigation aids could suffer from similar reflection and deflection effects as with radar. The effect of this may be that an aircraft is not tracked accurately towards the aid on the designated air route. This false tracking can cause the aircraft to deviate too far from the intended flight track and expose it to obstacles which infringe on the clearances defined in the design of the particular flight procedure in instrument conditions.

Similarly, visually navigated aircraft may be tracked erroneously due to a conflict of navigation data available from maps and navigation aids. Line of sight (LOS) principles apply but this type of facility will normally be protected by preventing new structures if they will extend above an elevation angle of one (1°) degree as seen from the site of the radio navigation aid. This means that, at ground level, a 150 m high wind turbine should be located at a minimum of 8 km from the radio navigation aid to avoid any impacts.

Impacts on radio navigation aids are assessed and it does not fall within 15 km from both KIA and Prampram airport. There is however a possibility that CNS may be affected thus the impact has been rated as very low in the impact assessment section.

7.3 INSTRUMENT FLIGHT PROCEDURES (IFP)

Instrument Flight Procedures can be affected by tall structures in their vicinity. The wind farm would have no effect on IFP for the KIA and the proposed Prampram International Airport. Hence, there will be no significant effect on CNS because it is further than 15 km radus and also not in the radar line of sight.

The Instrument Flight Procedures for the proposed Prampram airport have not, to the author's knowledge, been designed yet. The wind farm will not lie on the proposed extended runway centre line and it is anticipated that it will be possible to design any required procedures to accommodate the wind farm safely.

7.4 INSTRUMENT FLIGHT RULES (IFP)

Aircraft operating under the IFR are navigated by reference to cockpit instruments which process data from aircraft systems, ground-based NAVAIDS or satellites. All regular public transport (RPT) jet aircraft operating into Ghana operates under the IFR within controlled airspace. The proposed wind farm location is a low lying area and en route aircraft with reference to KIA are always at high altitude in that area. In addition, the proposed wind facility (preferred and alternative layout) is located beyond 15 km radius from both airports. It is therefore not anticipated that the proposed wind facility will have any impact on the operation of the KIA.

The complete airport master plan for the proposed future airport was not available at the time of this study. However, it is not anticipate that the proposed wind turbine site will have any negative impact on the operation of the proposed aerodrome.

7.5 VISUAL FLIGHT RULES (VFR)

Aircraft operating under VFR may do so only in visual meteorological conditions (VMC) defined as an average range of visibility of 5,000 m forward of the cockpit, horizontal cloud clearance of 1,500m and vertical cloud clearance of 3,500 m. At the moment there is no prescribed or designated VFR traffic operation around this area. The entire Ghana airspace is a designated controlled airspace and pilots are to fly with reference to Air Traffic Control (ATC) clearance.

VFR traffic in daylight hours is not confined to air routes and these aircraft may operate anywhere provided they do so in VMC and observe the same rules from ATC for selecting their cruising altitude.

In these conditions wind farms should be easily visible and have no impact on VFR flying activity, if applicable.

Military pilots periodically conduct low level flying training at that location. However, the training may not veer off to the proposed wind farm areas. Special use airspace, extending to varying heights, is defined on air navigation charts and identified as Prohibited, Restricted or Danger. For safety reasons flight into this airspace may be prohibited or restricted or the airspace may be designated as a danger area to warn pilots to take additional care. The proposed wind turbine projects do not fall within any of this special use airspace.

7.6 MINIMUM SAFE ALTITUDES

A pilot must maintain a safety margin between their aircraft and any obstacles beneath them. This defines a minimum safe altitude at which an aircraft can fly in any particular region. Introducing tall structures in an area can, therefore, increase the minimum safe level accordingly. The turbines would be the tallest structure in their immediate vicinity, and this may affect the minimum safe level in the area. Any restrictions imposed by the turbines will be relevant for the surveillance minimum altitude charts associated with the proposed Prampram airport. It is important to note that any increase in the minimum safe altitude due to the turbines will be modest. There are no anticipated impacts.

It should be noted that the maximum turbine altitude above mean sea level would be comparable to the terrain altitude approximately 10.5km to the west of the proposed airport location. The Prampram Airport is proposed to be located approximately 80 km from the proposed wind turbine project site (WPP1).

7.7 IMPACT ON AIRSPACE AROUND AERODROMES

There are two key airspace surfaces surrounding the aerodrome airspaces:

- Obstacle Limitation Surface (OLS)

- Procedures for Air Navigation Services – Operations Surfaces (PANS-OPS surfaces)

Obstacle Limitation Surface (OLS)

An Obstacle Limitation Surface (OLS) is an imaginary three-dimensional plane around an airport that should not be breached by a physical structure. They define the volume of airspace that should ideally be kept free from obstacles in order to minimize the danger to aircraft during an entirely visual approach or during the final visual segment of an instrument approach procedure.

The purpose is to ensure that the airspace around aerodromes is free from obstacles so as to permit the intended aircraft operations at the aerodrome to be conducted safely. It is also to prevent the aerodrome from becoming unusable by the growth of obstacles around the aerodrome.

These surfaces are of a permanent nature and comprise the reference datum which defines an obstacle. Anything above the vertical limits of the OLS is regarded as an obstacle. Obstacles are reported so that GCAA can determine if they are "hazardous" and therefore need to be marked and/or lit to ensure they are prominently identified.

Airspace requirements will depend on the nature and scale of activities at an aerodrome but could extend to a radius of 15 km. The OLS also need to be considered in relation to both current and future aerodrome developments and activities.

Wind turbines may be acceptable in the areas covered by the OLS but will need to be assessed in relation to critical manoeuvres such as the approach to land and possible low level missed approaches, and a reduced power take-off following an engine failure.

The obstruction evaluation assessment of the proposed project, against the KIA and Prampram airport as depicted in Figures 3 and 4 below shows that the wind turbine project is further away from the airport safeguarding protection zones and as such the wind turbine's operation phase will have no impact on both airports given that the proposed project falls outside the OLS defined by the GCAA and the International Civil Aviation Organisation (ICAO) for both airports. Therefore, no breach would occur.

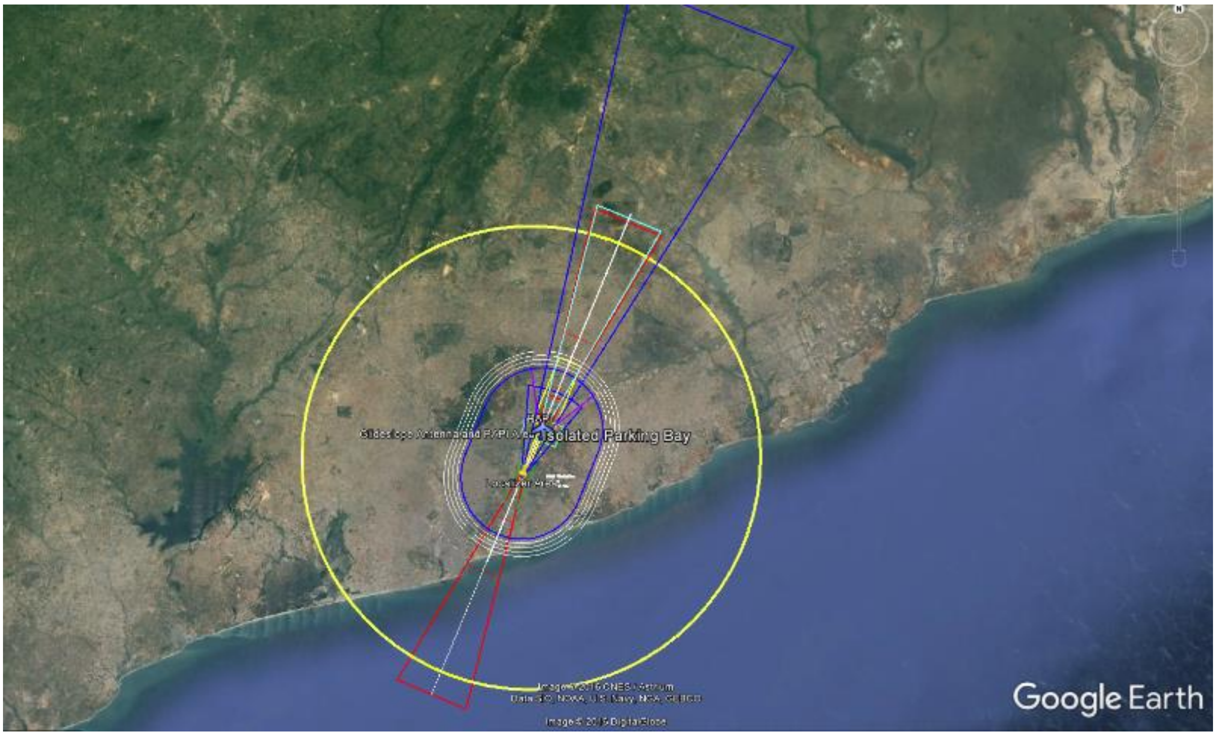


Figure 3: Protection Zones of Kotoka international Airport (KIA)

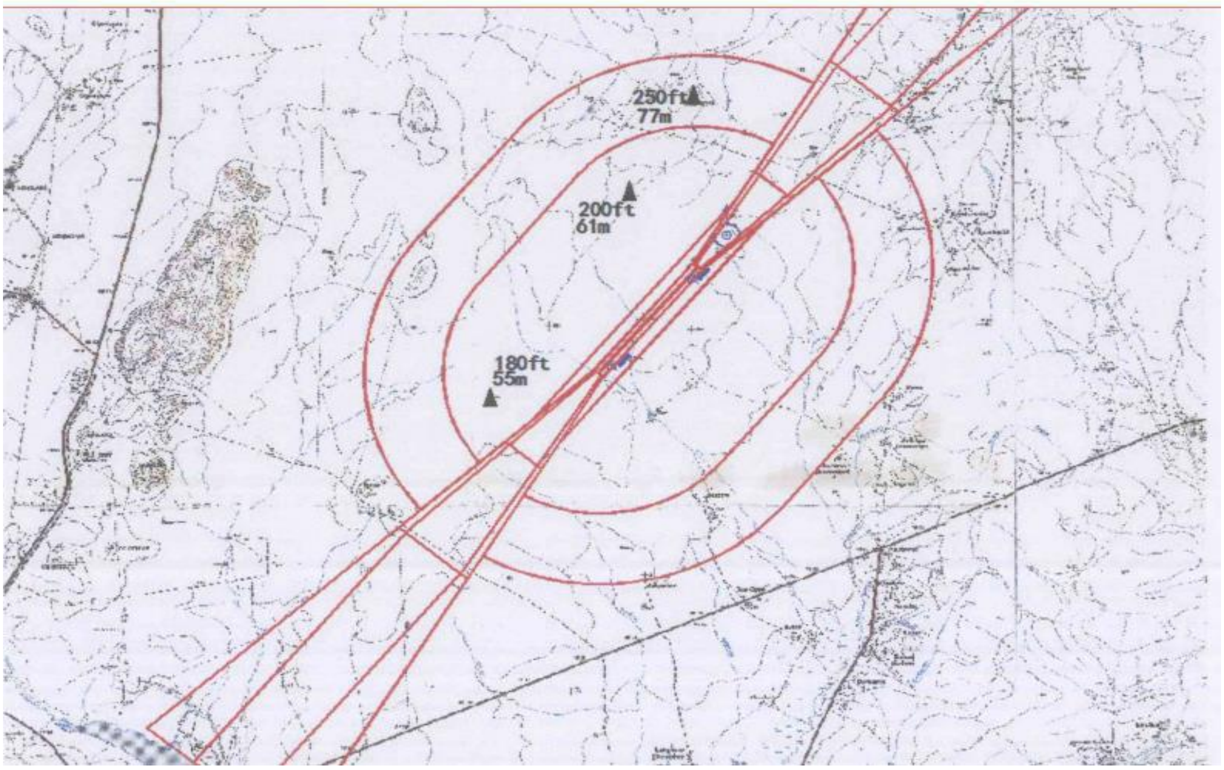


Figure 4: Proposed Protection Zones of future Prampram international Airport on 1:50,000 topographic map

<u>Procedures for air navigation services - aircraft operations (pans-ops surfaces)</u>

Airspace associated with aircraft instrument approach and departure procedures is defined by the PANS-OPS surfaces for an aerodrome. These surfaces are ascertained in accordance with the criteria specified in the International Civil Aviation Organization (ICAO) Procedures for Air Navigation Services - Aircraft Operations (Doc 8168, PANS-OPS).

The PANS-OPS surfaces are intended to safeguard an aircraft from collision with obstacles when the pilot is flying by reference to instruments. The designer of an instrument procedure determines the lateral extent of areas needed for an aircraft to execute a particular manoeuvre. The designer then applies minimum obstacle clearance to structures, terrain and vegetation within that area to determine the lowest altitude at which the manoeuvre can be safely executed.

As a result, PANS-OPS surfaces cannot be infringed on any circumstances. These airspace requirements will depend on the nature and scale of activities at an aerodrome but could determine the acceptable obstacle heights to a radius of 10 - 20 km from the aerodrome.

There are no anticipated impacts on procedures for air navigation services – PANS-OPS Surfaces.

7.8 AVIATION LIGHTING

In order to prevent any adverse effect from the proposed wind turbine project, all tall structures as well as other high-rise objects during the constructional phase should have obstruction lights in accordance with Ghana Civil Aviation Authority (GCAA) standards. The Ghana Civil Aviation Authority (GCAA) has produced and published guidance with regard to aviation lighting for tall structures. Wind turbines are listed as structures that require lighting and marking. Lighting will be in accordance with GCARs Obstacle Marking and Lighting and be operated in a manner consistent with a general duty of care towards aviation.

The guidance states that lights should be positioned to ensure that a pilot has an unobstructed view of at least one light at each level. The guidance states that structures above 45 metres require intermediate lights spaced equally between the top lights and ground level. The spacing between lights should not exceed 45 metres.

For structures that exceed 150 metres in height, the obstruction lighting should be of high intensity, which means flashing white lights (40-60 flashes per minute). The intensity requirements are:

- Minimum of 200,000 candela during the day.
- Minimum of 20,000 candela during twilight.
- Minimum of 2,000 candela during the night.

It is recommended that the lighting and marking requirements for the development are discussed with the GCAA. In practice, wind turbines are often not fitted with markings or intermediate lights. This can vary from one country to another.

8. HIGH LEVEL ASSESSMENT OF IMPACTS/RISKS AND IDENTIFICATION OF MANAGEMENT ACTIONS

The methodology applied to predict and assess impacts/risks is detailed in Chapter 6 of the ESIA report. The Aviation Impacts during Construction, Operation and Decommissioning Phases of the proposed WPP1 are discussed below.

8.1 CONSTRUCTION PHASE

The aviation impacts on the proposed wind turbine development have been assessed in this study and there are no anticipated impacts during the construction phase.

8.2 OPERATIONAL PHASE

The potential impacts of a WEF on aviation during the operational phase include Interference with Communication, Navigation and Surveillance (CNS) signals.

8.2.1 Interference with Communication, Navigation and Surveillance (CNS) signals

During the operational phase of the project, tall structures may interfere with electromagnetic transmissions. Steel towers and rotating turbine blades can cause reflection and/or deflection of radiated waves and cause interference with aviation communication, navigation and surveillance (CNS) systems established for air traffic management. The CNS system includes aerodrome based and en-route navigation aids (NAVAIDS) and radar used for air traffic control at aerodrome and/or en-route surveillance. Two types of radar are used for air traffic control (ATC) and surveillance primary radar and secondary surveillance radar (SSR).

Primary radar works by radiating electromagnetic energy and detecting a return signal from reflecting objects. Comparison of the return signal with the original transmission provides information such as the direction and range of the target from the radar site. ATC radars are designed to filter returns from stationary objects to avoid moving targets, primarily aircraft, being obscured by radar clutter.

Other than this means of differentiating between stationary and moving targets, primary radar cannot determine the type of object detected and has no means of determining the height of the object. Secondary Surveillance Radar (SSR) emits radio frequency (RF) interrogation messages that trigger automatic responses from a transponder on board an aircraft. The transponder reports aircraft identification and altitude.

Primary radar can detect aircraft up to 50 NM from the radar sensor while Secondary Surveillance Radar (SSR) can detect aircraft up to 250 NM. This is referred to as the radar coverage. Despite that, KIA Radar coverage extends as far as the proposed wind farm project location, the proposed wind farm project will not pose any significant hazard to aircraft navigation in that environment.

The study assessed all the available documents/literature per the proposed types of flying activities that could be conducted in this area in close proximity to the proposed wind farm. An assessment of the impact of the wind farm on the proposed future aerodrome has concerns that will have to be operationally addressed. Given that the detailed design of the Prampram airport (planning, design, and construction of terminals, runways and navigational aids like radar) have not yet been finalised, potential impacts of the proposed project on the proposed airport cannot be assessed.

Impacts on Interference with Communication, Navigation and Surveillance (CNS) signals for KIA are assessed to be of local extent and long-term duration (i.e. the impact and risk will occur for the project duration). The probability of the impact is rated as improbable. Given the above, the significance of the impact is rated as very low for the preferred and the alternative sites.

8.3 DECOMMISSIONING PHASE

The decommissioning of the proposed wind turbine project would have no impact on aviation, hence a written notification to the GCAA on the decommissioning should be enough.

8.4 CUMMULATIVE IMPACTS

At this stage, it is premature to provide a systematic analysis of how the concentration of two or more wind energy facilities is going to impact on aviation activities and the aviation community, as the existing information on the potential cumulative impacts of these wind farm projects is inadequate.

Despite the inadequate information, on-going studies have made some references to possible cumulative impacts as a result of the number of wind turbine generators proposed in specific geographic area. This would be a good area for research in future. Going forward, the aviation industry should partner with industry stakeholders and researchers to discuss issues of potential impacts associated with concentrated wind turbines in a particular geographic location As there are no other large development projects in the project's area of influence, the cumulative impact for both alternatives is thus assessed to be of very low significance.

9. IMPACT ASSESSMENT SUMMARY

The assessment of potential impacts and recommendation of mitigation measures as discussed above are collated in Table 2 below.

Table 2: Impact assessment summary table for the Operational Phase for the preferred and alternative layout

OPERATIONAL PHASE												
Direct Impacts												
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Intensity**	**Probability**	**Reversibility**	**Irreplaceability**	**Mitigation Measures**	**Significance of Impact**		**Confidence Level**
										Without Mitigation	***With Mitigation***	
Impact of Radar	Interference with Communication Navigation and Surveillance (CNS) signals	Negative	Local	Long term	Low	Improbable	High	Low	N/A	Very Low	Very Low	High

10. CONCLUSION AND RECOMMENDATIONS

It can be concluded that the wind farm could have some form of interference on CNS system of the proposed future airport; however, this perceived interference would be very low for both the preferred and the alternative layouts.

The following best practice measure is recommended and would involve a collaborative and coordinated approach between the proponent, the GCAA and the industry. This approach would help to ensure continued investment in mitigation actions in the interest of aviation and wind energy, given their importance.

In practice, the wind farm is not expected to have any effect on instrument flight procedures due to the wind farm’s distance from the airport (i.e. 100 km and 80 km from the KIA and the proposed Prampram airport respectively) and its direct approach routes in line with the provision of the GCARs.

High intensity lighting would need to be mounted on the wind turbine nacelles, with potential additional intermediate lighting on the turbine towers based on guidance from the GCAA.

11. REFERENCES

ICAO Annex 14 Volume 1 (Aerodrome Design and Operations), 7th edition

Ghana Civil Aviation Authority (GCAA) Act, 2004, Act 678)

Ghana Civil Aviation (Aerodrome) Regulations Part 27

ICAO Document on Procedure for Air Navigation Services-Operations (PANS-OPS)

Ghana Civil Aviation Guidelines, 2016 Managing the Risk of Wind Turbine Developments (Wind Farm)/Wind Monitoring Tower Installations to Aviation Safety

Managing the Impact of Wind Turbines on Aviation Prepared by the Airspace & Safety Initiative Wind farm Working Group in consultation with DCLG, RTPI, and Planning Officers

www.pagerpower.com

Eurocontrol Guidelines on How to assess the potential of Wind Turbines on Surveillance Sensors

"Managing the impact of Wind Turbines on Aviation" by Air Space and Safety Initiative Wind farm Working Group (ASIWWG)

CAA Policy Statements on lighting for tall structures, http://www.caa.co.uk/docs/33/20121122PolicyStatementWTG.pdf

http://www.caa.co.uk/docs/33/DAP_LightingEnRouteObstaclesAndWindTurbines

http://www.ead.eurocontrol.int/eadbasic/pamslight12F7B41C44093026F4726315FAC19FD6/7FE5QZZF3FXUS/EN/AIC/P/0212011/EG_Circ_2011_P_021_en_2011-04-21.pdf

12. CURRICULUM VITAE

EMMANUEL NKWANTA HAYFORD

P.O. Box KU 68
Winneba

Contact: +233 24 4687326
Email:emmanuelhayford@gmail.com

COMPETENCE

Airport Engineer, Certified ICAO ACIP Integrated Safety Management Instructor, Airport Certification Specialist,
Obstruction Evaluation/Airport and Airspace Analysis (OEAAA) Specialist, with over 13 years of experience as Aerodrome Safety Inspector.

EDUCATION

- Graduate Diploma in Occupational Health, Safety and Environment, GIMPA, Ghana - 2010
- Graduate Diploma in Airport Engineering, Nanyang Technological University/Singapore Aviation Academy, Singapore - 2005
- B.Sc. Civil Engineering, University of Science and Technology, Kumasi, Ghana - 1999

COURSES ATTENDED

- IATA Dangerous Goods Regulations (DGR) Initial Category 6 Course, Accra - 2014
- Aircraft Accident Investigation Course - 2014
- ICAO Aeronautical Meteorology Inspectors Basic Training Course, Accra - 2013
- Resolution of Safety Concerns (International FAA Academy Course, 15209001), Accra - 2013
- ICAO Aerodrome Inspectors Course (i.e. GSI Aerodromes), Accra, Ghana - 2012
- International Airport Certified Employee Program (IACE) by AAAE/FAA, Accra - 2010
- Inspector Training Systems and OJT Instructor Course by FAA, Accra, Ghana

- 2010

- Work Tracking System (Course 21000054) by FAA, Accra, Ghana - 2010
- On-the-job training (OJT) course for ICAO ACIP ISM SMS Instructors, Accra, Ghana - 2010
- ICAO State Safety Programme (SSP) & SMS Train-the-Trainer Course, S. Africa - 2009
- Airspace and Procedures, Mike Monroney Aeronautical Center (MMAC), Oklahoma City- 2009
- ICAO Safety Management System (SMS) Training Course, Addis Ababa, Ethiopia - 2008
- Internal Auditor Training by AIR-TEC Africa, Accra-Ghana - 2007
- Airport Ramp Operations & Management, Singapore Aviation Academy - 2007
- Aerodrome Certification, Operations and Auditing, Gatwick, UKCAA - 2005
- Basic Obstruction Evaluation and Airport/Airspace Analysis (OE/AAA) Course, MMAC,
  Oklahoma City, OK, U.S.A. - 2002

WORKSHOP & SEMINARS

- Runway Safety and Pavement Maintenance Seminar for Africa by FAA, Lagos, Nigeria- 2012
- Ninth Meeting of the Aerodrome Operations Planning Sub-Group (AOP/SG/9),Senegal - 2011
- Course in Improving Workplace Attitude by Ghana Employers Association - 2010
- Personnel Licensing and Aircraft Operations Seminar (PEL/OPS) by ICAO ACIP, Accra - 2009
- Seminar on Air Safety Administration for African Countries, Beijing, China - 2009
- Aerodrome Emergency Planning Workshop, by ICAO, Abuja, Nigeria - 2006
- 1st ICAO Western & Central African Region (WACAF) Workshop on Certification of Aerodromes, Dakar, Senegal - 2003
- Total Quality Management (TQM) – AMISU Management Consultant - 2000
- Materials Engineers Seminar on Bituminous Surfacing – specifications and workmanship

EXPERIENCE

Ghana Civil Aviation Authority - 2001 to date

Senior Aviation Safety Inspector (Aerodrome Safety & Standards)

- Obstacle Evaluation and Airport Airspace Analysis (OE/AAA) specialist, responsible for airspace reviews and supervision of obstruction evaluation exercise;
- On-the-job training (OJT) instructor for OE/AAA Specialist
- Key member, WGS-84 Obstacle Surveys & Maintenance Team
- Supervision of development and management of obstacle data
- Certified ICAO State Safety Programme (SSP)/Safety Management Systems (SMS) Instructor
- Part-time lecturer at the Ghana Civil Aviation Training Academy
- Aerodrome Expert, Aviation Safety Technical Committee for the Banjul Accord Group Aviation Safety Oversight Organisation (BAGASOO)
- Leader, ICAO SSP Planning Committee (Ghana)
- Leading member - Drafting of all five (5) parts of Ghana Civil Aviation Regulations relating to aerodrome construction, certification and operations, and safeguarding, including offshore helicopter landing sites.
- Coordinator - Certification of aerodromes
- Leader - Development of Manual of Standards for Aerodromes and all guidance materials, forms and checklists relating to aerodromes
- Aerodrome Inspections/Audits
- Wealth of experience in aerodrome site selection & conduct of aeronautical reviews of airport proposals;
- Provision of guidance on broad range of aviation issues to aerodrome operators and airport consultants;
- Maintaining effective relationships with clients and performing surveillance activities
- Conduct initial and OJT to Aviation Safety Inspectors
- Leading member, Implementation Committee - Performance Based Navigation in the Accra FIR

SKILLS

- Excellent knowledge of Ghana Civil Aviation Regulations (GCARs)
- Sound knowledge of ICAO Annex 14 and other related documents; ICAO Doc 9774 on certification of aerodromes; ICAO Doc 9859 (Safety Management Manual);
- Knowledge of safe work practices related to aerodrome operations;
- Ability evaluate aerodrome designs and interpret aerodrome plans and specifications;
- Ability to effectively communicate orally and in writing;
- Ability to work in a team and instructional abilities to train others;

- Capacity to take initiative, exercise tact and sound judgment, and able to maintain good inter-personal relations with subordinates, superiors, other employees and the public
- Computer literate (excellent with Microsoft office applications & fair knowledge of AutoCAD)
- QGIS
- Use of surveying instruments.

LANGUAGE SKILLS

Competence Scale of 1 to 5 (1-excellent; 5-basic)

Language	Reading	Speaking	Writing
English	1	1	1
French	4	5	4
Fante	1	1	1
Twi	2	1	2
Effutu/Awutu	-	1	-
Ga	4	4	3

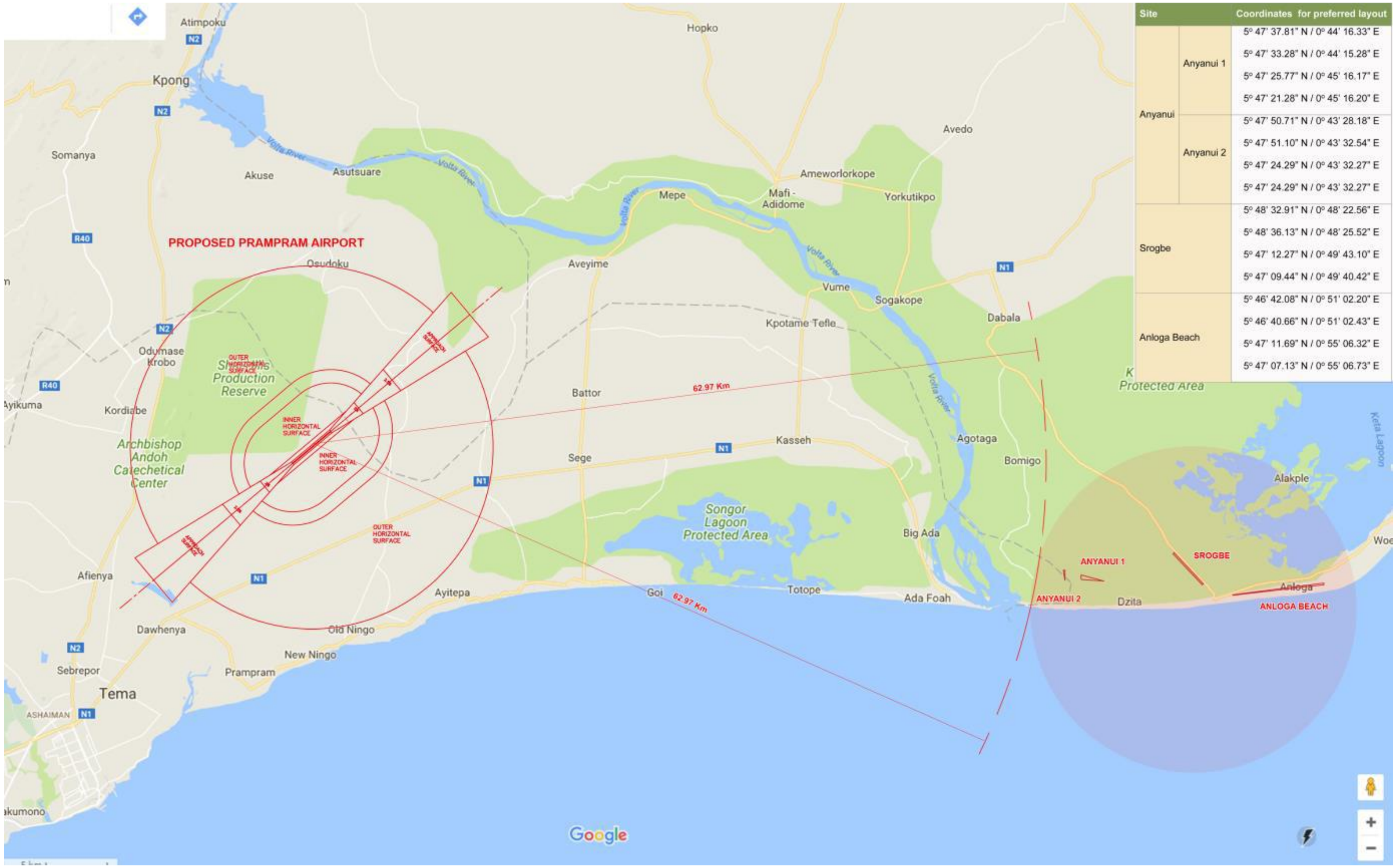
13. APPENDICES

APPENDIX 1: Table of coordinates of telecommunication towers

TELECOMMUNICATION TOWERS				
TOWER	**COMPANY**	**COORDINATES**	**HEIGHT**	**ELEVATION**
Kasseh Ada	Helios Tower Ghana Limited	05° 53' 44.52"N 000° 30' 55.91"E	60m	55ft
Krasseh Ada	Globacom Ghana Limited	05° 54' 12.00"N 000° 31' 08.85"E	36m	68ft
Krasseh Ada	Americal Tower Company Limited	05° 53' 48.52"N 000° 31' 26.72"E	36m	55ft
Dogo Ada	Globacom Ghana Limited	05° 53' 12.875"N 000° 33' 43.52"E	36m	18ft
Samavey Kope	Americal Tower Company Limited	05° 52' 02.57"N 000° 33' 54.91"E	36m	13ft
Samavey Kope	Globacom Ghana Limited	05° 50' 58.32"N 000° 26' 08.73"E	36m	18ft
Big Ada	Americal Tower Company Limited	05° 49' 35.50"N 000° 36' 54.88"E	40m	13ft
Big Ada	Vodafone Ghana Limited	05° 49' 29.64"N 000° 35' 53.64"E	60m	18ft
Ada	Helios Tower Ghana Limited	05° 47' 45.60"N 000° 37' 21.26"E	60m	7ft)
Ada	Americal Tower Company Limited	05° 47' 37.35"N 000° 37' 20.49"E	40	13ft
Ada	Vodafone Ghana Limited	05° 47' 04.18"N 000° 37' 39.52"E	60m	22ft
Ada Foah	Globacom Ghana Limited	05° 46' 53.40"N 000° 37' 53.69"E	40m	25ft
Ada Foah	Americal Tower Company Limited	05° 47' 02.95"N 000° 38' 09.63"E	60m	18ft

APPENDIX 2: Turbine locations in relation to telecommunication towers

APPENDIX 3: Interference zones



Site		Coordinates for preferred layout
Anyanui	Anyanui 1	5° 47' 37.81" N / 0° 44' 16.33" E
		5° 47' 33.28" N / 0° 44' 15.28" E
		5° 47' 25.77" N / 0° 45' 16.17" E
		5° 47' 21.28" N / 0° 45' 16.20" E
	Anyanui 2	5° 47' 50.71" N / 0° 43' 28.18" E
		5° 47' 51.10" N / 0° 43' 32.54" E
		5° 47' 24.29" N / 0° 43' 32.27" E
		5° 47' 24.29" N / 0° 43' 32.27" E
Srogbe		5° 48' 32.91" N / 0° 48' 22.56" E
		5° 48' 36.13" N / 0° 48' 25.52" E
		5° 47' 12.27" N / 0° 49' 43.10" E
		5° 47' 09.44" N / 0° 49' 40.42" E
Anloga Beach		5° 46' 42.08" N / 0° 51' 02.20" E
		5° 46' 40.66" N / 0° 51' 02.43" E
		5° 47' 11.69" N / 0° 55' 06.32" E
		5° 47' 07.13" N / 0° 55' 06.73" E

Environmental & Social Impact Assessment

for the proposed development of a Wind Energy Facility in Anloga Extension (WPP1)

APPENDIX 6:

Wetland Impact Assessment Study

WETLANDS IMPACT ASSESSMENT REPORT:

Ecological Survey and Wetland Habitat Assessment Report as part of the Environmental and Social Impact Assessment for a 75MW Wind Power Project situated at Anloga, Srogbe and Anyanui on the coast in the Keta Municipality in the Volta Region, Ghana

Report prepared for:	***Report prepared by:***
Seljen Consult Limited P. O. Box AT 140 Achimota-Accra Ghana-West Africa CSIR – Environmental Management Services P O Box 320 Stellenbosch, 7599 South Africa	Charles Christian Amankwah General Services Manager / Wetlands Coordinator Wildlife Division (Forestry Commission) P. O. Box MB 239 Ministries Post Office Accra Tel. +233 (0) 244 262467 Email: ccamankwah@yahoo.com Alexander Michael Whitehead SDP Ecological and Environmental Services PO Box 1016 Ballito 4420 South Africa Tel. +27732684157 Email: alex@ecocoast.co.za

DECEMBER 2017

EXECUTIVE SUMMARY

This report provides an overview of the wetland and aquatic ecology of the Srogbe, Anloga and Anyanui sites for a proposed 76 MW wind power facility (WPP 1). The three sites make up the project area, which is situated within the Keta Lagoon Complex Ramsar Site. The project area was characterised by estuarine habitat (mangroves, salt marsh, brackish lagoons and tidal channels), freshwater wetlands (floodplain wetlands and depressions) and open water bodies (freshwater). Existing disturbances included human settlement and associated activities and infrastructure (roads in particular). The Anloga site was unique in that it presented a coastal dune environment, influenced by the adjacent seashore environment.

A review of the status quo revealed that the wetland and estuarine habitats were highly functional systems with high ecological importance. The coastal zone, appeared to be more disturbed, but was sensitive to coastal erosion. Changes to the hydrology of the Volta River have influenced the coastal catchment and is considered a significant driver of ecological and coastal change within the Keta Region. Key issues identified and discussed included the following:

- Wetland birds, both resident and migratory species.
- Local artisanal fisheries
- Disturbance of estuarine, freshwater and coastal habitats and ecology, including aquatic and semi aquatic fauna.
- The potential for flooding
- Concerns regarding coastal erosion

A number of impacts were identified and have been summarised in Table (i) below. Impacts will generally be higher during the construction phase due primarily to the presence of recognised and clear disturbances associated with construction activities such as habitat loss and the disturbance of fauna.

Two alternative layouts options were assessed, the preferred layout and the alternative layout. The preferred layout included turbine clusters at all three sites, while the alternative layout option only presents turbine clusters at Srogbe and Anloga. The absence of turbines at the Anyanui site meant a reduced impact on freshwater ecosystems for the alternative layout option relative to the preferred layout option. All other impacts were comparable between the two layout options. Based on the findings and in order to further reduce the identified impacts, two additional layout variations were proposed for the Srogbe and Anyanui sites. These presented possible turbine relocation sites to reduce the disturbance of mangrove and freshwater wetland habitat respectively.

Overall, after the consideration of mitigation measures and management actions, impact significance for identified construction phase, operational phase and cumulative impacts varied between very low and medium, with the majority described as being of low significance.

Table (i): Summary of Impacts

Impact	Significance rating		Key mitigation/optimisation measures (summarised)
	Without	***With***	
CONSTRUCTION PHASE IMPACTS			
Disturbance of wetland birds due to habitat loss (Preferred)	LOW	VERY LOW	• Check construction area for nests prior to construction. • Safely remove and relocate and birds that become trapped
Disturbance of wetland birds due to habitat loss (Alternative)	LOW	VERY LOW	• Check construction area for nests prior to construction. • Safely remove and relocate and birds that become trapped
Disturbance of other fauna due to construction related activities – excavation/noise (Preferred)	LOW	VERY LOW	• Capture and relocate fauna
Disturbance of other fauna due to construction related activities – excavation/noise (Alternative)	LOW	VERY LOW	• Capture and relocate fauna
Interruption of local fishing activities (Both options)	VERY LOW	VERY LOW	• None required
Estuarine disturbance – loss of nursery habitat (Both options)	MEDIUM	LOW	• Shift turbines at Srogbe to outside of the mangrove area • Manage construction phase, particularly the extent of the disturbance footprint.
Disturbance of coastal dynamics (Both options)	MEDIUM	LOW	• Shift turbines inland. • Consider coastal dynamics during design of footing/foundations.
Loss of freshwater wetland habitat (Preferred only)	HIGH	MEDIUM	• Construction phase management only
Loss of freshwater wetland habitat (Preferred only if relocation possible)	HIGH	LOW	• Shifting of turbines out of the wetland area, and • Construction phase management
OPERATIONS PHASE IMPACTS			
Bird strikes and disturbance of resident birds (Preferred)	MEDIUM	LOW	• Long term monitoring by avian specialist
Bird strikes and disturbance of	MEDIUM	LOW	• Long term monitoring by avian specialist

Impact	Significance rating		Key mitigation/optimisation measures (summarised)
	Without	*With*	
resident birds (Alternative)			
Fauna may become trapped in infrastructure area (Preferred)	LOW	VERY LOW	• Regular inspections and checks • Capture and relocate
Fauna may become trapped in infrastructure area (Alternative)	LOW	VERY LOW	• Regular inspections and checks • Capture and relocate
Artisanal fisheries – limitation of access (Both options)	VERY LOW	VERY LOW	• Maintain/allow access to fishing grounds
Loss of estuarine habitat and change in processes (Both options)	MEDIUM	VERY LOW	• Shift turbines outside of mangrove habitats (Srogbe)
Alteration of coastal processes and increased erosion risk (Both options)	MEDIUM	LOW	• Design of Anloga foundations must consider erosion risk/coastal dynamics
Freshwater wetlands – contamination associated with maintenance activities (Preferred only)	MEDIUM	LOW	• Store hazardous substances correctly during maintenance
Change in functionality due to infilling/land reclamation (Preferred option only)	LOW	LOW	• Ensure adequate drainage and connectivity
DECOMMISSIONING PHASE IMPACTS			
Removal of infrastructure and rehabilitation	LOW	VERY LOW	• Rehabilitate areas disturbed during decommissioning • Management of decommissioning phase
CUMULATIVE IMPACTS			
Other development and associated infrastructure	LOW	LOW	• Design associated infrastructure accordingly. • Broad spatial planning of the Keta region identifying future development nodes and new infrastructure.
Increase in settlement and Pressure on the Keta Lagoon system	MEDIUM	MEDIUM	• Cannot be effectively managed by the applicant as the situation is complex

LIST OF ABBREVIATIONS

AEWA	Agreement on the Conservation of African-Eurasian Migratory Waterbirds
amsl	Above mean sea level
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
EIA	Environmental Impact Assessment
EMC	Environmental Management Committees
FAO	Food and Agriculture Organisation
IUCN	International Union of Conservation of Nature
LI	Legislative Instrument
MAR	Mean Annual Rainfall
MMDAs	Metropolitan, Municipal and District Assemblies
NCRC	Nature Conservation Research Centre
UNEP	United Nations Environment Programme
WRRI	Water Resources Research Institute

GLOSSARY

DEFINITIONS	
Change in ecological character	Within the context of the Ramsar Convention, change in ecological character is the impairment or imbalance in any biological, physical, or chemical components of the wetland ecosystem, or in their interactions, which maintain the wetland and its products, functions and attributes.
Modified habitats	Areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands.
Natural habitats	Areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition.
Critical habitats	Areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes.
Convention on Wetlands	Also known as the Ramsar Convention, is an intergovernmental environmental treaty established in 1971 by UNESCO, and coming into force in 1975.
Ramsar Site	A Ramsar Site is a wetland site designated of international importance under the Ramsar Convention.
Wetland	Means land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.

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WETLANDS IMPACT ASSESSMENT

1. INTRODUCTION

Charles Amankwah of the Wildlife Division (Ghana Forestry Commission) and Alex Whitehead of SDP Ecological and Environmental Services were appointed to conduct an aquatic ecology (including wetlands) specialist study as part of the ESIA for the proposed construction, operation and decommissioning of a 76 Megawatt (MW) Wind Energy Facility (WEF) ("WPP1") in Anloga Extension areas in the Volta Region, Ghana.

The report provides a reference in terms of wetlands (including estuarine habitats), their extent and their relation to the proposed development, in line with the requirements of the Environmental Assessment Regulations, 1999 (LI 1652) and as outlined in the Environmental Impact Assessment (EIA) Guidelines for the Energy Sector, Volume 1, 2010.

The potential aquatic and wetland impacts of the proposed wind energy project were reviewed within the context of the ecological sensitivity of the Keta region and potential mitigation measures were recommended to minimise key impacts. Impacts on associated fauna such as birds, bats and marine turtles have also been included in this study. Where possible, influences on the local communities have been highlighted, given their dependence on the local freshwater, estuarine and marine resources.

Two alternative layouts for the proposed wind power project have been assessed in this report. Further recommendations regarding the layout of the turbines and the associated infrastructure have been provided in addition to other relevant mitigation and management measures.

2. TERMS OF REFERENCE

The following broad terms of reference were specified for the aquatic ecology specialist study:

- A desktop aquatic biodiversity assessment of the study area. This will cover the study area and a 500m development buffer in relation to available information on the aquatic vegetation (including streams and rivers).
- Maps depicting demarcated aquatic and wetland vegetation delineated to a scale of 1:10 000, following the recognized methods and international standards.
- The determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of water bodies within the study area, estimating their biodiversity, conservation and ecosystem function importance with regard ecosystem services.
- Recommend buffer zones and no-go areas around delineated aquatic areas within the study area, based on the relevant legislation or best practice.
- Identification and assessment of wetland and aquatic impacts.
- Provide mitigations regarding project related impacts, including engineering services that could negatively affect demarcated aquatic vegetation units and potentially aquatic fauna.
- Recommend specific actions that could enhance the aquatic functioning in the areas, allowing the potential for a positive contribution by the project.

3. PROJECT DESCRIPTION

This project referred to as WPP1, will have the following main components which may impact on the aquatic ecology aspects:

- **Wind turbine area:**
  - Wind turbines; and
  - Hard standing areas;

- **Building Infrastructure:**
  - Offices;
  - Operational and maintenance control centre;
  - Warehouse/workshop;
  - Ablution facilities;
  - Converter/Inverter stations;
  - On-site substation building; and
  - Guard Houses.

- **Associated Infrastructure:**
  - Access roads;
  - Internal gravel roads;
  - Fencing;
  - Stormwater channels; and
  - Temporary work area during the construction phase (i.e. laydown area).

A detailed description of the project components is included in Chapter 3 of the ESIA report.

Two layouts have been assessed as part of this specialist study (Figure 1):

- *Preferred layout*: It is proposed to place turbines in three groupings, one to the east along the coastline (Anloga), a central grouping adjacent to the Srogbe road and a western grouping inland of Anyanui.

- *Alternative layout*: For this alternative layout, turbines would only be placed at two locations, one group of turbines at the eastern Anloga site and one at the central site (Srogbe). This alternative will result in fewer turbines at the eastern (Anloga) site and additional turbines at the central site.

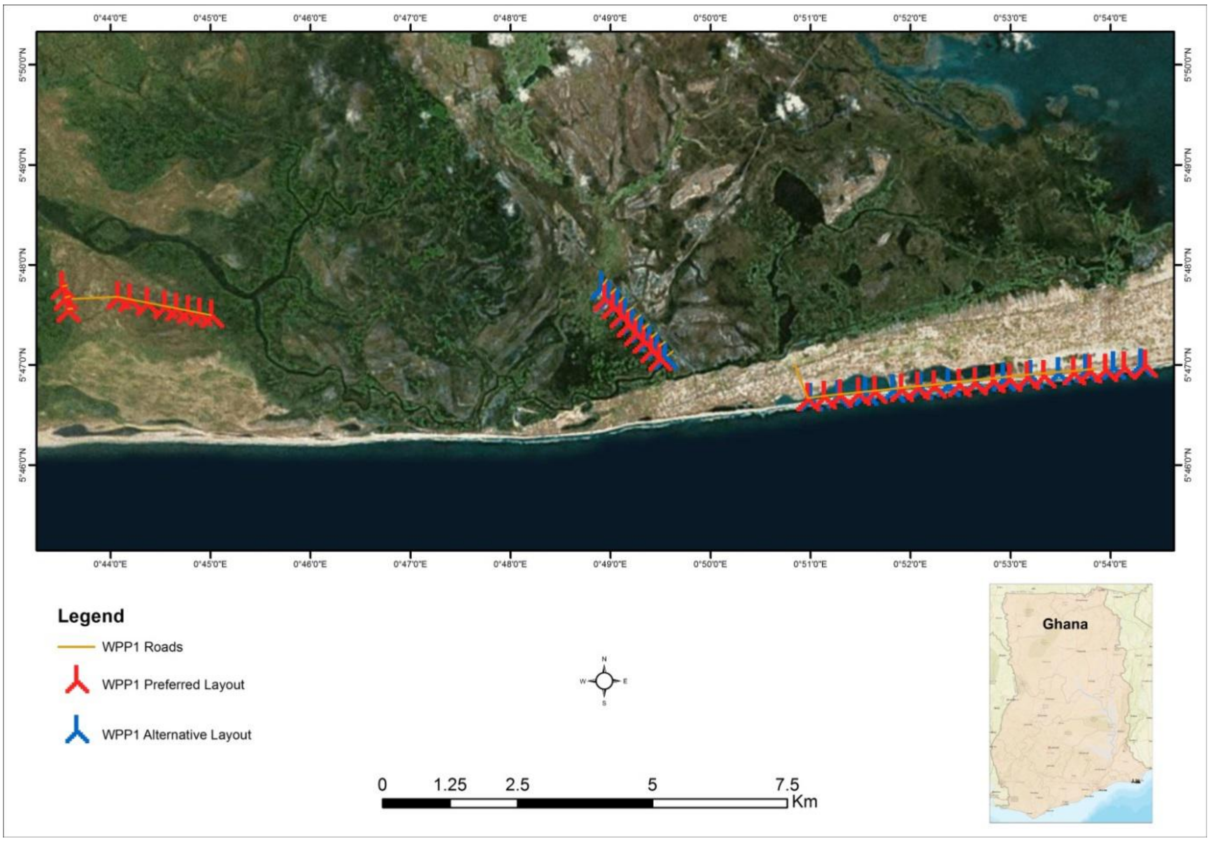

Figure 1: Location of the site for WPP1 with preferred and alternative layouts

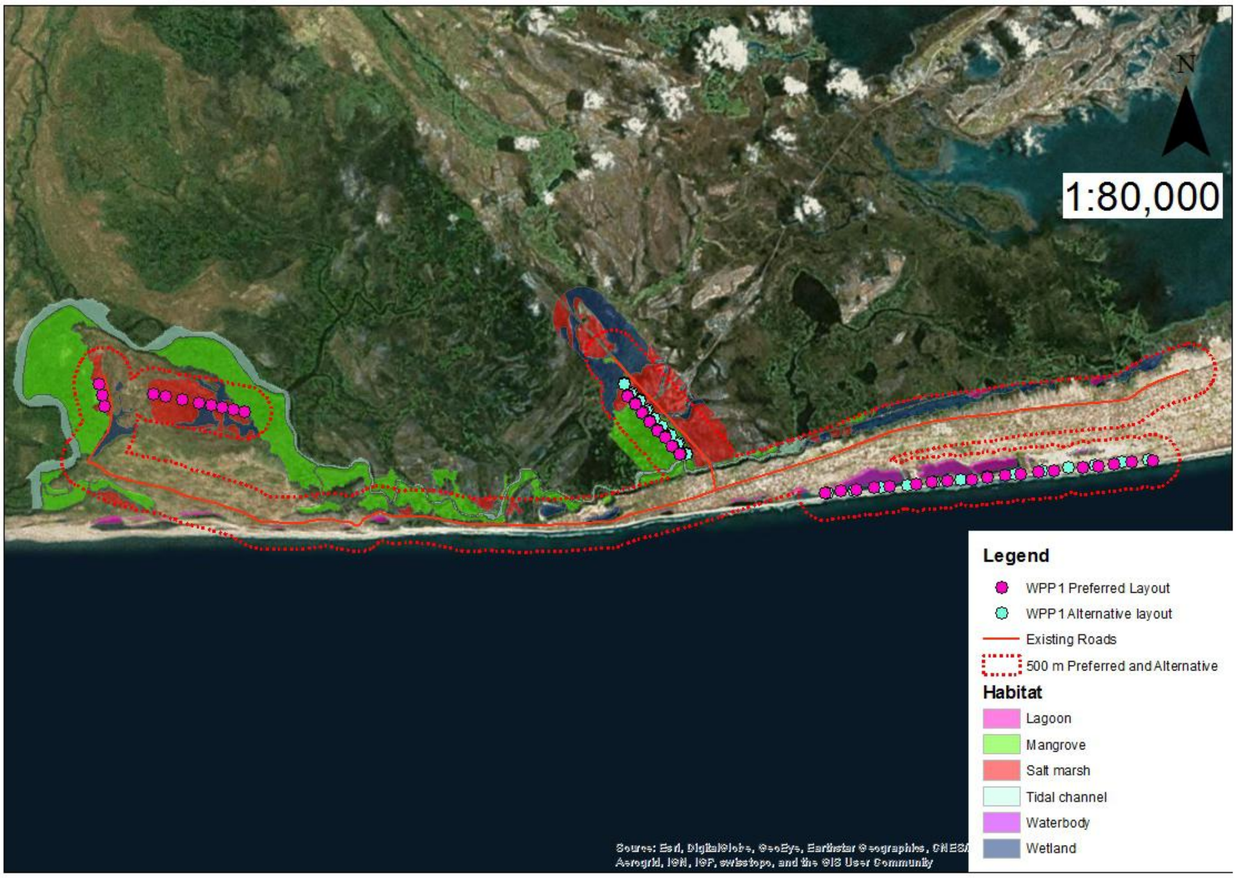

Figure 2: The proposed positioning of the turbine clusters for Preferred Layout and Alternative layout.

4. APPLICABLE LEGISLATION AND PERMIT REQUIREMENTS

The Project is required to comply with the relevant Ghanaian laws and regulations, and International Conventions to which Ghana is a signatory (as well as the relevant international standards including Performance Standards) for Environmental and Social Sustainability**.** The relevant laws and regulations applicable to the assessment of impacts of wind energy production on aquatic ecology (including wetland) are discussed below:

4.1 NATIONAL

Environmental regulation within Ghana falls under the requirement of the EPA Act 1994, Act 490. The Act 490 mandates the EPA with the responsibility for environmental and compliance for development activities. Supporting legislation includes the Ghana EIA Procedures 1995 and the Environmental Assessment Regulations 1999 (L.I 1652), which are consistent with Section 28 of the EPA Act 490 and ensures impact assessment for all projects/developments likely to affect the environment.

Other applicable legislations to the current project include:

- Wild Animal Preservation Act, 1961 (Act 43), passed to protect wildlife by conserving representative samples of Ghana's ecosystems.
- Wildlife Conservation Regulation, 1971 (LI 685) that provides a system of permits and certificates for regulating international trade in line with CITES regulations. It is the main instrument under which endangered species are legally protected through trade;
- Wildlife Reserves Regulations 1971 (LI 710) empowers the government to establish wildlife Protected Areas, including Ramsar Sites (and Marine Protected Areas) and also defines permissible and non-permissible activities within the Protected Area.

Fisheries, Wetlands, Coastal and Marine laws and regulations

- Fisheries Act, 2002 (Act 625) that provides for the regulation and management of fisheries, the development of the fishing industry, and the sustainable exploitation of fishery resources;
- Wetland Management (Ramsar Site) Regulations 1999 (LI 1659) regulates management of Ramsar Sites also defines wetland areas of environmental sensitivity and permissible and non-permissible activities within designated Ramsar site or wetlands of International Importance;
- Rivers Ordinance, 1903 (Cap 226);
- The Act establishing the Water Resources Commission, among others, deals with pollution of water;
- There are numerous laws and regulations covering protection of coastal and marine resources: Maritime Zones Law, 1986; Town and Country Planning Ordinance; the Towns Ordinance; National Building Regulations, 1996; Local Government Act, 1999; and Oil in Navigable Water Act, 1964.

Land

- Land Planning and Soil Conservation Act, 1957;
- Town and Country Planning Ordinance 1945 (Cap 84);
- National Land Policy, 1999 aims to protect a variety of habitat types, and recognizes Forest reserves, National Parks and wildlife reserves and similar land categories including Ramsar Sites as fully protected ecosystem for biodiversity conservation;
- Beaches Obstruction Ordinance, 1897 (Cap 240);
- Land Planning and Soil Conservation (Amendment) Act, 1957 (No. 35 of 1957)
- Volta River Development Act, 1961

Local Government Law

- Local Government Act, Act 462 gives local authorities (Metropolitan, Municipal and District Assemblies (MMDAs)) the responsibility for overall development of their areas of jurisdiction, including improvement and management of human settlements, management of solid waste, and other environmental issues.

- *The Metropolitan, Municipal and District Assemblies (MMDAs):* The development planning and administration of the MMDAs is fashioned by the Decentralization Policy and Local Government Act 462 (1993), introduced in 1988. The Policy mandates the Assemblies to enact byelaws that ensure good sanitation and to abate all nuisances within their jurisdiction. It also seeks to involve local communities in the political, social and economic administration of their districts within the broad framework of the national economic, social and political objectives. The assemblies work through committees and subcommittees, and in all cases has Environmental Management Committees (EMC) which handles issues related to the environment, including wetlands.
- Traditional management practices: a strong traditional base for protection of natural resources through indigenous management systems exists in Ghana. Most wetlands and their resources, for example, are protected and regulated through varied traditional practices, which involve customary laws or taboos. Though these rules and regulations are steeped in traditional beliefs, their main effect is to control resource use, which is generally observed by local populations. The administration of these traditional practices is not legally integrated with the district administrative structure though they provide viable and dependable structure through which development programmes are initiated and implemented. Chiefs and their elders perform executive, legislative and judicial functions at the village or community level.

The existing coastal Ramsar Sites are generally not government acquired. Access to land within the Ramsar Sites partly remains under the control of the traditional authorities in most local communities and generally has to be consulted (Danso, 1998).

A number of Environmental related Policies exist in Ghana. These include:

- o The National Environment Policy, 2012
- o National Wetlands Conservation Strategy, 1999 and its 2007 revised version, National Wetlands Conservation and Action Plan (2007-2016) comprise 12

programme areas, covering conservation and sustainable use of wetland resources;

- National Land Policy, 1999, recognises wetlands as environmental conservation areas and precludes practices such as: physical draining of wetland water; draining of streams and water courses feeding the wetlands and human settlements and their related infrastructural developments in wetlands. The policy, however, seeks to promote the use of wetlands for farming, grazing, fishing, timber production and salt-winning, provided that such uses serve to conserve the ecosystem, biodiversity and sustainable productivity of wetlands.

Other relevant policies are:

- Forest and Wildlife Policy, 2012
- Tourism Development Policy, 2006
- National Health Policy, 2007
- Energy Policy, 2010

The policies on marine and coastal protection, management and development are pivoted on the following three major areas:

- Integrated coastal zone management and sustainable development ;
- Marine environmental protection, both from land-based activities and from sea-based activities; and
- Sustainable use and conservation of marine living resources (both of the high seas and under national jurisdiction).

Important steps have been pursued towards the realization of prudent management of the marine and coastal environment. These include:

- Coastal Zone Management Indicative Plan, 1990
- National Environmental Action Plan, 1994
- Draft Integrated Coastal Zone Plan, 1998
- Coastal Zone Profile of Ghana, 1998

- National Oil Spill Contingency Plan with specific reference to the marine environment, 2002
- Environmental sensitivity map of the coastal areas of Ghana, 1999 and 2004

4.2 INTERNATIONAL TREATIES AND CONVENTIONS

Ghana has ratified or acceded to a large number of environmental and social international treaties and conventions. Those which may be relevant to the project are listed in Table 1 below:

Table 1: Relevant treaties and conventions

Treaties and Conventions	Year Ratified
African Convention on the Conservation of Nature and Natural Resources	1968
Convention on Biological Diversity	1992
The Convention on Wetlands of International Importance Especially Waterfowl Habitat (RAMSAR Convention)	1971
The Convention Concerning the Protection of World Cultural and Natural Heritage	1972
The Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matters, London	1972
The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Washington	1973
International Covenant on Economic, Social and Cultural Rights	2000
International Convention for the Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region - the Abidjan Convention	1981
United Nations Framework Convention on Climate Change	1996
United Nations Convention to Combat Desertification	1997
Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA)	2004

5. METHODS OF ASSESSMENT

5.1 MAPPING OF SENSITIVE AREAS

The identification of sensitive wetland and aquatic habitats was done using aerial photography and where possible on site verification during the site visit. ESRI online resources and Google Earth were used as aerial photography sources.

The identified habitats were classified as:

- Freshwater – wetlands (floodplain wetlands), water body (open water)
- Estuarine – mangroves, estuarine/tidal channels, salt marsh/salt flat, lagoon

The extent of these habitats was determined within a 500 m radius of the proposed wind turbines and associated infrastructure and road network (including larger arterial roads that may require upgrading).

5.2 PRESENT ECOLOGICAL STATE AND ECOLOGICAL IMPORTANCE AND SENSITIVITY

5.2.1 Estuarine ecosystems

The method used to determine the present ecological state (PES) of the estuarine systems is described by Taljaard *et al.* (1999).

This assessment method requires at least desktop data consisting of the following:

- Hydrology and estuarine physical dynamics
- Estuarine water quality
- Flora
- Fauna

Typically, the functional zone is defined as the area of tidal influence, generally up to 5m amsl. A description of the reference state of the system is required and is based on available information.

For the PES assessment the following criteria were scored from 0 to 5 in terms of change (0 critically modified, 5 natural) and the scores then assigned a confidence value based on the nature of the available information:

- Percentage of MAR currently abstracted
- Changes in seasonal river inflow patterns
- Changes in mouth condition
- Changes in water quality
- Changes in natural instream habitat
- Changes in riparian habitat
- Plants, including microalgae and macrophytes
- Benthic invertebrates
- Fish
- Birds

The Ecological Importance and Sensitivity (EIS) was then estimated using four criteria, which were scored from 1 to 5. The four criteria include:

- Rare/endangered/limited populations
- Habitat diversity (richness)
- Rarity of an estuary or unique estuarine features
- Input to the sea

Using the present ecological state score, an ecological management class (EMC) was assigned to the estuarine system within the study area (refer to Table 2).

Table 2: Ecological Management Classes based on the PES score

MEAN PRESENT ECOLOGICAL STATE SCORE	RECOMMENDED EMC CLASS	DESCRIPTION
> 4	A	Unmodified, natural – the natural abiotic template should not be modified. The characteristics of the resource should be completely determined by unmodified natural disturbance regimes. There should be no human induced risks to the abiotic and biotic maintenance of the resource.
> 3 and <= 4	B	Largely natural with few modifications – only a small risk of modifying the natural abiotic template and exceeding the resource base should be allowed. The risk to the well-being and survival of intolerant biota (depending on the nature of the disturbance) may be slightly higher than expected under natural conditions.
> 2 and <= 3	C	Moderately modified – a moderate risk of modifying the natural abiotic template may be allowed. Risks to the well-being and survival of intolerant biota (depending on the nature of the disturbance) may generally be increased with some reduction of resilience and adaptability at a small number of localities.
> 1 and <= 2	D	Largely modified – a large risk of modifying the abiotic template and exceeding the resource base may be allowed. Risks to the well-being and survival of intolerant biota (depending on the nature of the disturbance) may generally be allowed to increase substantially with resulting low abundance and frequency of occurrence.
<= 1	Not acceptable, should be upgraded to at least a Class D	

5.2.2 Wetland ecosystems

The method for determining the Present Ecological State (PES) of the wetlands is described by Duthie (1999a). This method was applicable to the current study as the method utilised available information and aerial photography with site verification rather than the collection of primary data as more detailed methods require. The method consists of 4 steps:

1) Literature review

2) Aerial photographic assessment

3) Site visit and use of local knowledge

4) Assessment of criteria and generation of preliminary PES scores.

The criteria used for the PES assessment include the following:

1) Hydrology

2) Water Quality

3) Geomorphology and

4) Biota

The criteria and attributes were scored between 0 and 5 and the confidence levels are scored between 1 and 4. A PES category is assigned based on the average score (Table 3).

Table 3: Interpretation of scores for determining present ecological status

Interpretation of Mean of Scores for all Attributes: Rating of Present Ecological Status Category (PES Category)
WITHIN GENERALLY ACCEPTABLE RANGE
CATEGORY A >4; Unmodified, or approximates natural condition.
CATEGORY B >3 and<=4; Largely natural with few modifications, but with some loss of natural habitats.
CATEGORY C >2 and <=3; moderately modified, but with some loss of natural habitats.
CATEGORY D =2; Largely modified. A large loss of natural habitats and basic ecosystem functions has occurred.
OUTSIDE GENERAL ACCEPTABLE RANGE
CATEGORY E >0 and <2; Seriously modified. The losses of natural habitats and basic ecosystem functions are extensive.
CATEGORY F 0; Critically modified. Modifications have reached a critical level and the system has been modified completely with and almost complete loss of natural habitat.

The "Ecological importance" of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. The "*Ecological sensitivity*" refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Duthie 1999b). In order to obtain an indication of the EIS of a wetland system, a number of determinants are rated on a scale of 0 to 4 (Duthie 1999b). The determinants are split into two categories – *primary determinants* and *modifying determinants.* The determinant scores are summed and the median calculated. The median is indicative of a predetermined EIS category (Table 4). Based on the median, an ecological management class (EMC) was then assigned for the wetland system.

Table 4: Ecological importance and sensitivity categories. Interpretation of median scores for biotic and habitat determinants.

Ecological Importance and Sensitivity Category (EIS)	Range of Median	Recommended Ecological Management Class
Very high Floodplains that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these floodplains is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4	A
High Floodplains that are considered to be ecologically important and sensitive. The biodiversity of these floodplains may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3	B
Moderate Floodplains that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2	C
Low/marginal Floodplains that are not ecologically important and sensitive at any scale. The biodiversity of these floodplains is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1	D

5.3 WETLAND FUNCTIONALITY

Utilization was made of the Wet-EcoServices tool (Kotze et. al. 2007) to determine the functionality of the delineated wetlands. This usually involves the identification of the various hydrogeomorphic (HGM) units, followed by an assessment of each unit according to the scoring criteria provided. In this instance, given the extent and complexity of the floodplain wetlands within the study area, the identified wetlands were treated as one hydrogeomorphic unit – essentially a large floodplain wetland associated with the Volta River.

A Level 2 assessment of their respective "Ecoservices" was undertaken. In total 15 eco-services (e.g. nutrient removal, phosphate removal etc.) which they provide were evaluated and an eco-services score was calculated for each service. This score indicates the level of benefit (service) offered by the HGM units and is ultimately an indication of the HGM units functional status. During the scoring process, criteria associated with each ecoservice were scored from 0 – 4 (0 = low, 4 = high)

Criteria are split into two sections; "*effectiveness*" and "*opportunity*". The average value of criterion for each section provides a score of *effectiveness* and *opportunity*. The average of the *effectiveness* and *opportunity* scores provide an *overall score* for the specific ecoservice rendered. The overall score was then assigned to a class. Table 5 below provides the classes for determining the extent to which a "functional benefit" is provided based on the overall scores

Table 5: Classes for determining the possible extent to which a benefit is being supplied. The score represents the overall score for each benefit, e.g. flood attenuation (Kotze *et. al*. 2007).

Score:	**<0.5**	**0.5-1.2**	**1.3-2.0**	**2.1-2.8**	**>2.8**
Rating of the likely extent to which a benefit is being supplied	Low	Moderately Low	Intermediate	Moderately High	High

This method aligns with the wetland functions provided by the National Wetlands Conservation Strategy (1999) for wetlands in Ghana.

5.4 ASSUMPTIONS AND GAPS

Given the scope of the project the opportunity for primary data collection was limited.

The data, literature and assumptions used to prepare this report were primarily sourced or derived from documents or information provided by others and are duly acknowledged or referenced. The source of data or information was not independently verified. The specialist, therefore, does not assume responsibility for their accuracy or fullness in completion of fact or ideas.

It has been assumed that the final layout of the WEF will take cognizance of this and the other specialist studies, with particular reference to the internal services such as road, underground cabling and storm water management. It is therefore assumed that the developer will apply best practice principles during the final design phase, recognizing the recommendations in this report.

In order to obtain a comprehensive understanding of the dynamics of the aquatic environment within a study site, as well as the status of endemic, rare or threatened species in any area, assessments should always consider investigations at different time scales (across seasons/years) and through replication. However, due to time constraints these long-term studies are not feasible and are mostly based on instantaneous sampling.

It should be further emphasised that information, as presented in this document, only has reference to the study area as indicated in the accompanying maps. Therefore, this information cannot be applied to any other area without detailed investigation.

6. DESCRIPTION OF THE AFFECTED ENVIRONMENT

The project is located approximately 168 km east of Accra (see Figure 1). Specifically, the location of the project facilities is close to the settlements of Anloga-Srogbe-Anyanui all situated east of the Volta River within the Keta Municipal Assembly of the Volta Region. The proposed project lies within the Keta Lagoon Complex Ramsar Site, along a coastal stretch of ***very high environmental sensitivity*** on the south-eastern coast of Ghana (EPA, 2004, Figure 3). The sensitivity ranking is attributed to, among others, the presence of certain natural features including open lagoons/estuarine, or as fertile breeding/nesting grounds for fisheries or marine turtles or the presence of mangroves.

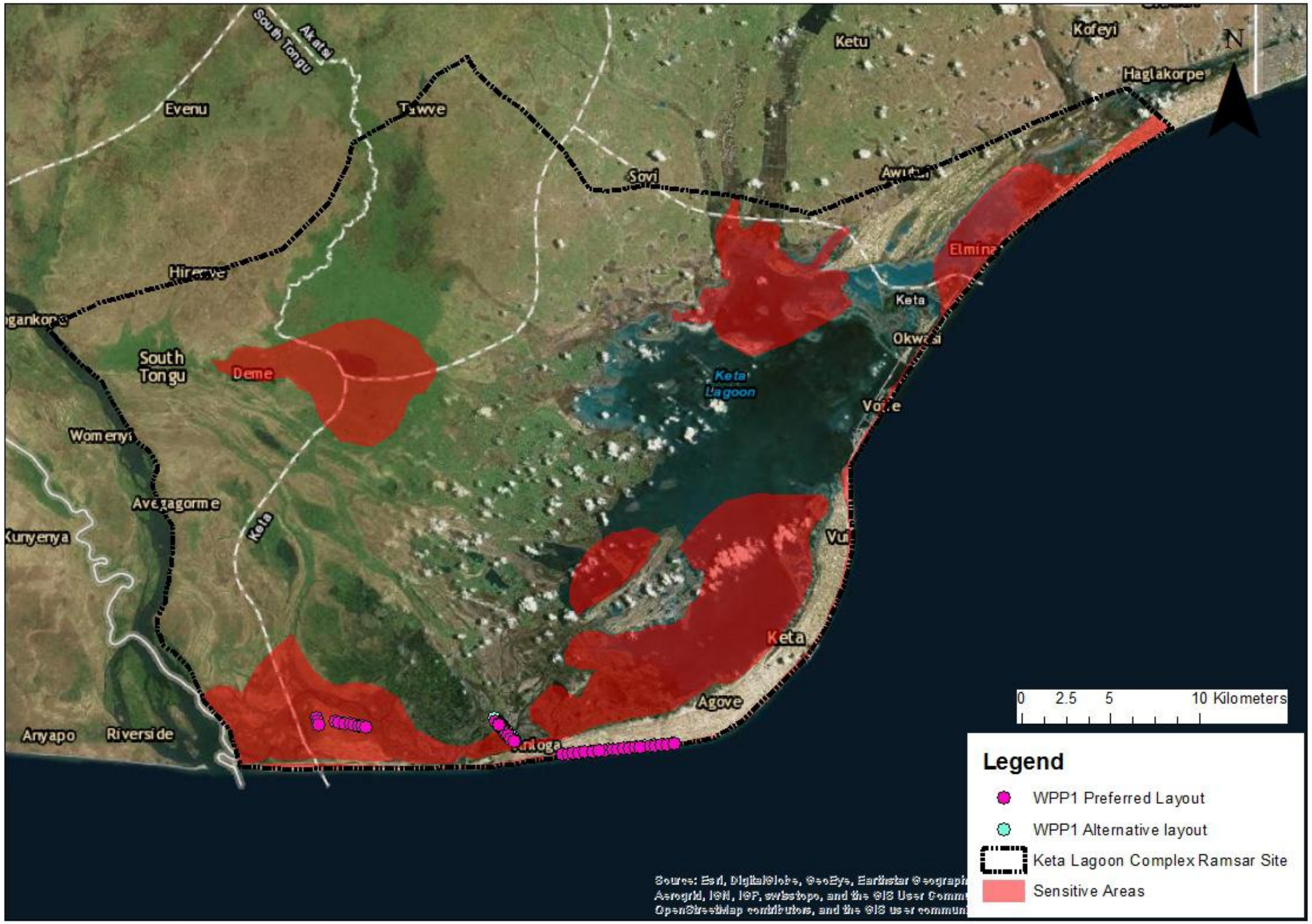

Figure 3: The extent of the Keta Lagoon Complex Ramsar Site and sensitive areas.

Preliminary consultation with the manager of the Keta Lagoon Complex Ramsar Site and the review of the management plan (*Keta Lagoon Ramsar Site*, 1999) revealed that the site was zoned into core, buffer and transitional zones based on perceived environmental sensitivity measure for management purposes.

The zonation map for the Keta Lagoon Complex Ramsar Site is not available to depict the reference location of the project facilities to the zones. However, the exact locations of the project at Anloga-Srogbe-Anyanui area are said to be within a buffer zone, which may require a more detailed impact assessment than the transition zone (Site Manager, *personal Comm.*).

6.1 PHYSICAL FEATURES

6.1.1 Climate

The climate of Ghana is tropical, warm and comparatively dry along the southeast coast; hot and humid in the southwest of Ghana and hot and dry in the north, with temperatures varying with season and elevation. The majority of the country's average rainfall falls 1 000 – 1 250 mm between the years 1981-2010 (Figure 4). The weather in Ghana is controlled by the position and intensity of the Azores anticyclone (high pressure centre) in the North Atlantic and the St Helena anticyclone in the South Atlantic. Rainfall throughout Ghana is determined by two prevailing air masses: the hot and dry Tropical Continental Air Mass (NE trade winds) and the warm and humid Tropical Maritime Air Mass (SW trade winds).

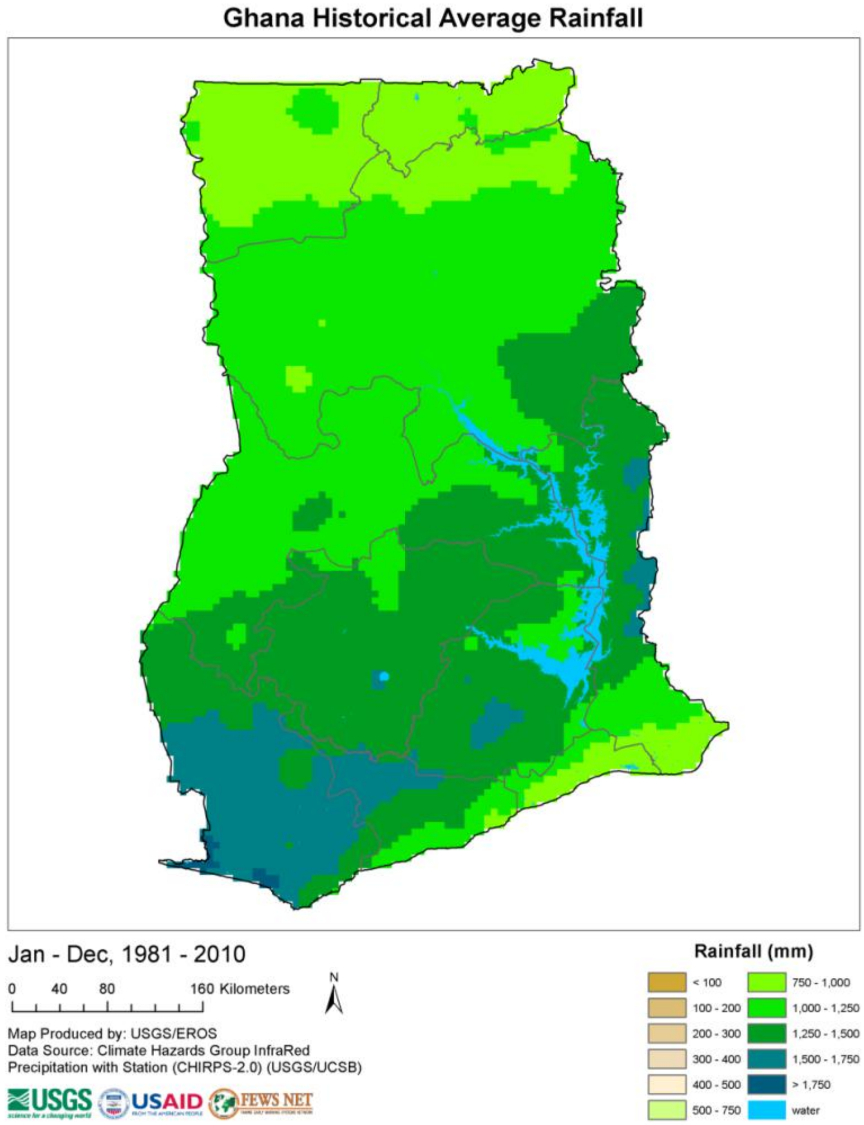

Figure 4: Mean Annual Rainfall Levels of Ghana
(*Source*: Climate Hazards Group InfraRed, 2017)

The mean annual temperature in Ghana ranges from 25.9 °C to 29.7 °C due to the low latitude of Ghana (Figure 5). The average daily temperature of Tema, which is approximately 127km from Anloga, is 27.7°C. The coolest time of the year is between June and September when the main rainfall occurs. Variations in temperature both annually and daily are quite small. In most areas the highest temperatures occur in March, the lowest in August.

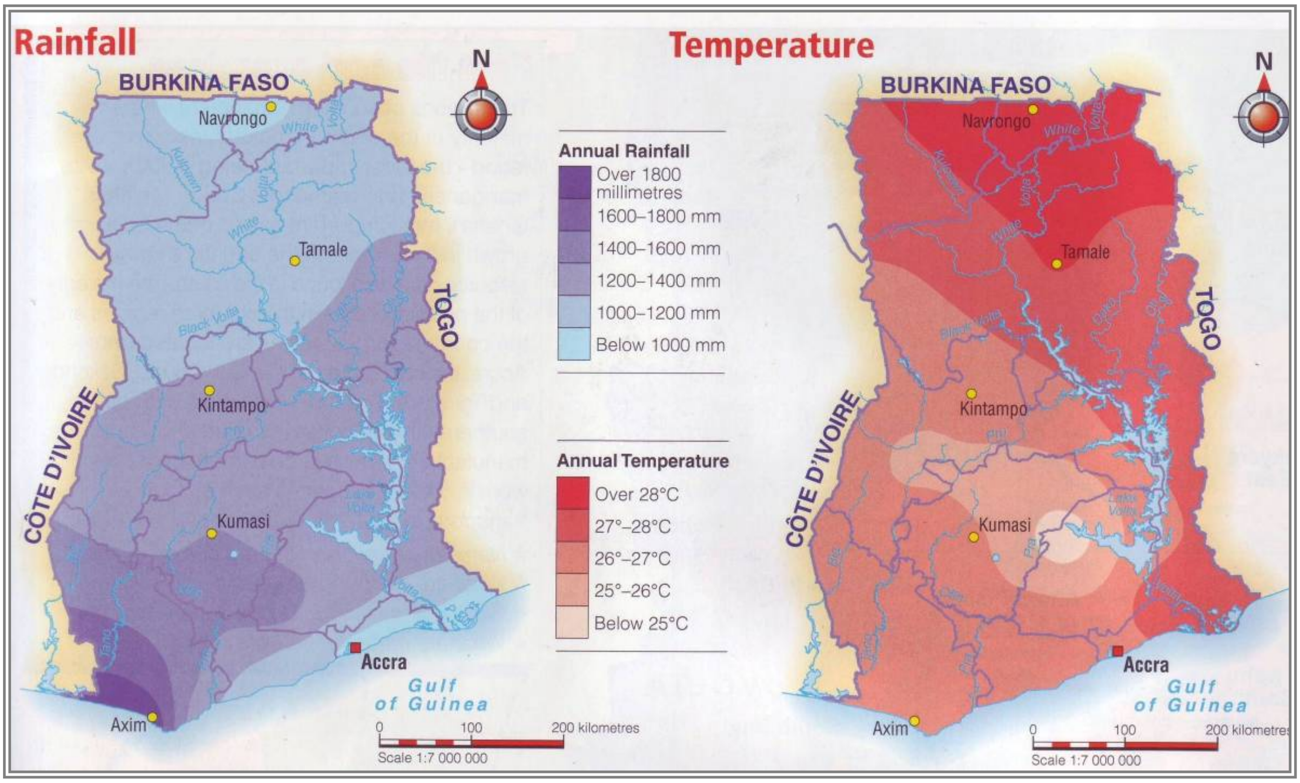

Figure 5: Average annual rainfall and temperatures in Ghana (MacMillan, 2007)

A noteworthy climatic phenomenon in Ghana is the harmattan winds which blow in from the northeast from December to March, bringing dust from the Sahara and reducing visibility to as little as 1 km (0.6 miles). This dry desert wind lowers the humidity and creates hot days and cool nights in the north. In the south, the effects of this wind are felt in January.

The proposed project sites lie within the dry equatorial climatic region of Ghana, which covers the entire south eastern coastal belt of the country. Temperatures are high throughout the year and range between 23°C and 33°C. August is normally the coldest month in the area. Rainfall is heavy during the major rainy season between March and September. The average rainfall is 750 mm per annum. Relative humidity ranges from 60% in the dry season to 80% in the rainy season. Evaporation ranges from 5.4 mm to 6.8 mm and is very high during the dry season (November -March). This is attributed to the proximity to the sea, the Volta River and other water bodies.

The prevailing wind direction is from the southwest all year round (the south-west monsoons). This is a characteristic feature for the entire coastal belt of the country (Tumbulto, 1997).

6.1.2 Hydrology, surface waters and flooding

Ghana lies along the Gulf of Guinea (3^0 5´ W and $1^0$10´ E and 4^0 35´N and 11^0 N) and has an area of about 239,000 km^2 and a 550 km coastline with about 90 lagoons and associated wetlands. Some of the lagoons are closed and others open to the sea (Mensah, 1979).

The coastal zone covers about 6.5% of the total area (Figure 6) and houses about 25% of the national population as well as 60% of the nation's industries.

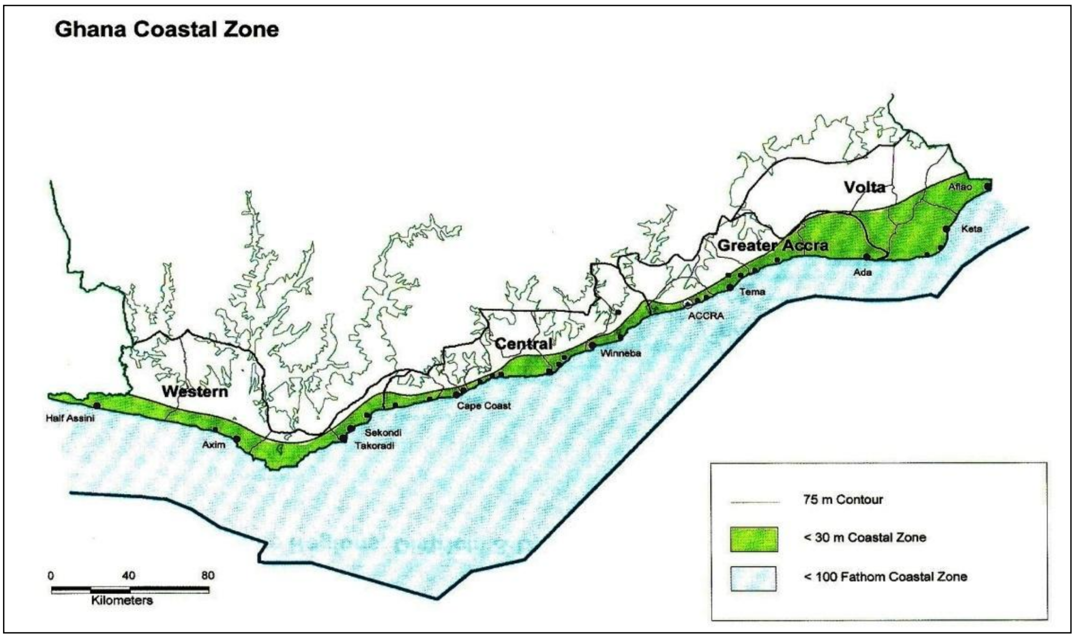

Figure 6: Map of Southern Ghana showing the coastal zones

The coastline has three geomorphic units. The West Coast (≈95 km), extends from the Ghana's-Côte d'Ivoire border to the Ankobra River estuary where there are gently sloping sandy beaches; the Central Coast (≈321 km) from the Ankobra estuary to Tema with rocky headlands and sandbars or spits enclosing coastal lagoons and the East Coast (≈149 km), stretching from Tema to the Ghana-Togo border where the shoreline is sandy and characterized by considerable coastal erosion (Ly, 1980).

The main watercourse along the East Coast is the Volta River, which discharges into the sea through an estuary at Ada-Foah, with extensive surrounding wetland floodplains and mangrove swamps on either side of its lower reaches (Figure 7). The Songor and the Keta Ramsar sites form part of the Volta River estuary within the project area of influence along the eastern coastline. The effective catchment area of the lower Volta estuary is estimated to be over 1,520 km^2 (estimated from total area of Songor and Keta Ramsar Sites). Notable on the eastern side is the Keta lagoon that receives inflow from the Todzie River through the neighboring Avu lagoon via several small tributaries. Others are the Aka and Belikpa streams which enter the Keta lagoon directly from the north.

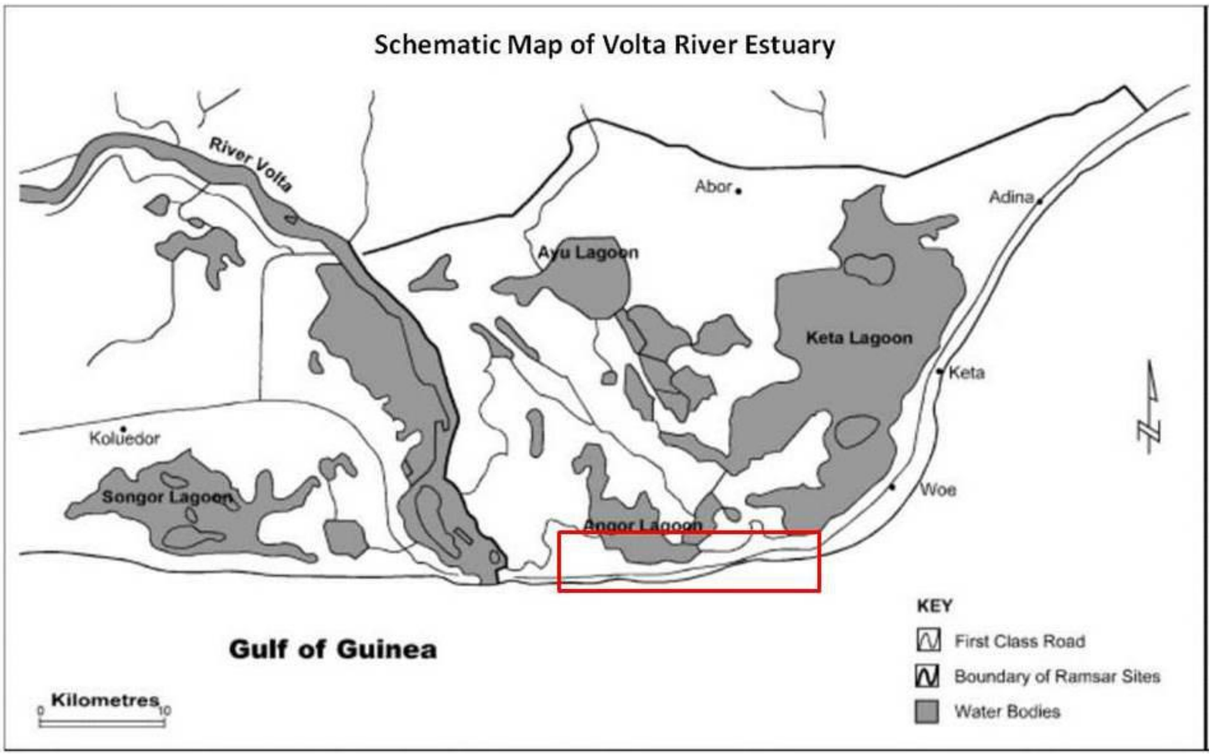

Figure 7: Schematic Map of the Volta River Estuary showing the Songor and Keta lagoon. The approximate position and extent of WPP 1 is indicated by the red frame.

The regulated flow in the Volta delta began when Akosombo and Kpong hydro-power plants were commissioned in 1965 and 1984, respectively. The reservoir has reduced downstream flow patterns and effectively eliminated the dynamic interactions between the river and its floodplains, wetlands, deltas, estuaries, mangrove and beach environments. The resulting change in fauna and flora encouraged the growth of disease vectors such as schistosomiasis carrying snails, and created changes in the flow regime between the interconnecting creeks and streams between the Lower Volta River and the Avu–Keta basin, including the Avu, Keta and Angaw lagoons.

Parts of the project core sites are considered to be vulnerable to flooding and as such, if the proposed facilities are built at current levels it is likely that they will be susceptible to inundation. If ground levels at the sites are raised to protect them from flooding this could however exacerbate flood risk in other low lying areas, potentially resulting in farmland or properties locally being flooded more frequently and or more severely than currently occurs.

In addition climate change related changes in sea level and or rainfall could further alter the flood regime locally. Essentially the Keta region is dynamic and susceptible to hydrological changes, whether natural or induced.

6.1.3 Geology and soils

The geological formations of the Ghana coastal areas are said to be influenced by the processes of continental drift during the Cretaceous period of about 135 million years ago. The underlying basement formations consist of hard granites, granodiorites and metamorphosed lava and pyroclastics. Some coastal areas are covered by Ordovician and Devonian sandstone and shale.

The area consists of the Caenozoic (Quaternary-Recent and Tertiary-Eocene) formations that include unconsolidated sands and clays of lagoon, delta and littoral areas, partly consolidated red continental deposits of sandy clay and gravel. It consists of a thick section of marine sands, clay, shale, limestone, sandstone and some gravel which underlie more recent sediments in the coastal areas and dips towards the southeast. The recent deposits comprise unconsolidated sand, clay and gravels of river valleys especially along the lower Volta River, marine clays along the northern banks of the lagoons and marine sands along the coastal littoral stretch from Aflao to Anyanui (Junner & Bates 1945). Groundwater occurrence in this hydrogeological province is controlled by matrix flow. Borehole yields for standard size wells (125 mm diameter) reaching a mean depth of 52 m is generally in the range 0.7–27.5 m^3h^{-1} with a mean value of 2.7 m^3h^{-1}. Transmissivity values are generally low due to high clay content of the regolith. They vary from 0.23 m^2h^{-1} in the clayey regolith to 4.0 m^2h^{-1} in the fissured zones (WRRI, 1993). These ranges are often exceeded in the Keta basin.

The soils in the area are predominantly coastal savanna ochrosols. The organic matter content is generally low, with a pH of less than 5.5. Coastal savanna ochrosols are mainly red and brown, moderately well drained medium to light texture soils developed over Voltaian sandstone, granite, philites and schists. They are generally low in organic matter due to insufficient accumulation of biomass.

Other soil types are the Keta, Amo and Oyibi (normal) series found on the higher grounds in the immediate surroundings of the mangrove swamps. The Keta series are developed on the narrow coastal sand dunes which separate the sea from the lagoons; the Amos series are developed in Volta alluvium and the Oyibi (normal) series developed around the edges of the lagoons and are susceptible to periodic flooding by slightly to moderately saline water, i.e., brackish water.

The Volta River has a dominant influence on the geomorphology of this coast. The project locations are mostly sandy and characterized by the deltaic features of the Volta River. Fluvial sediments from the river, as well as, marine and fluvial-marine sediment make up the surface geology of the area. The beaches comprise medium to coarse sand and rise steeply (a slope of about 1:10) in elevation to about 2 m above Mean Sea Level (MSL).

6.1.4 Coastal erosion

Coastal erosion, flooding and shoreline retreat are serious problems along the coast of Ghana. Past human impacts, inappropriate management interventions, climate change and sea-level rise have been identified as major contributing factors (Armah, 1991). Several consequences could be expected from sea level rise in Ghana. In particular, low-lying sandy coastal areas at the eastern coast such as the Volta Delta and Keta lagoon could be profoundly affected. The expected impacts of sea-level rise are: direct inundation (or submergence) of low-lying wetland and dry land areas; erosion of soft shores by increasing offshore loss of sediment; increasing salinity of estuaries and aquifers; raised water tables; and exacerbated coastal flooding and storm damage (IPCC, 2007). These impacts have in turn influence on coastal habitats, bio-diversity and socio-economic activities.

6.1.5 Keta-Aflao Coastal Stretch

Generally, the shoreline south of the Volta Delta runs virtually straight from west to east. Following the damming of the Volta River erosion became critical averaging about 2 - 3 m/year due to the cutting off of substantial amounts of sediments that previously reached the littoral zone.

The coastal recession in the Keta area was estimated to have increased from 4 m/year before the construction of the dam on the Volta River in 1965 to 8 m/year after the dam construction (Ly, 1980). Episodes of shore erosion over the last several decades have caused losses of about 70% of the original residences and buildings in the towns and the coastal road between Keta and Havedzi. The only shorelines of the East Coast that are stable are the shores from Aflao to Blekusu and from Dzelukope to Anloga.

Coastal defence works aimed at protecting the Keta area from further erosion as well as flooding from the Keta lagoon were completed in early 2004. This has effectively stopped the erosion at Keta and reclaimed land for rehabilitation.

6.2 BIOLOGICAL FEATURES

6.2.1 Overview

The coastal savanna zone covers approximately 12,000 km², some 5% of the land area. This zone runs westward from the Togo border, includes the delta of the Volta river, and narrows in width until it is replaced by forest zones in the Sekondi–Takoradi area, just east of Ghana’s southernmost extremity, Cape Three Points (Figure 8). The vegetation consists of grasses and shrubs. Some mangrove stands occur in the south-east, around the Volta lagoons, and also in the west around the Amanzuri wetlands. Most of the mangrove forests in the east are degraded as a result of heavy exploitation.

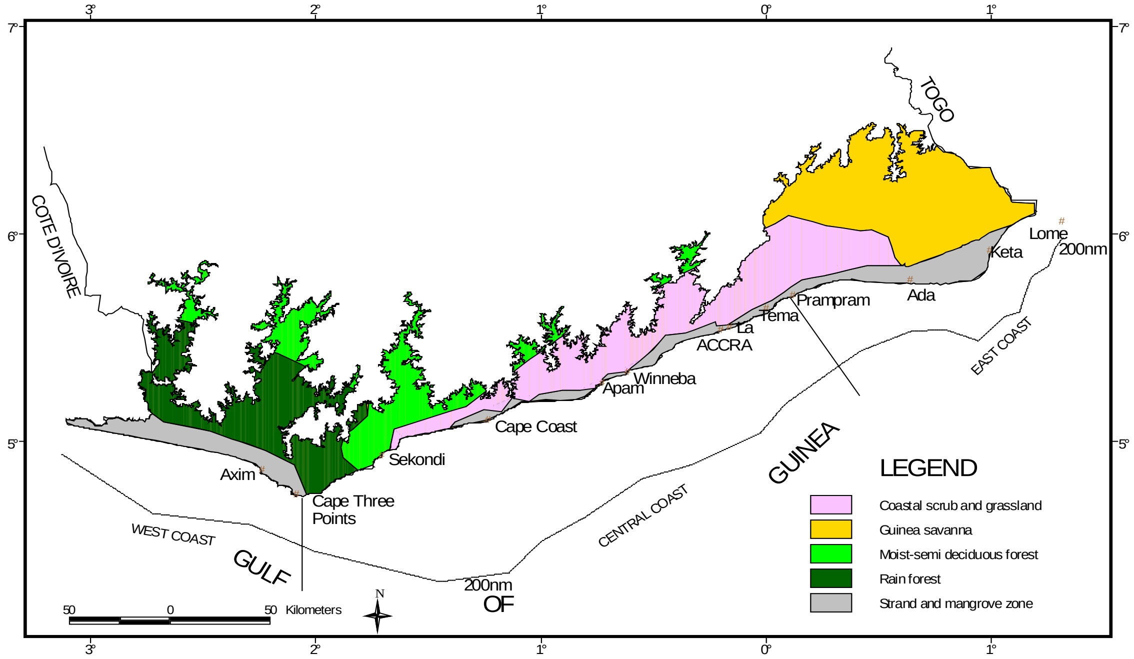

Figure 8: Vegetation of the Coastal Zone of Ghana

Ten wetland types based on the classification of the Ramsar Convention on Wetlands (Ramsar, Iran, 1971) occur in the coastal zone of Ghana (Gordon *et. al.*, 1998). The south eastern coastal area which comprises the study area, has wetland habitats including swamps, sandy beaches, lagoons, estuaries and mangroves. The wetland areas have a relatively low diversity of plant and animal species. The area has been modified by different anthropogenic activities such as settlement and farming, but small areas of primary vegetation may be intact.

6.2.2 Floral Diversity

The coastline vegetation is characterized by salt tolerant grasses like *Paspalum vaginatum*, *Sporobolus robustus*, the rhizomatous sedge *Cyperus articulatus* and the succulent forb *Sesuvium portulacastrum.* Madreporarian corals are found nearer to the shore of lagoons. Further landwards on floodable higher ground are grasses such as *Brachiaria distachyoides, Imperata cylindrica*, *Panicum repens*, tall grasses such as *Andropogon gayanus*, and *Vetiveria fulvibarbis.* Other vegetation includes the herbs *Cassia mimosoides and Croton lobatus*, and sedge *Fimbristylis pilosa.*

The terrestrial vegetation of the area is largely degraded and the terrain is characterised by farms, secondary growth on abandoned farms, and eroded lands invaded by Neem *Azadirachta indica*, and isolated trees like Fan Palm *Borassus aethiopum*, Mango *Magnifera indica*, Silk cotton Tree *Ceiba pentandra* and Baobab *Adansonia digitata*.

A hydro-biological survey of the Keta lagoon by Finlayson, *et. al*. (2000), informed a preliminary definition of the floral baseline of the site. A list of aquatic and wetland plants found in the Keta lagoon, in the swamps that occur between the lagoons and the Volta River, and in the Angor channel connecting Keta to the Volta River, is given in Appendix 2. The list is certainly not comprehensive as it is confined to the plants found at particular survey sites in a particular season. However, given the length of the list – 136 species in total, with 109 in Keta and surrounding swamps and 27 in the Angor channel – it is highly probable that this represents a major component of the macrophytic flora of the area.

The most dominant species were the large emergent species *Typha domingensis, Scirpus littoralis* and the rampant grass *Paspalum vaginatum.* These species were most common in the freshwater zones around both lagoons and towards the Volta River. At some sites they occurred together or in close proximity, whereas at others there was a definite monodominance. The relationship between these species and their preferred growth conditions is not known, but it is assumed that water depth and the extent of inundation would be influential. The drier and saline areas around the lagoons are characterised by a *Sesuvium portulacastrum* and *Sporobolus pyriamidalis* association. Whilst these species preferentially grow in the drier and more saline areas they also seem to be influenced by the extent of freshwater flooding, but again there is no evidence on which to base more specific comments.

The dry salt flats and shallow saline water bodies are dominated by *Sesuvium portulacastrum* and/or *Cyperus articularis* with some *Sporobolus pyramidalis* and *Paspalum vaginatum*. The deeper swamps adjacent to the wetlands contained extensive stands of *Paspalum vaginatum*, both in wet and dry conditions, and the tall *Typha domingensis* are generally found in wet areas or areas that prone to flooding.

The vegetation on the sand dunes or beach heads is subject to temperature extremes, high evaporation rates, sea sprays, windiness and unstable and unconsolidated substrates. Coconut (*Cocos nucifera*) plantations dominate the dunes whilst the ground cover is dominated by rhizomatous and straggling species including the sedges *Cyperus maritime* and *Remirea maritime*, the herbs, *Alternanthera maritima, Canavalia rosea,* and *Ipomoea pes-caprae*, and the grasses *Paspalum vaginatum, Sporobolus robustus* and *S. virginicus.* The creeping succulent forb *Sesuvium portulacastrum, Philoxerus vermicularis,* and xerophytes *Euphorbia glancophyll* and *Opuntia vulgaris* exist in the zone. Occasionally *Thespesia populnea* and the Indian almond *Terminalia catapa* may also occur (Boghey, 1957). The algae in the brackish habitats are rather poor and represented by ten species.

6.2.3 Mangroves

Mangroves along the coastline of Ghana are associated with coastal lagoons and estuaries. Their distribution is sparse and nature degraded through over-cutting and conversion to salt pans.

Good stands of mangroves are restricted to three main areas: the Amanzule wetlands in the Western Region, the Kakum River estuary west of Cape Coast (Central Region), and the Volta Delta. White mangrove *(Avicennia africana),* red mangroves *(Rhizophora racemosa)* and black mangroves *(Laguncularia racmosa)* are the dominant species. Typically *Rhizophora* and *Laguncularia* species are found on the seaward side of lagoons whilst *Avecinnia* is found on the landward side of the swamps (FAO/UNEP, 1981).

The *Avecinnia africana* and *Rhizophora racemosa* are common at the project sites. *Rhizophora racemosa* is not considered threatened by the IUCN Red List of Threatened Species and *Avicennia africana* has not been evaluated. The continual development of these species in the project areas is supported by the inundation of the mudflats of brackish water from the Volta River and the creeks.

Associated with the mangroves are swamp grasses and buttonwood *(Cornocarpus erectus).* Faunal composition includes the lagoon crab *(Cardiosoma amartum),* mudskipper *(Periophthalmus papilio)*, *Tilapia* species, weaver birds, pied king fisher and western reef egret. Mangroves also play an important role as nursery areas for many species of fish and crustaceans.

6.2.4 Faunal Diversity

The large numbers of coastal lagoons and marine ecosystem provide rich and diverse habitats for significant populations of water birds, turtles and mammals of conservation importance.

6.2.4.1 Birds

Ghana is on the boundary of two international migratory water bird flyways – the *East Atlantic Flyway* and the *Mediterranean Flyway* and receives diverse migratory bird species along the coast (Figure 9). Therefore, about 90% of the bird populations in the coastal regions of Ghana are migrant species, which makes the coast very important in terms of the global conservation effort.

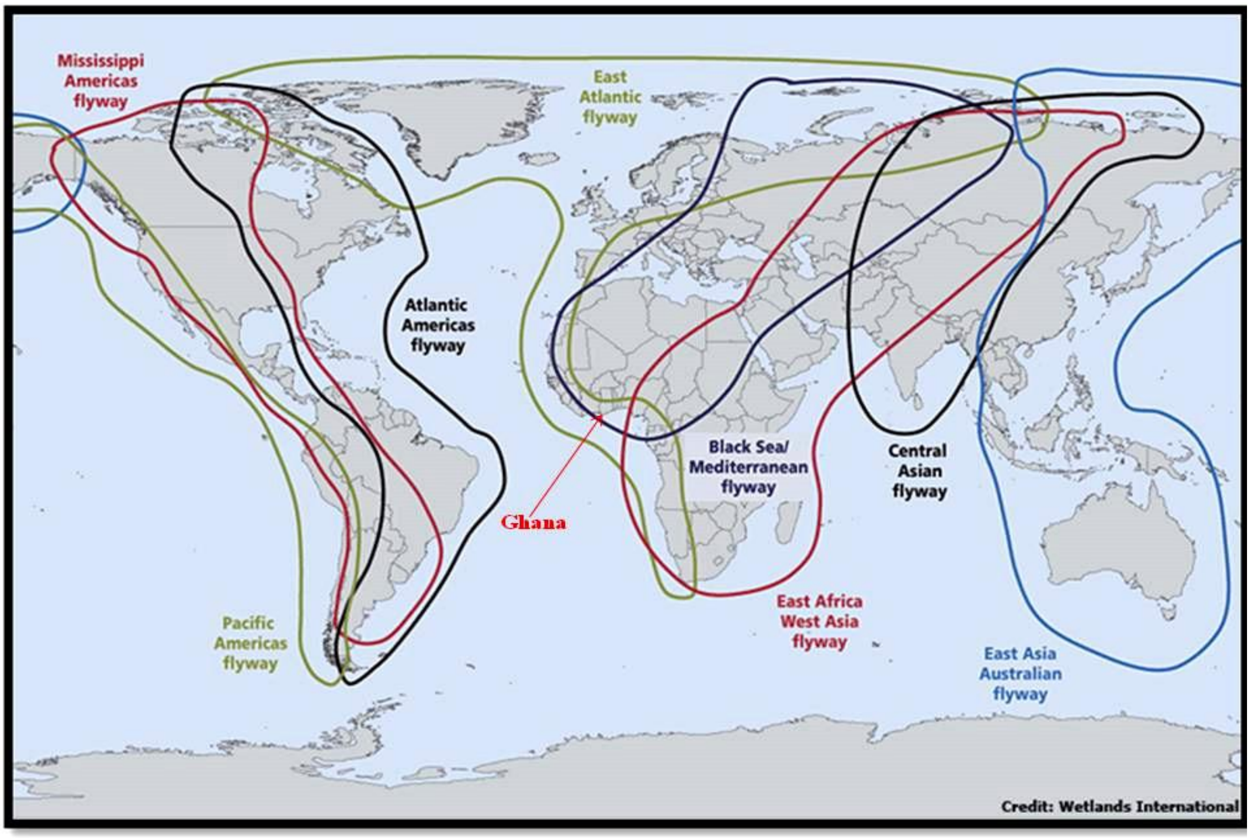

Figure 9: Map of the world showing the position of Ghana on the boundary of two international bird migratory routes (Birdlife International 2010)

Several coastal habitats are important for their biodiversity as well as for rare and endangered species. Sandy beaches, lagoons and floodplains on the coast provide feeding, roosting and nesting sites for a great number of birds, including mainly waterbirds such as waders, terns, herons/egrets etc.

Only five coastal protected areas currently exist within the country. These areas are all located onshore and are protected under the Ramsar convention (Ramsar, Iran, 1971) - the Muni-Pomadze, Densu Delta, Sakumo Lagoon, Songor Lagoon and the Keta Lagoon Complex Ramsar sites. The lagoon areas offer the highest avifaunal diversity. Species counts exceeding 40 have been recorded. They are the most important wetlands on the Ghanaian coast for waterbirds and are ranked fourth most important water bird sites on the Gulf of Guinea coast (Ntiamoa-Baidu *et. al*. 1998). The Songor Ramsar site is also recognised as a UNESCO biosphere reserve. Like all other coastal Ramsar Sites in Ghana, the Keta and Songor sites were identified and listed as *Wetlands of International Importance* based on their regular support of 1% of the individuals in a population of one species or subspecies of waterbird - Criterion 6 of *Criteria for Identifying Wetlands of International Importance* (Appendix: 1).

The Ghana coast continues to be important for some species of waterbirds of the East Atlantic population using the different coastal wetlands, including the five coastal Ramsar Sites as staging or wintering sites (Appendix 4). Table 6 below shows number of species and individual waterbirds observed on coastal Ramsar Sites in Ghana in January 2017.

Table 6: Number of species and individual waterbirds observed on coastal Ramsar Sites in Ghana, January 2017 count. (*Source*: Wildlife Division, 2017).

Ramsar Site	No. of waterbird species	No. of waterbird individuals
Densu Delta	31	13,233
Muni-Pomadze	25	1,998
Sakumo	25	614
Songor	28	4,098
Keta	37	29,762
Total	**51**	**54,885**

Peak counts of waterbirds in Ghana are observed between September and November. Therefore, the noticeably low numbers of waterbirds observed at these Ramsar sites during the January 2017 waterbirds count does not devalue the importance of these sites (Wildlife Division, 2017).

The avifauna of the estuaries consist of herbivorous feeding ducks that feed in the freshwater marshes, as well as visual and tactile surface foraging waders feeding on both dry and wet mudflats. Stalking herons can also be found in this habitat and these feed in the dry and wet mudflats and within the shallow waters. A list of common waterbird species and their abundance on coastal Ramsar Sites, including Keta Ramsar Site, as obtained in a single count in January 2017 can be found in Appendix 4.

6.2.4.2 Estuarine and freshwater fish and aquatic fauna

The fish fauna of a number of lagoons and estuaries have been documented. The dominant species in most lagoons belong to the Cichlidae, notably the black-chinned tilapia *Sarotherodon melanotheron* which makes up 80% to 99% of the fish biomass (Pauly, 1975, 1976; Koranteng *et al*., 1998, 2000).The remaining fish fauna are freshwater and marine species. Juveniles of marine fish are notably common in open (tidal) lagoons (Mensah, 1979, Pauly, 1975, 1976; Blay, 1998). Such systems serve as a vital nursery, providing food and sanctuary for juvenile fish. A number of marine fish species rely on functioning estuaries and lagoons for successful recruitment.

The wetlands of Volta Delta area, by aggregate, constitute about 70% of the coverage area of all the coastal wetlands of Ghana with over 50 species of fish, crustaceans and mollusc.

6.2.4.3 Marine Reptiles and Mammals

6.2.4.3.1 Marine Turtles

In general, five species of sea turtles have been identified as commonly nesting in the Gulf of Guinea (Marquez, 1990). About 70% of the 550 km shoreline of Ghana presents suitable sites for nesting turtles. These are the Leatherback Turtle *(Oermochelys coriacea),* Green Turtle *(Chelonia mydas),* Hawksbill Turtle *(Eretmochelys imbricata),* Loggerhead Turtle *(Caretta caretta)* and Olive Ridley Turtle *(Lepidochelys olivacea).* Leatherback and Hawksbill turtles are classified globally as Critically Endangered, green turtles as Endangered and Olive Ridley turtles as Vulnerable in the IUCN Red List of Threatened Species.

All five of the above named species of sea turtle are thought to nest on beaches in Ghana. Sea turtles are afforded protection in Ghana under the Wildlife Conservation Regulations, 1971 (LI 685), which prohibits hunting, capture and destruction of animals.

Beach cliffs impede emerging turtles from accessing suitable nesting sites along the beaches. Cliffs of 1.68 m high resulting from erosion by sea waves along the beach have been recorded at the beaches of the project sites (Agyeman, 2008).

Olive Ridley turtles can normally climb cliffs between 40-50 cm and will move as far as 80-120 m above the higher tidal mark to nest. Leatherback and Green turtles can only climb very gentle slopes and do not move far from high water mark to nest. The Leatherback, Olive Ridely and the Green Turtle are most common in the beaches close the project site (Anloga), which they use for nesting generally between October and January.

6.2.4.3.2 Manatee

The West African manatee (*Trichechus senegalensis*) occurs in coastal marshlands as well as inland marshlands of Ghana. The mammal attracts much socio-cultural interest in Ghana. Communities living along the Avu lagoon do not use the manatee meat as food, but consider it as high priced meat which is processed for the markets in Accra. Some communities in the North Tongu District regard the West African manatee as deity and therefore perform rituals to pacify the gods when they are un-intentionally caught in fishermen's net.

The West African manatee is globally classified as vulnerable by the International Union for Conservation of Nature and Natural resources (IUCN). In Ghana however, no assessment of the manatee population has been carried out. A large number of manatees have been reportedly killed by local hunters in the Tano, Afram and Avu lagoon. In one dry season, over 40 individual manatees were reported killed along the Avu lagoon. Ofori-Danson and Agbogah (1998) reported one hunter killing over 17 individuals in the Afram River.

Fishermen in the Lower Volta associated wetlands and elsewhere reported fewer manatee sightings in recent times compared to the pre-impoundment period of the Volta River (Ofori-Danson and Agbogah 1998). These reports suggest that the manatee population is under threat of possible extinction from increasing over exploitation.

6.2.4.4 Terrestrial fauna

The rare ungulate, the Sitatunga (*Tragelaphus spekei gratus*) was common along the Volta River but their population was reduced close to extinction with the construction of the Akosombo dam in the early 60s, which led to loss of its original habitat. The Sitatunga was thought to have gone extinct in West Africa in the 70s and 80s, but a small population was discovered in an inland fresh water lagoon (Avu lagoon) of the Lower Volta River system (NCRC, 2005).

Habitat destruction, burning and draining of wetlands are the major threats to the long-term survival of the species. Sitatunga is classified as an endangered animal species and wholly protected under Wildlife laws of Ghana.

7. IDENTIFICATION OF KEY ISSUES

7.1 OVERVIEW

Wetlands are dynamic areas, open to influence from natural and human factors. In order to maintain their biological diversity and productivity and to allow wise use of their resources by human beings, an agreement and understanding is needed between the various owners, occupiers and interested parties.

The scope of assessment was initially based upon baseline knowledge of the project area and subsequently updated to accommodate relevant findings after public and statutory consultation during the scoping phase.

7.2 KEY ISSUES

The potential issues of concern identified during the scoping phase include:

- Impact on birds/bats during the construction and operation phase of the project.
- The removal of natural vegetation containing threatened, protected and endemic species such as mangroves;
- An increased exotic infestation due to disturbances of the wetland ecosystem. There are a number of invasive plant species in the Keta lagoon and the catchment areas. Invasive terrestrial plants common in the area include *Azadirachta*, *Prosopis julifora, Mimosa pigra*, *Parkinsonia aculeata*, *Zanthoxylum xanthoxyloides. Also common are aquatic and semi-aquatics such as Pistia stratiotes*, *Azolla filiculoides, A. pinnata*, *Typha domingensis, Ceratophyllum demersum*, *Vossia cuspidata*, *Oxycarium cubense.* There is the high tendency for these non-native plants to increase and spread due to disturbances during the construction phase of the project.
- Increased dust deposition during construction, particularly if construction is undertaken during the dry season.

- High risk of coastal flooding and erosion: The main environmental hazard to be expected at the project sites is flooding. The flat nature of the topography of Keta Municipality coupled with climate change impacts exposes the area to serious threat of flood. The project area consists of approximately 25 km of coastline which is fast eroding posing a great threat to human life, property, infrastructure, tourism and marine turtle nesting sites.

Species of marine turtles listed on the IUCN list of endangered species as "Vulnerable" and "Endangered" are known to utilise the nearby sandy beach fronts as nesting grounds (See section 6.2.4.3.1). However, the marine turtles do not utilise the beaches beyond the high steep cliffs resulting from erosion by sea waves. The turtle nesting grounds will not be significantly impacted during the construction or operational phases of the project as the Anloga project site is well above areas accessible for turtle nesting.

There will be no impact on freshwater mammals, such as the Sitatunga considering the absence of their preferred habitats (within deep fresh water lagoons) and the human disturbances in close proximity to the project sites.

8. ECOSYSTEM HEALTH AND SENSITIVITY

8.1 WETLAND AND ESTUARINE ECOSYSTEMS

A spatial representation of the freshwater and estuarine habitats is provided in Appendix 3. The specific habitats are discussed below.

8.1.1 Freshwater

8.1.1.1 Floodplain Wetlands and depressions

A number of interconnected freshwater wetland areas lie within the WPP1 project area. These are generally situated some distance from the estuarine channels and are connected by poorly defined flow channels. Many of the extensive wetland areas consist of small depressions maintained by a shallow water table and linked by surface flow during the wet season. Essentially these wetlands are embedded within the extensive Volta River floodplain/Keta lagoon basin, arising where suitable topographical, hydrological and geohydrological features allow.

The vegetation found within these systems is dominated by hygrophilous grasses (Figure 10) and robust sedges. Where sustained open water was present, emergent, floating and submerged aquatic macrophytes are present.

From a faunal perspective, these wetland habitats provide numerous aquatic and semi aquatic habitats suitable for amphibians, invertebrates, small mammals and juvenile fish.

Figure 10: A freshwater wetland near the proposed structures at Anyanui.

8.1.1.2 Water bodies (open water)

Open freshwater dominated water bodies occur within larger freshwater wetlands, inland of the project area near Srogbe and along the fringes of Keta Lagoon. These are generally shallow and lined with emergent macrophytes. These systems appeared to be maintained during the dry season by ground water (fresh water sitting on top of denser salt water) and fed during the wet season by seasonal channels linked to the upper reaches of the Volta River floodplain.

Vegetation is similar to that associated with the wetland areas, however emergent and aquatic macrophytes are dominant.

These open bodies of freshwater are likely to provide refuge for freshwater fish species that are less tolerant of saline conditions, amphibians and water birds.

8.1.2 Estuarine

8.1.2.1 Mangroves

Within the project area, mangrove forests are a significant estuarine habitat both in terms of area (coverage) and ecological value. Mangroves are found along the marginal extent of almost all tidal channels and lagoon areas, often extending landward along minor channels. Large mangrove areas are present to the west of the Salo/Srogbe Road and around the Anyanui site (Figure 11). Some loss of mangrove habitat was noted within the project area, mainly due to the establishment of road infrastructure and the need for wood, primarily as a fuel source.

The mangroves are dominated by three tree species, the White mangrove (*Avicennia africana*), red mangrove (*Rhizophora racemosa*) and black mangrove (*Laguncularia racemosa*).

Mangroves are important sanctuaries for juvenile estuarine and marine fish (e.g. *Lutjanus* species.), which feed and reside within the dense cover provided by the roots of *R. racemosa* in particular.

Figure 11: Mangrove habitat west of the Salo/Srogbe Road.

Mangroves represent a globally and regionally important ecosystem, providing a range of ecosystem services to humans and, therefore, warranting special conservation measures (Olson *et al.*, 2000). In this regard, mangrove forests are important for the following reasons:

- they are highly productive, producing a large proportion of the organic matter that forms the basis of the food chains within the estuarine and nearshore coastal environment;
- they provide a sheltered nursery aquatic environment and habitat for many fish, prawn, crab and invertebrate species;
- they stabilise the coastline and trap sediments that would otherwise enter the sea, at least in some situations; and
- they provide a source of wood for construction, fuel (e.g. for fish-smoking) and tannin.

8.1.2.2 Estuarine/tidal channels

These consist of wide channels where tidal flow is present. These areas are well defined characterised by open water and dense marginal vegetation consisting usually of mangrove forest (Figure 12). These channels provide a permanent link between the main channel of the Volta estuary and the Keta Lagoon. Secondary and split channels often occurred.

These channels transport fish and invertebrate larvae in and out of the estuarine system and are important for maintaining connectivity between the ocean and nursery habitats. The channels also maintain the hydrological regimen and facilitate the cyclical changes in salinity and distribution of sediment required to maintain habitats such as mangroves.

Figure 12: A significant tidal channel within the project area.

8.1.2.3 Salt marsh/salt flat

Salt marsh/salt flats are extensive flat areas characterised by xerophytic conditions and saline soils. These areas are found landward of the mangrove areas and indicate the outer limit of the estuarine habitat and saline influence (Figure 13 and 14). Salt marsh areas are inhabited by specialised plant species that are able to handle the xerophytic conditions. Grasses and succulents such as *Sesuvium portulacastrum, Paspalum vaginatum* and *Sporobolus virginicus* are dominant (Figure 15).

Although of low diversity, the salt marsh vegetation is unique and highly adapted to the conditions.

Figure 13: An example of salt marsh habitat within the project area.

Figure 14: Salt marsh east of the Salo/Srogbe Road. Note the dominance of specialised vegetation and the lack of other savannah and coastal species.

Figure 15: *Sesuvium portulacastrum* within a salt marsh habitat.

8.1.2.4 Lagoon

The Keta lagoon is the most significant lagoon system in the WPP 1 project area (Figure 16). Smaller lagoons are present within the sand bar separating Keta Lagoon form the sea, immediately inland of the coastal zone, within the dune slack (Figure 17). These lagoon systems are brackish open water systems. The Keta lagoon is fed by freshwater (Aka and Tordzi Rivers) and salt water via the channel link with the Volta estuary mouth.

As mentioned previously, the Keta lagoon is a Ramsar site and supports a number of fish and bird species and sustains a plethora of mirco-habitats along its margin. The lagoon has been influenced by land reclamation and artificial drainage and inlet channels, which have altered the nature of system in some areas.

Figure 16: View of the Keta Lagoon

Figure 17: A smaller coastal lagoon near Anloga.

8.2 PRESENT ECOLOGICAL STATE

8.2.1 Wetland ecosystems

Based on the criteria of assessment (Table 7), the PES of the floodplain wetland system within and adjacent to the project area was considered to be "largely natural" or Ecological Category "B". The hydrological changes to the Volta river by the hydro-electric dams has undoubtedly had a long term effect on the freshwater wetland systems of the lower Volta River, including those within the project area. Being embedded within a floodplain the systems are highly dependent on flood waters for freshwater inputs and rejuvenation. The changes to the flooding regimen have probably resulted in the reduction of effective wetland area and an encroachment of saline habitat (salt marsh).

The changes in flow dynamics of the Volta River have changed the macro scale sediment regimen of the floodplain, with less sediment reaching the lower reaches of the Volta River and its associated floodplain habitats.

The floodplain itself was not found to be directly affected by dams and impoundments. The water quality appeared to be relatively unaffected by settlement in the floodplain area, although localised deterioration is likely in the immediate vicinity of settlements, where potential contaminants may be present. Physical disturbances within the wetland areas were limited to infilling for road crossings, agriculture and occasionally the creation of minor artificial channels. The former two disturbances have resulted in minor wetland habitat loss. Alien fauna and flora appeared limited and much of the wetland fauna and flora appeared intact.

Table 7: Scores assigned to the attributes associated with the determination of the PES of the wetland systems within the project area.

Criteria and attributes	Relevance	Score	Confidence
Hydrological			
Flow Modification	Consequence of abstraction, regulation by impoundments or increased runoff from human settlements or agricultural land. Changes in flow regime (timing, duration, frequency), volumes, velocity which affect inundation of wetland habitats resulting in floristic changes or incorrect cues to biota. Abstraction of groundwater flows to the wetland.	3	2
Permanent Inundation	Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota.	5	3
Water Quality			
Water Quality Modification	From point or diffuse sources. Measure directly by laboratory analysis or assessed indirectly from upstream agricultural activities, human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland	4	3
Sediment Load Modification	Consequence of reduction due to entrapment by impoundments or increase due to land use practices such as overgrazing. Cause of unnatural rates of erosion, accretion or infilling of wetlands and change in habitats.	3	2
Hydraulic/Geomorphic			
Canalisation	Results in desiccation or changes to inundation patterns of wetland and thus changes in habitats. River diversions or drainage.	4	3
Topographic Alteration	Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railway lines and other substrate disruptive activities which reduces or changes wetland habitat directly or through changes in inundation patterns.	3	3
Biota			
Terrestrial encroachment	Consequence of desiccation of wetland and encroachment of terrestrial plant species due to changes in hydrology or geomorphology. Change from wetland to terrestrial habitat and loss of wetland functions.	3	2
Indigenous Vegetation Removal	Direct destruction of habitat through farming activities, grazing or firewood collection affecting wildlife habitat and flow attenuation functions, organic matter inputs and increases potential for erosion.	3	3
Invasive Plant Encroachment	Affect habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading).	4	2
Alien Fauna	Presence of alien fauna affecting faunal community structure.	4	2
Overutilisation of Biota	Overgrazing, Over-fishing, etc	3	3
Total		39	28
Mean		3.5	2.5
Category		**B**	

8.2.2 Estuarine ecosystems

Estuarine systems are sensitive to changes in river flow. In this instance, the reduction in flow/change in seasonality for flow within the main Volta River is likely to have resulted in changes in a number of parameters including salinity and salinity gradients, turbidity, sediment load and mouth/channel state. This in turn influences the functioning of the estuarine system and habitats potentially reducing the favourability of the system for recruitment of juvenile fish and invertebrates.

Despite the hydrological changes to the system the biotic community appear only marginally changed with plant diversity, avian and invertebrate diversity largely intact. Some loss of mangrove habitat was identified in the Srogbe and Keta areas, however large areas of undisturbed mangrove forest remain.

Overall, the estuarine system was considered to be “largely natural” (ecological category B) and despite hydrological changes, remained intact and functional (Table 8).

Table 8: Scores assigned to the attributes associated with the determination of the PES of the estuarine systems within the project area.

Component	Brief Description of Change (if any)	Score	Confidence
Habitat-related or abiotic components:			
% of natural MAR currently abstracted	Small scale abstraction being undertaken	4	Low
Changes in seasonal river inflow patterns	Construction of hydro power dams has altered flow patterns of the Volta River significantly	1	High
Changes in mouth condition (i.e. frequency and duration of mouth closure)	Mouth always open	4	Low
Changes in water quality (referring to system variables, nutrients and toxic substances)	Minor pollution expected from adjacent settlements	4	Low
Changes in natural in-stream habitat (i.e. estuary bed modification, channel modification, infilling, migration barriers, bridges, weirs, bulkheads, training walls, canalisation, jetties, marinas)**	Some canalisation noted	4	Medium
Changes in riparian habitat (i.e. flood plain development, bank vegetation, agriculture, grazing, industry, housing, infrastructure, recreational development)	Removal of mangroves, small scale agriculture and settlement	3	High
Biotic components:			
Plants, including microalgae and macrophytes (i.e. change in botanical importance score)	No change identifiable	5	Low
Benthic invertebrates	No change identifiable	5	Low
Fish (i.e. change in estuarine health index score for fish)	Decrease in freauency of certain species due to exploitation and changes in hydrological and salinity regimens	3	Medium
Birds	No change. The Volta estuary and associated Keta lagoon are important bird areas.	5	Medium
MEAN ECOLOGICAL INTEGRITY SCORE (averaging the 9 scores above. If no information is available for one of the 9 components, then it is not a divisor		3.5	
Category		B	

8.3 WETLAND FUNCTIONALITY

Based on the Wet-ecoservices scores (Table 9), the floodplain wetland system is highly functional providing valuable physical, biodiversity and socio-economic ecoservices. With reference to Table 9 the following ecoservices were rated as "high":

- Flood attenuation

- Phosphate removal
- Nitrate removal
- Toxicant removal
- Erosion control
- Carbon storage
- Maintenance of biodiversity
- Provision of harvestable natural resources
- Provision of cultivated foods

Flood attenuation is a very important ecoservice given the low lying nature of the Keta/Anloga/Anyanui areas. Floodplain wetland systems absorb and slow flood waters aiding dissipation and limiting the extent to which floods affect the surrounding area. The sheer extent of the floodplain wetland system and the dense vegetation are attributes responsible for effective flood attenuation.

The vegetation cover and connectivity of the system both in terms of surface and subsurface flow account for the high scores associated with filtration functions. These functions become more valuable as human settlement increases.

Many of the wetland depressions embedded within the greater floodplain wetland system are relatively inaccessible and offer ideal sanctuary for a range of biota including sensitive and rare species.

In contrast, but of importance to the local communities are the natural resources and agricultural opportunities provided by the wetland system. Grazing within temporary wetland zones was noted, as was the cultivation of various cash crops.

Table 9: Ecoservices scores for the 15 ecoservices associated with the identified wetland system.

Parameter	Effectiveness	Opportunity	Final Score
Flood Attenuation	3.0	3.0	3.0
Stream Flow Regulation	2.2		2.2
Sediment Trapping	3.5	2.0	2.8
Phosphate Removal	3.8	2.3	3.0
Nitrate Removal	4.0	3.0	3.5
Toxicant Removal	3.3	3.0	3.2
Erosion Control	3.8	2.5	3.1
Carbon Storage	3.3		3.3
Maintenance of Biodiversity	3.3	2.6	2.9
Supply for Human Consumption	2.0		2.0
Provision of Harvestable Natural Resources	3.6		3.6
Provision of Cultivated Foods	3.8		3.8
Cultural Significance	1.8		1.8
Characteristics Contributing to Tourism Value	2.6		2.6
Education and Research	1.5		1.5

8.4 ECOLOGICAL IMPORTANCE AND SENSITIVITY

8.4.1 Wetland ecosystems

The wetland system associated with the project area is of a high significance in terms of ecological importance and sensitivity (Table 10). The reasons are fairly straight forward:

1) The habitats are linked with the Keta Lagoon which is a declared Ramsar site. Any changes to the associated habitats will influence the integrity of the core habitat.
2) The floodplain wetland areas support a number of unique and rare species.
3) The wetland habitats fall within a recognised and important bird migration corridor.
4) The changes to the hydrological regimen of the Volta have illustrated the sensitivity of the floodplain wetlands to hydrological changes.

Table 10: Scores and criteria for determining the EIS of the wetland system.

Determinant	Score	Confidence
PRIMARY DETERMINANTS		
Rare & Endangered Species	3	3
Populations of Unique Species	3	4
Species/taxon Richness	2	4
Diversity of Habitat Types or Features	2	4
Migration route/breeding and feeding site for wetland species	4	2
Sensitivity to Changes in the Natural Hydrological Regime	4	2
Sensitivity to Water Quality Changes	2	3
Flood Storage, Energy Dissipation & Particulate/Element Removal	3	3
MODIFYING DETERMINANTS		
Protected Status	4	4
Ecological Integrity	3	3
TOTAL	30	32
MEDIAN	3	3.2
OVERALL ECOLOGICAL SENSITIVITY AND IMPORTANCE	**High (B)**	

8.4.2 Estuarine ecosystems

The EIS of the estuarine system within the project area is considered to be very high (A) (Table 11). The estuarine and brackish water system effectively forms the core of the Ramsar site and is recognised for their biodiversity and conservation importance. A diverse range of estuarine habitats were identified, while the system supports a number of rare and endangered species, the most well-known being the manatee.

Table 11: The EIS of the estuarine systems within the project site.

Component	Brief Motivation	Score	Confidence
Rare/endangered/limited populations	Use of the system by rare fauna e.g. Manatee	5	High
Habitat diversity (richness)	The number of habitat types in an estuary should be tallied using the following list: 1. open surface water area 2. sand flats 3. mudflats 4. submerged macrophyte beds 5. intertidal salt marsh 6. supratidal salt marsh 7. reeds and sedges 8. mangroves 9. lagoon swamp forest 10. rocks 11. deep channels	5	High
Rarity of an estuary or unique estuarine features	Presence of unique features and rarity of the system type on a national scale	5	High
Input to sea	Estuaries are rated according to size and their potential input of sediments and nutrients to the coastal zone.	3	Medium
MEAN ECOLOGICAL IMPORTANCE SCORE (averaging the 4 scores above)		4.5	
Category		A	

Essentially the wetland system (floodplain wetland and smaller freshwater wetlands embedded therein) and estuarine system (estuarine channels and lagoons) are valuable ecological assets and highly functional systems supporting a number of important habitats and faunal communities.

The ecological state (PES) of the wetland and estuarine system was found to be “largely natural” despite hydrological changes to the Volta River. In terms of ecological importance (EIS), the wetland system was rated as “high” while the estuarine system was rated “very high”.

9. ASSESSMENT OF IMPACTS/RISKS AND IDENTIFICATION OF MANAGEMENT ACTIONS

9.1 WETLAND BIRDS

The wetland and estuarine habitats within the Keta Ramsar Site serve as a wintering ground for resident, migratory birds (en route the East Atlantic flyway) and other wildlife species and need to be preserved. Presently, terns, waders and herons in particular, are not seriously threatened by human activities. There was no evidence of bat hibernation areas and roosts within the period of visit. However, the presence of houses and human settlements presents the possibility of bats utilisation of the environment.

Construction phase

The footprint and potential area of disturbance is relatively small compared to the available area which birds have to forage and nest. Although habitat loss will occur and while having some influence on birds, this is considered to be a minor impact from an avian perspective given the availability of vast areas of similar or better habitat.

Nesting sites may be disturbed, however, mortality is expected to be very low as the footprint of disturbance and the probability of encountering a high density nesting site is considered very low, particularly in areas such as Anloga (within a densely populated area) and Srogbe (adjacent to a main road).

Construction related disturbances that may interfere with bird foraging or nesting (with the exception of habitat loss) will be temporary in nature.

Due to the location of the construction activities away from the main lagoon and perceived prime habitats for water and migrating birds, the construction activities are unlikely to directly influence bird migration or water birds, the two most significant bird groups that utilise the Keta Complex Ramsar Site. The construction phase is therefore not anticipated to present any physical barriers to the birds preventing their movement.

Based on the above, the impact of the construction phase of the proposed wind facility on wetland bird migration is anticipated to be of low significance without mitigation for layouts.

Management actions

The following management actions must be undertaken prior to the commencement of construction:

- The construction zone must be inspected for active nesting sites by an ornithologist. The ornithologist must make a recommendation regarding the need to relocate the nests.
- During construction, should any birds become trapped within the construction area, they must be relocated safely.

With the effective implementation of the above recommended management actions, the significance of the impacts of the proposed wind facility on birds/bats migration is anticipated to be very low for the preferred and the alternative layout during the construction phase.

Operation

From available information, the scale and the spread of the project facilities and the biologically important nature of the broad project area, including areas of estuaries, open lagoons and the sea (Gulf of Guinea) demonstrate that the project may have the potential for direct and indirect adverse impacts on the avifaunal and potentially bat biodiversity during the operation phase.

There is clear evidence that active wind turbines present a threat to the lives of birds and bats. The risk appears to be much greater in some areas than in others. The presence of large wind turbines may cause birds to avoid the site, thus losing a foraging resource and requiring extra energy to fly around it.

The key ornithological issues to be considered with respect to the proposed wind energy development are likely to include the following:

- Potential impacts on migratory bird species due to the risk of collision with turbines.

- Non-breeding, wintering birds within or adjacent to the site may be disturbed and/or displaced as a result of the functioning of the turbines. Individuals may also collide with the turbines.

The project may have a significant additional influence on birds through collision with the associated infrastructure, including overhead transmission lines, meteorological masts, substations and lighting.

The probability of the active turbines resulting in collisions and other disturbance related impacts as described is theoretically high. The habitat presented by the Keta Lagoon Complex Ramsar Site is highly irreplaceable and a wind power facility that obstructs or deters birds from accessing or using the habitat will have a highly significant influence on the bird population. On the contrary, bird populations may adjust their flight paths, in which case the turbines will be of no influence. The significance of the potential impact that the project may have on the bird population (for both alternatives) is thus considered to be medium although the level of confidence of this prediction is low given the.

Management actions

Given the low confidence and uncertainty surrounding the likelihood of collisions during the operational phase, it is highly recommended that a bird strike monitoring programme be implemented during the first 24 months of operation. The programme should involve regular site inspections around the base of each turbine with the intention of recording the number and species of dead birds (if any) found.

Review of Alternatives

The Preferred layout involves the establishment of wind turbines within 3 zones (Anyanui, Anloga and Srogbe) while the Alternative layout involves the establishment of wind turbines in only 2 zones – Anloga and Srogbe. Of the three turbine sites, Anloga and Srogbe are most likely to have an influence on migrating birds or resident birds moving between the coastal zone and Keta Lagoon. Disturbance of resident birds utilising moist grassland and wetland areas is most likely at Anyanui.

Both alternatives pose concerns form an avifaunal perspective with the Preferred layout likely to have a higher probability of having an impact on birds due to the presence of a third turbine node at Anyanui thus potentially disturbing resident bird activities and migratory birds/moving birds heading to or from the Avu Lagoon in addition to the Keta Lagoon.

Refer to the specialist avian assessment for further detailed assessment of bird related impacts and additional management action.

9.2 OTHER FAUNA

Construction

The installation of such large structures, along with supporting roads, and the associated clearing of wetland vegetation, will have a negative effect because of the loss, degradation, and fragmentation of habitat. The project is expected to cause displacement of wildlife through habitat conversion/degradation from land clearing activities. Although no endangered species of fauna were encountered during the visit, members of nearby communities confirm the presence of a variety of smaller wildlife including amphibians, reptiles, small mammals and invertebrates.

Apart from the marine turtles that utilise the sandy beach fronts as nesting grounds, low densities of some common terrestrial reptiles including the Royal python *Python regae*, the common lizard *Agama agama* and the Monitor lizard *Varanus niloticus* are reported to be present in the project area. The degraded mangroves, mainly *Avicennia africana*, along the margins of the lagoon, waterlogged grassland, riverine woodland and scattered thickets of shrubs, climbers and small trees on higher ground serve as suitable habitat for these reptiles. The habitat and its associated fauna will be directly impacted by the construction of the wind energy infrastructure, however once complete the operation of the turbines offers little threat to terrestrial fauna.

Given the above, the impact of the proposed wind facility on other fauna during the construction phase is assessed to be temporary, site specific and of medium-low to low intensity for the preferred and alternative layout respectively. This impact is therefore anticipated to be of low significance without mitigation for both the preferred and the alternative layout.

Management actions

Terrestrial and semi aquatic fauna are mobile and are likely to move away from the site to the nearest refuge once construction commences. Should fauna become trapped within the construction site or become threatened by activities, a capture and relocation programme should be implemented. Ad hoc removals during construction should also be effected. The pre-construction capture and relocation programme will ensure that vulnerable terrestrial or semi aquatic fauna can be captured and relocated prior to disturbance and potential loss. Candidates for removal include amphibian species that utilise a particular isolated depression which has been identified for infilling. The details of the capture and relocation programme will have to be finalised during the planning phase.

With the effective implementation of the above recommended management actions, the significance of the impacts of the proposed wind facility on other fauna during the construction phase is anticipated to be very low for the preferred and the alternative layout.

Operation

If fenced, fauna may become trapped within the fenced area. No other threat to terrestrial fauna has been identified for the operational phase. As such, the impact significance of the operation of turbines for both the Preferred and Alternative layouts is considered to be low.

Management actions

Should the sites be fenced, the implementation of “critter paths” can be used to allow either the escape of any trapped fauna or allow the free movement of small fauna, should total exclusion not be an option. The latter has been successfully implemented at photovoltaic solar plants in South Africa. Additional input may be required from a herpetologist.

Review of Alternatives

The Anloga coastal turbine cluster is unlikely to affect marine turtles due to its position above the beach slope and within the dune and dune slack area. The Srogbe road turbine cluster is positioned within a salt marsh and mangrove habitat which are not important habitats for terrestrial fauna. The Anyanui cluster is the most likely to result in the disturbance of terrestrial and semi aquatic fauna, particularly amphibians which utilise the moist grassland and freshwater wetland areas within the cluster site. Therefore, the preferred layout which proposes to establish the Anyanui cluster is likely to have a marginally greater influence (but still of low significance as described above) on terrestrial and semi aquatic fauna.

9.3 IMPACT ON LOCAL ARTISANAL FISHERIES

Construction

Land reclamation for the project development may have an impact on local artisanal fisheries, through disturbance of nursery habitat (mangrove), disturbance of local fish landing sites, and ultimately the livelihoods of the local people.

The construction activities may interfere with fisherman’s access routes or fish landing sites. This is however likely to be intermittent and temporary in nature as once construction is complete, many of the access routes should become usable.

As such, the significance of the impact on the local fisherman is considered to be low to very low.

Management actions

Due to the low level of the predicted impact, the only management action proposed is to consider where local access are relative to the proposed turbine cluster and ensure that access to these areas is not restricted during construction. If access is limited, alternative routes/access needs to be allowed for.

Operation

Residual impact on local fisherman through the restriction of access may exist. The placement of the turbines is not likely to interfere with fishing or have a significant influence on the fish population. The probability of the turbines influencing local fishing practices is low as is the impact intensity. The overall impact significance is considered to be very low.

Management actions

The turbines must not restrict access or use of the surrounding area. Access restriction measures must be limited to the individual turbines and essential infrastructure.

Review of Alternatives

The Srogbe road pylon cluster is a concern as it may result in significant loss of mangrove habitat to the west of the Srogbe Road. This cluster is present in both the Preferred layout and the Alternative layout, thus both alternatives pose the same level of threat. Mangrove areas may potentially be used as fishing areas. In the context of the project area, salt marsh appears to be less threatened and certainly less important from an artisanal fishing perspective.

9.4 ESTUARINE IMPACTS

Construction

Estuarine

The project location can be described as an area of *modified* wetland and estuarine habitats linked with the Keta lagoon and forming an integral part of the Volta river estuary and wetland system. An initial visit to the project site undertaken in early March and October 2016, indicated that much of the proposed project site was generally poor in flora and fauna diversity with salt flats covered with *Sesuvium portulacostrum*, and thicket vegetation that is seasonally flooded, but also includes more sensitive estuarine habitats, particularly of mangroves in the case of the

Anyanui and Srogbe project sites. These project sites may provide safe haven for wildlife species possibly including species of conservation interest. Despite areas of sensitivity, it is considered unlikely that the estuarine and lagoon system would meet the International Standards definition of *natural* or *critical habitat*.

Although estuarine habitats, particularly mangroves are recognised nursery habitats, the study did not identify the presence of protected fish species within the proposed development sites or the coastal lagoons and other water bodies near the project sites. The loss of nursery habitat will be comparatively small, limited to the footprint of the turbine infrastructure only. Fish will simply be able to move to other sections of mangrove. As such alternative nursery habitat is available in abundance and replaceable.

Potential vectors of change associated with the construction phase include construction vehicles operating within mangrove areas, a loss of vegetation cover, the disturbance of soils, and topographical changes.

Within the estuarine habitats (mangrove areas) such vectors are likely to cause localised turbidity as well as the potential for hydrocarbon contamination. The tidal nature and regular ebb and flow is likely to dilute and disburse any pollutants/sediment reducing the retention time and opportunity for the effects to take place. The loss of vegetation cover may expose the disturbed areas to scour during the ebb and flow of the tide.

Given the above, the estuarine impact is anticipated to be of medium significance without mitigation for both the preferred layout and the alternative layout. This is primarily due to the small footprint situated within mangrove habitats and the localised nature of the direct impacts.

Management actions

The estuarine impacts are directly linked to the placement of infrastructure and turbines within mangrove habitat. This is particularly evident at Srogbe where numerous turbines are positioned within a mangrove habitat. The relocation of these structures would alleviate the majority of the potential estuarine impacts. A proposal is provided in Figure 18. This relocation is highly recommended. In addition the following management measures must be implemented to mitigate and reduce the resultant impacts:

- Clearing of vegetation to be kept to a minimum, keeping the width and length of the earth works to a minimum
- Land reclamation must be limited to essential areas only
- Effective site management and proper disposal of hydrocarbon fluids will alleviate concerns of contamination
- The number of new roads will be kept to a minimum and as far as possible existing roads will be used only requiring a degree of upgrading
- All services must be coupled to the access roads thus minimising the development footprint
- Chemicals used must be stored safely on site and surrounded by bunds. Chemical storage containers must be regularly inspected so that any leaks are detected early.
- No stockpiling should take place within a wetland area.
- All stockpiles must be protected from erosion and stored outside of the mangrove footprint.
- Stockpiles must be located away from estuarine channels.

The estuarine impacts for both alternatives are assessed to be of low significance with the effective implementation of the recommended mitigations.

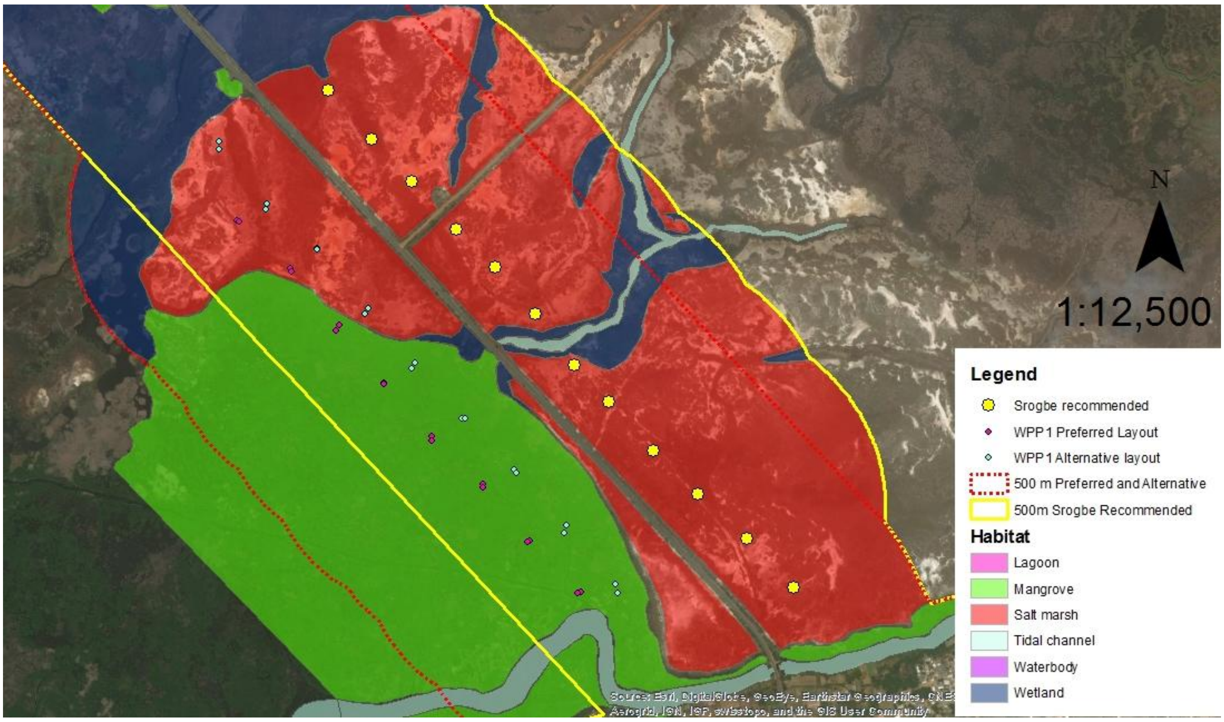

Figure 18: The recommended position of the Srogbe turbine cluster to avoid mangrove habitat loss and reduce local estuarine impacts.

Operation

Foundations within estuarine zones are likely to interfere with current and sediment dynamics. Indirect impacts as result of the changes in these drivers are likely to have an effect on channel scour within the estuarine habitats. It is anticipated to be of medium significance without mitigation for both the preferred layout and the alternative layout.

Management actions

At Srogbe, the relocation of the turbines (refer to Figure 17) would alleviate the majority of estuarine impacts, however should this not be possible, the following must be implemented during the operational phase:

- During operational maintenance, drip trays must be utilised to prevent lubricant spillages. All lubricants must be stored correctly if kept on site. Alternatively all lubricants and other hazardous substances must be stored off site between maintenance operations.
- Hydrocarbon spill kits must be kept on site
- Any spills must be cleaned up rapidly to avoid prolonged exposure and to contain the extent of the spill.
- Where land reclamation has taken place maintaining the hydrology through adequate drainage/system connectivity is considered important to maintaining some degree of tidal influence. An example includes incorporating culverts beneath access roads to maintain connectivity and flow between sections of mangrove that have been segmented by infill.

The impact for both alternatives is assessed to be of very low significance with the effective implementation of the recommended mitigation measures.

Review of Alternatives

Mangrove habitat is likely to be lost and infilled at the Srogbe Road site. The Anyanui cluster is of least concern from an estuarine perspective. The Srogbe Road cluster is one of the core development zones in both alternatives making both the preferred and alternative layouts a concern from an estuarine perspective.

9.5 COASTAL IMPACTS

Construction

The proposed project will not have any significant adverse impact on the sandy beach since the vegetation along the beach is already degraded and only a small width of beach will be impacted by the infrastructure associated with the wind energy facilities during construction phase. The few coconut plantations and strand vegetation occupying the dunes have no conservation importance. Despite the low ecological importance of these areas, coastal erosion remains a concern and may jeopardize the integrity of structures in the future.

Within coastal dune and dune slack habitats, the mobilisation of sand and the influence of wind on sand movement may become a problem. Some habitat loss (although generally degraded) will arise from the direct disturbance during construction with additional loss or alteration likely as a result of sand movement. Where open water bodies are present in the dune slack, water quality may become affected by hydrocarbon contaminants.

During construction, the following disturbances can be expected and could result in the identified impacts - construction vehicles operating within the coastal zone, a loss of vegetation cover, the disturbance of soils, and topographical changes.

Coastal impacts are anticipated to be of a medium significance without mitigation for both the preferred layout and the alternative layout primarily due to the proximity to the beach front, the potential to influence the local coastal dynamics and the history of serious coastal erosion experienced by the coastline within the project area.

Management actions

Prior to the commencement of construction it is recommended that the Anloga turbines be subject to a coastal erosion risk assessment to ensure the positioning of these structures is sustainable and feasible. The results of this assessment should indicate whether the proposed turbines be positioned back form the frontal dune area.

Furthermore the design of the foundation and structures must take cognisance of the risk of coastal erosion and where possible involve the use of soft engineering options. The expertise of a coastal erosion specialist or coastal engineer must inform the final placement and design of the Anloga cluster.

The coastal impacts (Anloga) are largely physical in nature given the degraded nature of the habitat. The following must be implemented during construction to reduce the extent of disturbance and ultimately the significance of the construction related impacts:

- Implement wind and sand control measures. Shade cloth fencing and the use of other soft geofabrics must be used to retain and control sediment.
- Additional input in this regard may be required by a coastal erosion specialist to determine if the proposed turbine cluster at Anloga will have any influence on the local coastal geomorphology and to determine the level of risk posed to the turbine cluster by the coastal erosion
- No plant may operate in the littoral active zone (i.e close to or below the high water mark)
- Hardened surfaces must be kept to a minimum
- Fuel and other hazardous substances must be stored off site to reduce the risk of contamination should a storm or coastal erosion even affect the site.

The impact for both alternatives is assessed to be of low significance with the effective implementation of the recommended mitigations.

Operation

The presence of hardened foundations within the dynamic coastal zone will influence localised sediment transfer and ultimately localised coastal erosion. Hardened structures may concentrate wave energy during storm events exacerbating erosion in adjacent areas. The significance of these impacts are likely to be medium without the implementation of management actions for both alternatives.

Management actions

The impact of the foundations on the coastal dynamics is highly dependent on the design thereof and the consideration of prevailing conditions. Implementation of such measures prior to construction will reduce the impacts during operation.

If correctly designed, the impact on coastal dynamics should be of low significance for both alternatives.

Review of Alternatives

The Anloga cluster is proposed to stretch along a large portion of the coastal zone, with turbines positioned within the frontal dune and dune slack zones. This is likely to have localised effects on the stability and integrity of the dune system as a result of foundations for the turbines and infilling for access roads. Therefore, the preferred layout and the alternative layout are both a concern from a coastal perspective as both include proposed turbines as Anloga.

9.6 FRESHWATER WETLAND IMPACTS

The Anyanui turbine cluster site was the only portion of the project site where freshwater wetland habitat will be affected by the proposed placement of turbines. As such, the following impact assessment applies specifically to the Anyanui site, and the implementation of the preferred layout. Anyanui has been excluded from the Alternative layout which makes the Alternative layout favourable for the avoidance of freshwater wetland impacts.

Construction

Freshwater ecology would be impacted primarily from the raising of land to erect wind turbines and construction of access routes through the wetlands.

Fish and fish spawning as well as breeding areas could be impacted during construction (and operation), particularly as access routes are constructed through open pools or wetland habitats.

The displacement of freshwater fish due to land reclamation is likely to be a permanent impact as this will permanently alter the character of the project core areas. Land reclamation may have additional impacts on water quality as the increased vehicular activity and dumping of fill material will create zones of turbidity. Dead vegetation that has been removed or pushed aside is likely to decay, potentially reducing oxygen levels and creating pockets of anoxic conditions.

Depending on the extent of disturbance during construction, some loss of ecoservices (temporary or permanent) may occur. Likely scenarios relate primarily to hydrological or physical wetland functions, where flow is interrupted or blocked limiting the ability of the affected section to perform ecoservices such as nitrate removal or flood attenuation. The significance of the impacts are related to the extent and positioning of the infilling. It appears that the majority of infilling will occur along the wetland margins or only affect small portions of the specific wetland, however the changes will ultimately be permanent and the impacts a certainty.

At the moment, the sites are used for agricultural purposes with some evidence of residential settlements and as such have been altered from their natural state by human activities.

Given the above, this impact is anticipated to be of high significance without mitigation for the preferred layout.

Management actions

The following essential management actions must be implemented during the construction phase:

- Effective site management and proper disposal of hydrocarbon fluids will alleviate concerns of contamination.
- Clearing of vegetation to be kept to a minimum, keeping the width and length of the earth works to a minimum
- The number of new roads will be kept to a minimum and as far as possible existing roads will be used only requiring a degree of upgrading
- All services must be coupled to the access roads thus minimising the development footprint
- Chemicals used must be stored safely on site and surrounded by bunds. Chemical storage containers must be regularly inspected so that any leaks are detected early.
- No stockpiling should take place within a wetland area.
- All stockpiles must be protected from erosion, stored on flat areas where run-off will be minimised, and be surrounded by bunds.

- Stockpiles must be located away from river channels.

The impact on freshwater wetland ecology associated with the construction of the preferred layout is assessed to be of medium significance with the implementation of the above.

In addition, adjusting the project area to avoid wetland areas watercourses and sensitive habitats would be ideal from an ecological perspective, but may not be feasible. This would apply specifically to the Anyanui cluster (only for the Preferred layout), where the 5 eastern most turbines fall within or close to wetland areas. Either these turbines should be abandoned or repositioned closer to the main road (see Figure 19 below). If implemented the proposed turbine relocation (alternative positioning) will reduce the impact of the layout further to a low significance, subject to the effective implementation of the standard management actions mentioned initially.

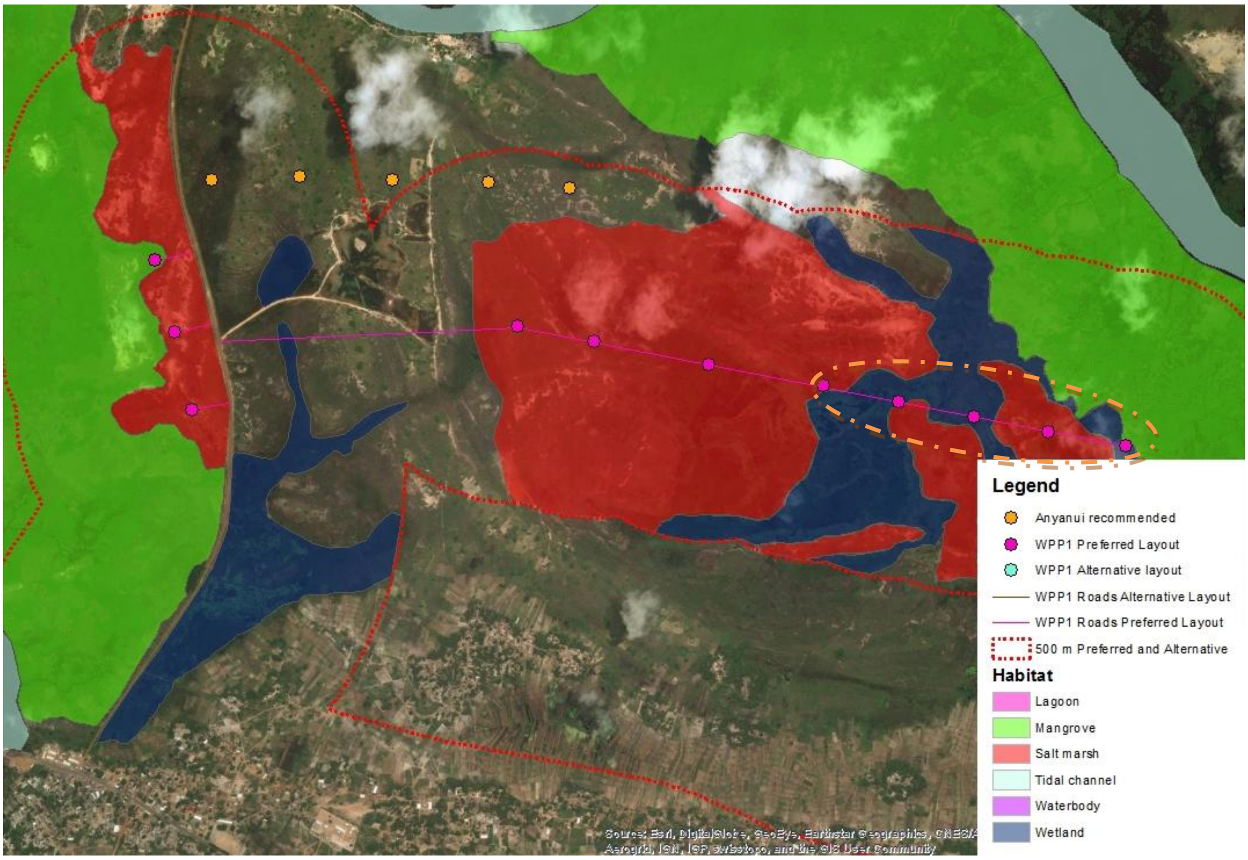

Figure 19: Recommended alternative positioning of the eastern most 5 turbines in Anyanui, to avoid infilling and alteration of wetland habitat.

Operation

No significant impacts on freshwater ecology are anticipated during the operation phase, at this stage. Hydrocarbon contamination and reduced wetland functionality could arise. The former, from lubricating fluid spillages and the later if land reclamation is undertaken.

Contamination by lubricants may result in the localised disturbance and possibly the killing of aquatic fauna and flora at the site of the spill. The stagnant nature of the freshwater wetland systems may result in the contamination remaining largely local and in close proximity to the source. Contamination may be temporary i.e. a small spillage occurs and is quickly cleaned up or more prolonged, in the event of a leak from the turbine itself. The latter may go long periods without identification or rectification. At worst the impact significance is likely to be medium (before mitigation).

The effects of land reclamation may manifest themselves during the operational phase as changes in surface flow and loss or alteration of aquatic and wetland habitat. Over time such changes may have localised effects on the water quality and aquatic/wetland fauna and flora ultimately affecting community structure and usage. Such changes may render a small portion of the wetland dysfunctional or with impaired functionality. This impact is essentially a residual impact as result of the construction phase disturbance. As such the significance of the land reclamation on wetland functionality during the operational phase is low (before mitigation).

Management actions

To address the abovementioned operation impacts on freshwater wetlands, the following management actions are recommended:

- During operational maintenance, drip trays must be utilised to prevent lubricant spillages. All lubricants must be stored correctly if kept on site. Alternatively all lubricants and other hazardous substances must be stored off site between maintenance operations.
- Hydrocarbon spill kits must be kept on site

- Any spills must be cleaned up rapidly to avoid prolonged exposure and to contain the extent of the spill.
- Where land reclamation has taken place maintaining the hydrology through adequate drainage/system connectivity is considered important to maintaining some degree of wetland functionality. An example includes incorporating culverts beneath access roads to maintain connectivity and flow between a section of wetland that has been infilled.

If implemented correctly, such measures are highly likely to reduce the residual impact significance. This may occur through the reduction of the probability of the impact occurring and the reduction of the resultant impact's magnitude. The impact after mitigation is likely to be low.

Review of Alternatives

The Anyanui cluster is positioned within and adjacent to a freshwater wetland and moist grassland system. Some loss and alteration of habitat is likely to arise as a result of the establishment of the turbine cluster. Because the Anyanui cluster has been excluded from the Alternative Layout, this is the favourable layout option from a freshwater wetland perspective.

9.7 IMPACTS ASSOCIATED WITH FLOODING

The risk of flooding to the wind turbines must be confirmed by a hydrologist. Based on the changes to the hydrology of the Volta River following the installation of the two hydro-electric power dams and the resultant controlled flow, seasonal flooding resulting form the Volta River is unlikely, however flooding may result from localised rainfall. The interaction of this additional freshwater flow with tidal forces and wave overtopping during storm events may result in flooding of the project area.

Due to the potential flood risk, it is recommended that a flood risk assessment be undertaken prior to the commencement of construction.

9.8 DECOMMISSIONING IMPACTS AND MANAGEMENT/MITIGATION ACTIONS

The primary impacts are associated with the construction phase and operational phase. Should the project be decommissioned and the turbines removed, the affected areas are likely to return to a state similar to the status quo, except where infilling and foundations have been established and cannot be removed.

Impacts as a result of decommissioning are likely to be temporary in nature and be related the following:

- Operation of plant used to dismantle the turbines
- Physical disturbances associated with the breaking up of platforms or removal of roads

Likely impacts may include:

- Localised turbidity which may temporarily displace fish and aquatic fauna.
- Vibration and noise which may temporarily displace fauna (fish, birds, terrestrial fauna).
- Waste material such as rubble, steel and potentially used hydrocarbon lubricants which may contaminate the surrounding soil and water.

Essential management measures include the following:

- Rehabilitation of the turbine sites. This must include removal of all material and hard structures. The vacant area must be ripped and seeded/planted if terrestrial.
- Waste disposal skips must be available during decommissioning.
- The working area must be screened using shade cloth fencing (terrestrial sites only)

For both layout options, decommissioning impacts are considered to be of low significance.

9.9 CUMULATIVE IMPACTS

9.9.1 Other development and associated infrastructure

The habitat loss from the actual turbines is likely to be limited, depending on their placement, and too small to have a significant impact on the overall integrity of the Keta Lagoon/Volta estuary complex. Changes associated with other associated activities such as the upgrade of roads may result in the loss of more estuarine and wetland habitat where the footprint of the main roads will be increased in addition to the obvious habitat loss associated with the turbines. Because of the relatively small extent of the disturbance and the nature of the habitat that will be disturbed by the upgrade of associated infrastructure (road servitude areas, existing bridge crossings) the significance of the cumulative impact is expected to be low.

Additionally, there are no existing wind or gas energy related facilities or infrastructure on the wetland areas adjoining the selected project sites. The cumulative impact of construction of several new large infrastructure for the projects is therefore not likely to significantly alter the wetlands hydrological system during the construction or operational phase of the project.

Management actions

To ensure that the impact of associated infrastructure and related upgrades remain low it is essential that the following be implemented:

1) existing servitudes and routes be used wherever possible.

2) Where new routes are required, the route of least impact is implemented.

3) The construction phase be managed and undertaken according to the relevant environmental management plans.

9.9.2 Settlement and increased pressure on Keta Lagoon

The establishment of WPP1, if successful, may prompt the establishment of further similar projects or additional phases, stimulating local growth. This may have a concomitant negative effect on the integrity of the Keta Lagoon and its status as a Ramsar site as the extent of settlement and associated activities such as agriculture, artisanal fishing and salt mining. These activities are high intensity activities, expanding habitat loss and habitat change. The changes are also permanent. The impact significance is thus considered to be medium.

Management actions

Due to the social complexity of the area, managing and controlling such activities may be difficult, requiring broad scale planning and inter-ministry co-operation. No management actions are proposed.

9.10 IMPACT SUMMARY

A summary of identified impacts, impact significance and mitigation and management measures is provided below in Tables 12 to 15.

Table 12: ESIA level Impact assessment summary table for the Construction Phase

CONSTRUCTION PHASE															
Direct Impacts															
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Alternative Site**	**Status**	**Spatial Extent**	**Duration**	**Intensity**	**Probability**	**Reversibility of Impact**	**Irreplaceability**	**Can the Impact/Risk be Avoided?**	**Can the Impact/Risk be Mitigated/ Managed?**	**Mitigation Measures**	**Significance of Impact and Risk**		**Confidence Level**
													Without Mitigation/ Management	***With Mitigation/ Management (Residual Impact/ Risk)***	
Disturbance of Wetland Birds	Disturbance of birds/bats associated with the loss of habitat	Preferred	Negative	Site specific	Permanent (habitat loss, other disturbances temporary)	Medium - Low	Probable	Moderate reversibility	Low irreplaceability	No	Yes	Check for nests and important habitat prior to commencement of construction	Low	Very Low	Medium
Disturbance of Wetland Birds	Disturbance of birds/bats associated with the loss of habitat	Alternative	Negative	Site specific	Permanent (habitat loss, other disturbances temporary)	Medium - Low	Probable	Moderate reversibility	Low irreplaceability	No	Yes	Check for nests and important habitat prior to commencement of construction	Low	Very Low	Medium
Disturbance of other fauna	Construction related activity such as excavation and noise	Preferred	Negative	Site specific	Temporary	Medium	Highly probably	High reversibility	Replaceable	No	Yes	Capture and relocate fauna	Low	Very low	Medium
Disturbance of other fauna	Construction related activity such as excavation and noise	Alternative	Negative	Site specific	Temporary	Medium - Low	Probable	High reversibility	Replaceable	No	Yes	Capture and relocate fauna	Low	Very low	Medium
Artisanal fisheries	Interruption of fishing activities of locals.	Both	Negative	Site specific	Temporary	Low	Low probability	Low reversibility	Low irreplaceability	No	Yes	No mitigation required	Very low	Very low	Medium
Estuarine	Loss of nursery habitat due to construction activities and Loss of habitat due to excavation and infilling	Both	Negative	Site specific	Permanent	Medium-Low	Definite	Non-reversible	High irreplaceability	No	Yes	Shift turbines at Srogbe outside of mangrove habitats. Construction phase management.	Medium	Low	Medium
Coastal	Disturbance of coastal dynamics	Both	Negative	Site specific	Permanent	Medium	Probable	Non-reversible	High irreplaceability	No	Yes	Move coastal turbines (Anloga) inland out of frontal dune habitat. Consider coastal dynamics during design of footing	Medium	Low	Medium

CONSTRUCTION PHASE															
Direct Impacts															
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Alternative Site**	**Status**	**Spatial Extent**	**Duration**	**Intensity**	**Probability**	**Reversibility of Impact**	**Irreplaceability**	**Can the Impact/Risk be Avoided?**	**Can the Impact/Risk be Mitigated/ Managed?**	**Mitigation Measures**	**Significance of Impact and Risk**		**Confidence Level**
													Without Mitigation/ Management	***With Mitigation/ Management (Residual Impact/ Risk)***	
Freshwater wetlands	Loss of habitat due to excavation and infilling. Changes in water quality associated with habitat and hydrological changes	Preferred	Negative	Site specific	Permanent	Medium	Definite	Non - reversible	High irreplaceability	No	Yes	Construction phase management only – • Disposal of hydrocarbon lubricants • Minimal clearance of vegetation • Minimal road infrastructure • Services linked with roads • Safe chemical storage • No stockpiling in wetlands • Stockpiles away from rivers/channels	High	Medium	Medium
Freshwater wetlands	Loss of habitat due to excavation and infilling. Changes in water quality associated with habitat and hydrological changes	Preferred	Negative	Site specific	Permanent	Medium	Definite	Non - reversible	High irreplaceability	No	Yes	Shift turbine at Anyanui to outside of wetland habitat and construction phase management as listed above	High	Low	Medium

Table 13: ESIA level Impact assessment summary table for the Operational Phase

OPERATIONAL PHASE															
Direct Impacts															
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Alternative Site**	**Status**	**Spatial Extent**	**Duration**	**Intensity**	**Probability**	**Reversibility of Impact**	**Irreplaceability**	**Can the Impact/Risk be Avoided?**	**Can the Impact/Risk be Mitigated/ Managed?**	**Mitigation Measures**	**Significance of Impact and Risk**		**Confidence Level**
													Without Mitigation/ Management	***With Mitigation/ Management (Residual Impact/ Risk)***	
Disturbance of Wetland Birds	Bird strikes by operating turbines and general disturbance of resident birds. May influence migrating birds to Keta Lagoon and Avu Lagoons	Preferred	Negative	Local (but possibly inter-national	Permanent	Medium – Low	Highly probable	Low reversibility	Replaceable	No	Yes	Long term monitoring by relevant specialists	Medium	Low	Low
Disturbance of Wetland Birds	Bird strikes by operating turbines and general disturbance of resident birds. May influence migrating birds to Keta lagoon	Alternative	Negative	Local (but possibly inter-national	Permanent	Medium – Low	Highly probable	Low reversibility	Replaceable	No	Yes	Long term monitoring by relevant specialists	Medium	Low	Low
Disturbance of other fauna	Fauna may become trapped in infrastructure or area.	Preferred	Negative	Site specific	Permanent	Low	Probable	Low reversibility	Replaceable	No	Yes	Capture and relocate fauna. Regular inspections and checks	Low	Very low	Medium
Disturbance of other fauna	Fauna may become trapped in infrastructure or area.	Alternative	Negative	Site specific	Permanent	Low	Probable	Low reversibility	Replaceable	No	Yes	Capture and relocate fauna. Regular inspections and checks	Low	Very low	Medium
Artisinal fisheries	Limiting access to fishing areas and potential to interfere with livelihood.	Both	Negative	Site specific	Permanent	Low	Low probability	Low reversibility	Low irreplaceability	No	Yes	Allow access to fishing grounds and resources.	Very low	Very low	Medium
Estuarine	Loss of habitat and a change in estuarine processes.	Both	Negative	Site specific	Permanent	Medium-Low	Definite	Non-reversible	High irreplaceability	No	Yes	Shift turbines outside of mangrove habitats.	Medium	Very low	Medium
Coastal	Alteration of coastal processes and increased risk of coastal erosion	Both	Negative	Site specific	Permanent	Medium	Probable	Non-reversible	High irreplaceability	No	Yes	Design of Anloga foundations must consider coastal erosion risks	Medium	Low	Medium
Freshwater wetlands	Contamination associated with maintenance activities.	Preferred	Negative	Site specific	Permanent	Medium	Probable	Non-reversible	High irreplaceability	No	Yes	Store hazardous substances/materials correctly during maintenance.	Medium	Low	Medium
Freshwater wetlands	Impacts of land reclamation on wetland functionality.	Preferred	Negative	Site specific	Permanent	Medium-Low	Probable	Non-reversible	High irreplaceability	No	Yes	Adequate drainage/system connectivity	Low	Low	Medium

Table 14: ESIA level Impact assessment summary table for the Decommissioning Phase

DECOMMISSIONING PHASE															
Direct Impacts															
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Alternative Site**	**Status**	**Spatial Extent**	**Duration**	**Intensity**	**Probability**	**Reversibility of Impact**	**Irreplaceability**	**Can the Impact/Risk be Avoided?**	**Can the Impact/Risk be Mitigated/ Managed?**	**Mitigation Measures**	**Significance of Impact and Risk**		**Confidence Level**
													Without Mitigation/ Management	***With Mitigation/ Management (Residual Impact/ Risk)***	
Return to status quo	Removal of infrastructure and rehabilitation	Both	Neutral	Site specific	Temporary	Low	Definite	NA	NA	No	Yes	Rehabilitate areas disturbed during decommissioning	Low	Very Low	Medium

Table 15: ESIA level cumulative impact assessment summary table

Cumulative Impacts															
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Alternative Site**	**Status**	**Spatial Extent**	**Duration**	**Intensity**	**Probability**	**Reversibility of Impact**	**Irreplaceability**	**Can the Impact/Risk be Avoided?**	**Can the Impact/Risk be Mitigated/ Managed?**	**Mitigation Measures**	**Significance of Impact and Risk**		**Confidence Level**
													Without Mitigation/ Management	***With Mitigation/ Management (Residual Impact/ Risk)***	
Other development and associated infrastructure	The upgrade of main roads and other associated infrastructure to support this project	Both	Negative	Local	Medium term	Medium	Low probability	Non-reversible	Moderate irreplaceability	Yes	Yes	Design associated infrastructure accordingly. Broad spatial planning of the Keta region identifying future development nodes and new infrastructure.	Low	Low	Low
Increase in settlement and Pressure on the Keta Lagoon system	The lagoon is under pressure form increasing settlement, usage and agriculture. The success of WPP1 and the potential for similar projects may increase development and pressures on the lagoon.	Both	Negative	Regional	Permanent	High	Probable	Non-reversable	High irreplaceability	No	No	Cannot be effectively managed by the applicant as the situation is complex	Medium	Medium	Low

10. CONCLUSION AND RECOMMENDATIONS

A review of available information and a preliminary site investigation indicated that the project location falls within the Keta lagoon Complex Ramsar Site characterized by extensive lagoon, estuarine habitat and freshwater wetlands. The lagoon and associated habitats support a diverse range of fauna and flora, but are known specifically for their importance for migratory birds.

Identified sensitive habitats included:

1) Mangrove
2) Salt marsh
3) Tidal channels
4) Lagoons
5) Freshwater wetlands and depressions
6) Open water bodies (freshwater)

The Volta River, the most significant watercourse in the region, has been subjected to extreme changes in hydrology as a result of two hydro-power dams established during the 1960's and 1980's. The hydrological changes have affected the wetland ecosystem with significant coastal erosion having been recorded since the completion of the second dam. The PES, EIS and wetland functionality results are summarised in Table 16. Despite the hydrological changes, the estuarine and wetland systems remain highly functional and ecologically important systems.

Table 16: Summary of the PES. EIS and functionality assessment.

Ecosystem	PES	EIS	Functionality (ecoservices)
Freshwater wetland	B (Largely Natural)	High	High
Estuarine	B (Largely Natural)	Very High	NA

Based on the available data, a number of potential wetland and aquatic impacts were identified, mainly associated with the potential for habitat loss due to the land reclamation for the establishment of the turbine clusters and the operation of the turbines. Impacts included:

1) Interference with bird migration and behaviour through bird strikes and residual disturbances such as flight path diversion.

2) Displacement of other fauna during construction. Fauna may become trapped or their activity affected by the infrastructure.

3) Loss of mangrove habitat may have an influence on fish recruitment in some areas and temporarily disturb fishing activities.

4) Physical impacts such as habitat loss within the coastal and estuarine environments and the potential to change dynamics at a site specific level (e.g. increased coastal erosion at localised points).

5) Physical disturbance and loss of wetland habitat through infilling and site specific hydrological alterations.

Although not an impact of the proposed turbines, the risk of flooding and the influence that this may have on the construction and operation of turbines was highlighted as a potential issue based on the nature of the surrounding area.

Long term cumulative impacts identified included the following:

1) The influence of other development and associated infrastructure that may arise as a result of WPP1.

2) Changes to the Keta Lagoon as a result of increased settlement and utilisation.

During the exercise however, two ecological/biophysical issues were identified that will require further evaluation and operational phase monitoring:

1) The potential risk to the birds population; and

2) The risk posed by coastal erosion and the changes that the Anloga cluster may have on the coastal dynamics;

A number of the impacts were applicable to both proposed alternatives, however the Preferred layout was likely to have a slightly more significant impact on freshwater wetland habitat, avifauna and other fauna than the Alternative layout. This was due to the Anyanui cluster proposed as part of the Preferred layout, which directly affects a freshwater wetland system. In both alternative layouts, the positioning of the turbine cluster at Srogbe is a concern as it will directly impact on mangrove habitat, which is a significant and sensitive estuarine habitat. It is recommended that this cluster should be reviewed and potentially relocated to the east of the road into the less sensitive salt marsh area.

Although the Present Ecological State would be considered important for the study area system, i.e. largely natural and moderately modified, with the proposed mitigation the impact significance for all the impacts could be reduced to medium to low significance.

Key management actions and mitigation measures proposed include the following:

- *Construction Phase*
  - Prior to the commencement of construction a flood risk assessment must be undertaken to determine the flood risk posed to the turbines.
  - Prior to commencement of construction, input form a coastal erosion specialist is recommended to determine the potential influence on local coastal erosion and provide input into the design of the turbine foundations to potentially limit coastal impacts. Turbine foundations must take consideration of coastal erosion and related forces. “Soft” engineering options may be required following input form a coastal engineer or coastal erosion specialist (Anloga).
  - Final positioning of Anloga turbine cluster to be confirmed following the coastal erosion risk assessment
  - Relocate the turbine cluster at Srogbe to the eastern aside of the road (highly recommended).
  - Construction zone must be inspected for active bird nesting site by an ornithologist.
  - Any birds that become trapped in the construction area must be removed and safely relocated.
  - Relocation of sensitive terrestrial and semi aquatic fauna prior to construction
  - Safely remove trapped terrestrial fauna
  - Construction activities must not limit or restrict access to natural resources (fishing sites, etc.)
  - Clearing of vegetation (specifically mangrove vegetation) must be kept to a minimum
  - Hydrocarbon lubricants and fuels must be stored and disposed correctly and safely
  - The establishment of new access roads must be kept to a minimum. Where possible utilize or upgrade existing roads.

  - Services to follow road servitudes
  - All chemicals (in addition to hydrocarbons) must be stored correctly
  - No material is to be stockpiled in wetland areas, mangrove areas or adjacent to tidal channels
  - Stockpiles must be protected from erosion/slumping
  - Implement wind and sand control measures (Anloga)
  - No plant may operate in the littoral active zone (near or below the high water mark) (Anloga)
  - Hardened surfaces must be kept to a minimum
  - Fuel and other hydrocarbons must be stored off site (Anloga)
- *Operational phase*
  - Monitoring of the turbine sites and recording of bird strikes (if any)
  - Drip trays must be utilised during maintenance operations when changing hydrocarbon lubricants
  - Hydrocarbon spill kits must be kept on site
  - Hydrocarbon spills must be cleaned up rapidly
  - Adequate drainage must be provided where infilling has occurred to maintain wetland and estuarine system connectivity
- *Decommissioning Phase*
  - Rehabilitation of the turbine sites
  - Removal of all waste (skips to be provided and serviced regularly)
  - The working area must be screened using shade cloth fencing (terrestrial sites only)

The following additional actions recommended by not essential, but if implemented will further reduce impact significance:

- *Construction Phase*
    - Management of construction noise
    - Limit construction footprint (this will limit habitat loss)
    - Relocate some of the turbines within the Anyanui cluster to avoid freshwater wetland habitats
- *Operational Phase*
    - Habitat enhancement or creation as an offset for habitat loss
    - If the turbine sites are fenced, "critter paths" should be provided to allow smaller terrestrial fauna to move freely.

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CURRICULUM VITAE OF CHARLES CHRISTIAN AMANKWAH

1. PERSONAL RECORD

Full Name:	CHARLES CHRISTIAN **AMANKWAH**
Date of Birth:	01 – 12 – 1959
Nationality:	Ghanaian
Marital Status:	Married with 2 Children
Contact Address:	Wildlife Division (Forestry Commission), Box MB.239, Accra
Telephone:	(233) 21 401210 / 401277 Mobile: 0244-262467
Email:	ccamankwah@yahoo.com

2. EDUCATION

- University of Leicester, UK (1991–1993) M.Sc. Natural Resources Management
- KNUST, Kumasi Ghana (1984–1988) B.Sc. (Hons.) Biological Sciences
- Konongo-Odumase Secondary School, Ghana (1973-1981), GCE 'O' & 'A' levels

3. EMPLOYMENT RECORD

- Wildlife Division (Forestry Commission), (1995 – to date):
- GES: Science Teacher: Accra Girls' Sec. School (1990/1991),
- GES: Science Teacher Konongo-Odumase Sec. Sch. (1994/1995)
- National Service Secretariat, Ghana: Service Person: Team Leader – Community Improvement Unit (Fisheries) (1988-1990)

4. TRAINING & EXPERIENCE

- Pursued degree in Biological Sciences and Masters in Natural Resource Management.
- Built requisite knowledge through regular short courses in Ghana and abroad.
- Exposed to biodiversity related (Protected Area and Wetlands) management systems through job training, national and international training and workshops.
- Strong background training in natural resources management with extensive field work in ecological and social data collection, collation, inventory, analyses and information cataloging.
- Extensive skills in reporting and presentations at local and international meetings;

5. CURRENT POSITIONS

- **General Services Manager/Wetlands Coordinator:** Wildlife Division
- **National Focal Point**: Ramsar Convention on Wetlands
- **Focal Point**: Biodiversity Component of the GEF/Word Bank funded *Sustainable Land and Water Management Project* (SLWMP) hosted by Ministry of Environment, Science, Technology and Innovation (MESTI) (2011-2016);

- **Reviewer**: Natural Resources Sector Technical Review Committee, EPA Environmental Impact Assessments of development projects for recommendation on compatible land-use practices within wetland conservation areas and other Protected Areas;

6. COMPLIMENTARY JOB TRAINING

- Study Tour to Brazil and Mexico on ***Payment for Environmental Services***, August 18 - September 1, 2012.
- Global Environment Facility (GEF)/World Bank, Environment Alert: ***Training Workshop in Writing Skills***, Nov 1997, Accra, Ghana.
- Royal Society for the Protection of Birds (rspb): ***Practical Attachment Training to some Nature Reserves of the (RSPB), UK***, July 1996, UK.
- Ramsar Bureau/IUCN, ***Wetlands Inventory Training Course***, Dec. 2000, Kampala, Uganda
- Forestry Commission (FC), ***Training Programme in Team Building and Motivation***, April 2004, Ghana Institute of Management & Public Administration (GIMPA), Accra,
- Japan International Co-operation Agency (JICA), ***Short Course in Wetland Conservation***: Sept. – Nov. 1998, Japan.
- Protected Area Management & Wildlife Conservation Project (PAMWCP), Wildlife Division, ***Study Tour on Community Conservation Initiatives in Nature Conservation,*** April – May 1997, Kenya & Tanzania.
- Department for International Development (DfID), ***Short Course in Aquatic Resources, Environment and Project Management,*** May – June 1997, University of Hull, UK
- Remote Sensing Applications Unit, Dept. of Geography and Resource Development, ***Course in Spatial Information Management Technologies, Remote Sensing and GIS in Natural Resources Planning & Management***, December, 1999, Univ. of Ghana, Legon,
- ***Cross-Learning Dialogue on Climate Change Adaptation***, Centre for African Wetlands, University of Ghana, September 2010.

7. LIST OF WORK

- K.A.A. deGraft-Johnson, J. Blay, F.K.E. Nunoo, **C.C. Amankwah,** 2010. "Biodiversity Threats Assessment of the Western Region of Ghana". The *Integrated Coastal and Fisheries Governance (ICFG)* Initiative, Ghana.
- Asmah R., Dankwa H., Biney C.A, **Amankwah, C.C.** 2008. Trends analysis relating to pollution in Sakumo Lagoon, Ghana. African Journal of Aquatic Science, 2008, 33(1):81-93.
- Adzobu, C.D., Owusu, E. H., **Amankwah, C. C**., Ayivor, J. S., 2004. Preliminary Inventory of Wetlands in Ghana. Report prepared for IUCN-BRAO, West Africa Regional Office, Burkina Faso.
- **Amankwah, C. C.**, 1992. Conservation, Management and Protection of African Wetland Vegetation, Zoology Dept., Univ. of Leicester, Leicester, UK.
- **Amankwah, C. C.**, 1992. The advantages & problems of using remote sensing techniques in forestry management. Zoology Dept., Univ. of Leicester, UK.

- **Amankwah, C. C**., 1992. An evaluation of the importance of habitat variation in the assessment of river pollution using macro-invertebrates. Thesis submitted for MSc. Degree, School of Biological Sciences, Zoology Department, Univ. of Leicester, UK.
- **Amankwah, C. C**., 1988. The influence of applied combined phosphorus and Endomycorrhizal Inoculation on the Growth of *Vigna subterranean* (Bambara groundnut). Thesis submitted for B.Sc. Degree. Dept. of Biological Sciences, UST, Kumasi, Ghana

Referees:

Nana Kofi Adu-Nsiah Executive Director Wildlife Division (FC) P. O. Box M.239, Accra Tel: 021 401210 Mobile : 0244107143 / 0208120120 Email: **adunsiah@yahoo.com**	**Prof. Yaa Ntiamoa-Baidu** Dean, School of Research & Graduate Studies Center for African Wetlands ℅ P. O. Box LG67 University of Ghana, Legon, Accra Tel:021-512-835/6 : Mobile : 0244769081 Email: **ynbaidu@ug.edu.gh**

CURRICULUM VITAE OF ALEXANDER MICHAEL WHITEHEAD

Name:	Alexander Michael Whitehead
Profession:	Environmental Consultant/Ecologist
Date of Birth:	30/08/1983
Current Employment:	Sustainable Development Projects cc (SDP Ecological and Environmental Services)
Position:	Ecologist/Environmental Consultant
Years with Firm:	11
Years of experience:	11
Nationality:	South African
Disability:	None
Marital Status:	Married
Education:	Matric – Glenwood High School, Durban, 2001
Contact number:	073 268 4157
Email address:	alex@ecocoast.co.za
Driver's License:	Code B

Tertiary Qualifications:

Institution [Date from - Date to]	Degree(s) or Diploma(s) obtained:
Rhodes University [2002-2004]	BSc Ichthyology and Entomology (with distinction in Ichthyology)
Rhodes University [2005]	BSc (Hons.) Ichthyology and Fisheries Science (with distinction)

Professional Affiliations:
South African Council for Natural Scientific Professions – Reg. No. 400176/10 (Ecological Science)

Fields of interest:

- Ichthyology
- Entomology
- Aquaculture
- Aquatic Ecology

Key Skills and experience:

- Computer skills – (MS Word, STATISTICA, Excel, MS Access, PRIMER 5 (multivariate statistical program), CAP 4 (multivariate statistical program));
- Staff supervision
- Project management – management of Environmental Authorization processes and internal project management
- Bioassessment - Experience in sampling aquatic invertebrates (SASS 5) and ichthyofauna (Electrofishing and estuarine sampling techniques);

- Water quality - Experience in carrying out water samples and interpreting results in both freshwater and estuarine environments;
- Wetland and riparian habitat delineation – Delineation of wetland and riparian areas using accepted methods (DWAF 2005);
- Wetland functionality assessments – Assessment of wetland functionality using ecological indicators and standard methods such as Wet-Ecoservices and Wet-Health.
- Aquatic assessments – Assessment of freshwater ecosystems using bioassessment/sampling protocols, water quality data and ecological indicators.
- Terrestrial ecological assessments – General biodiversity assessments and identification of sensitive habitats.
- Environmental Impact Assessment (EIA) and Basic Assessment (BA) Processes – Undertaking and management of all aspects of the environmental approval processes. Project experience includes housing developments, aquaculture projects, industrial developments, coastal development, infrastructure, agri-industry and renewable energy (solar)
- Environmental management – Compilation of practical EMPr documents and environmental management processes.
- Rehabilitation – Compilation of wetland and terrestrial rehabilitation plans as well as practical experience in planning and conducting weed eradication and re-vegetation programs.
- Environmental monitoring and auditing – Environmental Control Officer (ECO) duties in both the construction and operational project phases. Experience includes ECO duties for the construction of housing developments, coastal infrastructure including piers and sand pumping schemes, industrial development and industrial operations and renewable energy projects.
- Open space and conservation planning – Identification of areas of open space or conservation importance.
- GIS competence (QGIS) and database usage (SANBI BGIS)
- ARC MAP 10.1 competent.
- Botanical/protected species permits and Risk Assessments – Permit applications under the National Forest Act (84 of 1998), Natal Nature Conservation Ordinance (15 of 1973) and National Environmental Management: Biodiversity Act (10 of 2004).
- Environmental Legislation – A good understanding of various statutes associated with environmental processes.
- Water Use License Applications – Managing the WULA process for Section 21 activities under the National Water Act (36 of 1998).
- ISO 14001 Environmental Management Systems
- National (Kwazulu-Natal, Western Cape, Eastern Cape, Northern Cape, Limpopo Province, Free State, Gauteng) and international (Ghana) experience.

Employment History:

- ***December 2003- January 2004***

Sustainable Development Projects cc.
Student work. Assisting with field research and preliminary report compilation. General administrative duties.

- ***January 2006 – Current***

Sustainable Development Projects cc.
Environmental consultant and specialist ecologist. Core duties included the following:

- EIA/BA reports/BID document compilation, client liaison, basic management of the environmental authorisation process.
- Environmental control officer duties, compliance monitoring.
- Water Use License Applications.
- Compilation of specialist ecological reports including bio-assessment, wetland functionality assessments, wetland delineations, general terrestrial and aquatic ecological assessments.
- GIS

Additional tasks include provide enviro-legal opinions on proposed developments and offer general advise for environmental matters (e.g. stocking of fish into dams, suitable plant species). General business administration and management.

Key Clients:

- ESKOM
- Umgeni Water
- Kwadukuza Municipality
- eThekwini Municipality
- Motheo Construction Group
- Scatec Solar
- CSIR

Other Experience and training:

1. Co-author on a paper presented at ASA conference in Grahamstown during 2005 "Testing clove oil as an anaesthetic for long distance transport of live fish: the case of the lake Victorian cichlid *Haplochromis obliquidens*". Journal of Applied Ichthyology 22 (2006) 510-514
2. Main author "Reproductive and feeding biology of the endangered fiery redfin, *Pseudobarbus phlegethon* (Barnard 1938) (Teleostei: Cyprinidae), in the Noordhoeks River, South Africa." Published in the African Journal of Aquatic Science Volume 32 No. 3 (2007) 99-111
3. Completed a LLM Natural Resources Law Course (Mr. E. Couzens University of Kwazulu-Natal) during 2007. NDP.
4. Attended the following workshops/short courses:
    - "Development of the new South African sludge guidelines series: Training Sessions on Volume 1, 2 and 3" hosted by the Department of Water Affairs and

Forestry and the Water Research Commission and presented by Dr. Heidi Snyman and Elize Herselman (18 July 2007).

- "Grass identification: Introduction to Grasses, How to Identify Grasses and Practical Grass Identification" presented by Fritz van Oudtshoorn (3 March 2009)
- "Habitat creation as offset for coastal development" presented by Prof. Mike Elliot and Mr. Nick Cutts (16 and 17 July 2009).

5. Co-author "Agricultural impact on the pelagic ecosystem of the Small temporarily open/closed
Seteni Estuary, South Africa". Marine and Estuarine Research 2013, 64, 1-13.
6. QGIS training course - Dominic Wieners EKZN Wildlife. Basic GIS training including practical utilization of GIS software and familiarity with EKZN Wildlife GIS data.
7. Sembcorp Siza Water ISO 14001, 18001 and 9001 service provider training (September 2014).
8. ESRI ArcGIS Basic Training Course, 27 – 31 October 2014 – SAQA NQF level 6 competency received for "Demonstrate an understanding of the context of GI Science"
9. National Training and Development Buffer Zone Workshop, 29 & 30 October 2015, La Mercy Beach Hotel, Tongaat. Hosted by the Institute of Natural Resources NPC and Eco-Pulse Consulting.

Referees

1) Jeremy Cahill
Company: Jack's Fisheries
Position: Aquaculture Manager (Former eThekwini Municipality Northdene Tilapia Hatchery Manager)
Contact Details:
Cell: 079 9149213
Email: jemcah@gmail.com

2) Mike Webster
Company: HSG
Position: Environmental Consultant
Contact Details:
Tel: 031 9401208
Cell: 084 2067882
Email: mikew@siyaconsulting.co.za

3) Francis Smith
Company: Geosure (Pty) Ltd
Position: Associate/Geologist/Geotechnical Engineer
Contact Details:
Tel: 072 2971617
Email: francis@geosure.co.za

SPECIALIST DECLARATIONS

I, **CHARLES CHRISTIAN AMANKWAH**, as the appointed independent specialist, hereby declare that:

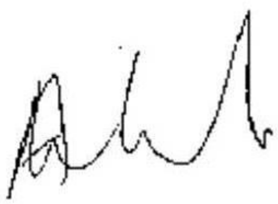
- I act as the independent specialist in this application;
- I perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the any Acts, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Acts, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- I realise that a false declaration is an offence

Charles Christian Amankwah

15 May 2017

I, **ALEXANDER MICHAEL WHITEHEAD**, as the appointed independent specialist, hereby declare that:

- I act as the independent specialist in this application;
- I perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the any Acts, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Acts, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- I realise that a false declaration is an offence



Alexander Michael Whitehead

15 May 2017

12. APPENDICES

Appendix 1:

Criteria for Identifying Wetlands of International Importance

Adopted by the 7th (1999) and 9th (2005) Meetings of the Conference of the Contracting Parties, superseding earlier Criteria adopted by the 4th and 6th Meetings of the COP (1990 and 1996), to guide implementation of Article 2.1 on designation of Ramsar Sites.

Group A of the Criteria **Sites containing representative, rare or unique wetland types**		**Criterion 1**: A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
Group B of the Criteria **Sites of international importance for conserving biodiversity**	Criteria based on species and ecological communities	**Criterion 2**: A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.
		Criterion 3: A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.
		Criterion 4: A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.
	Specific criteria based on waterbirds	**Criterion 5**: A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.
		Criterion 6: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.
	Specific criteria based on fish	**Criterion 7**: A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.
		Criterion 8: A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.
	Specific criteria based on other taxa	**Criterion 9**:A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species.

Appendix 2:

List of macrophyte species from Keta lagoon and associated Angor wetlands.

(*Adopted from*: Finlayson, *et. al.*, 2000).

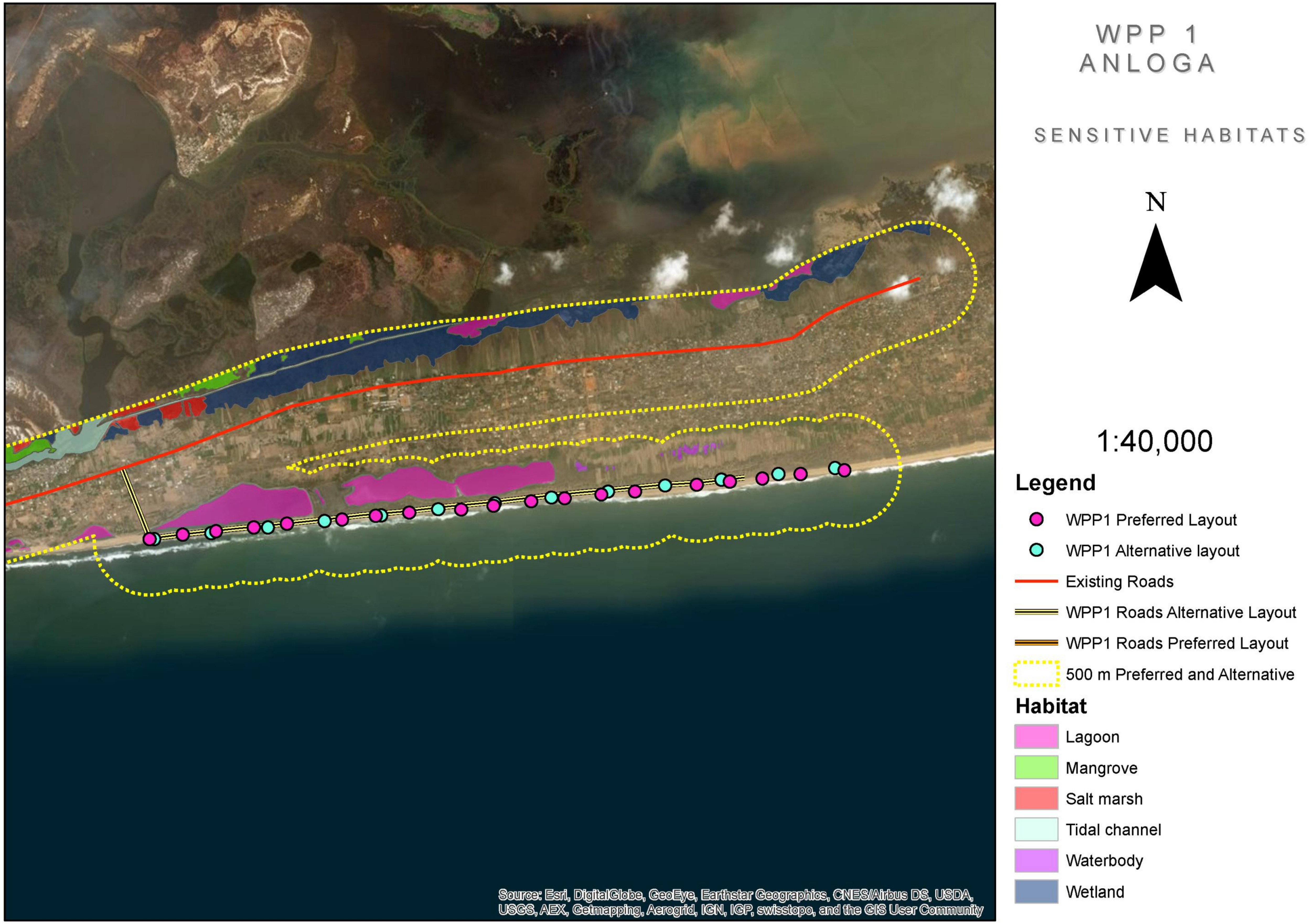
Species	Keta lagoon	Angor channel
Abutilon mauritianum	X	
Acrochaetium aureum	X	X
Acrostichum aureum	X	
Andropogon contortus	X	
Andropogon gayanus		
Avicennia nitida	X	X
Azadirachta indica	X	
Azolla africana	X	
Bacopa crenata	X	
Blumea aurita	X	
Borassus aethiopum	X	
Borreria natalensis	X	
Brachiaria mutica	X	
Brachiaria pyramidalis	X	
Canavalia rosea		X
Ceratophyllum demersum	X	X
Ceratopteris cornuta	X	
Chara sp.	X	
Chloris gayana	X	
Cocos nucifera	X	
Commelina africana	X	
Commelina benghalensis	X	X
Conocarpus erectus	X	
Crotalaria retusa	X	
Cyclosorus denudataus	X	
Cynodon sp.(not flowering*)*	X	
Cyperus articulatus	X	X
Cyperus denudatus	X	
Cyperus distans	X	X
Cyperus esculentus	X	
Cyperus rotundus	X	
Diodea serrulata		X
Dodder cuscatha	X	
Echinochloa pyramidalis	X	
Eclipta prostrata	X	
Elaeis guineensis	X	
Eleocharis atropurpurea	X	X
Eleocharis dulcis	X	
Eleocharis mutata	X	
Ficus capensis	X	
Fimbristylis dichotoma	X	
Fimbristylis ferruginea		X

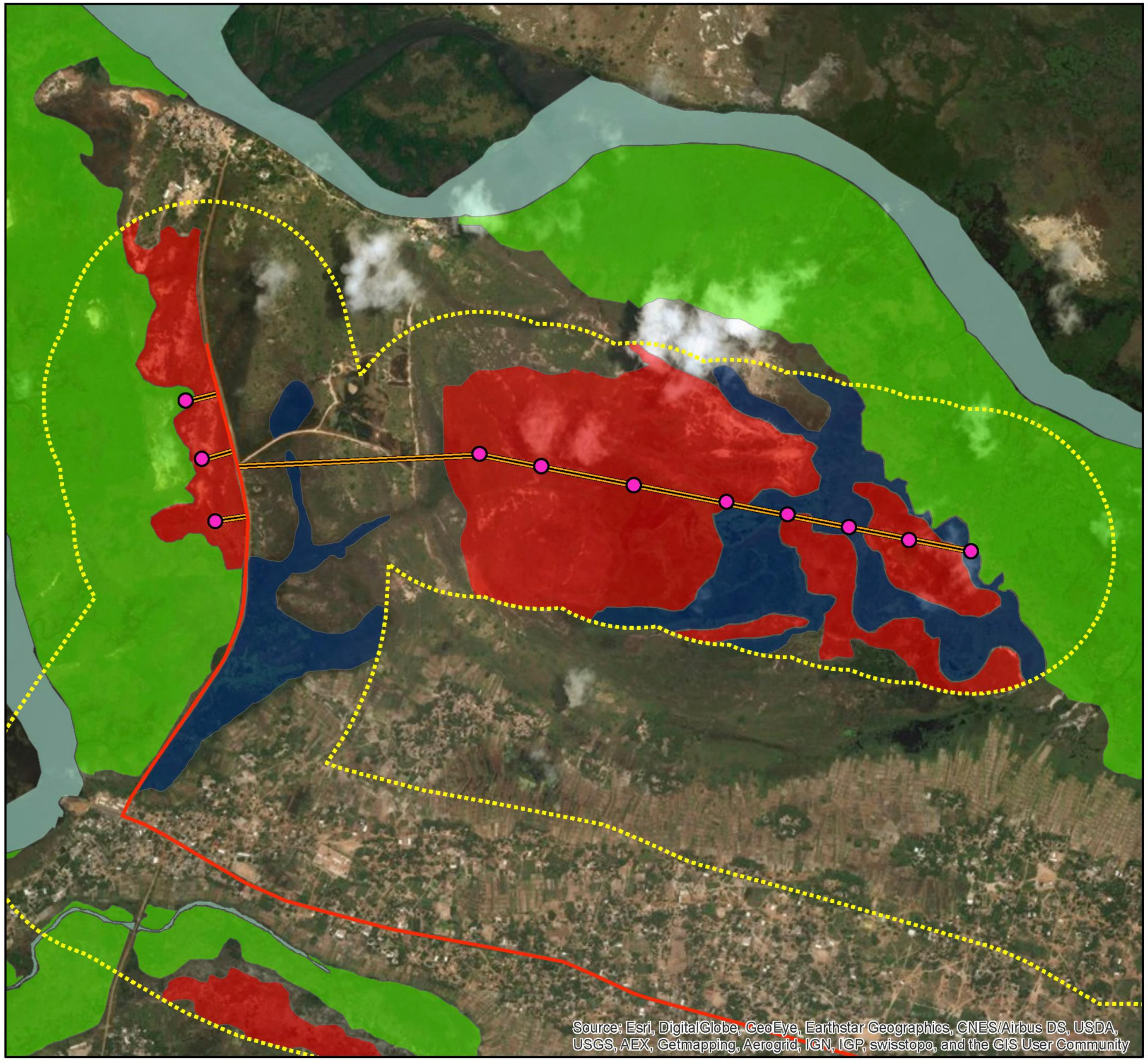
Species	Keta lagoon	Angor channel
Fimbristylis obtusifolia	X	
Fuirena umbellata	X	
Gossypium heterophylla	X	
Grewia villosa	X	
Heteropogon contortus	X	
Hibiscus micrantha	X	
Hygrophilla auriculata	X	
Imperata cylindrica	X	
Indigofera spicata	X	
Ipomoea aquatica	X	X
Ipomoea mauritiana		X
Ipomoea pes-caprae		X
Ipomoea rubens	X	
Killinga nemoralis	X	
Lactuca taraxacifolia	X	
Launea taxifolia	X	
Leersia hexandra	X	
Lemna paucicostata	X	
Leptochloa caerulescens	X	
Ludwidgia stolonifera		X
Ludwigia erecta	X	
Ludwigia leptocarpa	X	
Ludwigia stolonifera	X	
Luffa cylindrica	X	
Marsilea polycarpa		X
Mimosa pigra	X	
Mimosa pudica	X	
Mitracarpus scaber	X	
Mitragyna inermis	X	
Nauclea sp.		X
Neptunia oleracea	X	
Nymphaea lotus	X	X
Nymphaea micrantha	X	X
Opuntia sp.		
Oryza longistaminanta	X	
Parkinsonia aculeata	X	
Paspalum orbiculare		
Paspalum polystachyum	X	X
Paspalum vaginatum	X	
Passiflora foetida	X	
Passiflora glabra	X	
Pentadon pentandrus	X	
Philoxerus vermicularis	X	
Phoenix dactylifera	X	
Phragmites karka	X	
Phyllanthus amarus	X	
Physallis micranta	X	

Species	Keta lagoon	Angor channel
Pistia stratiotes	X	
Polygonum lanigerum var. *africanum*	X	X
Polygonum salcifolium	X	
Pycereus lanceolatus	X	
Remirea maritima		
Rhizophora racemosa	X	X
Rimerea maritima		X
Ruppia maritima	X	
Salvinia nymphellula	X	
Scaveola plumieri		
Schizachyrium sanguinium	X	
Schwankia americana	X	
Scirpus cubensis	X	
Scirpus cubensis with *atriculatus* infloresence	X	
Scirpus littoralis	X	
Securinega virosa	X	
Sesbania sesbans	X	
Sesbania sp.		X
Sesuvium portulacastrum	X	
Setaria anceps	X	
Sida cordifolia	X	
Sphenoclea zeylanica		
Sporobolus maritima		
Sporobolus pyramidalis	X	X
Sporobolus virginicus	X	
Stachytarpheta angustifolia	X	
Teramnus labialis	X	
Typha domingensis	X	X
Urena lobata	X	
Utricularia inflexa	X	
Vernonia cinerea	X	
Vigna ambacensis	X	
Vigna radiata	X	
Vetiveria fulvibarbis	X	
Vossia cuspidata	X	X
Wolfia arrhiza	X	
Xanthozylon xantholoides	X	

Appendix 3:

Wetland and aquatic habitat mapping


WPP 1
ANLOGA
SENSITIVE HABITATS
N
1:40,000
Legend
WPP1 Preferred Layout
WPP1 Alternative layout
Existing Roads
WPP1 Roads Alternative Layout
WPP1 Roads Preferred Layout
500 m Preferred and Alternative
Habitat
Lagoon
Mangrove
Salt marsh
Tidal channel
Waterbody
Wetland
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



WPP 1
ANYANUI

SENSITIVE HABITATS

N

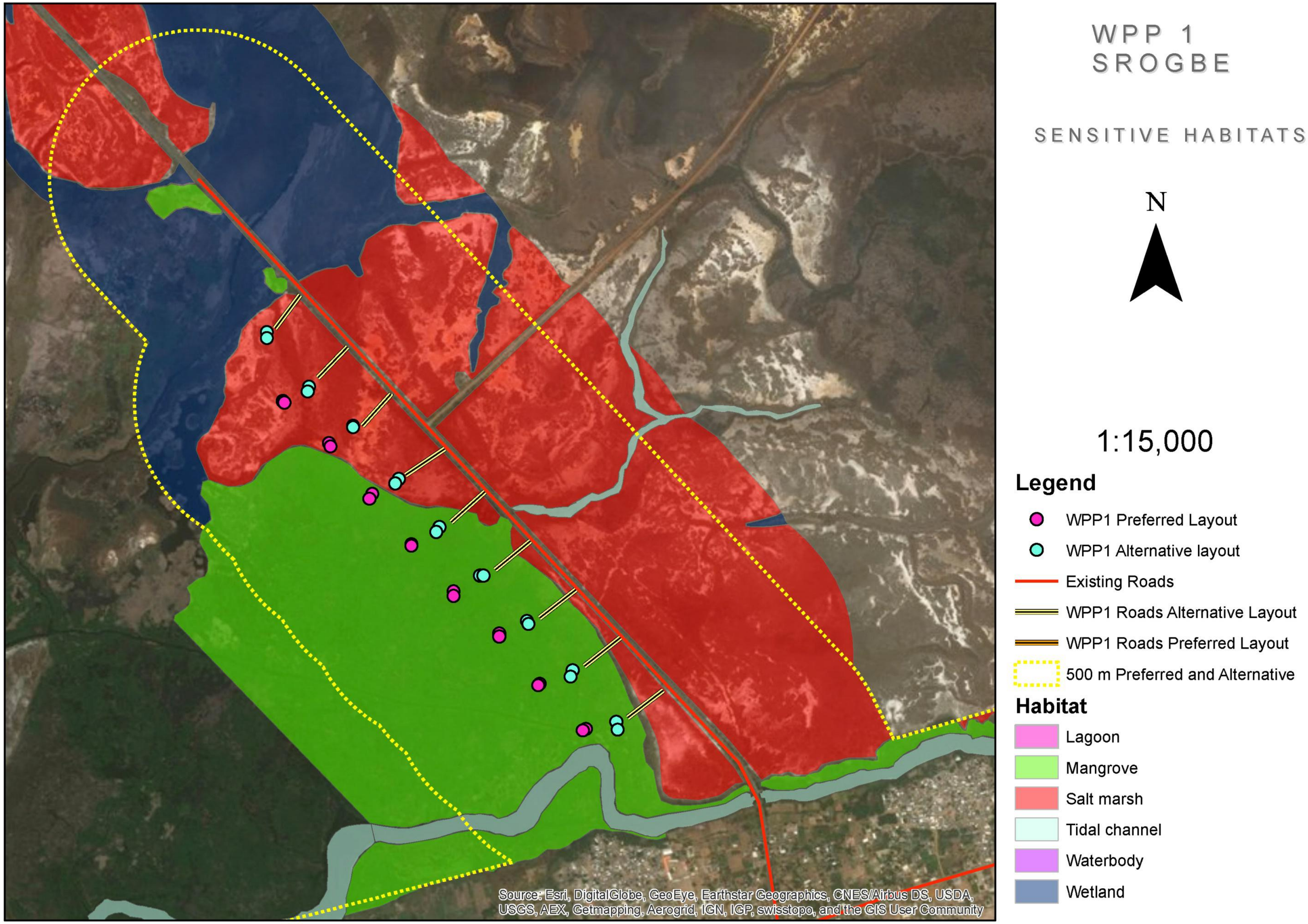
1:18,000

Legend

- WPP1 Preferred Layout
- WPP1 Alternative layout
- Existing Roads
- WPP1 Roads Alternative Layout
- WPP1 Roads Preferred Layout
- 500 m Preferred and Alternative

Habitat

- Lagoon
- Mangrove
- Salt marsh
- Tidal channel
- Waterbody
- Wetland


WPP 1
SROGBE
SENSITIVE HABITATS
N
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Legend
WPP1 Preferred Layout
WPP1 Alternative layout
Existing Roads
WPP1 Roads Alternative Layout
WPP1 Roads Preferred Layout
500 m Preferred and Alternative
Habitat
Lagoon
Mangrove
Salt marsh
Tidal channel
Waterbody
Wetland
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Appendix 4:

List of common waterbird species and their abundance on coastal Ramsar Sites, including Keta Ramsar Site, as obtained in a single count in January 2017.

(*Source*: Wildlife Division, 2017)

Species		**Densu Delta**	**Muni - Pomadze**	**Sakumo**	**Songor**	**Keta**	**Grand Total**
Common Name	**Scientific Name**						
Common Sandpiper	*Actitis hypoleucos*	51	48	15	36	32	182
African Jacana	*Actophilornis africanus*			54			54
Great White Egret	*Ardea alba*	194		59		261	514
Yellow-billed Egret	*Ardea brachyrhyncha*					1	1
Grey heron	*Ardea cinerea*	649	2	9	4	144	808
Purple Heron	*Ardea purpurea*	1		3		8	12
Squacco Heron	*Ardeola ralloides*	15		16			31
Turnstone	*Arenaria interpres*	2			1	8	11
Cattle Egret	*Bubulcus ibis*			71			71
Senegal Thick-knee	*Burhinus senegalensis*			2			2
Dwarf Bittern	*Butorides striata*				1		1
Sanderling	*Calidris alba*	140	83		123	201	547
Knot	*Calidris canutus*		38	1	2	1	42
Cerlew sand piper	*Calidris ferruginea*	1613	113	13	1512	14395	17646
Little stint	*Calidris minuta*	430			933	902	2265
Ruff	*Calidris pugnax*			5			5
Ringed plover	*Charadrius hiaticula*	3775	236	2	569	2610	7192
White-fronted Plover	*Charadrius marginatus*		3			5	8
Kittlitz's plover	*Charadrius pecuarius*				73	345	418
Black Tern	*Chlidonias niger*	85	99	27		102	313
Fulvous Whistling Duck	*Dendrocygna bicolor*			5		00	5
White-faced Whistling Duck	*Dendrocygna viduata*	24		3		174	201
Black Heron	*Egretta ardesiaca*	99			1	7	107
Little egret	*Egretta garzetta*	446	17	71	96	407	1037
Western reef heron	*Egretta gularis*	394	12	2	35	124	567
Common Moorhen	*Gallinula chloropus*	24			1		25
Collared Practincole	*Glareola pratincola*	1		101			102
Black-wing stilt	*Himantopus himantopus*	601	54		60	903	1618
Caspian Tern	*Hydroprogne caspia*					1	1
Lesser black backed gull	*Larus fuscus*		1			19	20
Black-headed gull	*Larus ridibundus*					18	18

Species		Densu Delta	Muni - Pomadze	Sakumo	Songor	Keta	Grand Total
Common Name	**Scientific Name**						
Bar-tailed godwit	*Limosa lapponica*	8	13		3	11	35
Black-tailed godwit	*Limosa limosa*					13	13
Long-tailed Cormorant	*Microcarbo africanus*	3270	37	20		5465	8792
Curlew	*Numenius arquata*	39				7	46
Whimbrel	*Numenius phaeopus*	159	35		1	42	237
Grey plover	*Pluvialis squatarola*	23	75		62	29	189
Avocet	*Recurvirostra avosetta*				1		1
Painted snipe	*Rostratula benghalensis*	1	0	1			2
Roseatte tern	*Sterna dougallii*		1				1
Common tern	*Sterna hirundo*	110	411		254	929	1704
Little tern	*Sternula albifrons*				137	232	369
Royal Tern	*Thalasseus maximus*	388	212		50	127	777
Sandwich Tern	*Thalasseus sandvicensis*	238	352		51	371	1012
Wood sand piper	*Tringa glareola*	160		15	2	2	179
Greenshank	*Tringa nebularia*	277	124	31	75	1817	2324
Marsh sand piper	*Tringa stagnatilis*	12	19	16	6	46	99
Redshank	*Tringa totanus*	4	7		8	1	20
Wattle Plover	*Vanellus senegallus*			19			19
Spur-winged plover	*Vanellus spinosus*		5	53	1	2	61
Terek Sandpiper	*Xenus cinereus*		1				1
	Grand Total	**13,233**	**1,998**	**614**	**4,098**	**29,762**	**49,705**

Species distribution of waterbirds on coastal Ramsar Sites in Ghana, January 2017 count.

(*Source*: Wildlife Division, 2017)

Family	Densu Delta	Muni - Pomadze	Sakumo	Songor	Keta	Grand Total
Anatidae	24		8		174	206
Ardeidae	1798	31	231	137	952	3149
Burhinidae			2			2
Charadridae	3798	319	74	705	2991	7887
Glareolidae	1		101			102
Jacanidae		48	54			102
Laridae		1			37	38
Phalacrocoracidae	3270	37	20		5465	8792
Rallidae	24			1		25
Recurvirostridae	601	54		61	903	1619
Rostratulidae	1		1			2
Scolopacidae	2895	433	96	2702	17478	23604
Sternidae	821	1075	27	492	1762	4177
Grand Total	**13,233**	**1,998**	**614**	**4,098**	**29,762**	**49,705**

Environmental & Social Impact Assessment

for the proposed development of a Wind Energy Facility in Anloga Extension (WPP1)

APPENDIX 7:

Noise and Flicker Impact Assessment Study

NOISE AND SHADOW IMPACT ASSESSMENT:

Scoping and Environmental and Social Impact Assessment for the proposed Development of the 76MW Wind Power Project situated at Anloga, Srogbe & Anyanui (Anloga Extension) in the Volta Region of Ghana

Report prepared for:	*Report prepared by:*
Seljen Consult Limited P. O. Box AT 140 Achimota-Accra Ghana-West Africa CSIR – Environmental Management Services P O Box 320 Stellenbosch, 7599 South Africa	Airshed Planning Professionals (Pty) Ltd P. O. Box 5260 Halfway Gardens, 1685 South Africa

DECEMBER 2017

EXECUTIVE SUMMARY

Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by the Council for Scientific and Industrial Research (CSIR) to conduct a specialist study on potential noise and shadow flicker impacts of the project through the construction, operation and decommissioning of a 76-megawatt (MW) Wind Energy Facility (WEF) in Anloga Extension areas in the Volta Region of Ghana (Figure 1). The project is referred to as Wind Power Project 1 (WPP1). Two layout alternatives are under consideration.

The main objectives of the study were therefore to determine the significance of noise and shadow flicker impacts, and to identify and recommend suitable management and mitigation measures to ensure the impact of WPP1 on the receiving environment is minimised. To achieve the study objectives the following tasks were included in the Terms of Reference (ToR).

- A desktop review of existing data and literature on noise and flicker effects, both published and unpublished in order to determine the environmental baseline.
- A study of Ghanaian and international requirements pertaining to:
    - Environmental noise measurement and impact criteria for day- and night-time; and
    - Shadow flicker impacts.
- A short-term baseline noise survey, incl.:
    - Attended short term measurements during day- and night-time;
    - Surveys of ground characteristics and other site-specific features that influence the propagation of noise such as meteorology, topography etc.
    - The identification of all existing sources of environmental noise such as communities, industries and public roads.
- A study of the receiving environment by referring to:
    - Survey results;
    - Noise and shadow flicker sensitive receptors; and
    - Details on the physical environment i.e. meteorology, land use and topography.

- Desktop environmental noise impact study:
    - The compilation of a noise source inventory incl. identification and quantification sound power levels (L_W's) associated with proposed operational phase activities and description of noise sources typically present during the construction and decommissioning phases.
    - Noise propagation simulations of wind turbine generator (WTG) noise during the operational phase using the WindPRO software.
    - Compliance and impact assessment by comparing simulated noise levels to the relevant noise criteria as identified.
    - The identification of noise management and mitigation measures based on the findings of the compliance and impact assessment.
- Desktop shadow flicker impact study:
    - Determining the impact of shadow flicker and identifying the need for it to be addressed and modelled if required due to the presence of receptors. If required, assessing the potential for shadow flicker impacts on property occupiers in the vicinity of WPP1, using internationally recognised guidelines or standards.
- The recommendation of monitoring and management measures to be included in the WPP1 Environmental Management Plan (EMP).

The results of the environmental noise and shadow flicker impact studies are summarised below.

Environmental Noise

Given the findings of the environmental noise study it is concluded that the significance of environmental noise impacts during the construction and decommissioning phases is *low* for the preferred and alternative layout. The significance of operational phase noise impacts for both the preferred and alterative layout is considered *medium* but should be reduced to *low* with the implementation of management and mitigation measures recommended in this report as a condition of project approval.

During the **construction and decommissioning phases** of the project, *low* significance noise impacts may be maintained by implementing basic good practice measures such as the maintenance of diesel mobile equipment, traffic management, and limiting noise generating activities to day-time hours.

The *medium significance* rating for the **operational phase** is based on the finding that exceedance of noise impact guidelines may occur up to 4.7 rotor diameters from the preferred layout WTG arrays and 3.6 rotor diameters from the alternative layout WTG arrays. Given available satellite imagery, several residential structures fall within this distance from WPP1, specifically at Anloga. Special measures (such as operating certain WTGs at lower noise modes and or relocation) must be adopted to manage noise impacts at all NSR within 4.7 rotor diameters from V110 WTGs, and 3.6 rotor diameters from V136 WTGs.

It is also concluded that, from an environmental noise perspective, the alternative layout is the preferred option for the following reasons:

- Residents in and around Anyanui, where lower background noise levels prevail in comparison with Anloga, will not be impacted.
- The alternative layout necessitates the use of larger WTGs. The Vestas V136 WTG with the serrated LNTE at the optimised operational mode has a reference L_W of 105.5 dB which is comparable to the 106 dB of the smaller WTG (Vestas V110) with the LNTE, proposed for use with the preferred layout.
- At the same L_W, larger WTGs result in lower ground level noise due to increased emission height (95 m vs. 112 m), distance from receptors, as well as larger distances between WTGs.

Shadow Flicker

It is concluded that shadow flicker impacts, only of concern during the operational phase are *of medium* significance (for the preferred and alternative layout) and must be reduced by implementing the appropriate mitigation measures as a condition for project approval.

Receptors at Anloga within 3 rotor diameters of the eastern WTG array must be relocated. This requirement will be met if the recommendations for the mitigation of noise impacts are met.

To further reduce shadow flicker impacts at Anloga and those SSRs within the 8 to 30-hour real shadow impact zone, VRA should consider shutting down WTGs proposed as part of the eastern WTG array of WPP1 during early morning and afternoon hours from October to February. From a shadow flicker perspective, the preferred layout it slightly more preferred since the impact area of the V110 WTGs is somewhat smaller than the larger V136 WTGs.

LIST OF ABBREVIATIONS AND TERMINOLOGY

DEFINITIONS	
Airshed	Airshed Planning Professionals (Pty) Ltd
CSIR	Council for Scientific and Industrial Research
dB	Descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure.
dBA	Descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure that has been A-weighted to simulate human hearing.
DTI	Department of Trade and Industry
EHS	Environmental, Health, and Safety (IFC)
EMP	Environmental Management Program
EPHC	Environment Protection Heritage Council (Australia)
ETSU	Energy Technology Support Unit (UK)
GEPA	Ghana Environmental Protection Agency
Hz	Frequency in Hertz
IEC	International Electro Technical Commission
IFC	International Finance Corporation
ISO	International Standards Organisation
Kn	Noise propagation correction factor
K1	Noise propagation correction for geometrical divergence
K2	Noise propagation correction for atmospheric absorption
K3	Noise propagation correction for the effect of ground surface;
K4	Noise propagation correction for reflection from surfaces
K5	Noise propagation correction for screening by obstacles
MW	Power in mega watt
L_{Aeq} (T)	The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured) (in dBA)
L_{A90}	The A-weighted 90% statistical noise level, i.e. the noise level that is exceeded during 90% of the measurement period. It is a very useful descriptor which provides an indication of what the L_{Aeq} could have been in the absence of noisy single events and is considered representative of background noise levels (L_{A90}) (in dBA)
L_{AFmax}	The A-weighted maximum sound pressure level recorded during the measurement period
L_{AFmin}	The A-weighted minimum sound pressure level recorded during the measurement

	period
LNTE	Low noise trailing edge
L_P	Sound pressure level (in dB)
L_{PA}	A-weighted sound pressure level (in dBA)
L_{PZ}	Un-weighted sound pressure level (in dB)
Ltd	Limited
L_W	Sound Power Level (in dB)
m^2	Area in square meters
m/s	Speed in meters per second
NSR	Noise sensitive receptor
p	Pressure in Pa
Pa	Pressure in Pascal
µPa	Pressure in micro-pascal
p_{ref}	Reference pressure, 20 µPa
Pty	Proprietary
SLM	Sound Level Meter
SSR	Shadow sensitive receptor
ToR	Terms of Reference
UK	United Kingdom
VRA	Volta River Authority
WEF	Wind energy facility
WHO	World Health Organisation
WPP1	Wind Power Project No. 1
WTG	Wind turbine generator
%	Percentage

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NOISE AND SHADOW IMPACT ASSESSMENT: ESIA PHASE

1. INTRODUCTION

Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by the Council for Scientific and Industrial Research (CSIR) to conduct a specialist study on potential noise and shadow flicker impacts associated with the proposed construction, operation and decommissioning of a 76-megawatt (MW) Wind Energy Facility (WEF) in Anloga Extension areas in the Volta Region of Ghana (Figure 1). The project is referred to as Wind Power Project 1 (WPP1). Two layout alternatives are under consideration.

Noise will be generated during the construction, operational as well as decommissioning phases of WPP1. Shadow flicker impacts will be limited to the operational phase of the project. The main objectives of the study were therefore to:

- For environmental noise
  - Determine the extent to which the existing acoustic climate of the area will be affected by noise as a result of WPP1; and
  - Identify and recommend suitable management and mitigation measures to ensure the impact of WPP1 on the receiving acoustic environment is minimised.
- For shadow flicker
  - Determine the impact of shadow flicker on nearby receptors; and
  - Identify and recommend suitable management and mitigation measures to ensure that the impacts associated with shadow flicker of WPP1 on nearby sensitive receptors is minimised.

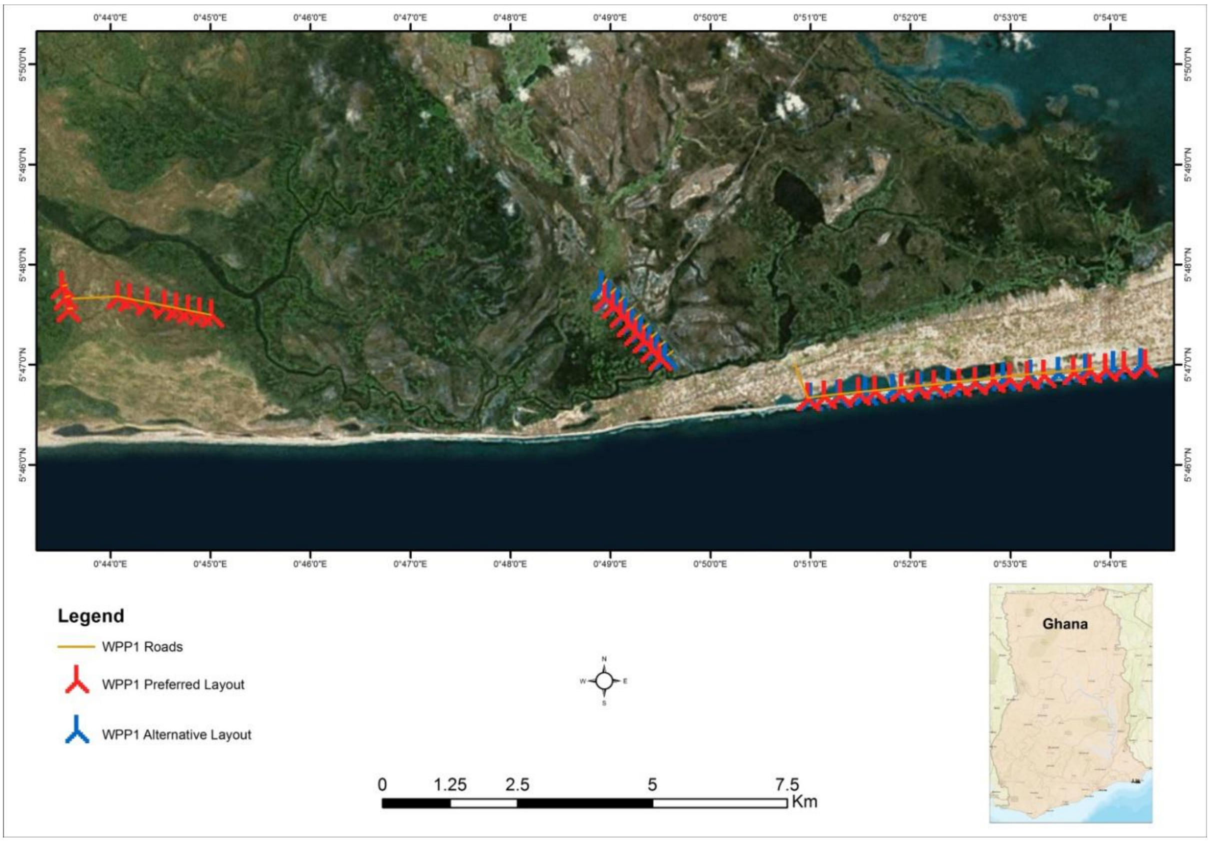


Figure 1: Location of the site for WPP1 with preferred and alternative layouts

2. TERMS OF REFERENCE

To achieve the study objectives, the following tasks were included in the Terms of Reference (ToR):

- A desktop review of existing data and literature on noise and flicker effects, both published and unpublished in order to determine the environmental baseline.
- A study of Ghanaian and international requirements pertaining to:
  - Environmental noise measurement and impact criteria for day- and night-time; and
  - Shadow flicker impacts.
- A short-term baseline noise survey, including:
  - Attended short term measurements during day- and night-time;
  - Surveys of ground characteristics and other site-specific features that influence the propagation of noise such as meteorology, topography etc.
  - The identification of all existing sources of environmental noise such as communities, industries and public roads.
- A study of the receiving environment by referring to:
  - Survey results;
  - Noise and shadow flicker sensitive receptors; and
  - Details on the physical environment i.e. meteorology, land use and topography.
- A desktop environmental noise impact study which involved:
  - A compilation of a noise source inventory including identification and quantification of sound power levels (L_W's) associated with proposed operational phase activities and description of noise sources typically present during the construction and decommissioning phases.
  - Noise propagation simulations of wind turbine generator (WTG) noise during the operational phase.
  - Compliance and impact assessment by comparing simulated noise levels to relevant noise criteria as identified.

  - Identification of noise management and mitigation measures based on the findings of the compliance and impact assessment.
- A desktop shadow flicker impact study to:
  - Determining the impact of shadow flicker and identifying the need to address and mode if required due to the presence of receptors. If required, assessing the potential for shadow flicker impacts on property occupiers in the vicinity of WPP1, using internationally recognised guidelines or standards.
- The recommendation of monitoring and management measures to be included in the WPP1 Environmental Management Plan (EMP).

Additionally, the ToR included training on WEF noise impact assessments to Volta River Authority (VRA) staff. Training included:

- An introduction to the physics of sound;
- Measurement of sound (practical showing the settings required on a noise meter) as well as the technical requirements from a measuring standard;
- An introduction to WindPro (BASIS and DECIBEL modules);
- Inputting digital elevation data, noise sensitive receptors and turbines;
- Modelling of a windfarm layout with the correct standards;
- Generating reports in WindPRO; and
- Integration of WindPRO with Google Earth.

The required Environmental and Social Impact Assessment (ESIA) end-product from the noise assessment, was to provide a comprehensive and detailed Noise and Shadow Flicker Impact Assessment (N&SFIA) that presents and evaluates the noise and shadow flicker impact of the wind turbines under different operating conditions.

3. PROJECT DESCRIPTION

3.1 ENVIRONMENTAL NOISE

3.1.1 Background to Environmental Noise and the Assessment thereof

Before more details regarding WPP1, the approach and methodology adopted in the study is given, the reader is provided with some background, definitions and conventions used in the measurement, calculation and assessment of environmental noise.

Noise is generally defined as unwanted sound transmitted through a compressible medium such as air. Sound in turn, is defined as any pressure variation that the ear can detect. Human response to noise is complex and highly variable as it is subjective rather than objective.

Noise is reported in decibels (dB). "dB" is the descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure. The relationship between sound pressure and sound pressure level is illustrated in the equation given below wherein Lp is the sound pressure level in dB, p is the actual sound pressure in Pa, and p_{ref} is the reference sound pressure (p_{ref} in air is 20 µPa).

$$L_p = 20 \cdot \log_{10}\left(\frac{p}{p_{ref}}\right)$$

where L_p is the sound pressure level in dB, p is the actual sound pressure in Pa; and p_{ref} is the reference sound pressure (p_{ref} in air is 20 µPa).

3.1.1.1 Perception of Sound

Sound has already been defined as any pressure variation that can be detected by the human ear. The number of pressure variations per second is referred to as the frequency of sound and is measured in hertz (Hz). The hearing frequency of a young, healthy person ranges between 20 Hz and 20 000 Hz.

In terms of L_P, audible sound ranges from the threshold of hearing at 0 dB to the pain threshold of 130 dB and above. By doubling sound pressure (in Pa), the sound pressure level increases by 6 dBA. The smallest perceptible change is about 1 dB. Noise levels have to increase by 8 to 10 dBA to appear significantly louder (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

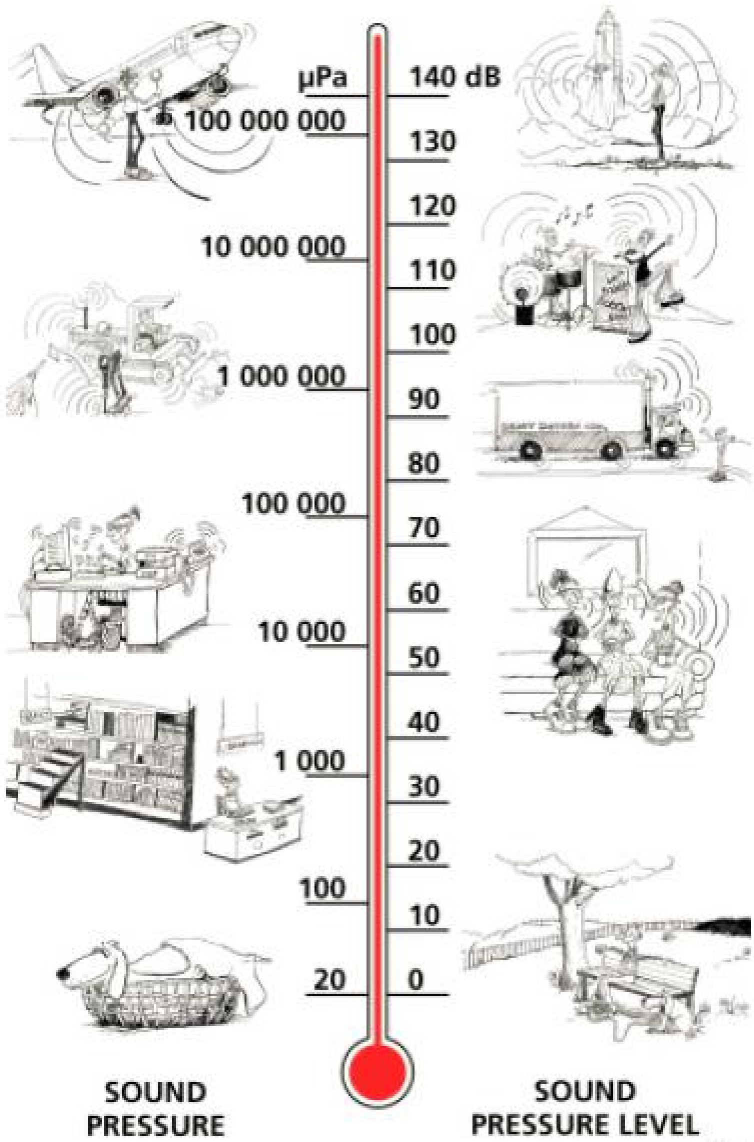


Figure 2: The decibel scale and typical noise levels (Brüel & Kjær Sound & Vibration Measurement A/S, 2000)

3.1.1.2 Frequency Weighting

Since human hearing is not equally sensitive to all frequencies, a ‘filter’ has been developed to simulate human hearing. The ‘A-weighting’ filter simulates the human hearing characteristic, which is less sensitive to sounds at low frequencies than at high frequencies (Figure 3). “dBA” is the descriptor that is used to indicate 10 times a logarithmic ratio of quantities, that have the same units (in this case sound pressure) that has been A-weighted.

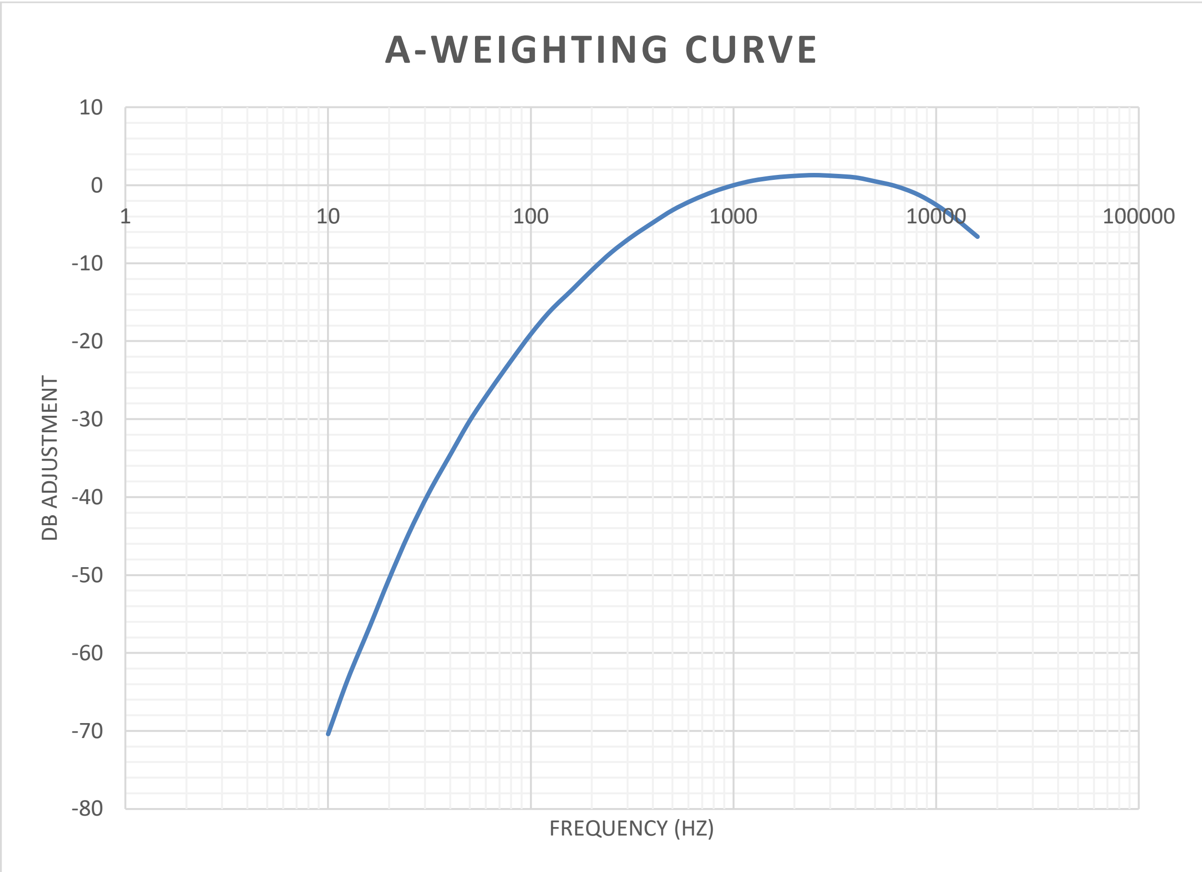


Figure 3: A-weighting curve

3.1.1.3 Adding Noise Levels

Since sound pressure levels are logarithmic values, the sound pressure levels as a result of two or more sources cannot just simply be added together. To obtain the combined sound pressure level of a combination of sources such as those at an industrial plant, individual sound pressure levels must be converted to their linear values and added using:

$$L_{p\_combined} = 10 \cdot \log\left(10^{\frac{L_{p1}}{10}} + 10^{\frac{L_{p2}}{10}} + 10^{\frac{L_{p3}}{10}} + \cdots 10^{\frac{L_{pi}}{10}}\right)$$

This implies that if the difference between the sound pressure levels of two sources is nil the combined sound pressure level is 3 dB more than the sound pressure level of one source alone. Similarly, if the difference between the sound pressure levels of two sources is more than 10 dB, the contribution of the quietest source can be disregarded (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

3.1.1.4 Environmental Noise Propagation

Many factors affect the propagation of noise from source to receiver. The most important of these are:

- The type of source and its sound power, L_W;
- The distance between the source and the receiver;
- Atmospheric conditions (wind speed and direction, temperature and temperature gradient, humidity etc.);
- Obstacles such as barriers or buildings between the source and receiver;
- Ground absorption; and
- Reflections

To arrive at a representative result from either measurement or calculation, all these factors must be taken into account (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

3.1.1.5 Environmental Noise Indices

In assessing environmental noise either by measurement or calculation, reference is generally made to the following indices:

- **L_{Aeq} (T) –** The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured).
- **L_{A90} –** The A-weighted 90% statistical noise level, i.e. the noise level that is exceeded during 90% of the measurement period. It is a very useful descriptor which provides an indication of what the L_{Aeq} could have been in the absence of noisy single events and is considered representative of background noise levels.
- **L_{AFmax} –** The maximum A-weighted noise level measured with the fast time weighting. It's the highest level of noise that occurred during a sampling period.
- **L_{AFmin} –** The minimum A-weighted noise level measured with the fast time weighting. It's the lowest level of noise that occurred during a sampling period.

3.1.2 Construction Phase Noise

Several activities associated with the construction/erection of wind turbines and hard standing areas, buildings and ancillary infrastructure will generate noise. Noise is emitted by construction equipment used for the fabrication, and erection of infrastructure including all related activities such as land clearing, site preparation, excavation, clean-up, and landscaping.

Construction equipment can be described or divided into distinct categories. These are earthmoving equipment, materials handling equipment, stationary equipment, impact equipment, and other types of equipment. The first three categories include machines that are powered by internal combustion engines. Machines in the latter two categories are powered pneumatically, hydraulically, or electrically. Additionally, exhaust noise tends to account for most of the noise emitted by machines in the first three categories (those that use internal combustion engines) whereas engine-related noise is usually secondary to the noise produced by the impact between impact equipment and the material on which it acts (Bugliarello, Alexandre, Barnes, & Wakstein, 1976).

Construction equipment generally produces noise in the lower end of the frequency spectrum. Reverse, or moving beeper, alarms emit at higher frequency ranges and are often heard over long distances.

Noise generated during construction is highly variably since it is characterised by variations in the power expended by construction equipment. Besides having daily variations in activities, major construction projects are accomplished in several different phases where each phase has a specific equipment mix depending on the work to accomplish during that phase.

3.1.3 Operational Phase Noise

3.1.3.1 Noise Mechanisms of Wind Turbines

Wind turbine operation generates four types of noise namely tonal, broadband, low-frequency, and impulsive (Figure 4) (Manwell, McGowan, & Rogers, 2009).

- *Tonal noise*, is noise at discrete frequencies that is caused by wind turbine components such as meshing gears, nonlinear boundary layer instabilities interacting with a rotor blade surface, by vortex shedding from a blunt trailing edge, or unstable flows over holes or slits.
- *Broadband noise*, is characterized by a continuous distribution of sound pressure with frequencies greater than 100 Hz. It is often caused by the interaction of wind turbine blades with atmospheric turbulence, and is also described as a characteristic ‘swishing’ or ‘whooshing’ sound.
- *Low frequency noise*, in the range of 20 Hz to 100 Hz, is mostly associated with downwind turbines i.e. machines have the rotor placed on the lee side of the tower. It is caused when the turbine blade encounters localized flow deficiencies due to the flow around a tower, wakes shed from other blades, etc. The wind turbine generator units proposed for WPP1 are upwind machines with rotors facing the wind.
- *Impulsive noise*, involves short acoustic impulses or thumping sounds that vary in amplitude with time characterize this noise. They may be caused by the interaction of wind turbine blades with disturbed air flow around the tower of a downwind machine, and/or the sudden deployment of tip breaks or actuators.

There are various causes of the noise emitted from operating wind turbines. These can be divided into two categories, namely (1) aerodynamic noise, and (2) mechanical noise.

Aerodynamic noise is generated by several complex flow phenomena of air around the rotor blades (Manwell, McGowan, & Rogers, 2009). It tends to increase with blade tip speed or tip speed ratio and is broadband in nature. It is typically also the largest source of wind turbine noise. During turbulent wind conditions, blades may emit low-frequency noise as they are buffeted by changing winds. Aerodynamic noise mechanisms, divided into three distinct groups, and its importance in wind turbine noise impacts, are summarised in Table 1.

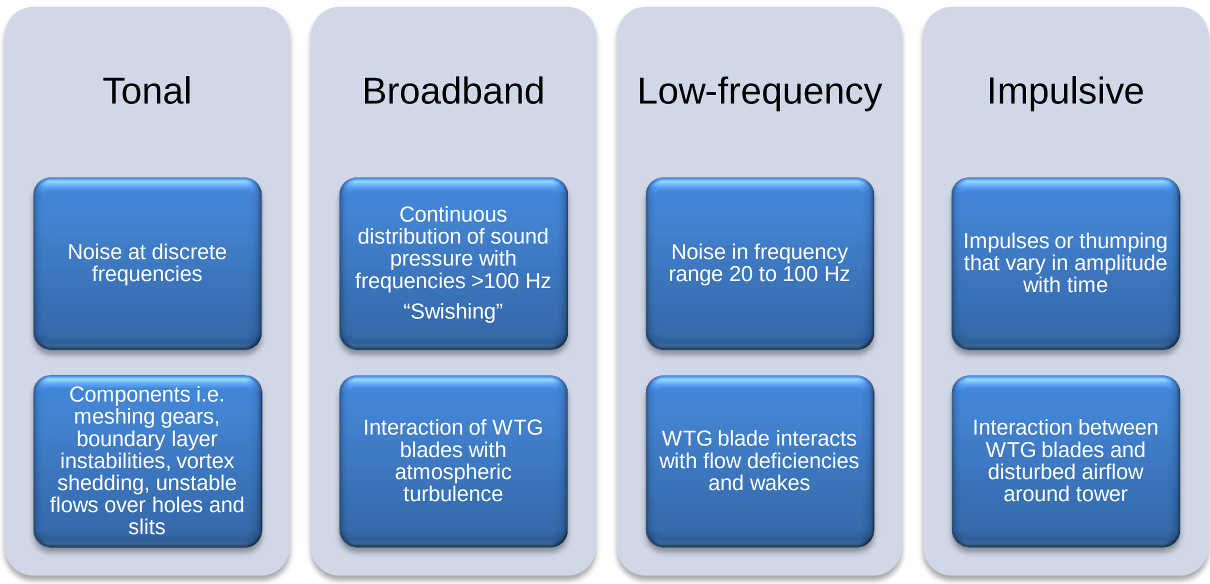
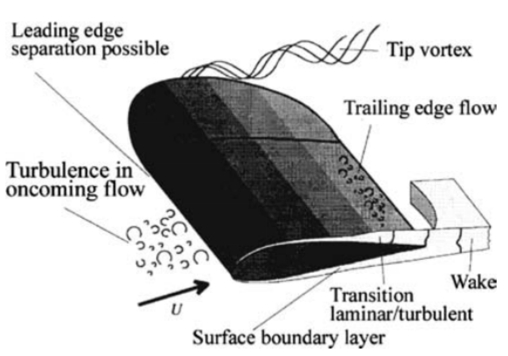


Figure 4: Types of noise generated by wind turbine operation

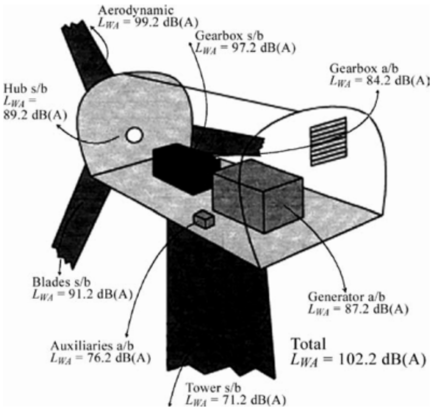
Table 1: Aerodynamic noise mechanisms (Manwell, McGowan, & Rogers, 2009)

Type of noise	Indication	Mechanism	Main characteristics and importance
Low frequency noise	Steady thickness noise; steady loading noise	Rotation of blades or rotation of lifting surfaces	Frequency is related to blade passing frequency, not important at current rotational speeds
	Unsteady loading noise	Passage of blades through tower velocity deficit or wakes	Frequency is related to blade passing frequency, small in cases of upwind turbines, possibly contributing in case of wind farms
Inflow turbulence noise		Interaction of blades with atmospheric turbulence	Contributing to broadband noise; not yet fully quantified
Airfoil (blade) self-noise	Trailing-edge noise	Interaction of boundary layer turbulence with blade trailing edge	Broadband, main source of high frequency noise (770 Hz to 2 kHz)
	Tip noise	Interaction of tip turbulence with blade tip surface	Broadband; not fully understood
	Stall, separation noise	Interaction of turbulence with blade surface	Broadband
	Laminar boundary layer noise	Nonlinear boundary layer instabilities interacting with the blade surface	Tonal, can be avoided
	Blunt trailing edge noise	Vortex shedding at blunt trailing edge	Tonal, can be avoided
	Noise from flow over holes, slits and intrusions	Unstable shear flows over holes and slits, vortex shedding from intrusions	Tonal, can be avoided

The relative motion of mechanical components and the dynamic response that results, results in *mechanical noise*. Main mechanical noise sources include the gearbox, generator, yaw drives, cooling fans, and auxiliary equipment such as hydraulics (Manwell, McGowan, & Rogers, 2009). Noise emitted by these components tend to be tonal in character but may have broadband components. Mechanically generated noise can also be transmitted, amplified and radiated by the hub, rotor and tower. The transmission of the noise can be air-borne (directly from the component into air) or structure-borne (noise transmitted along other structural components before being radiated to air). The diagrams in Figure 5, retrieved from *'Wind Energy Explained'* by Manwell, McGowan, & Rogers (2009), provides a visual representation noise from operating wind turbines.



(a) Aerodynamic noise, schematic of flow around a rotor blade



(b) Components and total sound power level for wind turbine (2 MW, 115 m downwind)

Figure 5: Schematic of airflow around a rotor blade and components as well as total L_W's for a 2 MW wind turbine at a downwind distance of 115 m (Manwell, McGowan, & Rogers, 2009)

3.1.3.2 Wind Turbine Selections for WPP1

WPP1 will consist of either:

- a total of 38 Vestas V110 wind turbine generator units with 2 MW rated power, hub height at 95 m, and rotor diameter of 110 m (the preferred layout); or
- a total of 22 Vestas V136 wind turbine generator units with 3.45 MW rated power, hub height at 112 m, and rotor diameter of 136 m (the alternative layout).

Both units can be specified with one of several different 'noise modes'. Each mode is set in the turbine software as part of the installation, although it may be changed to another mode later. Each unique (distinct) noise mode implies a different power curve, so that for quieter operation, some energy yield is sacrificed. Noise mitigation is managed by adjustments to the blade pitch angle.

For both the preferred and alternative layouts different operational noise modes were considered. Operational noise modes and associated power curves were obtained from WTG specification sheets and the feasibility study (Lahmeyer International, 2016). L_W data for the Vestas V110 and V136 wind turbine generator units are presented in Table 2 and

Table 3 respectively. Note that all sound power levels reported below are under the following conditions:

- Measurement standard: International Electrotechnical Commission (IEC) 61400-11 ed. 3
- Maximum turbulence at hub height: 30%
- Inflow angle (vertical): 0±2º
- Air density: 1.225 kg/m^3

Table 2: Noise data (L_{WA}) for the 2 MW V110 WTG with serrated low noise trailing edge (LNTE) (Lahmeyer International, 2016)

Wind speed, 10 m above ground (m/s)	Noise mode 0	Noise mode 1	Noise mode 2
3	95.3	95.3	95.0
4	96.0	95.8	95.6
5	97.0	97.0	96.5
6	100.8	101.0	100.6
7	102.4	102.4	100.6
8	104.6	103.5	100.6
9	106.0	103.7	100.6
10	106.0	103.8	100.6
11	106.0	103.8	100.6
12	106.0	103.8	100.6
Rated power (kW) at 12 m/s	*2 000*	*1 950*	*1 150*

Table 3: Noise data (L_{WA}) for the 3.45 MW V136 WTG with serrated LNTE (Vestas, 2016; Lahmeyer International, 2016)

Wind speed, at hub height (m/s)	L_{WA} (dBA)	L_{WA} (dBA) Available sound optimized modes			
	Mode 0	**Mode SO1**	**Mode SO2**	**Mode SO3**	**Mode SO4**
3	92.2	92.2	92.2	92.2	92.2
4	92.5	92.5	92.5	92.5	92.5
5	94.5	94.5	94.5	94.5	94.5
6	97.4	97.4	97.4	97.4	97.4
7	100.5	100.5	100.5	100.5	98.0
8	103.4	103.3	103.0	102.1	98.0
9	105.4	104.4	103.5	101.8	98.0
10	105.5	104.4	103.5	101.2	98.0
11	105.5	104.4	103.5	100.8	98.0
12	105.5	104.4	103.5	100.4	98.0
13	105.5	104.4	103.5	100.2	98.0
14	105.5	104.4	103.5	100.2	98.0
15	105.5	104.4	103.5	101.3	98.0
16	105.5	104.4	103.5	102.1	98.0
17	105.5	104.4	103.5	102.3	98.0
18	105.5	104.4	103.5	102.4	98.0
19	105.5	104.4	103.5	102.4	98.0
20	105.5	104.4	103.5	102.4	98.0
Rated power (kW) at 12 m/s	*3 450 kW*	*3 400 kW*	*3 370 kW*	*2 700 kW*	*1 040 kW*

3.1.4 Decommissioning Phase Noise

At the end of its operational lifetime, the WEF will be decommissioned and infrastructure removed. Information regarding the decommissioning phase was limited at the time but it can be reasonably assumed that noise sources and impacts would be similar to those of the construction phase.

It is expected to include the demolition and (or) removal of wind turbines and hard standing areas, buildings and ancillary infrastructure. Noise will also be emitted by mobile equipment and all related activities such as land clearing, site preparation, excavation, clean-up, and landscaping.

3.2 SHADOW FLICKER

When the moving blades of a wind turbine rotor cast moving shadows, shadow flicker occurs. This flickering effect may annoy people living close to the turbine. Sunlight may also be reflected from gloss-surfaced turbine blades and cause a “flashing” effect. Shadow flicker and blade glint is more of a problem in higher and lower latitudes, and the low angle of the sun in the sky (Manwell, McGowan, & Rogers, 2009).

In the worst-case conditions in Norther Europe, flickering only occurs for approximately 30 minutes a day for 10 to 14 weeks during winter. To mitigate shadow flicker and blade glint impacts European countries typically avoid wind turbines operation during short impact periods, site turbines taking account of the shadow path on nearby residences, and using non-reflective, no-gloss blades. In Denmark, a minimum separation distance of 6 to 8 rotor diameters between the turbine and closest neighbour is recommended (Manwell, McGowan, & Rogers, 2009).

To calculate shadow flicker impacts, the following information is typically needed:

- The position of wind turbine generator units and operational times;
- Hub heights and rotor diameters;
- The position of the shadow receptor object and its orientation;
- The geographic position of the project with time zone and daylight savings time information, if applicable; and
- Information about the earth’s orbit and rotation relative to the sun.

4. APPLICABLE LEGISLATION

Noise level guidelines and limits for calculating shadow flicker impacts are discussed in Sections 4.1 and4.2 respectively.

4.1 ENVIRONMENTAL NOISE LEVEL GUIDELINES

This study refers to environmental noise standards published by the Ghana Environmental Protection Agency (GEPA), and guidelines published by the International Finance Corporation (IFC) in their General Environmental, Health, and Safety (EHS) Guidelines.

In the absence of specific of noise guidelines in Ghana for WEFs, reference is also made to the report compiled as an Energy Technology Support Unit (ETSU) project by a working group on wind turbine noise and facilitated by the United Kingdom (UK) Department of Trade and Industry (DTI).

4.1.1 Environmental Noise Standards in Ghana

The GEPA specifies environmental noise standards for various zones during both day- and night-time (Table 4). Given the predominantly rural and residential nature of the study area and receptors, environmental noise standards for Zone A is considered most applicable. In residential areas with negligible or infrequent traffic (Zone A), outdoor noise levels at noise sensitive receptors should not exceed 55 dBA during the day, and 48 dBA during the night.

It should be noted that standards for Zone A are comparable to the IFC guidelines for residential, educational and institutional receptors (see Section 4.1.2).

Table 4: GEPA environmental noise standards

Zone	Description	Permissible noise level in dBA	
		Day (06:00 to 22:00)	Night (22:00 to 06:00)
A	Residential areas with negligible or infrequent transportation	55	48
B1	Educational and health facilities	55	50
B2	Areas with commercial or light industrial activities	60	55
C1	Areas with light industry, entertainment, public assembly or places of worship	65	60
C2	Commercial areas	75	65
D	Light industrial areas	70	60
E	Heavy industrial areas	70	70

4.1.2 IFC Environmental Noise Level Guidelines

The IFC General EHS Guidelines on noise address impacts of noise beyond the property boundary of the facility under consideration and provides noise level guidelines.

The IFC states that noise impacts **should not exceed the levels presented in** Table 5, OR result in a maximum **increase above background levels of 3 dBA** at the nearest receptor location off-site (IFC, 2007). For a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level is not detectable. Δ = 3 dBA is, therefore, a useful significance indicator for a noise impact.

Table 5: IFC Noise Level Guidelines

Receptor Type	One-hour LAeq (dBA) 07:00 to 22:00	One-hour LAeq (dBA) 22:00 to 07:00
Industrial	70	70
Residential, Institutional and Educational	55	45

4.1.3 The Assessment and Rating of Noise from Wind Farms According to ETSU-R-97 (1996)

The main aim of the report by the Working Group on Noise from Wind Turbines (ETSU-R-97, 1996), was to provide information and advice to developers and planners on the environmental assessment of noise from wind turbines. It contains the consensus view of the members of the Noise Working Group who have extensive experience in assessing and controlling environmental impact of noise from wind farms.

Noise limits derived by the Noise Working Group took into account:

- Existing standards and guidance relating to noise;
- The need of society for renewable energy sources to reduce the emission of atmospheric pollutants in pursuance of energy policies;
- The ability of manufacturers to meet noise limits;
- Research of Noise Working Groups in the UK, Denmark, the Netherlands, and Germany; and
- The professional experience of members of the Noise Working Group.

An important finding by the Noise Working Group was that absolute noise limits, applied at all wind speeds, are not suited to wind farms and that limits set relative to the background noise are more appropriate. To accurately determine the impact of wind turbine noise (which varies with wind speed), background noise over a range of wind speeds must be measured. They do however make allowances for circumstances where a more simplified approach, based on a fixed limit, may be appropriate.

They further recommend that noise limits should only be set for wind speeds up to 12 m/s as recorded at a height of 10 m above ground level, siting the following reasons:

- In the UK wind speeds are not often measured at speeds greater than 12 m/s;
- Reliable measurement of background noise levels and turbine noise is difficult in high wind conditions;
- Turbine manufacturers are unlikely to be able to provide information on L_W's at high wind speeds for similar reasons; and
- If a wind farm meets noise limits at wind speeds lower than 12 m/s it is most unlikely to cause loss of amenity at higher wind speeds.

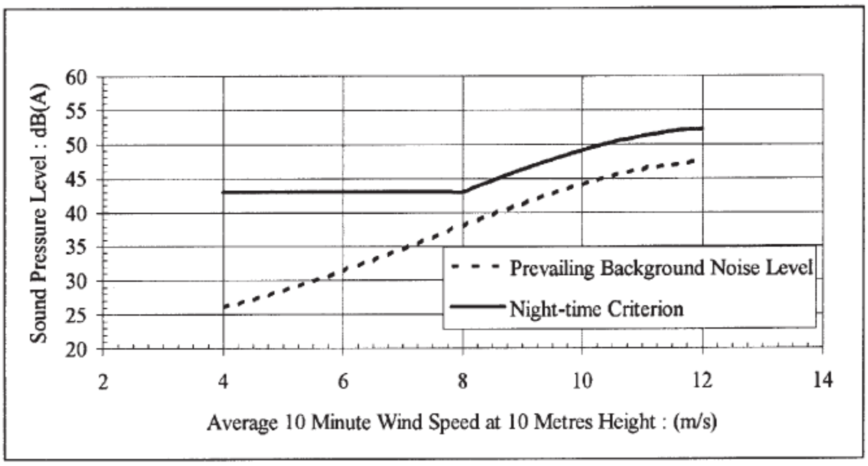
Separate noise limits should also be applied for day- and night-time, since during the night, protection of external amenity becomes less important and the emphasis should be on preventing sleep disturbance. Whereas day-time limits should be derived from background noise data taken during quiet periods of the day, night-time noise levels must be derived from background noise data collected at night. Periods of the day are defined as follows:

- Quiet day-time periods:
  - All evenings from 18:00 to 23:00;
  - Saturdays from 13:00 to 18:00;
  - All day Sunday
- Night-time from 23:00 to 07:00

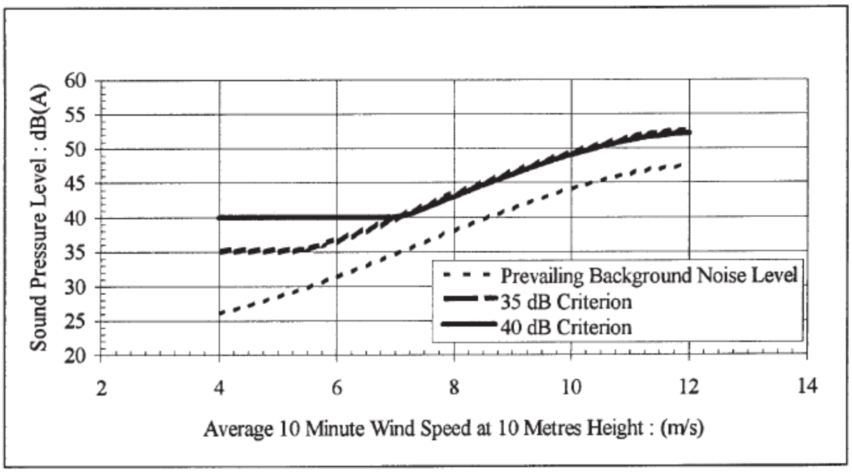
Furthermore:

- The $L_{A90,10min}$ descriptor should be used for both background and windfarm noise. It allows the reliable measurement of noise without interference from relatively loud, transitory noise events from other sources.
- When setting limits, it should be borne in mind that the $L_{A90,10min}$ of the wind farm is likely to be about 1.5 to 2.5 dBA less than the L_{Aeq} over the same period.
- Limits are applicable to free-field (except for ground reflection) measurements in the vicinity of NSRs.
- The cumulative effect of all wind turbines within an area must be considered. Existing wind farms must not be considered as part of the prevailing background noise.
- Background noise levels upon which limits are based and the noise limits themselves must be based on typical rather than extreme values at any given wind speed. The approach entails the derivation of limits from average levels but also appreciating that both background and turbine noise levels can vary over several dB for the same nominal conditions.
- Variation in background noise level with wind speed must be determined by correlating $L_{A90,10min}$ noise measurements taken over a period of time, with average wind speeds measured over the same 10 min periods and then fitting a curve to the data.

- Noise from a WEF should be limited to 5 dBA above background for both day- and night-time.
- In low noise environments the day-time level of the $L_{A90,10min}$ of the WEF should be limited to an absolute level within the range of 35 to 40 dBA. The actual choice of value will depend on:
  - The number of dwellings in the neighbourhood of the wind farm;
  - The effect of noise limits on the power generation capacity (i.e. operational mode vs power output sacrifice); and
  - Duration and level of exposure.
- The fixed night-time limit is 43 dBA. The value was derived from the 35 dBA sleep disturbance criteria with a 10 dBA allowance for noise attenuation through an open window and 2 dBA subtracted to account for the use of $L_{A90,10min}$ rather than $L_{Aeq,10min}$.
- The day- and night-time lower fixed limits can be increased to 45 dBA and the permissible margin above background increased where the occupier of the property has some financial involvement in the wind farm.
- If noise from a WEF is limited to an $L_{A90,10min}$ of 35 dBA up to wind speeds of 10 m/s measured 10 m above ground level, then this condition alone would offer sufficient protection of amenity and background noise surveys would be unnecessary.
- Recommended wind dependent limits based on typical background noise curves are presented in Figure 6.
- Penalties should be applied if wind turbines present tonal character.



(a) Example of night-time noise criterion at typical background noise levels



(b) Example of day-time noise criterion at typical background noise levels

Figure 6: Example wind-dependant noise limits for typical background noise conditions (ETSU-R-97, 1996)

4.2 GUIDELINES FOR SHADOW FLICKER

International regulations for shadow flicker vary widely. The most comprehensive regulations are those implemented in Germany. The limits are:

- A maximum of 30 hours per year and 30 minutes per day of astronomical maximum shadow (worst-case);

- A maximum of 8 hours per year for real shadow impact.

The limit is based on the following:

- The angle of the sun over the horizon must be at least 3 degrees; and
- The blade of the wind turbine must cover at least 20% of the sun.

Other European countries refer to German regulations with some minor modifications. For example, although no official guidelines have been set, Sweden and Demark use the 10-hour criterion for real shadow impact rather than 8. In the UK, no official limits are in force, however an assessment is required at all dwellings within 10 rotor diameters of turbine locations. In both the Republic of Ireland and Northern Ireland a worst-case limit of 30 hours per year, 30 minutes per day has been set.

In Australia, the Victorian guidelines specify a limit of 30 hours per year whereas the South Australian development plan suggests that shadows need only be considered out to a distance 500 m from the turbine.

One commonality in most regulations is the 30 hours per year limit which, according to the Australian Environment Protection and Heritage Council (EPHC, 2010), appears to be based on a German court ruling which set this as the acceptability limit for a particular wind farm. Subsequent studies have supported its use as a reasonable determinant for acceptable levels of annoyance. The EPHC notes however, that one study concluded that setting a limit based on hours per year is overly simplistic, as survey results show that the time of day and year at which shadow flicker occurs is important in determining its annoyance value. In the above court ruling and in the subsequent studies, the 30 hours per year limit is taken as the modelled (worst-case) limit, not the actual amount of shadow flicker, which may be considerably less because of cloud cover. This interpretation is not, however, universal and some regulations (notably in Australia) use 30 hours per year as the actual limit (EPHC, 2010).

For the purpose of this assessment, 30 hours per year of actual shadow impact was adopted as the assessment criterion.

5. METHODOLOGY AND STUDY APPROACH

5.1 ENVIRONMENTAL NOISE IMPACT STUDY

The approach to the environmental noise impact study and its components are discussed in more detail in this section.

5.1.1 Study of the Receiving Acoustic Environment

A study of the receiving acoustic environment was made by referring to:

- The results of a short-term baseline noise survey conducted by Airshed and supplemented by data collected by VRA.
- The identification of potential noise sensitive receptors; and
- Details on the physical environment i.e. meteorology, land-use and topography and how these factors affect local atmospheric noise propagation.

The extent of noise impacts as a result of an intruding noise depends largely on existing noise levels in an area. Higher ambient noise levels will result in less noticeable noise impacts and a smaller impact area-the opposite also holds true. Increases in noise will be more noticeable in areas with low ambient noise levels. For WEFs both ambient and wind turbine noise increase with wind speed.

The survey methodology, which closely followed guidance provided by the IFC (2007), is summarised below:

- The survey was designed and conducted by a trained specialist on 17, 18 and 19 October 2016 at three sites (Figure 9, page 44; Figure 10, page 45; Figure 11, page 46).
- Sampling was carried out using a Type 1 sound level meter (SLM) that meet all appropriate IEC standards and is subject to calibration by an accredited laboratory (Annex A). Equipment details are included in Table 6.
- The acoustic sensitivity of the SLM was tested with a portable acoustic calibrator before and after each sampling session and found to be within acceptable limits.

- Samples, 10 to 15 minutes in duration, representative and sufficient for statistical analysis were taken with the use of the portable SLM capable of logging data continuously over the sampling time period. Samples representative of the day- and night-time acoustic environment were taken.
- L_{Aeq} (T); L_{AFmax}; L_{AFmin}; L_{A90} and 3rd octave frequency spectra were recorded.
- The SLM was located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface.
- Measurements are not affected by residual noise and extraneous influences, e.g. electrical interference and any other non-acoustic interference, and the instrument was operated under the conditions specified by the manufacturer.
- A detailed electronic log and record was kept. Records included site details, weather conditions during sampling and observations made regarding the acoustic environment of each site.

Table 6: Sound level meter details

Equipment	Serial Number	Purpose	Last Calibration Date
Brüel & Kjær Type 2250 Lite SLM	S/N 2731851	Attended 15 to 30-minute sampling.	26 January 2016
Brüel & Kjær Type 4950 ½" Pre-polarized microphone	S/N 2709293	Attended 15 to 30-minute sampling.	26 January 2016
SVANTEK SV33 Class 1 Acoustic Calibrator	S/N 57649	Testing of the acoustic sensitivity before and after each daily sampling session.	14 June 2016

VRA conducted noise measurements in February 2015, the results of which are reported in the *'Anloga and Anyanui Background Noise Level Assessment Report'* (VRA, 2015). They recorded $L_{Aeq,5min}$ over 24-hours at three sites, once during a weekday and once during the weekend. The locations of noise sampling sites are shown in Figure 9 and Figure 10 (VRA, 2015).

NSRs generally include private residences, community buildings such as schools, hospitals and any publicly accessible areas outside a facility/development property boundary. Homesteads and residential areas which were included in the assessment as NSRs were identified from available satellite imagery and during visits to site.

5.1.2 Source Inventory

Wind turbine noise, its characteristics and origins, have been discussed in detail in Section 3.1.3. A-weighted noise emissions, L_{WA}'s as it is referred to, as per the specifications for the Vestas V110 and V136 units were applied in the study. For both the preferred and alternative layouts the 'default' operational mode and one lower noise operational or design mode was considered (Table 2 and Table 3, pages 24 and 25).

For the 38 Vestas V110 units to be used with the preferred layout, the reference L_{WA}'s for operational mode 0 and mode 1 are 107.3 dBA and 105 dBA respectively Reference L_{WA}'s for operational mode 0/0-0S and mode 0 (includes a serrated trailing edge) of the 22 Vestas V136 units proposed for use with the alternative layout, are 108.2 dBA and 105.5 dBA respectively.

5.1.3 Noise Propagation Simulations

As per the requirements and ToR of the project, use was made of WindPRO and its BASIS and DECIBEL modules. To calculate the noise impact of one or more wind turbines, WindPRO requires the following information:

- Wind turbine positions and elevation;
- Wind turbine hub height and noise emissions $L_{WA,ref}$ at one or more wind speeds and if possible, at different frequencies;
- Pure tone contents in wind turbine noise;
- The location of NSRs;
- Impact criteria; and
- The required calculation model.

For the study of noise impacts from WPP1, use was made of the International Organisation for Standardization's (ISO) 9613-2 model 'Acoustics, Attenuation of sound during propagation outdoors, Part 2: General method of calculation'. With the ISO 9613-2 model, the user has access to all the parameters available in WindPRO.

5.1.3.1 ISO 9613

ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure level under meteorological conditions favourable to propagation from sources of known sound emission. These conditions are for downwind propagation or, equivalently, propagation under a well-developed moderate ground based temperature inversion, such as commonly occurs at night.

The method also predicts an average A-weighted sound pressure level. The average A-weighted sound pressure level encompasses levels for a wide variety of meteorological conditions. The method specified in ISO 9613 consists specifically of octave-band algorithms (with nominal midband frequencies from 63 Hz to 8 kHz) for calculating the attenuation of sound which originates from a point sound source, or an assembly of point sources. The source (or sources) may be moving or stationary. Specific terms are provided in the algorithms for the following physical effects; geometrical divergence, atmospheric absorption, ground surface effects, reflection and obstacles. A basic representation of the model is given in the equation below:

$$L_P = L_W - \sum [K_1, K_2, K_3, K_4, K_5]$$

where;

- ***L_P*** *is the sound pressure level at the receiver;*
- ***L_W*** *is the sound power level of the source;*
- ***K_1*** *is the correction for geometrical divergence;*
- ***K_2*** *is the correction for atmospheric absorption;*
- ***K_3*** *is the correction for the effect of ground surface;*
- ***K_4*** *is the correction for reflection from surfaces; and*
- ***K_5*** *is the correction for screening by obstacles.*

This method is applicable in practice to a great variety of noise sources and environments.

5.1.3.2 WindPRO Noise Calculation Model Parameters

The WindPRO DECIBEL model setup makes it possible to choose settings from a range of parameters. Settings for the WPP1 are:

- Wind speed: loudest up to 95% of rated power. WindPRO chooses the highest noise level irrespective of wind speed. Note: at the calculated average wind speeds of 6 to 6.5 m/s at wind turbine hub heights, noise levels are at their maximum.
- Octave data: In the absence of octave band source noise data, calculations were limited to the total noise value.
- Ground attenuation: General, terrain specific ground attenuation was selected. WindPRO calculates ground attenuation for each wind turbine-NSR pair as a weighting of hard and soft terrain along line-of sight.
- Meteorological coefficient: Defined to reflect damping due to special meteorological conditions i.e. propagation in the upwind direction. EMD, the developers of WindPro recommend using 0 since for wind turbines, noise is considered for downwind impact
- Type of demand in calculations: Use was made of the fixed 43 dBA guideline (ETSU-R-97, 1996) recommended for night-time for initial noise impact screening.
- Noise values in calculation: as per the ETSU recommendation, L_{A90} noise levels were calculated.
- Pure tones: Since, for modern turbines pure tones are a rare phenomenon, penalties are only applied if the specifications of wind turbines indicate its presence.
- Height of emission point above ground level: NSRs were simulated at 1.5 m above ground level.
- Deviation from official noise demands: None.
- Air absorption: Standard ISO 9613 air absorption coefficients.

Noise levels were simulated over an area of 188 km^2 at 250 m intervals and at NSRs. All simulation parameters are indicated in summary reports generated by WindPRO. These are included in Annex B.

5.1.4 Assumptions and Limitations

The noise impact study is based on a number of assumptions and is subject to certain limitations, which should be borne in mind when considering information presented in this report.

- Since the loudest L_W's up to 95% of rated power were applied in simulations, results presented in this report may be considered conservative since it assumes continuous maximum noise emission levels.
- Wind dependent background noise levels were not available for the study area. The monitoring of baseline noise levels as per the recommendations of the IFC for WEFs (2015) were provided for in the original scope of work for the noise impact assessment. VRA later changed requirement to short-term spot measurements as a result of time and budget constraints. In determining background noise levels, use was therefore made of average recorded background L_{A90} levels as recommended by ETSU (1996).
- Cumulative impacts are assessed by adding expected impacts from this proposed development to existing and proposed developments with similar impacts in a 20-km radius.

5.2 SHADOW FLICKER STUDY

Shadow flicker impacts were determined using the WindPRO SHADOW module. SHADOW calculates how often and the time of day a specific shadow receptor (SRs) will be affected by shadows generated by one or more WTGs. These calculations are 'worst-case' or 'astronomical maximum shadow' based solely on the position of the sun relative to WTGs and SSRs. If the weather is overcast or calm, or the rotor plane is parallel with the line between the sun and SSR, the WTG will not produce a shadow impact but the impact will still appear in calculations.

SHADOW calculates the position of the sun relative to each WTG rotor at 1-minute intervals for a period of one year. If the shadow of the rotor, assumed to be solid, falls on a SSR for a calculation step, it is registered aa a minute of shadow impact. SHADOW assumed the following standard parameters:

- The diameter of the sun 1 390 000 km

- The distance to the sun 150 000 000 km
- Angle of attack 0.531 degrees

Theoretically, this will result in shadow impacts up to 48 km behind a 45 m rotor. However, shadows would not reach the theoretical maximum due to the optical characteristics of the atmosphere. When the sun is very low on the horizon the shadow dissipates before it reaches the receptor. Exactly how far a shadow will be visible is not known but German guidelines have set a limit of 2.5 km or coverage of 20% of the sun disk, whichever is the shortest.

SRs are objects for which the potential risk for shadow impact is calculated. Since very little is known about the orientation and construction of SSRs in the study area, use is made of the "greenhouse" mode which conservatively assumes the receptor faces all directions.

Furthermore, wind WTGs that are not within line of sight were excluded from calculations. The calculation is done using terrain data.

Shadow impacts were calculated for 'worst-case' and 'real' conditions. Worst-case, as discussed earlier, assumes no clouds, the wind direction aligned with WTG and SSR, and continuous operation. Circumstances more representative of 'real' conditions were taken into account by specifying (a) monthly sunshine possibilities, and (b) wind direction statistics.

Data on the former was obtained from Weatherbase at http://www.weatherbase.com/weather/weather.php3?s=601993&cityname=Anloga-Ghana. Wind statistics were obtained from the report by Lahmeyer International (2015) for WPP1. It was still conservatively assumed that wind turbines will be operational all hours of the year. Monthly sunshine possibilities and wind direction statistics as applied in calculations are graphically presented in Figure 7 and Figure 8 respectively.

All SHADOW model inputs and results reports are included in Annex C.

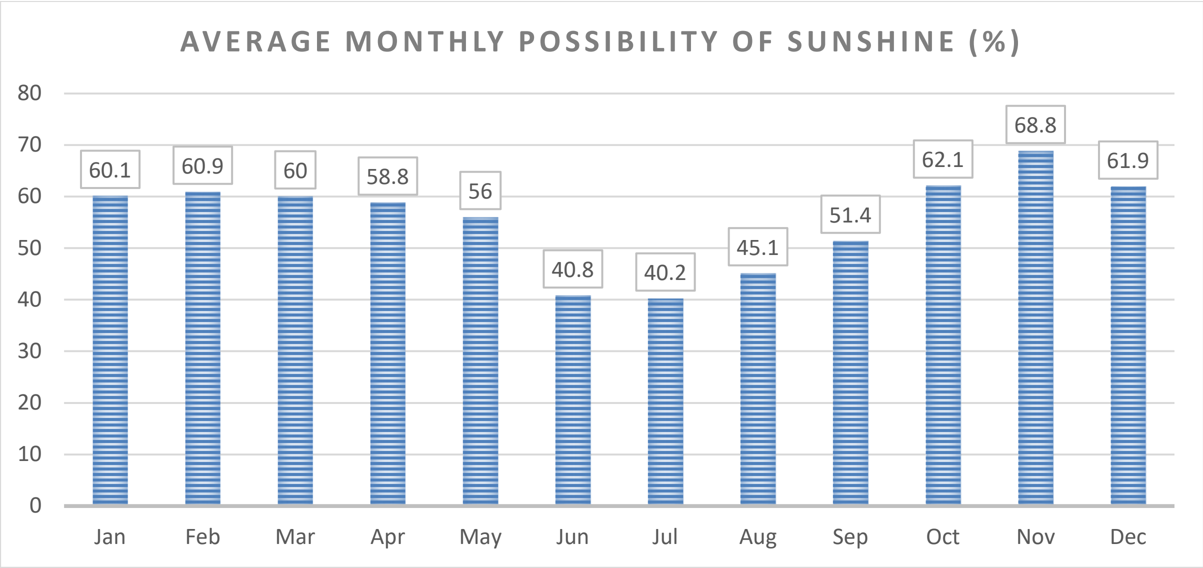


Figure 7: Average monthly possibility of sunshine, www.weartherbase.com

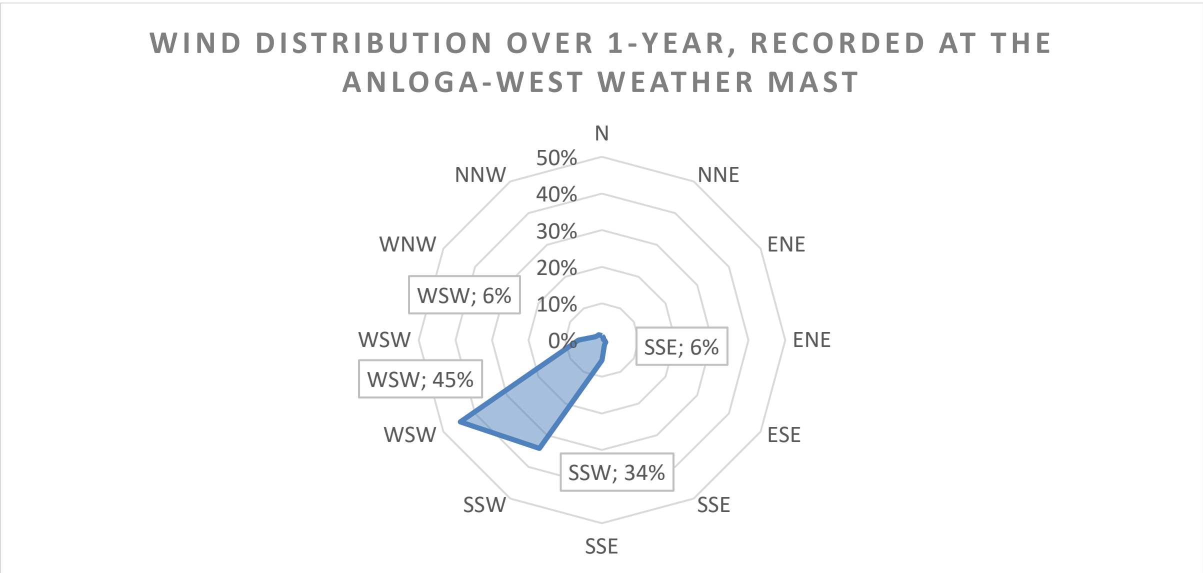


Figure 8: Wind distribution over 1-year at Anloga West

6. DESCRIPTION OF THE BASELINE ENVIRONMENT

6.1 NOISE AND SHADOW SENSITIVE RECEPTORS

Villages likely to be most affected by noise and shadow flicker include Anloga and Anyanui. Whereas the preferred layout for WPP1 will affect both Anloga and Anyanui, noise and shadow impacts associated with the alternative layout will be limited to Anloga. For the purpose of this assessment a total of 31 discrete NSRs and SSRs, representative of maximum impacts within each village, were identified from available satellite imagery. The locations of these relative to WPP1 are shown in Figure 9, Figure 10, and Figure 11 for the western, central and eastern sections of the WEF.

6.2 BACKGROUND NOISE LEVELS

Airshed conducted a background noise survey on 17, 18 and 19 October 2016 at the three sites indicated in Figure 9 and Figure 10. VRA conducted noise measurements at three sites (Figure 9 and Figure 10) in February 2015, the results of which are reported in the *'Anloga and Anyanui Background Noise Level Assessment Report'* (VRA, 2015). The results of these are summarised in this section with detailed results included in Annex D.

During the Airshed campaign, a slight breeze from the south-southwest with average wind speeds between 0.3 and 2 m/s was recorded; ambient air temperature was between 28 ºC and 33 ºC, humidity between 67% and 78%, with some cloud cover. Conditions during the VRA campaign were similar, with a breeze from the southwest and temperatures between 24ºC and 33 ºC.

Measurements and observations within Anloga, and at its southern border indicate noise levels influenced by noise from the ocean (waves breaking on the beach) and community activities, specifically road traffic and farming. Natural sources of noise include wind rustling trees and other vegetation, birds, frogs, and insects. Anyanui was found to be somewhat quieter than Anloga since its further away from main transport routes as well as the ocean. Community activities and natural noise sources such as the wind, birds, frogs, and insects influence background noise levels in Anyanui most notably. **Despite reduced community activity at night, night time noise levels were frequently found to be higher than during the day. This is**

mostly attributed to increased frog and insect noise but may also be a result of noise from the ocean surf which will propagate further during night-time conditions. There is no notable difference between weekday and weekend noise level. As per the recommendation of ETSU, background noise levels at NSRs were determined based on average L_{A90} values rather than extremes. Since background noise levels are highly variable throughout the study area, different background noise levels were assigned to NSRs depending on their location in relation to community activities, roads, the ocean, and measurement locations. These assignments are summarised in Table 8.

Figure 9: Noise sensitive and shadow receptors around the western section of WPP1 near Anyanui

Figure 10: Noise sensitive and shadow receptors around the central section of WPP1 near Srogbe

Figure 11: Noise sensitive and shadow receptors around the eastern section of WPP1 near Anloga

Table 7: Summary of background noise data, L_{A90}, as measured and reported by Airshed and VRA

Site	Description	Coordinates	Measurement date and time	Notes and observations	Weekday L_{A90} in dBA (duration)		Weekend L_{A90} in dBA (duration)	
					Day-time	*Night-time*	*Day-time*	*Night-time*
Airshed Site 1	Anloga, central section of WPP1	0.822664° E 5.791029° N	Day-time 18/10/2016 11:43 Night-time 19/10/2016 01:16	Background noise levels affected by road traffic, insects, birds and frogs. Wind generated noise in mangroves, trees and other vegetation.	32.4 (15 min)	45.4 (15 min)		
Airshed Site 2	Anyanui, western section of WPP2	0.729372° E 5.795581° N	Day-time 18/10/2016 12:28 Night-time 19/10/2016 00:27	Quiet environs, away from community. Birds, insects, frogs and wind in vegetation.	34.5 (15 min)	42.0 (15 min)		
Airshed Site 3	Anloga, eastern section of WPP1	0.879924° E 5.784285° N	Day-time 18/10/2016 15:42	Ocean clearly audible, manual farming activities, birds, insects, frogs, and wind in vegetation.	43.5 (15 min)			
VRA Site 1	Anloga 1, on southern border of Anloga, 500 m from shoreline, 800 from main road, on pepper farm	0.900511° E 5.787526° N	Weekday 24/02/2015 Weekend 07/03/2015	Ocean, breeze, faring and fishing activities and community noise.	50.9 (5 hours)	49.6 (8 hours)	47.4 (5 hours)	47.0 (8 hours)
VRA Site 2	Anloga 2, on southern border of Anloga, 330 m from shoreline, 700 m from main road, on farm	0.878752° E 5.784091° N	Weekday 26/02/2015 Weekend 07/03/2015	Ocean, breeze, faring and fishing activities and community noise.	61.6 (5 hours)	62.1 (8 hours)	55.5 (5 hours)	53.3 (8 hours)
VRA Site 3	Anyanui, on northern outskirts of Anyanui	0.733180° E 5.786800° N	Weekday 05/03/2015 Weekend 03/05/2015	Main sources of noise from wind in vegetation and the Anyanui community.	51.2 (5 hours)	53.2 (8 hours)	52.4 (5 hours)	52.8 (8 hours)

The following important assumptions/limitations with regards do background noise levels should be noted:

- Background noise levels could not be determined at different wind speeds. Levels used in this assessment are for low wind speed conditions which prevailed during measurements.
- Where Airshed and VRA noise levels are averaged, it is done so giving equal weight to 15 min and 5 hour or 8 hour levels. This approach yielded a somewhat conservative estimate of background noise levels.
- L_{A90} values were determined from VRA data by considering quiet day-time hours between 18:00 and 23:00, and night-time hours between 23:00 and 07:00, as defined by ETSU (1996).

Table 8: Background L_{A90} at NSRs

Receptor group	NSR numbers	Background quiet day-time L_{A90} (dBA)	Background night-time L_{A90} (dBA)	Measurement reference site
Anyanui, WPP1 western section	1, 3, 5, 6, 7, 8, and 9	46.0	49.4	Average of Airshed site 2 and VRA site Anyanui
	2, and 4	34.5	42.0	Airshed site 2
	10	51.7	53.0	Average of Airshed site 3, VRA site Anloga 1 and Anloga 2
Salo, WPP1 central section	11	32.4	45.4	Airshed site 1
Anloga, WPP1 central section	12, 13, 14, 15, 16, and 17	51.7	53.0	Average of Airshed site 3, VRA site Anloga 1 and Anloga 2
Anloga, WPP1 eastern section	18 to 31	51.7	53.0	Average of Airshed site 3, VRA site Anloga 1 and Anloga 2

7. NOISE AND SHADOW FLICKER IMPACTS

In this section, the results of noise and shadow flicker simulations are discussed in more detail.

7.1 ENVIRONMENTAL NOISE

7.1.1 Construction and Decommissioning Phases

Table 9 lists diesel mobile equipment that might be used in the construction of roads, platforms and erection of WTGs, and typical L_{WA}'s for such equipment. L_{WA}'s were sourced from the British Standard BS 5228-1:2009 code of practice for noise and vibration on construction and open sites (BSI, 2008). Resulting L_{Aeq} at 10 m, 100 m and 500 m from each activity or piece of equipment is also included in Table 9 and compared to the day-time Ghana EPA noise standard of 55 dBA. L_{Aeq}'s were calculated assuming hemispherical propagation and by conservatively not taking into account atmospheric and ground attenuation.

The impact of most activities reduces to below the Ghana EPA noise standard and IFC guideline for residential areas within 30 m to 350 m from the activity or piece of operational equipment. During the demolition of WTG platforms, the breaking of concrete may result in impacts up to 700 m from the platform.

The European Commission (EC) Working Group for the Assessment of Environmental Noise (WG-AEN) developed default area based L_{WA}'s for heavy industrial, light industrial, commercial, and port activities that are recommended for use when a detailed source inventory is not available. By assuming that construction and demolition activities within a certain area of activity will generate 65 dBA/m^2, the default for heavy industrial activities (EC WG-AEN, 2006), L_{Aeq} as a function of downwind distance can be calculated assuming hemispherical noise propagation. Figure 12 shows the likely impact area for different sized construction/demolition areas.

Table 9: Noise data for construction and demolition equipment

Activity	Equipment	LWA (dBA)	LAeq (dBA) at distance "d"		
			10 m	100 m	500 m
Sound level data on site preparation					
Clearing site	Dozer (142 kW)	103	75[(a)]	55	41
	Tracked excavator (102 kW)	106	78	58	44
	Wheeled backhoe loader (62 kW)	96	68	48	34
Distributing of material	Articulated dump truck (tipping fill) (187 kW)	102	74	54	40
	Articulated dump truck (187 kW)	109	81	61	47
Earthworks	Dozer (142 kW)	109	81	61	47
	Tracked excavator (226 kW)	107	79	59	45
Loading lorries	Tracked excavator (75 kW)	107	79	59	45
	Wheeled loader (193 kW)	108	80	60	46
Rolling and compacting	Dozer (towing roller) (142 kW)	109	81	61	47
	Hydraulic vibratory compactor (tracked excavator)	106	78	58	44
	Vibratory roller (29 kW)	102	74	54	40
Sound level data on piling and ancillary operations					
Rotary bored piling – cast in situ	Compressor for mini piling (45 kW)	103	75	55	41
	Large rotary bored piling rig	111	83	63	49
	Mini piling rig (29 kW)	104	76	56	42
	Mini tracked excavator (17 kW)	96	68	48	34
	Tracked drilling rig (104 kW)	110	82	62	48
Welding / cutting steel piles	Gas cutter (cutting top of pile)	96	68	48	34
	Generator for welding	101	73	53	39
	Hand-held gas cutter	93	65	45	31
	Hand-held welder (welding piles)	101	73	53	39
Sound level data on general site activities					
Distribution of materials	Articulated dump truck (194 kW)	109	81	61	47
	Fuel tanker lorry	104	76	56	42
	Fuel tanker pumping	100	72	52	38
	Tracked excavator (41 kW)	99	71	51	37
	Wheeled backhoe loader (62 kW)	95	67	47	33
	Wheeled excavator (90 kW)	94	66	46	32
Lifting	Caged material hoist (electric)	96	68	48	34
	Lifting platform (35 kW)	95	67	47	33
	Mobile telescopic crane (260 kW)	110	82	62	48
	Tower crane (51 kW)	105	77	57	43
	Tracked mobile crane (240 kW)	103	75	55	41
	Wheeled mobile crane (275 kW)	98	70	50	36
Miscellaneous	Angle grinder (grinding steel) (2.3 kW)	108	80	60	46
Mixing concrete	Cement mixer truck (discharging)	103	75	55	41
	Concrete mixer truck (216 kW)	108	80	60	46
Power for lighting	Diesel generator (15 kW)	93	65	45	31
	Pumping water (7.5 kW)	93	65	45	31
Power for site cabins	Diesel generator	94	66	46	32

Activity	Equipment	LWA (dBA)	LAeq (dBA) at distance "d"		
			10 m	**100 m**	**500 m**
Pumping concrete	Concrete mixer truck (discharging) & concrete pump (pumping)	103	75	55	41
Pumping water	Water pump (diesel) (10 kW)	96	68	48	34
	Water tanker extracting water	107	79	59	45
Dust suppression	Dust suppression unit trailer	106	78	58	44
Sound level data on road construction works					
Earthworks	Articulated dump truck (194 kW)	109	81	61	47
	Bulldozer (250 kW)	114	86	66	52
	Tracked excavator (172 kW)	108	80	60	46
Paving	Asphalt paver (and tipper truck) (94 kW)	112	84	64	50
Road planing	Road planer (185 kW)	110	82	62	48
Rolling and compaction	Road roller (95 kW)	108	80	60	46
Trenching	Tracked excavator (27 kW)	102	74	54	40
	Wheeled excavator (51 kW)	98	70	50	36
Sound level data on demolition					
Breaking up concrete	Breaker mounted on backhoe (59 kW)	120	92	72	58
	Hand-held pneumatic breaker	111	83	63	49
	Pulverizer mounted on excavator (147 kW)	104	76	56	42
Breaking up/cutting steel	Gas cutter	107	79	59	45
	Tracked excavator (74 kW)	111	83	63	49
Crushing concrete	Tracked crusher (172 kW)	110	82	62	48
Dumping rubble	Articulated dump truck (dumping) (250 kW)	108	80	60	46
	Tracked excavator (loading truck) (228 kW)	113	85	65	51

***Notes*:**

(a) *Shaded cells indicate exceedance of Ghana EPA day-time noise guideline of 55 dBA*

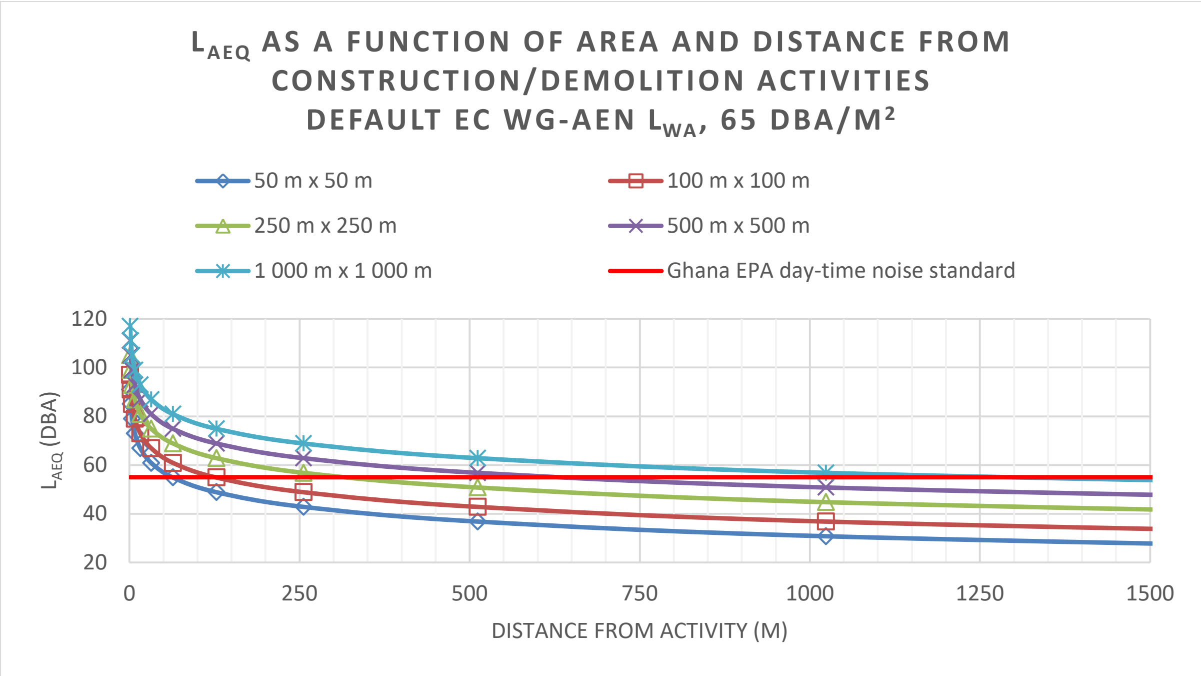


Figure 12: L_{Aeq} as a function of area and distance from construction/demolition activities using the default LWA of 65 dBA/m^2 for heavy industrial activities

7.1.2 Operational Phase

The propagation of noise generated by WPP1 during its operational phase was calculated with WindPRO in accordance with ISO 9613. Site specific acoustic parameters and source data discussed in Section 3.1.3.2, were applied in the model for the following scenarios:

1. Preferred layout, 38 Vestas V110 WTGs (with serrated LNTE):
    a. Optimised operational mode 0 at a reference L_{WA} of 106 dBA
    b. Operating in mode 1 at a reference L_{WA} of 103.8 dBA
    c. Operating in mode 2 at a reference L_{WA} of 100.6 dBA
2. Alternative layout, 22 Vestas V136 WTGs (with serrated LNTE):
    a. Optimised operational mode 0 at a reference L_{WA} of 105.5 dBA
    b. Operating in mode SO1 at a reference L_{WA} of 104.4 dBA

c. Operating in mode SO2 at a reference L_{WA} of 103.5 dBA

d. Operating in mode SO3 at a reference L_{WA} of 102.4 dBA

e. Operating in mode SO4 at a reference L_{WA} of 98 dBA

Results are presented in tabular form (Table 10 and Table 11) as well as graphically in the form of isophones (Figure 13 to Figure 14) for modes 0 and the first modes that will meet guidelines at all NSRs. An isophone is a line on a map connecting points at which a given variable (in this case L_{A90}) has a specified constant value. This is analogous to contour lines on a map showing terrain elevation. In the assessment of environmental noise, isopleths present lines of constant noise level as a function of distance. Detailed WindPro reports are included in Annex B.

7.1.2.1 WPP1 Preferred Layout

The preferred layout proposed for WPP1, using V110 WTG units with serrated LNTE, operating at the optimised power mode (mode 0), will not result in exceedance of the 55-dBA day-time guideline of the IFC and Ghana EPA limit at NSRs. Due to low day-time baseline noise levels an increase of 6.5 dBA is expected at residents of Anyanui situated north of the western section of the preferred layout.

Noise levels in exceedance of the night-time IFC guideline (45 dBA) and Ghana EPA limit (48 dBA) at residences along the southern edge of Anloga are indicated. Given prevailing background noise levels in Anloga, the increase in noise levels is however expected to be low (less than 3 dBA).

Simulations indicate that at a reduced noise operational mode (mode 2), noise impacts may be reduced to within assessment criteria.

Table 10: Summary of noise simulation results for WPP1 preferred layout where tabulated values represent maximum impacts within each receptor group

Village and WPP1 section	Anyanui, WPP1 western section			Salo, WPP1 central section	Srogbe, WPP1 central section	Anloga, WPP1 eastern section
Discrete NSRs	1, 3, and 5 to 9	2, 4	10	11	12 to 17	18 to 31
Background L_{A90} (dBA)						
Day-time	46	34.5	51.7	32.4	51.7	51.7
Night-time	49.4	42	53	45.4	53	53
WPP1 V110 LNTE | L_{A90} (dBA) | Assessment criteria 45 dBA (IFC) and 48 dBA (Ghana EPA)						
All WTGs at operational mode 0	40.4	39.9	23.8	21.3	43.5	49.3(a)(b)
All WTGs at operational mode 1	38.8	36.8	22	18.7	43.6	45.1(b)
All WTGs at operational mode 2	35.6	33.6	18.8	15.5	40.4	41.9
Increase in day-time L_{A90} above background (dBA) | Assessment criterion 5 dB (ETSU-R-97, 1996)						
All WTGs at operational mode 0	1.1	6.5(c)	0.0	0.3	0.6	2.0
All WTGs at operational mode 1	0.8	4.3	0.0	0.2	0.6	0.9
All WTGs at operational mode 2	0.4	2.6	0.0	0.1	0.3	0.4
Increase in night-time L_{A90} above background (dBA) | Assessment criterion 5 dB (ETSU-R-97, 1996)						
All WTGs at operational mode 0	0.5	2.1	0.0	0.0	0.5	1.5
All WTGs at operational mode 1	0.4	1.1	0.0	0.0	0.5	0.7
All WTGs at operational mode 2	0.2	0.6	0.0	0.0	0.2	0.3

Notes:

(a) Exceeds the Ghana EPA night-time limit of 48 dBA

(b) Exceeds the IFC night-time guideline of 45 dBA

(c) Exceeds the ETSU guideline of 5 dB

7.1.2.2 WPP1 Alternative Layout

The alternative layout of WPP1 will only impact residents of Anloga. It will potentially result in noise levels in exceedance of the night-time Ghana EPA limit guideline of 48 dBA and IFC guideline of 45 dBA at residences within the southern part of Anloga. Given prevailing background noise levels in Anloga, the increase in noise levels is however expected to be low (less than 2 dBA). At low noise operating mode SO4, noise levels can be reduced to with assessment criteria.

Table 11: Summary of noise simulation results for WPP1 alternative layout where tabulated values represent maximum impacts within each receptor group

Village and WPP1 section	Anyanui, WPP1 western section			Salo, WPP1 central section	Srogbe, WPP1 central section	Anloga, WPP1 eastern section
Discrete NSRs	1, 3, and 5 to 9	2, 4	10	11	12 to 17	18 to 31
Background L_{A90} (dBA)						
Day-time	46	34.5	51.7	32.4	51.7	51.7
Night-time	49.4	42	53	45.4	53	53
WPP1 V136 LNTE | L_{A90} (dBA) | Assessment criteria 45 dBA (IFC) and 48 dBA (Ghana EPA)						
Mode 0	Neg.[(d)]	Neg.	Neg.	20.7	42.6	49.1[(a)(b)]
Mode SO1	Neg.	Neg.	Neg.	19.6	41.5	48.0[(b)]
Mode SO2	Neg.	Neg.	Neg.	18.7	40.6	47.1[(b)]
Mode SO3	Neg.	Neg.	Neg.	17.1	39	45.5[(b)]
Mode SO4	Neg.	Neg.	Neg.	13.2	35.1	41.6
Increase in day-time L_{A90} above background (dBA) | Assessment criterion 5 dB (ETSU-R-97, 1996)						
Mode 0	Neg.	Neg.	Neg.	0.3	0.5	1.9
Mode SO1	Neg.	Neg.	Neg.	0.2	0.4	1.5
Mode SO2	Neg.	Neg.	Neg.	0.2	0.3	1.3
Mode SO3	Neg.	Neg.	Neg.	0.1	0.2	0.9
Mode SO4	Neg.	Neg.	Neg.	0.1	0.1	0.4
Increase in night-time L_{A90} above background (dBA) | Assessment criterion 5 dB (ETSU-R-97, 1996)						
Mode 0	Neg.	Neg.	Neg.	0.0	0.4	1.5
Mode SO1	Neg.	Neg.	Neg.	0.0	0.3	1.2
Mode SO2	Neg.	Neg.	Neg.	0.0	0.2	1.0
Mode SO3	Neg.	Neg.	Neg.	0.0	0.2	0.7
Mode SO4	Neg.	Neg.	Neg.	0.0	0.1	0.3

Notes:

(a) Exceeds the Ghana EPA night-time limit of 48 dBA

(b) Exceeds the IFC night-time guideline of 45 dBA

(c) Exceeds the ETSU guideline of 5 dB

(d) Neg. – negligible

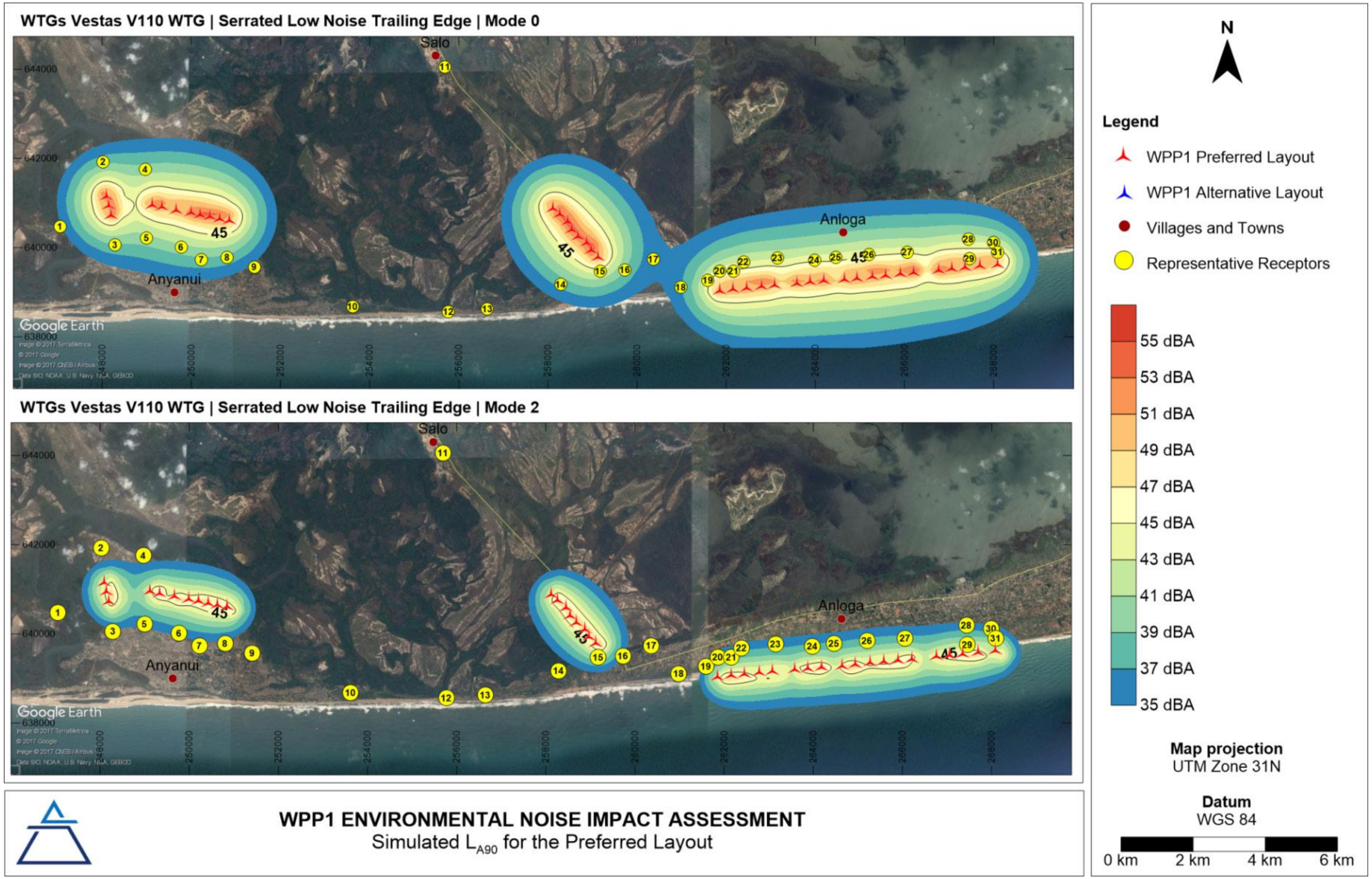


Figure 13: WindPRO simulation results, L_{A90} for WPP1 preferred layout with Vestas V110 WTGs with serrated LNTE at operational modes 0, and 2

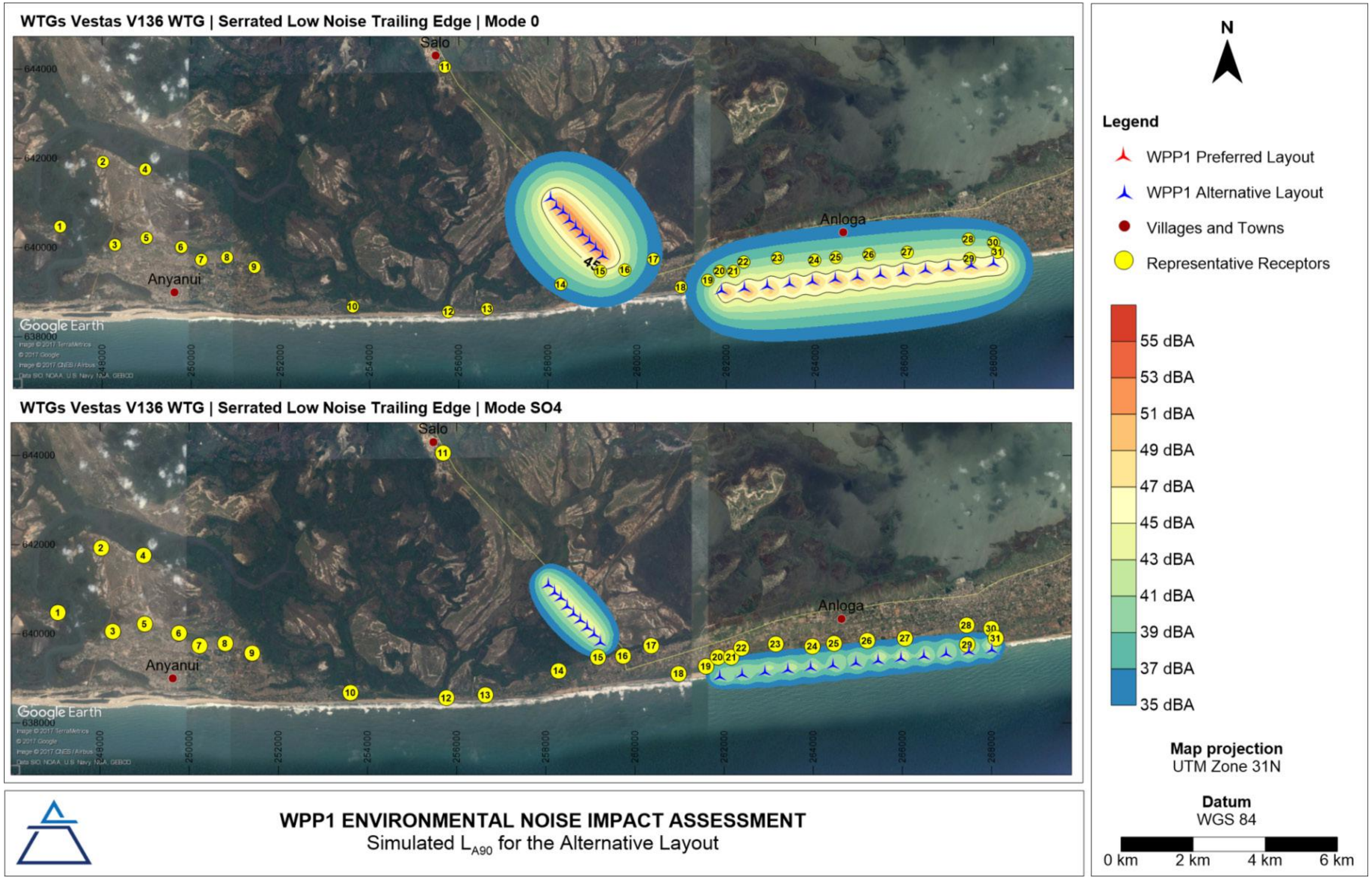


Figure 14: WindPRO simulation results, L_{A90} for WPP1 alternative layout with Vestas V136 WTGs with serrated LNTE at operational modes 0, and SO4

7.1.3 Main Findings

In summary:

- From an environmental noise perspective, the alternative layout is the preferred option for the following reasons:
    - Residents in and around Anyanui, where lower background noise levels prevail in comparison with Anloga, will not be impacted.
    - The alternative layout necessitates the use of larger WTGs. The Vestas V136 WTG with the serrated LNTE at the optimised operational mode has a reference L_W of 105.5 dB which is comparable to the 106 dB of the smaller WTG (Vestas V110) with the LNTE, proposed for use with the preferred layout.
    - At the same L_W, larger WTGs result in lower ground level noise due to increased emission height (95 m vs. 112 m), distance from receptors, as well as larger distances between WTGs.
- Exceedance of impact guidelines (night-time IFC guideline of 45 dBA) may occur:
    - up to 4.7 rotor diameters from WTG arrays of the preferred layout; and
    - up to 3.6 rotor diameters from WTG arrays of the alternative layout.
- Given available satellite imagery, some residential structures fall within these distance from WPP1.
- Special measures (such as operating certain WTGs at lower noise modes) must be adopted to manage noise impacts at all NSR within 4.7 rotor diameters from V110 WTGs, and 3.6 rotor diameters from V136 WTGs.

7.2 SHADOW FLICKER

Shadow flicker as a result of WPP1 during its operational phase was calculated with the WindPRO SHADOW module. Model parameters discussed in Section 5.2 were applied in the calculations for the following two scenarios:

1. Preferred layout using 38 Vestas V110 WTGs
2. Alternative layout using 22 Vestas V136 WTGs

Both *worst-case* and *real* estimated of shadow impacts were calculated. Results are presented in tabular form (Table 12) as well as graphically in the form of isopleths for a single V110 and V136 WTG located within the WPP1 project area (Figure 15). In this instance isopleths connect points at which real shadow hours per year has a specified constant value. Cumulative real shadow flicker impacts are shown in Figure 16. For detailed WindPRO reports, refer to Annex C.

Shadow impacts lie in the east-west plane, more or less parallel to the coastline. For the Vestas V110 WTG, the maximum shadow impact of 407 hours per year occurs approximately 60 m to the northeast of the WTG (Figure 15). Real shadow impacts are expected to exceed 30 hours per year at residences along the southern edge of Anloga. The maximum shadow impact is expected at SSR 29 (WindPRO reference AC), where a real shadow impact of 131 hours per year is predicted.

For the Vestas V136 WTG, the maximum shadow impact of 34 hours per year occurs approximately 80 m to the east-northeast of the WTG (Figure 15). Real shadow impacts are expected extend somewhat further and will exceed 30 hours per year at residences along the southern edge of Anloga (SRs19, 26, 29, and 31).

From the detailed calendar reports generated by WindPRO (Annex C), it was also found that shadow impacts at Anloga will occur mostly during sunrise and sunset hours e.g. 06:00 to 07:00 and 17:00 to 18:00. Calendar plots indicate the time of day, and day of year that shadow flicker will occur as well as the WTG responsible for the shadow. As an example, the calendar plots for SSR 29 (WindPRO reference AC) are shown in Figure 17.

From a shadow flicker impact perspective, the preferred layout is favoured since the Vestas V110 WTGs have smaller shadow impact zones.

Table 12: Simulated shadow hours per year at discrete SSRs

Village and WPP1 Section	No.	WindPRO Reference	Preferred Layout with Vestas V110 WTGs		Alternative Layout with Vestas V136 WTGs	
			Maximum shadow h/y	Real shadow h/y	Maximum shadow h/y	Real shadow h/y
Anyanui, WPP1 western section	1	A	08:20:00	02:53:00	00:00:00	00:00:00
	2	B	00:00:00	00:00:00	00:00:00	00:00:00
	3	C	00:00:00	00:00:00	00:00:00	00:00:00
	4	D	00:00:00	00:00:00	00:00:00	00:00:00
	5	E	09:53:00	03:34:00	00:00:00	00:00:00
	6	F	00:00:00	00:00:00	00:00:00	00:00:00
	7	G	00:00:00	00:00:00	00:00:00	00:00:00
	8	H	00:00:00	00:00:00	00:00:00	00:00:00
	9	I	00:00:00	00:00:00	00:00:00	00:00:00
Srogbe, WPP1 central section	10	J	00:00:00	00:00:00	00:00:00	00:00:00
	11	K	00:00:00	00:00:00	00:00:00	00:00:00
	12	L	00:00:00	00:00:00	00:00:00	00:00:00
	13	M	00:00:00	00:00:00	00:00:00	00:00:00
	14	N	00:00:00	00:00:00	00:00:00	00:00:00
	15	O	00:00:00	00:00:00	00:00:00	00:00:00
	16	P	00:00:00	00:00:00	00:00:00	00:00:00
	17	Q	06:29:00	01:43:00	60:57:00	14:34:00
Anloga, WPP1 eastern section	18	R	15:56:00	05:14:00	22:55:00	07:30:00
	19	S	55:51:00[a]	17:19:00	104:41:00[a]	32:57:00[a]
	20	T	27:11:00[a]	08:30:00	22:02:00	06:43:00
	21	U	59:28:00[a]	18:44:00	65:46:00[a]	20:59:00
	22	V	09:01:00	02:49:00	38:58:00[a]	12:17:00
	23	W	14:34:00	04:41:00	13:19:00	04:09:00
	24	X	28:23:00	11:52:00	42:43:00[a]	17:40:00
	25	Y	40:59:00[a]	14:43:00	38:47:00[a]	15:14:00
	26	Z	28:32:00	12:36:00	76:27:00[a]	30:30:00[a]
	27	AA	35:15:00[a]	12:37:00	60:33:00[a]	27:05:00
	28	AB	00:00:00	00:00:00	05:49:00	03:55:00
	29	AC	308:18:00[a]	131:24:00[a]	332:41:00[a]	162:29:00[a]
	30	AD	08:11:00	05:26:00	15:32:00	09:48:00
	31	AF	46:26:00[a]	28:37:00	86:07:00[a]	53:06:00[a]

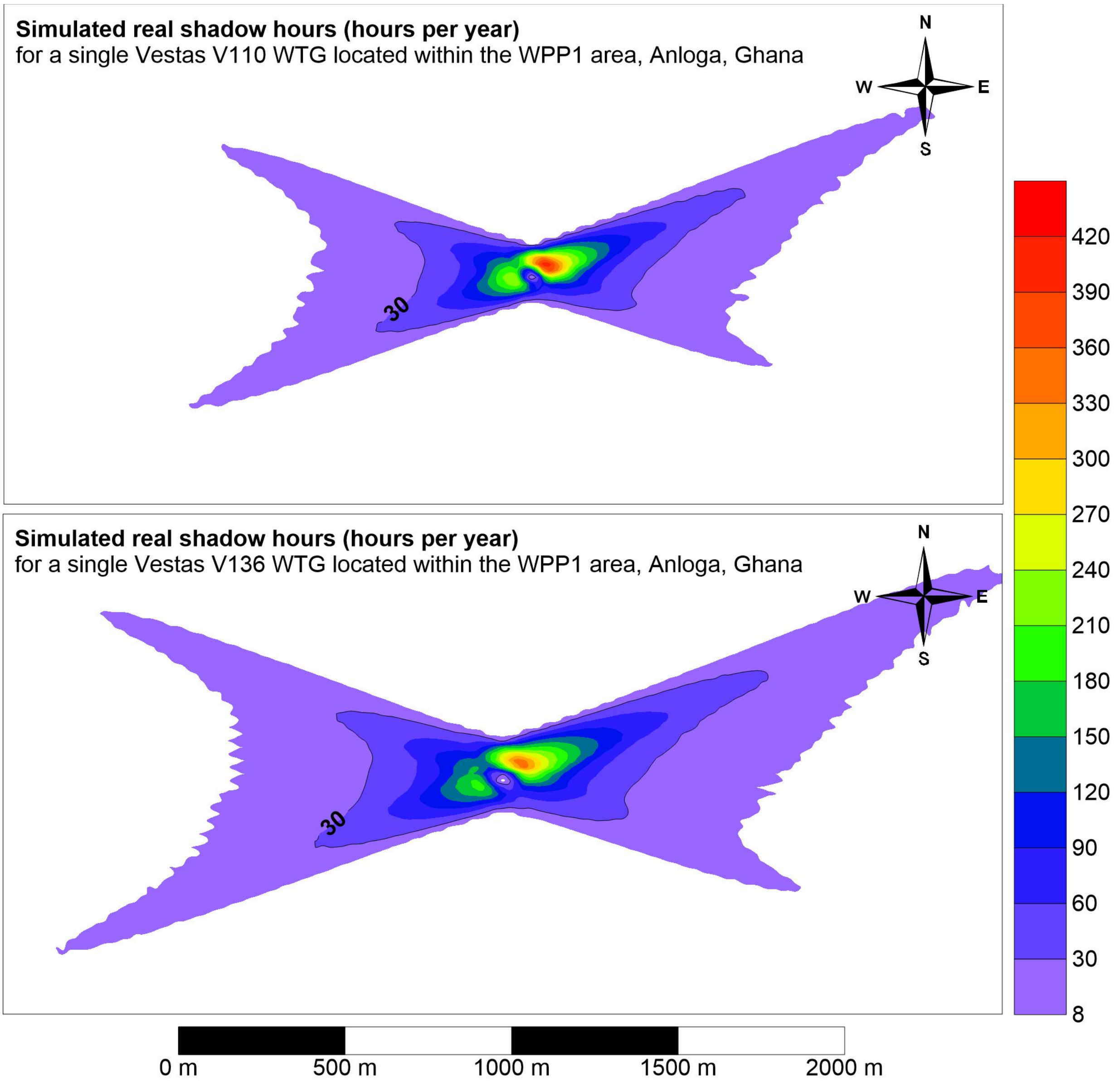


Figure 15: Simulated real shadow impacts of a single Vestas V110 and V136 WTG located within the WPP1 area in Anloga, Ghana

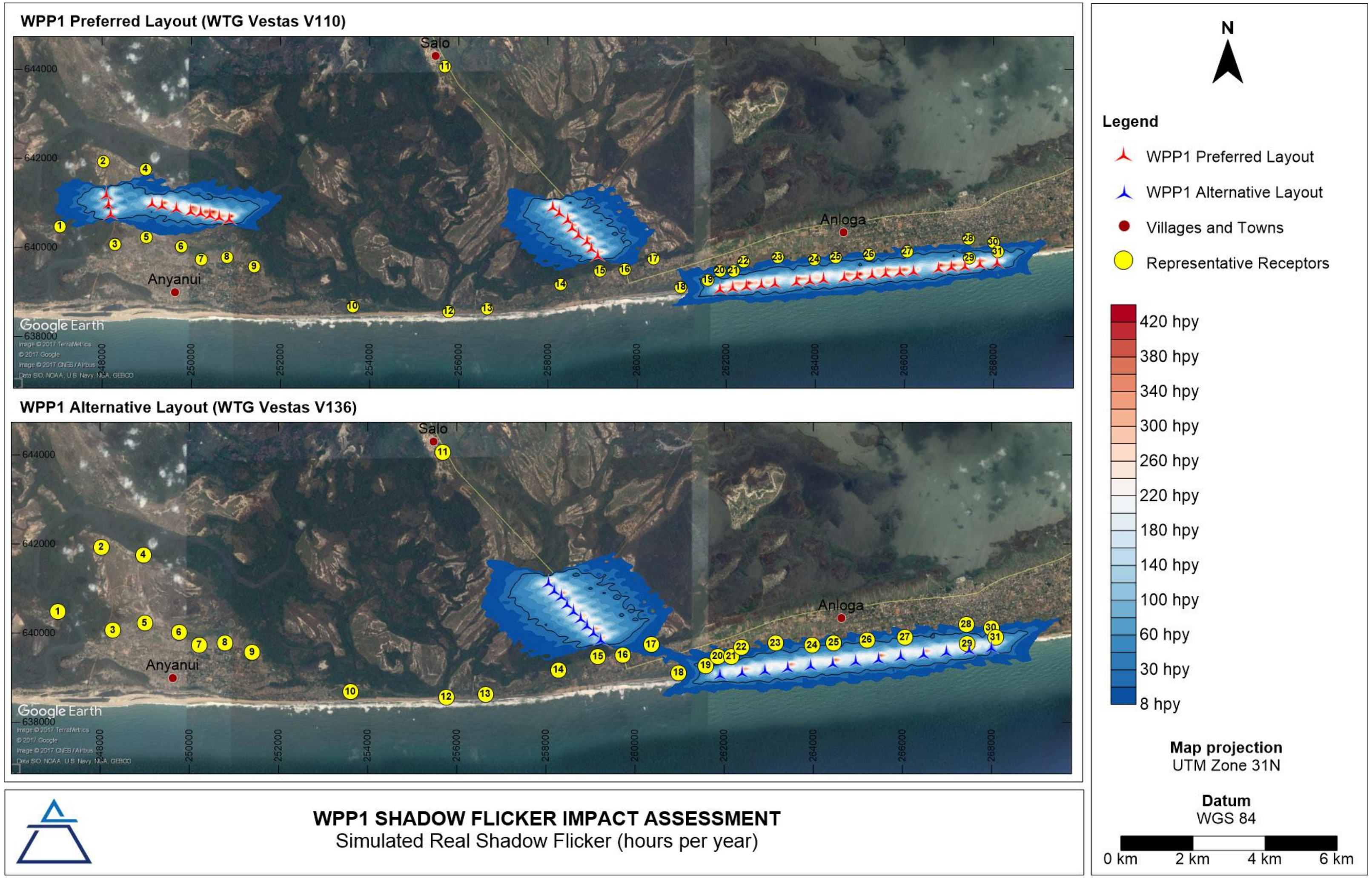
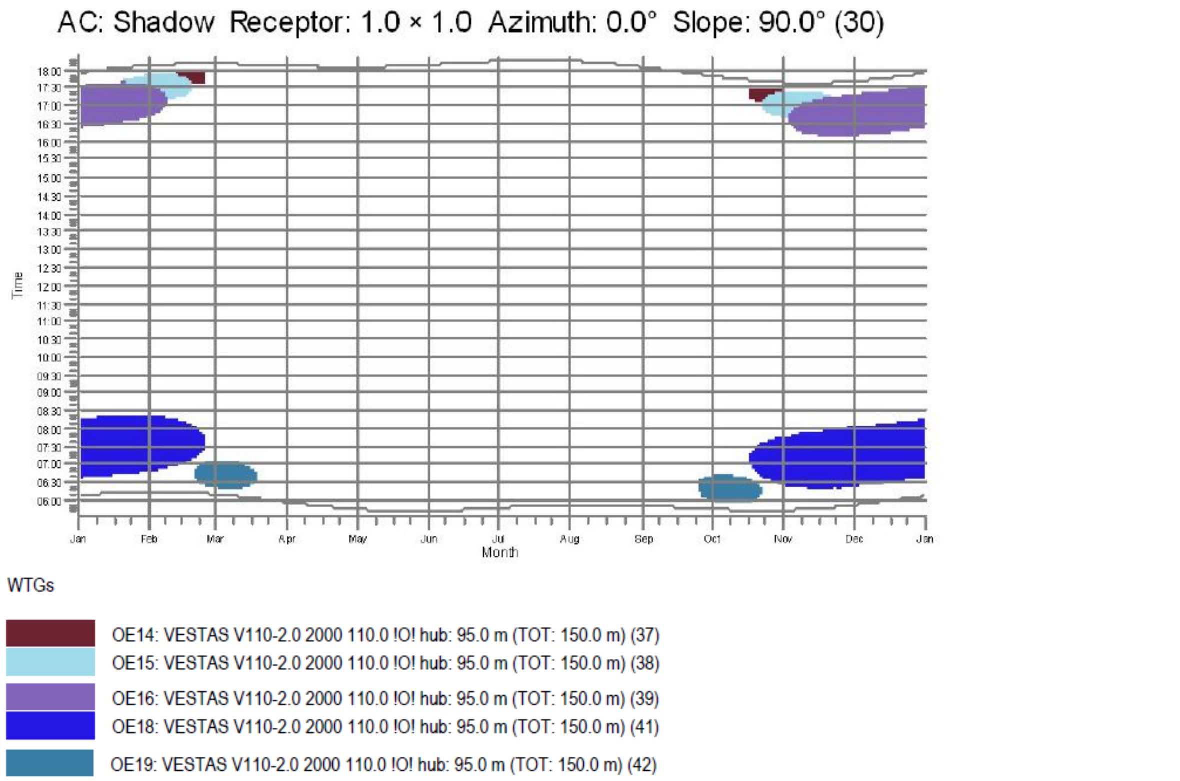


Figure 16: WindPRO simulation results, real shadow flicker for WPP1

WPP1 Preferred Layout



WPP1 Alternative Layout

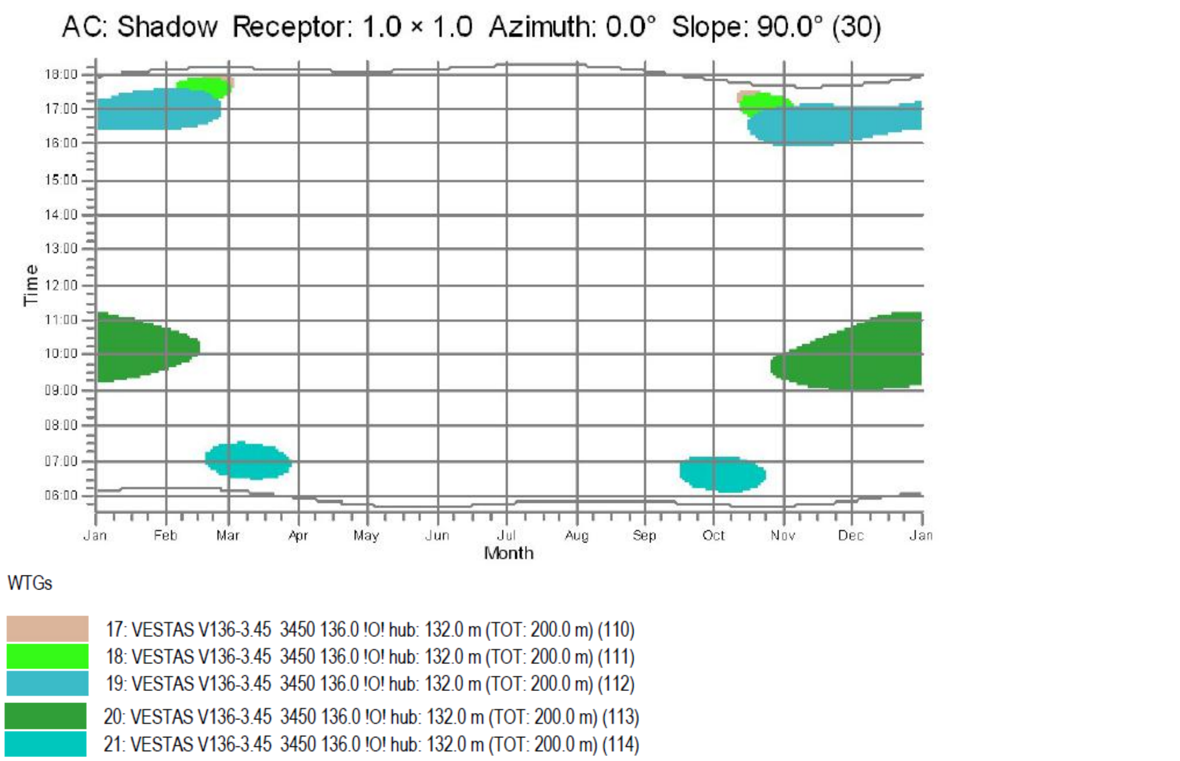


Figure 17: Graphic calendar shadow flicker results for SSR 29 (WindPRO reference AC)

8. SIGNIFICANCE ASSESSMENT AND MITIGATION MEASURES

8.1 ENVIRONMENTAL NOISE

The acoustic climate of the WPP1 area and noise levels within the communities of Anloga and Anyanui will be impacted during the construction, operational, and decommissioning phases. Whereas the significance of construction and decommissioning phase impacts are hereafter assessed based on typical noise impacts during construction and decommissioning activities, noise impacts associated with the operational phase are assessed based on the results of environmental noise calculations and simulations.

To determine the significance of noise impacts, the assessment of the CSIR's prescribed methodology was adopted (refer to Chapter 1 of the ESIA report). It allows for the assessment of direct, indirect as well as cumulative impacts, without and with mitigation and management.

When considering environmental noise, the impact is always direct in nature. Furthermore, since the impact of a project is dependent on prevailing background noise levels, noise assessments by default, consider cumulative impacts. The cumulative impact with proposed developments within 20 km are however also considered if applicable.

The significance of environmental noise impacts associated with the proposed construction and decommissioning of WPP1 is considered *low* for both the preferred and alterative layout (Table 13 and Table 15). Low impact significance implies that the impact may result in minor alterations of the environment and can be easily avoided by implementing appropriate mitigation and management measures. Such measures proposed for adoption in WPP1 environmental management plan are discussed in detail in Section 8.1.1, and entails general good practice for managing environmental noise impacts from these phases.

Operational phase noise impacts associated with the preferred and alternative layout are anticipated to be of *medium* significance (Table 14). This means the impact will result in moderate alteration of the environment and can be reduced or avoided by implementing the appropriate mitigation measures. The impact will also only have an influence on the decision-making if not mitigated. Specific measures for the mitigation and management of noise during the operational phase are discussed in more detail in Section 8.1.2. With these measures implemented, the significance of the residual impact can be reduced to *low*.

8.1.1 Construction and Decommissioning Phases

The main impact of construction and decommissioning phases are disturbance as a result of increased environmental noise levels caused by traffic, earthworks, infrastructure erection and demolition.

Noise from construction/decommissioning works can be difficult to control for several reasons, including:

- Activities are carried out in the open;
- Although transient in nature, it can cause notable disturbances when ongoing;
- Noise arises from many different activities and types of plants and the intensity and character can vary significantly at different phases of construction/decommissioning;
- Sites cannot be excluded by planning control from areas sensitive to noise.

The impact for both alternatives is local in extent, of temporary duration, highly reversible and as a result is of low significance. With the alternative layout for WPP1, residents of Anyanui will however not be impacted by construction/demolition noise.

8.1.1.1 Compulsory Measures

To manage noise impacts and ensure low significance noise impacts, the following must be included in the project's environmental management plan:

- Construction and decommissioning activities *must be limited to day-time working hours*;
- *Implement a complaint register* at site offices where members of the public can easily communicate issues to VRA and contractors. In response to any complaints received, short term monitoring must be conducted as per the methodology set out in

Section 8.1.1.3. Once the source or sources of noise resulting in complaints have been identified, appropriate good practice measures (Section 8.1.1.2) must be implemented.

8.1.1.2 Good Practice Measures

The measures discussed in this section are measures typically applicable to construction sites and considered good practice by the IFC (2007) and BSI (2008). They are also considered applicable to the decommissioning phase. Noise control measures can be applied at the source, at the receiver, or the path from source to receiver. The focus of the measures below is on noise control at the source and the path from source to receiver.

General Good Practice Measures

General measures to reduce noise levels at the source include:

a) Avoiding unnecessary revving and idling times for all mobile construction equipment.
b) Minimising individual construction vehicle engine, transmission, and body noise/vibration. This is achieved through the implementation of an equipment maintenance program.
c) Keeping temporary construction roads well maintained and avoiding steep inclines.
d) Using rubber linings in for instance chutes and dump trucks to reduce impact noise.
e) Minimizing drop height of materials to reduce impact noise.
f) The sequential start-up of equipment and plants rather than simultaneously.
g) All movements and activities on site should take cognisance of the location of NSRs and normal operating hours of the site as far as is practicable.
h) Minimising the need for trucks/equipment to reverse. This will reduce the frequency at which disturbing, but necessary, reverse warnings will occur. Alternatives to the traditional reverse ‘beeper’ alarm such as a ‘self-adjusting’ or ‘smart’ alarm could be considered. These alarms include a mechanism to detect the local noise level and automatically adjust the output of the alarm is so that it is 5 to 10 dB above the noise level near the moving equipment. The promotional material for some smart alarms does state

that the ability to adjust the level of the alarm is of advantage to those sites 'with low ambient noise level' (Burgess & McCarty, 2009). Also, when reversing, vehicles should travel in a direction away from NSRs if possible.

i) Limit construction traffic and activities to day-time work hours (08:00 to 17:00).

Specifications and Equipment Design

If a construction site is within an especially sensitive area, equipment and methods to be employed should be reviewed to ensure the quietest available technology is used. Equipment with lower sound power levels must be selected in such instances and vendors/contractors should be required to guarantee optimised equipment design noise levels.

Enclosures

A far as is practically possible, source of significant noise should be enclosed. The extent of enclosure will depend on the nature of the machine and their ventilation requirements. Generators and air compressors are examples of such equipment. It should be noted that the effectiveness of partial enclosures and screens can be reduced if used incorrectly, e.g. noise should be directed into a partial enclosure and not out of, there should not be any reflecting surfaces such as parked vehicles opposite the open end of a noise enclosure.

Use and Siting of Equipment

Plant and equipment should be sited as far away from NSRs as possible. Also:

a) Machines (e.g. cranes) used intermittently should be shut down between work periods or throttled down to a minimum and not left running unnecessarily. This will reduce noise and conserve energy.

b) Plants or equipment from which noise generated is known to be particularly directional, should be orientated so that the noise is directed away from NSRs.

c) Acoustic covers of engines and compressors should be kept closed when in use or idling.

d) Construction materials such as beams and bricks should be lowered and not dropped.

Maintenance

Regular and effective maintenance of equipment and plants are essential to noise control. Increases in equipment noise are often indicative of eminent mechanical failure. Also, sound reducing equipment/materials can lose effectiveness before failure and can be identified by visual inspection.

Noise generated by vibrating machinery and equipment with vibrating parts can be reduced through the use of vibration isolation mountings or proper balancing. Cutting tools and saws must be kept sharp to reduce frictional noise. Noise generated by friction in conveyor rollers, trolley etc. can be reduced by sufficient lubrication.

Naturally, if noise activities can be minimised or avoided, the amount of noise reaching NSRs will be reduced. Alternatively, the distance between source and receiver must be increased, or noise reduction screens, barriers, or berms must be installed.

Distance

To increase the distance between source and receiver is often the most effective method of controlling noise since, for a typical point source at ground level, a 6 dB decrease can be achieved with every doubling in distance. It is however conceded that it might not always be possible. Ideally, stationary plants such as generators, compressors, cement and asphalt works (if applicable) should be located as far away from NSRs within the development footprint.

Screening

If noise control at the source and the use of distance between source and receiver is not possible, screening methods must be considered. The effectiveness of a noise barrier is dependent on its length, effective height, and position relative to the source and receiver as well as material of construction. To optimize the effect of screening, screens should be located close to either the source of the noise, or the receiver.

The careful placement of barriers such as screens or berms can significantly reduce noise impacts but may result in additional visual impacts. Although vegetation such as shrubs or trees may improve the visual impact of construction sites, it will not significantly reduce noise impacts and should not be considered as a control measure.

Site buildings such as construction offices and stores can be grouped together to form a substantial barrier between construction activities and nearby NRs. Similarly, one may use construction materials such as bricks, timber and aggregate if placed strategically.

8.1.1.3 Monitoring

Noise monitoring at sites where noise is an issue or may become an issue is essential. In the event that noise related complaints are received during either the construction or decommissioning phase, short term (24-hour) ambient noise measurements should be conducted as part of investigating the complaints. The results of the measurements should be used to inform any follow up interventions.

The following procedures should be adopted for all noise surveys during the construction and decommissioning phase:

- All surveys should be designed and conducted by a trained specialist.
- Sampling should be carried out using a Type 1 SLM that meets all appropriate IEC standards and is subject to annual calibration by an accredited laboratory.
- The acoustic sensitivity of the SLM should be tested with a portable acoustic calibrator before and after each sampling session.
- Samples of at least 24 hours in duration and sufficient for statistical analysis should be taken with the use of portable SLM's capable of logging data continuously over the time period. Samples representative of the day- and night-time acoustic environment should be taken.
- The following acoustic indices should be recoded and reported: L_{Aeq} (T), statistical noise level $L_{A90,}$ L_{AFmin} and $L_{AFmax,}$ octave band or 3rd octave band frequency spectra.
- The SLM should be located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface.

- Efforts should be made to ensure that measurements are not affected by the residual noise and extraneous influences, e.g. wind, electrical interference and any other non-acoustic interference, and that the instrument is operated under the conditions specified by the manufacturer. It is good practice to avoid conducting measurements when the wind speed is more than 5 m/s, while it is raining or when the ground is wet.
- A detailed log and record should be kept. Records should include site details, weather conditions during sampling and observations made regarding the acoustic environment of each site.

The investigation of complaints should include an investigation into equipment or machinery that could likely result or resulted in noise levels annoying to the community. This could be achieved with source noise measurements.

8.1.2 Operational Phase

The main impact of the operational phase is disturbance as a result of increased environmental noise levels caused by operating WTGs.

The impact for both alternatives is local in extent, long-term in duration, and highly reversible and with highly likely probability. Without mitigation, the impact significance rating is medium. It can be reduced to low significance if the recommended management and mitigation measures are adopted and adhered to. With the alternative layout for WPP1, residents of Anyanui will not be impacted by operational phase noise.

Measures to prevent and control noise are mainly related to engineering design standards and turbine siting. With modern turbines, mechanical noise is usually significantly lower than aerodynamic noise, and continuous improvement in aerofoil design is reducing the latter (IFC, 2015). Additional recommended noise management measures might include:

- Operating turbines in reduced noise mode.
- Building walls/appropriate noise barriers around potentially affected buildings (only an option in hilly terrain, due to the height of turbines).

The measures recommended and discussed below are compulsory for WPP1.

8.1.2.1 Separation Distance

Increasing the distance between source and receiver is an essential mitigation measure since noise reduction options for WTGs are limited. For an elevated point source such as a WTG, a 6-dB decrease can be achieved with every doubling in distance.

It is recommended that no new permanent residences be permitted within 4.7 rotor diameters of the WPP1 preferred layout, or 3.6 rotor diameters of the WPP1 alterative layout.

Relocation of residences already within these zones will be required if operating at lower noise modes as recommended in Section 8.1.2.2 are not possible.

At the recommended separation/buffer distances, 520 m for the preferred layout and 480 m for the alternative layout with WTGs (with LNTE) at optimised operational modes, residents of Anloga and Anyanui will be protected from noise levels in excess of 45 dBA. The 4.7 and 3.6 rotor diameter separation zones are shown in Figure 18, Figure 19, and Figure 20 for the Anyanui, Srogbe, and Anloga sections of WPP1.

8.1.2.2 WTG Design and Reduced Noise Modes

The benefit of running WTGs in reduced noise operating modes have been illustrated for both the preferred and alternative layouts of WPP1.

Changes to the operational modes of the following WTGs with NSRs within the recommended buffer distances (as identified from satellite imagery) are required to meet assessment criteria:

- For the ***preferred layout***, with Vestas V110 WTGs with LNTE, hub height 95 m, and rotor diameter of 110 m:
  - During the day:
    - Mode 2: WTG nos. 2, 4, and 5 (Figure 18)
    - Required to ensure an increase in day-time noise levels of less than 5 dBA at Anyanui residents north of the western section of the preferred layout.
  - During the night:
    - Mode 2: WTG nos. 19 to 22, 25 to 33, 38 (Figure 19, and Figure 20)

        - To ensure night-time noise levels at closest residences of Anloga remain below 45 dBA.
    - All other WTGs at optimised operational mode (mode 0).
- For the ***alternative layout***, with Vestas V136 WTGs with LNTE, hub height 112 m, and rotor diameter 136 m:
    - During the night:
        - Mode S04: WTG nos. 9, 10, 11, 14 to 19, 22 (Figure 19, and Figure 20)
        - To ensure night-time noise levels at closest residences of Anloga remain below 45 dBA.

8.1.2.3 Monitoring

ETSU (1996) and the IFC (2015) clearly specify noise monitoring practices for WEFs. Methods closely follow the IFC's general monitoring requirements but requires the additional monitoring of wind speed. Environmental noise measurements at receptors near WEF's need also be longer in duration to facilitate determining impacts under various wind conditions.

At least one monitoring station should be installed in Anloga, along its southern edge, and one in Anyanui (at the cluster of residents north of the array), to verify the findings of this assessment. It is recommended that such a station be maintained for a period of 1 year from the day the WEF is fully operation. The specification of such a remote semi-permanent station will depend on power supply options, security of equipment, and remote data access options.

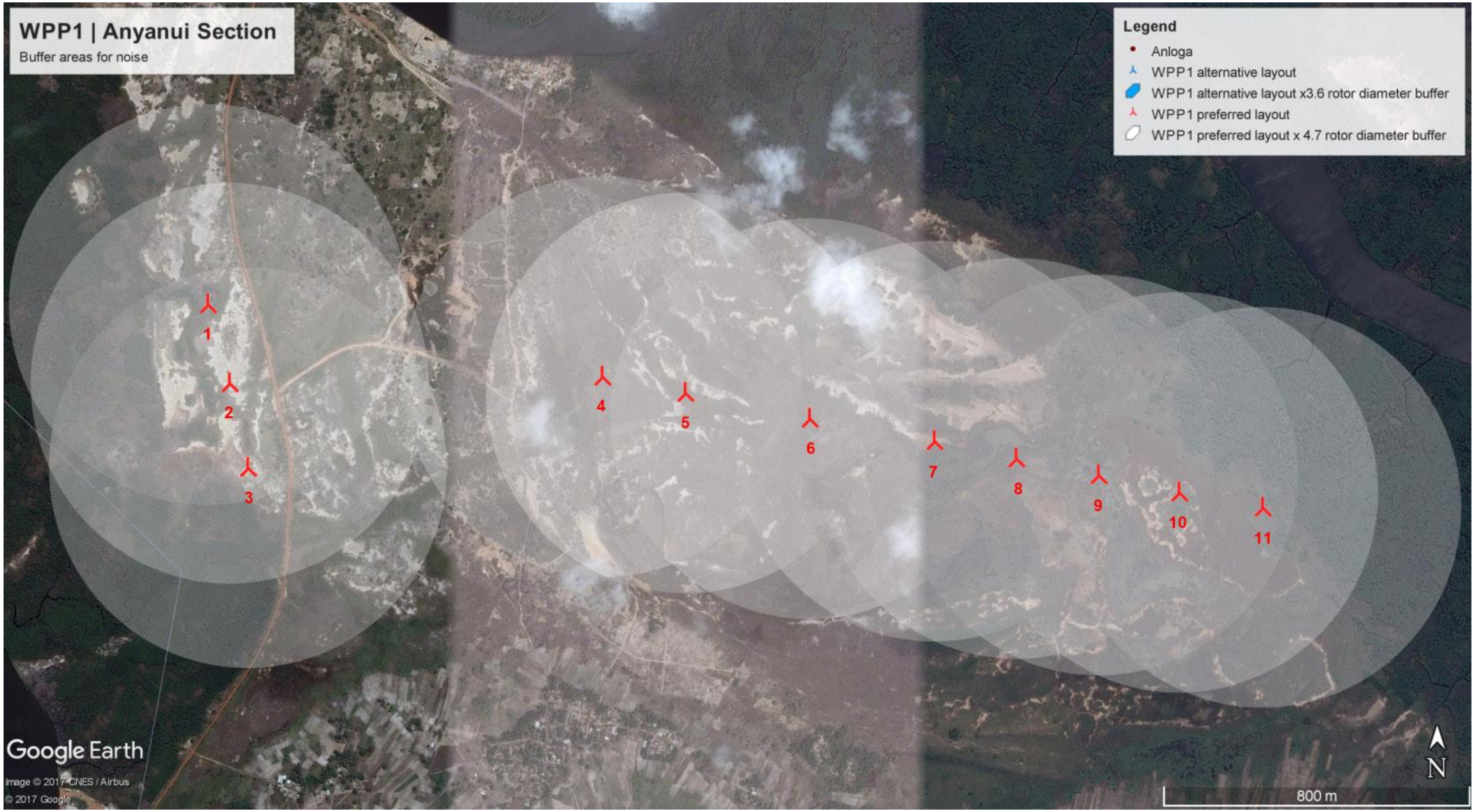


Figure 18: Buffer for the Anyanui section of WPP1, for noise impact mitigation

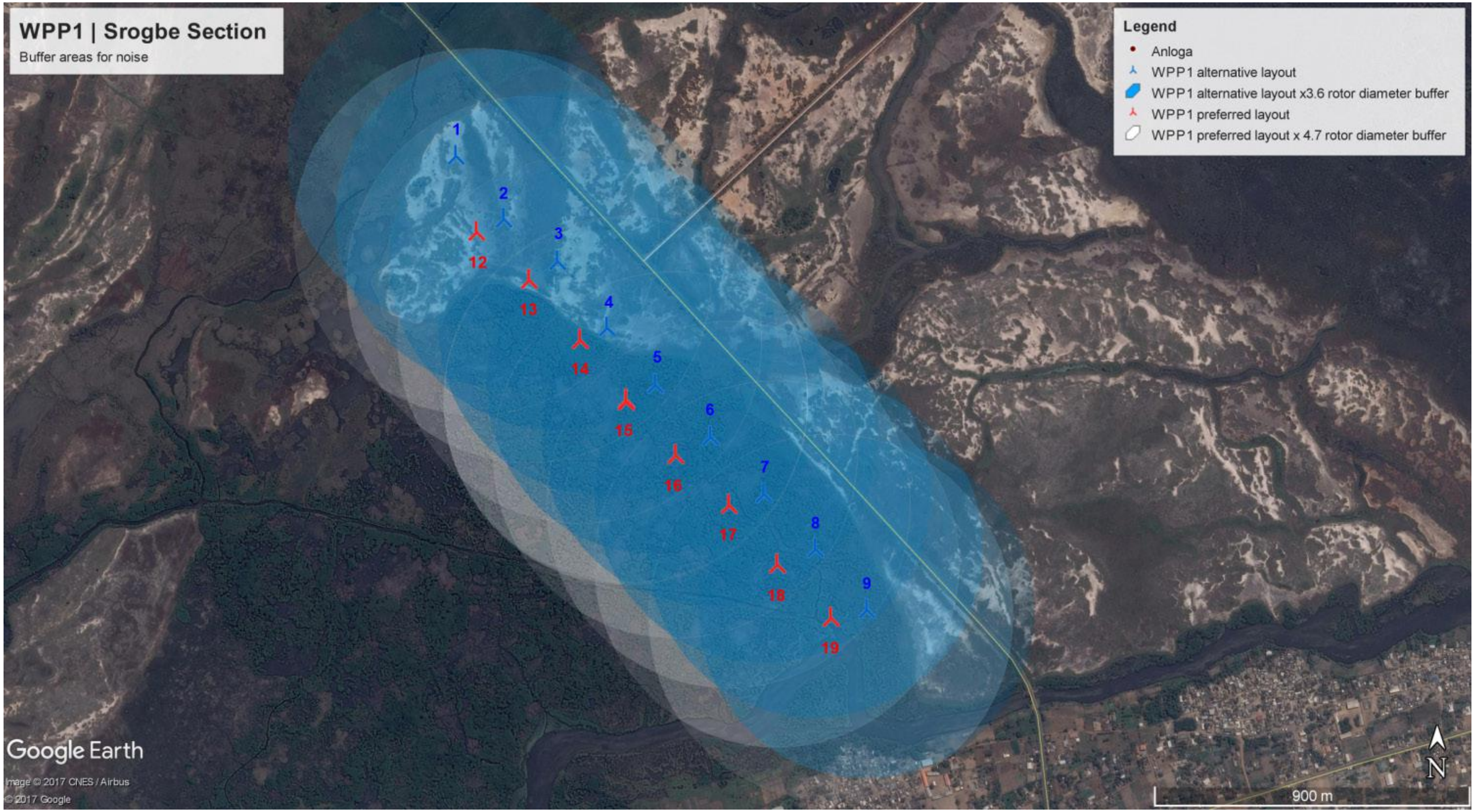


Figure 19: Buffer for the Srogbe section of WPP1, for noise impact mitigation

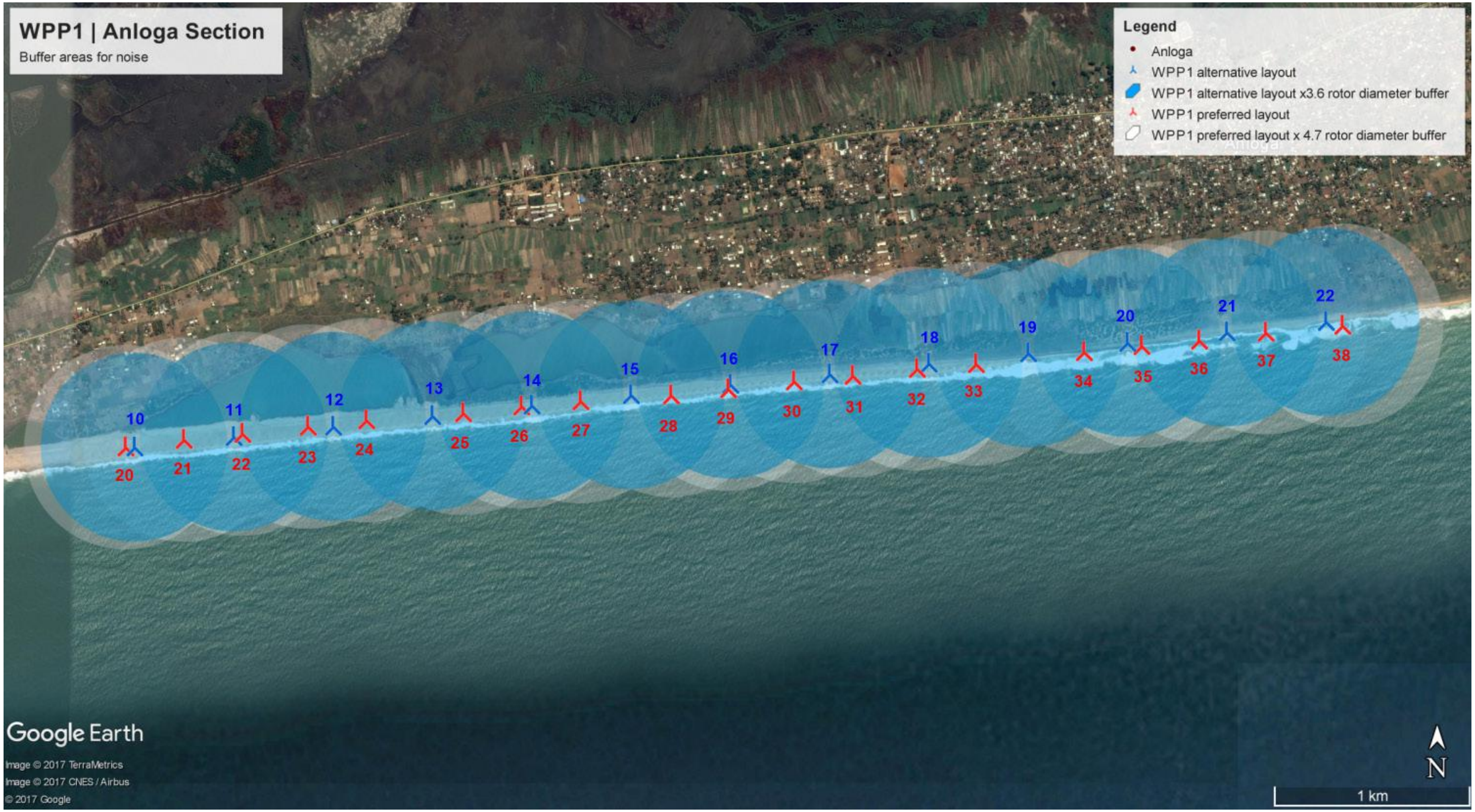


Figure 20: Buffer for the Anloga section of WPP1, for noise impact mitigation

8.2 SHADOW FLICKER IMPACT SIGNIFICANCE AND MITIGATION MEASURES

Shadow flicker impacts are only of concern during the operational phase of a WEF.

Operational phase shadow flicker impacts are anticipated to be of *medium* significance for both the preferred and the alternative layouts (Table 14). This means the impact will result in moderate alteration of the environment and can be reduced or avoided by implementing the appropriate mitigation measures. The impact will also only have an influence on the decision-making if not mitigated. Prevention and control measures to avoid significant shadow flicker impacts generally include the following:

- Site wind turbines appropriately to avoid shadow flicker being experienced; or
- Wind turbines can be programmed to shut down at times when shadow flicker limits are exceeded.

The IFC recommends that, if it is not possible to locate the wind energy facility/turbines such that neighbouring receptors experience no shadow flicker effects, the predicted duration of shadow flicker effects experienced at a sensitive receptor should not exceed 30 hours per year and 30 minutes per day on the worst affected day (IFC, 2007).

8.2.1 Compulsory Measures

Shadow flicker impacts in exceedance of impact criteria at SSRs were only found to occur as a result of the Anloga section of WPP1. **To mitigate these shadow flicker impacts, SSRs within the 30 hours per year, real shadow impact must be relocated**. Residences in Anloga within this zone of approximately **3 rotor diameters** are shown in Figure 21. With the relocation of receptors within five rotor diameters for noise, shadow flicker impacts will also be avoided.

8.2.2 Good Practice Measures

To further reduce shadow flicker impacts at Anloga and those SSRs within the 8 to 30-hour real shadow impact zone, VRA should consider shutting down WTGs proposed as part of the Anloga Section of WPP1 during early morning and afternoon hours. Curtailment periods per WTG can be determined from calendar plots included in Annex C.

8.3 CUMULATIVE IMPACTS

To the author's knowledge there are no another wind power projects within 20 km of WPP1 that may result in cumulative environmental noise, or shadow flicker impacts.

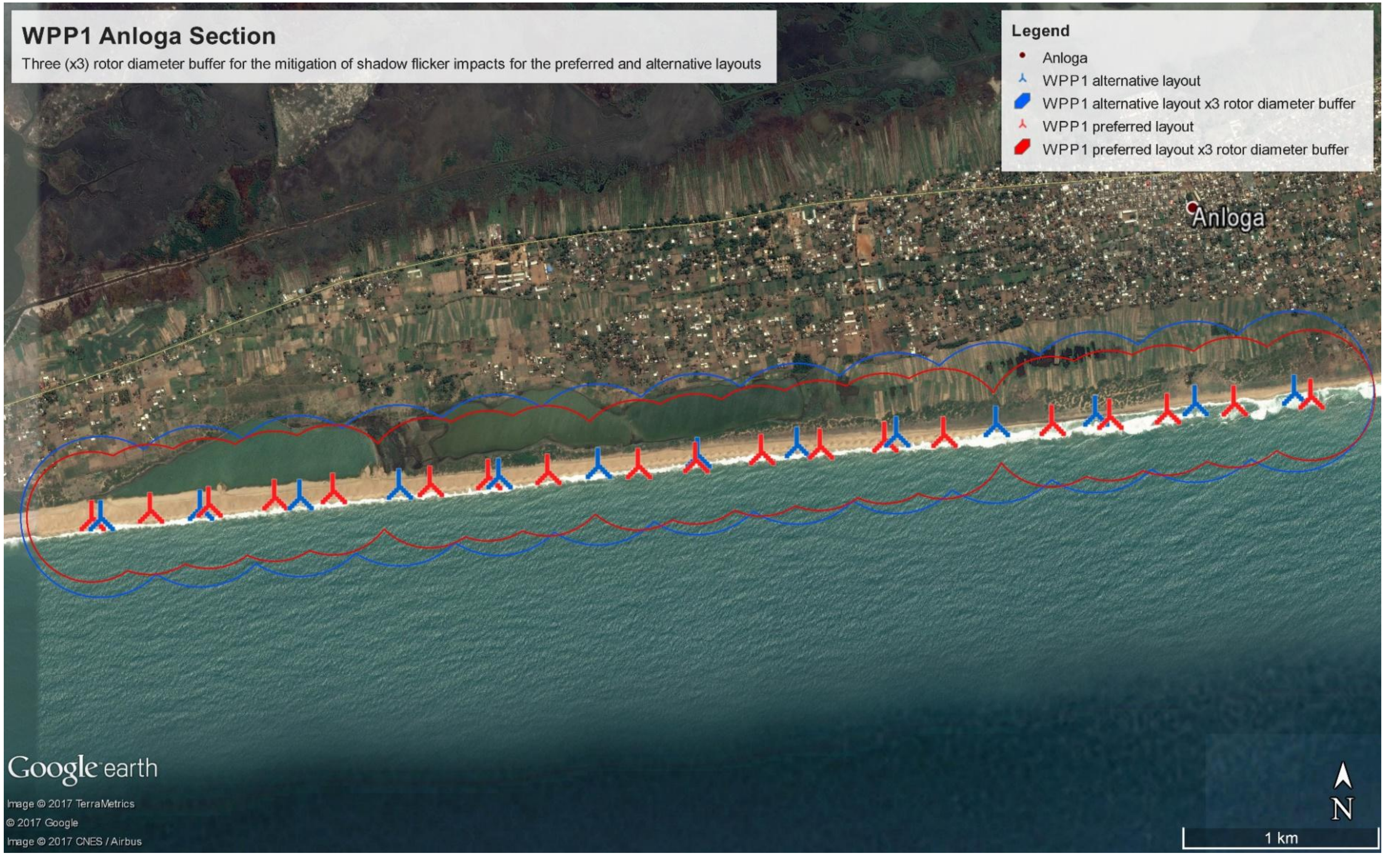


Figure 21: Three rotor diameter buffer for the Anloga section of WPP1, for shadow flicker impact mitigation

Table 13: Impact assessment summary table for the construction phase of the preferred and alternative layout

Construction Phase, Preferred and Alterative Layout															
Direct, cumulative impacts															
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Site Alternative**	**Status**	**Spatial Extent**	**Duration**	**Intensity**	**Probability**	**Reversibility of Impact**	**Irreplace-ability**	**Can the Impact/Risk be Avoided?**	**Can the Impact/Risk be Mitigated/ Managed?**	**Potential Mitigation Measures**	**Significance of Impact**		**Confidence Level**
													Without Mitigation/Management	***With Mitigation/Management***	
Construction noise, traffic, bulk earthworks, infra-structure erection	Disturbance as a result of increased environmental noise levels caused by construction of WTGs	Preferred layout	Negative	Local	Temporary	Medium	Highly likely	Highly reversible	Low	No	Yes	Compulsory: - Limit activities to day-time hours, complaints register and investigation through short term monitoring. Good practice - Basic good practice noise and, traffic management.	Low	Low	Medium
		Alternative layout	Negative	Local	Temporary	Medium	Highly likely	Highly reversible	Low	No	Yes	Compulsory: - Limit activities to day-time hours, complaints register and investigation through short term monitoring. Good practice - Basic good practice noise and, traffic management.	Low	Low	Medium

Table 14: Impact assessment summary table for the operational phase of the preferred and alternative layout

Operational Phase, Preferred and Alternative Layout															
Direct, cumulative impacts															
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Site Alternative**	**Status**	**Spatial Extent**	**Duration**	**Intensity**	**Probability**	**Reversibility of Impact**	**Irreplaceability**	**Can the Impact/Risk be Avoided?**	**Can the Impact/Risk be Mitigated/ Managed?**	**Potential Mitigation Measures**	**Significance of Impact**		**Confidence Level**
													Without Mitigation/Management	***With Mitigation/Management***	
WTG noise	Disturbance as a result of increased environmental noise levels caused by operational WTGs	Preferred layout	Negative	Local	Long-term	Medium	Highly likely	Highly reversible	Low	No	Yes	*Compulsory:* - WTG at low noise operating mode 1 (L_{WA} ≤105 dBA) - Relocation of permanent residences within 5 rotor diameters. - Maintaining 5 rotor diameter buffer around WEF.	Medium	Low	Medium
		Alternative layout	Negative	Local	Long-term	Medium	Highly likely	Highly reversible	Low	No	Yes	*Compulsory*: - WTG at low noise operating mode 0 (L_{WA} ≤105.5 dBA) with serrated training edge - Relocation of permanent residences within 5 rotor diameters. - Maintaining 5 rotor diameter buffer around WEF.	Medium	Low	Medium
Shadow Flicker	Disturbance as a result of shadows cast by operational WTGs	Preferred layout	Negative	Local	Long-term	Medium	Highly likely	Highly reversible	Low	No	Yes	*Compulsory:* - Relocation of permanent residences at Anloga within approximately 3 rotor diameters. - Maintaining 5 rotor diameter buffer as recommended for noise, around Anyanui and Srogbe sections. *Good Practice:* - Curtailing WTG operation at Anloga section during early morning and afternoon hours.	Medium	Low	Medium
		Alternative layout	Negative	Local	Long-term	Medium	Highly likely	Highly reversible	Low	No	Yes	*Compulsory:* - Relocation of permanent residences at Anloga within approximately 3 rotor diameters. - Maintaining 5 rotor diameter buffer as recommended for noise, around Anyanui and Srogbe sections. *Good Practice:* - Curtailing WTG operation at Anloga section during early morning and afternoon hours.	Medium	Low	Medium

Table 15: Impact assessment summary table for the decommissioning phase for the preferred and alternative layout

Decommissioning Phase, Preferred and Alternative Layout															
Direct, cumulative impacts															
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Site Alternative**	**Status**	**Spatial Extent**	**Duration**	**Intensity**	**Probability**	**Reversibility of Impact**	**Irreplace-ability**	**Can the Impact/Risk be Avoided?**	**Can the Impact/Risk be Mitigated/ Managed?**	**Potential Mitigation Measures**	**Significance of Impact**		**Confidence Level**
													Without Mitigation/Management	***With Mitigation/Management***	
Construction noise, traffic, bulk earthworks, infra-structure erection	Disturbance as a result of increased environmental noise levels caused by decommissioning activities WTGs	Preferred layout	Negative	Local	Temporary	Medium	Highly likely	Highly reversible	Low	No	Yes	*Compulsory:* - Limit activities to day-time hours, complaints register and investigation through short term monitoring. *Good practice* - Basic good practice noise and, traffic management.	Low	Low	Medium
		Alternative layout	Negative	Local	Temporary	Medium	Highly likely	Highly reversible	Low	No	Yes	*Compulsory:* - Limit activities to day-time hours, complaints register and investigation through short term monitoring. *Good practice* - Basic good practice noise and, traffic management.	Low	Low	Medium

9. CONCLUSIONS

9.1 ENVIRONMENTAL NOISE

Given the findings of the environmental noise study it is concluded that the significance of environmental noise impacts during all project phases are considered *medium* but should be reduced to *low* with the implementation of management and mitigation measures recommended in this report as a condition of project approval.

During the **construction and decommissioning phases** of the project, low significance noise impacts may be achieved by implementing basic good practice measures such as the maintenance of diesel mobile equipment, traffic management, and limiting noise generating activities to day-time hours.

The *medium significance* rating for the **operational phase** is based on the finding that exceedance of noise impact guidelines may occur up to 4.7 rotor diameters from the preferred layout WTG arrays and 3.6 rotor diameters from the alternative layout WTG arrays. Given available satellite imagery, several residential structures fall within this distance from WPP1, specifically at Anloga. Special measures (such as operating certain WTGs at lower noise modes and or relocation) must be adopted to manage noise impacts at all NSR within 4.7 rotor diameters from V110 WTGs, and 3.6 rotor diameters from V136 WTGs.

It is also concluded that, from an environmental noise perspective, the alternative layout is the preferred option for the following reasons:

- Residents in and around Anyanui, where lower background noise levels prevail in comparison with Anloga, will not be impacted.
- The alternative layout necessitates the use of larger WTGs. The Vestas V136 WTG with the serrated LNTE at the optimised operational mode has a reference L_W of 105.5 dB which is comparable to the 106 dB of the smaller WTG (Vestas V110) with the LNTE, proposed for use with the preferred layout.

- At the same L_W, larger WTGs result in lower ground level noise due to increased emission height (95 m vs. 112 m), distance from receptors, as well as larger distances between WTGs.

9.2 SHADOW FLICKER

It is concluded that shadow flicker impacts, only of concern during the operational phase are *of medium* significance (for the preferred and alternative layout) and must be reduced by implementing the appropriate mitigation measures as a condition for project approval.

Receptors at Anloga within 3 rotor diameters of the eastern WTG array must be relocated. To further reduce shadow flicker impacts at Anloga and those SSRs within the 8 to 30-hour real shadow impact zone, VRA should consider shutting down WTGs proposed as part of the eastern WTG array of WPP1 during early morning and afternoon hours from October to February.

From a shadow flicker perspective, the preferred layout it slightly more preferred since the impact area of the V110 WTGs is somewhat smaller than the larger V136 WTGs.

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11. ANNEX A – CALIBRATION CERTIFICATES

nmisa
National Metrology Institute of South Africa

Certificate of Conformance

Private Bag X34, Lynnwood Ridge, Pretoria, 0040
CSIR Campus, Meiring Naude Road, Brummeria, 0184
Calibration office: +27 12 841 4623
Reception: +27 12 841 4152
Fax: +27 12 841 4458
E-mail enquiries: info@nmisa.org

Calibration of:	SOUND LEVEL METER, OCTAVE BAND FILTER, THIRD OCTAVE BAND FILTER & MICROPHONE
Manufacturer:	BRÜEL & KJÆR
Model number:	2250, 4950
Serial number:	2731851, 2709293
Calibrated for:	AIRSHED PLANNING PROFESSIONALS (PTY) LTD Johannesburg
Calibration procedure:	AV\AS-0007 AV\AS-0010
Period of calibration:	26 – 27 January 2016

1 PROCEDURE

The sound level meter was electrically calibrated according to the relevant clauses of SANS 656 and 658 specifications. The microphone with the sound level meter was acoustically calibrated according to the relevant clauses of SANS 656 specifications. The instrument complete with filters was electrically calibrated according to IEC 61260 specification.

The results of the measurements are traceable to the national measurement standards.

The following equipment was used:

Brüel & Kjær 4226 Multi-function calibrator	(AS-131)
Inline Capacitor	(AS-98)
Brüel & Kjær 3630 Calibration platform	(AS-109)

Calibrated by **R Nel** **Metrologist (Technical Signatory)**	Checked by **ML Temba** **Metrologist**	For Chief Executive Officer
Date of issue **27 January 2016**	**Page 1 of 3**	Certificate number **AV\AS-4534**

Your measure of excellence

CALIBRATION OF A SOUND LEVEL METER, OCTAVE BAND FILTER,
THIRD OCTAVE BAND FILTER & MICROPHONE
(2731851, 2709293)

2 RESULTS

2.1 The following parameters of the sound level meter were calibrated and conformed to the SANS 656 and SANS 658 specifications, type 1:

Indication under reference conditions (SANS 656 clause 11.2)		U = 0,20 dB
Electrical self generated noise		
A-weighted	(12,4 dB)	U = 0,30 dB
C-weighted	(13,2 dB)	U = 0,30 dB
Linear	(18,9 dB)	U = 0,30 dB
Linearity range (SANS clause 9.9, table 11)		
31,5 Hz		U = 0,12 dB
1 kHz		U = 0,12 dB
8 kHz		U = 0,12 dB
Frequency Weightings (SANS 656 clauses 8.1, 11.2, tables 4 & 5)		
A-weighting	(25 Hz – 16 kHz)	U = 0,12 dB
C-weighting	(25 Hz – 16 kHz)	U = 0,12 dB
Linear	(25 Hz – 16 kHz)	U = 0,12 dB
Time weightings (SANS 656 clauses 9.2, 9.3, 9.5, 11.4, table 9, 7 & 10)		
Slow and Fast		U = 0,11 dB
Impulse		U = 0,11 dB
Peak		U = 0,09 dB
Time averaging, L_{Aeq} (SANS 658 clause 11.3.3, table 4)		U = 0,12 dB
Impulse weighted time averaging, L_{AIeq} (SANS 658 Annex C, table C1)		U = 0,12 dB
Overload indication (SANS 656 clause 11.3)		U = 0,31 dB

2.2 The following parameter of the microphone with the sound level meter were calibrated and conformed to the SANS 656 specifications, type 1:

Frequency response (SANS 656 clauses 8.1, tables 4 & 5) 31,5 Hz – 12,5 kHz	U = 0,20 dB @ 1 kHz

Calibrated by **R Nel** **Metrologist (Technical Signatory)**	Checked by **ML Temba** **Metrologist**	For Chief Executive Officer
Date of Issue **27 January 2016**	**Page 2 of 3**	Certificate number **AV/AS-4534**

CALIBRATION OF A SOUND LEVEL METER, OCTAVE BAND FILTER,
THIRD OCTAVE BAND FILTER & MICROPHONE
(2731851, 2709293)

2.3 The following parameter of the octave band filter was calibrated and conformed to the IEC 61260 specification, class 0 base 2:

Relative attenuation $U = 0{,}12$ dB @ f_m
(IEC 61260 clause 4.4, 5.3)
16 Hz - 8 kHz

2.4 The following parameter of the third octave band filter was calibrated and conformed to the IEC 61260 specification, class 0 base 2:

Relative attenuation $U = 0{,}12$ dB @ f_m
(IEC 61260 clause 4.4, 5.3)
12,5 Hz - 16 kHz

3 REMARKS

3.1 The reported uncertainties of measurement were calculated and expressed in accordance with the BIPM, IEC, ISO, IUPAP, OIML document entitled "A Guide to the Expression of Uncertainty in Measurement" (International Organisation for Standardisation, Geneva, Switzerland, 1993).

3.2 The reported expanded uncertainty of measurement, U, is stated as the standard uncertainty of measurement multiplied by a coverage factor of $k = 2$, which for a normal distribution approximates a level of confidence of 95,45 %. The reported expanded uncertainty of measurements is at the reference points.

3.3 Certain of the NMISA certificates are consistent with the capabilities that are included in appendix C of the MRA (Mutual Recognition Arrangement) drawn up by the CIPM. Under the MRA, all participating institutes recognise the validity of each other's calibration and measurement certificates for the quantities and ranges and measurement uncertainties specified in Appendix C. For details see http://www.bipm.org.

3.4 The calibrations were carried out at an ambient temperature of 23 °C ± 2 °C and a relative humidity of 50 %RH ± 20 %RH.

3.5 Only parameters given in 2.1, 2.2, 2.3 and 2.4 were calibrated.

3.6 The above statement of conformance is based on the measurement value(s) obtained, extended by the estimated uncertainty of measurement, being within the appropriate specification limit(s).

3.7 The firmware version of the sound measuring device at the time of calibration was: 4.4.0.44; BZ7130 v4.4; BZ7131 v4.4; BZ7132 v4.4

---------------- *end of certificate* ----------------

Calibrated by R Nel Metrologist (Technical Signatory)	Checked by ML Temba Metrologist	For Chief Executive Officer
Date of Issue 27 January 2016	Page 3 of 3	Certificate number AV\AS-4534

12. ANNEX B – WINDPRO DECIBEL REPORTS

Project:
VRA WPP1 (v2)

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
07/12/2017 2:53 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP1 | Alternative | Mode0 | Loudest up to 95% rated power | LA90

Noise calculation model:
ISO 9613-2 General
Wind speed:
Loudest up to 95% rated power
Ground attenuation:
General, terrain specific
Ground factor for porous ground: 1.0
Area object with hard ground: Project Wizard Roughness Areas (GlobCover 20
Area type with hard ground: 0,0000m(cl.0,0) Water bodies
Meteorological coefficient, C0:
0.0 dB
Type of demand in calculation:
1: WTG noise is compared to demand (DK, DE, SE, NL etc.)
Noise values in calculation:
All noise values are 90% exeedance values (L90)
Pure tones:
Fixed penalty added to source noise of WTGs with pure tones: 5.0 dB(A)
Height above ground level, when no value in NSA object:
1.0 m Don't allow override of model height with height from NSA object
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0.0 dB(A)

Scale 1:400 000
New WTG   Noise sensitive area

WTGs

	Easting	Northing	Z [m]	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data Creator	Name	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones
1	258 055	641 160	2.3	VESTAS V136-3.45 3450 13...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 0- Calculated- Mode 0 - 11.02.2016	10.0	105.5	No
2	258 190	640 980	5.9	VESTAS V136-3.45 3450 13...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 0- Calculated- Mode 0 - 11.02.2016	10.0	105.5	No
3	258 343	640 859	11.5	VESTAS V136-3.45 3450 13...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 0- Calculated- Mode 0 - 11.02.2016	10.0	105.5	No
4	258 484	640 670	2.2	VESTAS V136-3.45 3450 13...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 0- Calculated- Mode 0 - 11.02.2016	10.0	105.5	No
5	258 621	640 508	0.2	VESTAS V136-3.45 3450 13...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 0- Calculated- Mode 0 - 11.02.2016	10.0	105.5	No
6	258 778	640 360	1.0	VESTAS V136-3.45 3450 13...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 0- Calculated- Mode 0 - 11.02.2016	10.0	105.5	No
7	258 930	640 197	2.3	VESTAS V136-3.45 3450 13...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 0- Calculated- Mode 0 - 11.02.2016	10.0	105.5	No
8	259 077	640 040	0.9	VESTAS V136-3.45 3450 13...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 0- Calculated- Mode 0 - 11.02.2016	10.0	105.5	No
9	261 900	639 088	0.0	VESTAS V136-3.45 3450 13...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 0- Calculated- Mode 0 - 11.02.2016	10.0	105.5	No
10	262 408	639 139	0.0	VESTAS V136-3.45 3450 13...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 0- Calculated- Mode 0 - 11.02.2016	10.0	105.5	No
11	262 917	639 190	0.0	VESTAS V136-3.45 3450 13...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 0- Calculated- Mode 0 - 11.02.2016	10.0	105.5	No
12	263 425	639 242	2.3	VESTAS V136-3.45 3450 13...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 0- Calculated- Mode 0 - 11.02.2016	10.0	105.5	No
13	263 934	639 293	4.5	VESTAS V136-3.45 3450 13...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 0- Calculated- Mode 0 - 11.02.2016	10.0	105.5	No
14	264 442	639 344	2.3	VESTAS V136-3.45 3450 13...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 0- Calculated- Mode 0 - 11.02.2016	10.0	105.5	No
15	264 951	639 395	0.8	VESTAS V136-3.45 3450 13...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 0- Calculated- Mode 0 - 11.02.2016	10.0	105.5	No
16	265 459	639 446	1.2	VESTAS V136-3.45 3450 13...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 0- Calculated- Mode 0 - 11.02.2016	10.0	105.5	No
17	265 967	639 498	5.3	VESTAS V136-3.45 3450 13...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 0- Calculated- Mode 0 - 11.02.2016	10.0	105.5	No
18	266 476	639 549	6.3	VESTAS V136-3.45 3450 13...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 0- Calculated- Mode 0 - 11.02.2016	10.0	105.5	No
19	266 984	639 600	5.4	VESTAS V136-3.45 3450 13...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 0- Calculated- Mode 0 - 11.02.2016	10.0	105.5	No
20	267 493	639 651	0.5	VESTAS V136-3.45 3450 13...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 0- Calculated- Mode 0 - 11.02.2016	10.0	105.5	No
21	268 001	639 702	0.0	VESTAS V136-3.45 3450 13...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 0- Calculated- Mode 0 - 11.02.2016	10.0	105.5	No
22	259 223	639 867	3.0	VESTAS V136-3.45 3450 13...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 0- Calculated- Mode 0 - 11.02.2016	10.0	105.5	No

Calculation Results

Sound level

Noise sensitive area No.	Name	Easting	Northing	Z [m]	Imission height [m]	Demands Noise [dB(A)]	Sound level From WTGs [dB(A)]	Distance to noise demand [m]	Demands fulfilled ? Noise
A	Noise sensitive point: User defined (1)	247 056	640 476	7.7	1.0	45.0	-0.9	10 740	Yes
B	Noise sensitive point: User defined (2)	248 022	641 929	7.2	1.0	45.0	1.5	9 798	Yes
C	Noise sensitive point: User defined (3)	248 289	640 061	0.9	1.0	45.0	2.4	9 541	Yes
D	Noise sensitive point: User defined (4)	248 970	641 756	2.6	1.0	45.0	4.1	8 841	Yes
E	Noise sensitive point: User defined (5)	248 997	640 221	5.1	1.0	45.0	4.4	8 821	Yes
F	Noise sensitive point: User defined (6)	249 771	640 012	9.2	1.0	45.0	6.5	8 073	Yes
G	Noise sensitive point: User defined (7)	250 228	639 732	10.6	1.0	45.0	7.8	7 661	Yes
H	Noise sensitive point: User defined (8)	250 804	639 783	9.8	1.0	45.0	9.5	7 085	Yes
I	Noise sensitive point: User defined (9)	251 412	639 569	6.0	1.0	45.0	11.2	6 530	Yes
J	Noise sensitive point: User defined (10)	253 617	638 680	9.8	1.0	45.0	17.5	4 747	Yes
K	Noise sensitive point: User defined (11)	255 693	644 057	1.4	1.0	45.0	20.7	3 492	Yes
L	Noise sensitive point: User defined (12)	255 767	638 564	6.2	1.0	45.0	24.6	3 004	Yes
M	Noise sensitive point: User defined (13)	256 642	638 627	2.9	1.0	45.0	27.9	2 300	Yes
N	Noise sensitive point: User defined (14)	258 286	639 176	-1.2	1.0	45.0	36.6	776	Yes
O	Noise sensitive point: User defined (15)	259 173	639 472	1.8	1.0	45.0	42.6	124	Yes

To be continued on next page...

Project:
VRA WPP1 (v2)

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
07/12/2017 2:53 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP1 | Alternative | Mode0 | Loudest up to 95% rated power | LA90

...continued from previous page

Noise sensitive area						**Demands**	**Sound level**		**Demands fulfilled ?**
No.	Name	Easting	Northing	Z	Imission height	Noise	From WTGs	Distance to noise demand	Noise
				[m]	[m]	[dB(A)]	[dB(A)]	[m]	
P	Noise sensitive point: User defined (16)	259 729	639 505	5.7	1.0	45.0	39.1	365	Yes
Q	Noise sensitive point: User defined (17)	260 367	639 740	0.1	1.0	45.0	35.3	902	Yes
R	Noise sensitive point: User defined (18)	260 982	639 111	2.9	1.0	45.0	34.9	721	Yes
S	Noise sensitive point: User defined (19)	261 591	639 271	2.6	1.0	45.0	41.5	163	Yes
T	Noise sensitive point: User defined (20)	261 857	639 479	4.2	1.0	45.0	41.5	190	Yes
U	Noise sensitive point: User defined (21)	262 163	639 475	3.4	1.0	45.0	42.4	135	Yes
V	Noise sensitive point: User defined (22)	262 388	639 685	2.5	1.0	45.0	40.3	303	Yes
W	Noise sensitive point: User defined (23)	263 152	639 772	4.3	1.0	45.0	40.5	328	Yes
X	Noise sensitive point: User defined (24)	263 978	639 723	3.5	1.0	45.0	42.2	169	Yes
Y	Noise sensitive point: User defined (25)	264 462	639 785	0.6	1.0	45.0	42.0	167	Yes
Z	Noise sensitive point: User defined (26)	265 204	639 846	1.9	1.0	45.0	42.1	205	Yes
AA	Noise sensitive point: User defined (27)	266 060	639 903	4.4	1.0	45.0	42.5	157	Yes
AB	Noise sensitive point: User defined (28)	267 435	640 192	6.3	1.0	45.0	40.2	276	Yes
AC	Noise sensitive point: User defined (29)	267 454	639 756	5.9	1.0	45.0	49.1	-137	**No**
AD	Noise sensitive point: User defined (30)	267 992	640 117	5.4	1.0	45.0	40.9	176	Yes
AE	Noise sensitive point: User defined (31)	268 091	639 901	8.3	1.0	45.0	45.1	-32	**No**

Distances (m)

	WTG																					
NSA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A	11020	11145	11293	11430	11565	11723	11877	12029	14909	15410	15913	16415	16919	17423	17928	18432	18936	19442	19947	20454	20959	12182
B	10062	10212	10376	10537	10694	10870	11045	11215	14166	14654	15145	15636	16129	16622	17118	17613	18109	18607	19104	19604	20103	11389
C	9827	9944	10086	10213	10342	10493	10642	10788	13646	14149	14654	15158	15664	16169	16675	17181	17687	18194	18701	19208	19715	10936
D	9104	9253	9416	9576	9731	9907	10081	10252	13202	13690	14181	14672	15165	15659	16154	16650	17146	17645	18143	18642	19142	10426
E	9106	9224	9368	9498	9628	9782	9933	10082	12953	13455	13958	14461	14966	15470	15975	16480	16985	17492	17998	18505	19011	10232
F	8363	8474	8614	8738	8864	9014	9161	9306	12164	12667	13172	13676	14181	14686	15193	15698	16204	16711	17218	17726	18233	9453
G	7956	8059	8193	8309	8429	8573	8714	8854	11690	12194	12701	13206	13713	14219	14727	15234	15741	16249	16757	17265	17773	8996
H	7380	7482	7615	7731	7851	7995	8137	8277	11118	11622	12128	12633	13139	13645	14152	14659	15166	15674	16181	16690	17197	8419
I	6831	6923	7050	7157	7270	7408	7544	7679	10499	11004	11511	12017	12525	13032	13540	14048	14555	15064	15572	16081	16590	7817
J	5084	5119	5204	5258	5327	5428	5525	5627	8293	8803	9314	9824	10335	10845	11357	11867	12377	12888	13399	13910	14420	5730
K	3738	3963	4153	4389	4601	4815	5038	5252	7951	8323	8711	9109	9519	9938	10366	10800	11240	11687	12139	12596	13056	5479
L	3460	3422	3450	3438	3453	3506	3560	3624	6155	6666	7177	7688	8199	8710	9222	9732	10243	10754	11265	11776	12287	3693
M	2900	2817	2806	2751	2730	2751	2775	2815	5278	5789	6300	6811	7322	7833	8344	8855	9366	9877	10388	10899	11410	2863
N	1997	1807	1684	1507	1373	1282	1207	1171	3615	4122	4631	5139	5649	6158	6669	7178	7688	8198	8708	9219	9729	1164
O	2025	1800	1616	1382	1174	972	765	576	2754	3252	3755	4258	4764	5271	5779	6286	6794	7303	7812	8322	8831	398
P	2354	2132	1938	1705	1495	1279	1057	843	2211	2704	3204	3705	4210	4716	5223	5730	6238	6747	7256	7765	8274	622
Q	2713	2505	2313	2100	1907	1706	1508	1324	1666	2128	2609	3098	3595	4094	4597	5100	5605	6112	6618	7127	7634	1151
R	3573	3360	3165	2945	2743	2533	2322	2119	918	1426	1937	2447	2958	3468	3979	4490	5000	5511	6022	6533	7044	1915
S	4009	3806	3615	3407	3217	3016	2818	2629	359	828	1328	1834	2343	2852	3362	3872	4382	4893	5403	5914	6424	2442
T	4157	3962	3775	3577	3396	3203	3014	2836	393	647	1099	1586	2085	2589	3095	3602	4110	4620	5128	5639	6148	2662
U	4440	4249	4063	3868	3690	3499	3313	3137	468	416	806	1283	1780	2283	2789	3296	3804	4314	4823	5333	5842	2966
V	4577	4393	4212	4026	3856	3673	3496	3330	771	546	724	1128	1595	2082	2579	3080	3584	4090	4597	5105	5613	3170
W	5283	5107	4930	4754	4590	4413	4243	4084	1427	977	628	596	917	1359	1838	2330	2828	3331	3836	4343	4850	3930
X	6095	5923	5748	5575	5414	5239	5070	4911	2173	1675	1187	733	432	599	1027	1507	2002	2504	3009	3516	4023	4757
Y	6553	6385	6213	6043	5886	5713	5547	5391	2655	2153	1656	1171	722	441	625	1053	1532	2028	2529	3034	3540	5240
Z	7269	7105	6935	6770	6616	6447	6284	6130	3390	2884	2379	1879	1385	912	517	474	839	1306	1797	2297	2801	5981
AA	8103	7943	7776	7615	7464	7296	7136	6984	4239	3731	3223	2717	2212	1712	1220	755	416	546	972	1455	1951	6837
AB	9430	9279	9116	8964	8820	8659	8505	8359	5644	5136	4628	4121	3615	3111	2609	2112	1624	1155	744	544	749	8218
AC	9504	9345	9178	9016	8865	8697	8535	8382	5594	5084	4572	4062	3550	3040	2529	2019	1509	1000	495	112	550	8232
AD	9992	9840	9677	9524	9379	9217	9062	8915	6178	5669	5159	4650	4141	3633	3126	2620	2117	1619	1133	683	415	8773
AE	10115	9960	9795	9638	9489	9324	9166	9015	6244	5734	5223	4712	4201	3691	3181	2671	2162	1653	1147	648	218	8868

Project:
VRA WPP1 (v2)

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
07/12/2017 11:04 AM/3.1.617

DECIBEL - Main Result

Calculation: WPP1 | Original | LNTE Mode0 | Loudest up to 95% rated power | LA90

Noise calculation model:
ISO 9613-2 General
Wind speed:
Loudest up to 95% rated power
Ground attenuation:
General, terrain specific
Ground factor for porous ground: 1.0
Area object with hard ground: Project Wizard Roughness Areas (GlobCover 20
Area type with hard ground: 0,0000m(cl.0,0) Water bodies
Meteorological coefficient, C0:
0.0 dB
Type of demand in calculation:
1: WTG noise is compared to demand (DK, DE, SE, NL etc.)
Noise values in calculation:
All noise values are 90% exeedance values (L90)
Pure tones:
Fixed penalty added to source noise of WTGs with pure tones: 5.0 dB(A)
Height above ground level, when no value in NSA object:
1.0 m Don't allow override of model height with height from NSA object
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0.0 dB(A)

Scale 1:400 000
New WTG   Noise sensitive area

WTGs

	Easting	Northing	Z [m]	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data Creator	Name	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones
1	248 091	641 206	-1.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
2	248 147	641 000	3.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
3	248 194	640 780	4.8	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
4	249 122	641 014	-0.2	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
5	249 339	640 971	5.7	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
6	249 664	640 902	1.1	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
7	249 990	640 843	2.4	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
8	250 204	640 797	-1.6	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
9	250 419	640 753	3.7	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
10	250 630	640 707	-0.5	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
11	250 848	640 667	0.4	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
12	258 113	640 938	5.4	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
13	258 262	640 807	0.9	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
14	258 448	640 639	2.6	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
15	258 538	640 461	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
16	258 679	640 308	1.7	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
17	258 873	640 163	0.3	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
18	258 968	639 996	2.9	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
19	259 121	639 844	-0.2	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
20	261 854	639 088	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
21	262 152	639 125	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
22	262 452	639 155	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
23	262 788	639 190	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
24	263 087	639 221	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
25	263 582	639 255	6.4	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
26	263 881	639 289	6.6	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
27	264 184	639 314	0.6	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
28	264 647	639 341	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
29	265 276	639 410	0.6	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
30	265 576	639 437	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
31	265 906	639 471	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
32	266 208	639 494	2.7	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
33	266 761	639 553	7.8	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
34	267 056	639 583	2.5	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
35	267 351	639 609	2.1	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
36	267 692	639 648	0.9	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
37	268 085	639 682	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No
38	264 939	639 371	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 0	10.0	106.0	No

Calculation Results

Project:
VRA WPP1 (v2)

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
07/12/2017 11:04 AM/3.1.617

DECIBEL - Main Result

Calculation: WPP1 | Original | LNTE Mode0 | Loudest up to 95% rated power | LA90

Sound level

Noise sensitive area						Demands	Sound level		Demands fulfilled ?
No.	Name	Easting	Northing	Z	Imission height	Noise	From WTGs	Distance to noise demand	Noise
				[m]	[m]	[dB(A)]	[dB(A)]	[m]	
A	Noise sensitive point: User defined (1)	247 056	640 476	7.7	1.0	45.0	34.7	829	Yes
B	Noise sensitive point: User defined (2)	248 022	641 929	7.2	1.0	45.0	38.2	453	Yes
C	Noise sensitive point: User defined (3)	248 289	640 061	0.9	1.0	45.0	38.7	442	Yes
D	Noise sensitive point: User defined (4)	248 970	641 756	2.6	1.0	45.0	39.9	429	Yes
E	Noise sensitive point: User defined (5)	248 997	640 221	5.1	1.0	45.0	40.4	419	Yes
F	Noise sensitive point: User defined (6)	249 771	640 012	9.2	1.0	45.0	40.4	416	Yes
G	Noise sensitive point: User defined (7)	250 228	639 732	10.6	1.0	45.0	38.5	587	Yes
H	Noise sensitive point: User defined (8)	250 804	639 783	9.8	1.0	45.0	38.3	520	Yes
I	Noise sensitive point: User defined (9)	251 412	639 569	6.0	1.0	45.0	34.4	927	Yes
J	Noise sensitive point: User defined (10)	253 617	638 680	9.8	1.0	45.0	23.8	3 114	Yes
K	Noise sensitive point: User defined (11)	255 693	644 057	1.4	1.0	45.0	21.3	3 661	Yes
L	Noise sensitive point: User defined (12)	255 767	638 564	6.2	1.0	45.0	25.5	2 897	Yes
M	Noise sensitive point: User defined (13)	256 642	638 627	2.9	1.0	45.0	28.6	2 178	Yes
N	Noise sensitive point: User defined (14)	258 286	639 176	-1.2	1.0	45.0	37.7	651	Yes
O	Noise sensitive point: User defined (15)	259 173	639 472	1.8	1.0	45.0	43.5	87	Yes
P	Noise sensitive point: User defined (16)	259 729	639 505	5.7	1.0	45.0	39.0	394	Yes
Q	Noise sensitive point: User defined (17)	260 367	639 740	0.1	1.0	45.0	35.7	946	Yes
R	Noise sensitive point: User defined (18)	260 982	639 111	2.9	1.0	45.0	36.7	617	Yes
S	Noise sensitive point: User defined (19)	261 591	639 271	2.6	1.0	45.0	43.8	45	Yes
T	Noise sensitive point: User defined (20)	261 857	639 479	4.2	1.0	45.0	43.9	60	Yes
U	Noise sensitive point: User defined (21)	262 163	639 475	3.4	1.0	45.0	45.3	-16	**No**
V	Noise sensitive point: User defined (22)	262 388	639 685	2.5	1.0	45.0	42.8	154	Yes
W	Noise sensitive point: User defined (23)	263 152	639 772	4.3	1.0	45.0	42.6	190	Yes
X	Noise sensitive point: User defined (24)	263 978	639 723	3.5	1.0	45.0	44.3	36	Yes
Y	Noise sensitive point: User defined (25)	264 462	639 785	0.6	1.0	45.0	43.8	85	Yes
Z	Noise sensitive point: User defined (26)	265 204	639 846	1.9	1.0	45.0	44.3	42	Yes
AA	Noise sensitive point: User defined (27)	266 060	639 903	4.4	1.0	45.0	44.3	37	Yes
AB	Noise sensitive point: User defined (28)	267 435	640 192	6.3	1.0	45.0	42.1	210	Yes
AC	Noise sensitive point: User defined (29)	267 454	639 756	5.9	1.0	45.0	49.3	-226	**No**
AD	Noise sensitive point: User defined (30)	267 992	640 117	5.4	1.0	45.0	42.4	144	Yes
AE	Noise sensitive point: User defined (31)	268 091	639 901	8.3	1.0	45.0	46.4	-34	**No**

Distances (m)

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	1267	726	1162	1037	1338	2061	2596	3064	3703	6076	8119	8118	8931	10395	11217	11762	12363	13060	13638	13874	14178	14378
2	1210	937	950	1118	1153	1901	2437	2922	3565	5942	8142	8000	8820	10302	11131	11678	12285	12973	13555	13794	14099	14302
3	1178	1162	725	1247	978	1754	2288	2794	3438	5815	8184	7891	8718	10219	11057	11605	12217	12896	13482	13725	14030	14236
4	2135	1431	1266	757	803	1194	1693	2084	2708	5065	7241	7082	7890	9347	10169	10714	11317	12012	12590	12827	13131	13332
5	2336	1629	1389	867	824	1052	1525	1886	2503	4853	7064	6864	7670	9125	9948	10493	11096	11791	12369	12607	12911	13112
6	2643	1937	1612	1100	953	896	1299	1597	2198	4535	6805	6536	7339	8793	9616	10161	10766	11459	12038	12276	12580	12782
7	2957	2248	1872	1369	1172	859	1136	1336	1909	4223	6546	6210	7011	8462	9285	9830	10435	11128	11707	11945	12250	12452
8	3164	2458	2052	1563	1337	897	1065	1178	1723	4016	6384	5994	6794	8243	9066	9612	10218	10909	11489	11727	12032	12235
9	3374	2670	2240	1762	1518	984	1039	1044	1545	3811	6223	5779	6576	8024	8847	9393	9999	10690	11270	11509	11813	12017
10	3581	2880	2428	1964	1704	1105	1055	940	1381	3610	6071	5566	6362	7808	8632	9178	9785	10474	11055	11294	11599	11802
11	3797	3095	2630	2171	1904	1261	1122	885	1234	3408	5913	5350	6143	7586	8410	8957	9564	10253	10833	11073	11378	11582
12	11067	10140	9863	9179	9144	8393	7977	7400	6839	5031	3947	3338	2740	1771	1809	2160	2553	3401	3857	4018	4306	4455
13	11211	10301	10001	9340	9284	8528	8106	7528	6961	5109	4143	3355	2716	1631	1616	1961	2360	3205	3666	3832	4122	4276
14	11394	10506	10176	9544	9461	8700	8270	7692	7117	5213	4391	3390	2704	1472	1373	1710	2119	2959	3427	3600	3893	4053
15	11482	10618	10257	9655	9544	8778	8342	7764	7182	5233	4585	3358	2638	1309	1175	1527	1966	2792	3277	3461	3757	3927
16	11624	10780	10393	9816	9682	8913	8471	7892	7304	5317	4793	3394	2641	1198	971	1322	1781	2595	3091	3284	3582	3761
17	11821	10994	10585	10031	9876	9104	8656	8078	7485	5462	5027	3494	2709	1149	753	1080	1553	2357	2860	3061	3361	3547
18	11922	11115	10679	10152	9974	9197	8744	8167	7568	5510	5217	3507	2699	1067	563	906	1422	2200	2721	2935	3237	3434
19	12082	11293	10834	10329	10131	9352	8894	8317	7714	5626	5431	3590	2762	1069	376	696	1250	2000	2536	2760	3064	3271
20	14863	14121	13600	13157	12907	12118	11644	11072	10453	8247	7915	6110	5232	3569	2708	2166	1624	872	320	391	495	801
21	15156	14406	13895	13442	13201	12413	11939	11367	10749	8547	8127	6410	5532	3866	2999	2453	1888	1170	580	461	350	608
22	15453	14694	14192	13731	13497	12710	12238	11665	11048	8848	8349	6711	5834	4166	3294	2745	2166	1471	869	677	431	534
23	15784	15018	14525	14054	13829	13043	12572	11999	11382	9185	8604	7049	6172	4502	3626	3075	2483	1808	1200	975	687	636
24	16080	15306	14822	14343	14125	13339	12869	12296	11680	9485	8835	7349	6472	4801	3922	3370	2769	2108	1497	1257	958	839
25	16571	15788	15314	14824	14617	13832	13363	12789	12174	9982	9236	7845	6968	5297	4414	3861	3251	2604	1991	1739	1436	1269
26	16867	16077	15611	15114	14913	14129	13660	13086	12472	10282	9475	8146	7269	5596	4712	4158	3543	2904	2290	2033	1728	1545
27	17167	16372	15913	15409	15214	14430	13962	13388	12775	10586	9726	8450	7573	5900	5013	4459	3841	3208	2593	2333	2027	1834
28	17628	16825	16374	15862	15675	14891	14424	13850	13237	11050	10120	8914	8037	6363	5476	4921	4299	3672	3057	2793	2488	2285
29	18251	17437	16999	16474	16299	15517	15051	14477	13865	11682	10650	9547	8669	6994	6103	5548	4920	4304	3688	3420	3114	2901
30	18549	17730	17298	16767	16598	15815	15351	14776	14165	11983	10910	9848	8971	7295	6403	5847	5218	4606	3988	3719	3413	3198
31	18877	18052	17627	17089	16926	16144	15680	15105	14494	12314	11195	10179	9302	7626	6733	6177	5546	4937	4320	4049	3743	3525

To be continued on next page...

Project:
VRA WPP1 (v2)

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
07/12/2017 11:04 AM/3.1.617

DECIBEL - Main Result

Calculation: WPP1 | Original | LNTE Mode0 | Loudest up to 95% rated power | LA90

...continued from previous page

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
32	19177	18348	17928	17386	17226	16445	15982	15407	14796	12617	11462	10482	9605	7928	7035	6479	5846	5240	4622	4351	4045	3825
33	19727	18889	18479	17927	17777	16996	16534	15959	15349	13173	11949	11038	10161	8483	7588	7032	6397	5796	5178	4905	4599	4375
34	20020	19178	18773	18216	18070	17290	16829	16253	15644	13469	12212	11335	10458	8779	7884	7327	6691	6092	5474	5200	4894	4669
35	20314	19468	19067	18506	18364	17585	17123	16548	15939	13765	12478	11631	10754	9075	8179	7623	6985	6388	5770	5496	5190	4964
36	20653	19802	19407	18840	18704	17925	17464	16889	16280	14108	12783	11974	11097	9418	8521	7964	7326	6731	6113	5837	5532	5304
37	21044	20188	19800	19227	19096	18317	17857	17281	16673	14503	13142	12369	11492	9812	8914	8358	7718	7126	6507	6231	5926	5697
38	17917	17109	16664	16146	15965	15182	14715	14141	13528	11343	10366	9207	8330	6656	5767	5212	4587	3966	3349	3084	2778	2570

WTG	W	X	Y	Z	AA	AB	AC	AD	AE
1	15129	15956	16433	17167	18016	19371	19417	19931	20043
2	15055	15882	16360	17096	17947	19305	19347	19865	19974
3	14992	15819	16298	17036	17888	19250	19287	19809	19916
4	14085	14912	15389	16124	16974	18331	18375	18891	19002
5	13865	14692	15169	15905	16755	18113	18156	18673	18783
6	13535	14362	14840	15576	16426	17785	17827	18345	18454
7	13206	14033	14511	15247	16097	17457	17498	18017	18125
8	12989	13816	14294	15030	15881	17242	17281	17801	17909
9	12771	13598	14076	14813	15664	17025	17064	17585	17693
10	12557	13384	13863	14599	15451	16813	16851	17372	17480
11	12337	13164	13643	14379	15231	16594	16631	17153	17260
12	5172	5990	6453	7175	8014	9352	9416	9913	10032
13	4998	5818	6284	7008	7850	9194	9252	9754	9871
14	4783	5605	6074	6802	7647	8998	9049	9558	9671
15	4665	5490	5962	6694	7543	8901	8944	9460	9569
16	4505	5331	5807	6541	7392	8757	8792	9315	9421
17	4297	5124	5602	6339	7191	8562	8590	9119	9221
18	4190	5017	5498	6238	7093	8469	8489	9025	9123
19	4032	4859	5341	6083	6939	8321	8333	8875	8970
20	1467	2217	2700	3435	4284	5689	5640	6224	6290
21	1191	1921	2402	3136	3985	5390	5339	5924	5989
22	933	1628	2106	2837	3685	5090	5038	5623	5688
23	686	1304	1777	2503	3349	4754	4700	5286	5350
24	555	1023	1486	2207	3050	4455	4400	4986	5050
25	672	613	1027	1726	2561	3965	3904	4493	4555
26	874	445	764	1435	2264	3667	3603	4194	4254
27	1129	458	547	1150	1966	3367	3300	3892	3951
28	1556	770	481	752	1521	2915	2838	3434	3489
29	2155	1335	896	442	926	2296	2205	2807	2858
30	2447	1623	1167	553	672	2006	1905	2510	2557
31	2770	1944	1478	796	459	1690	1574	2184	2227
32	3069	2242	1770	1064	435	1412	1273	1890	1926
33	3616	2788	2311	1584	784	929	722	1354	1375
34	3909	3081	2602	1871	1046	717	434	1078	1083
35	4202	3375	2894	2160	1324	589	179	818	796
36	4542	3715	3233	2496	1652	602	261	557	472
37	4934	4107	3624	2886	2037	826	635	445	219
38	1831	1023	632	544	1241	2628	2544	3143	3196

Project:
VRA WPP1 (v2)

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
07/12/2017 1:41 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP1 | Alternative | Mode SO1 | Loudest up to 95% rated power | LA90

Noise calculation model:
ISO 9613-2 General
Wind speed:
Loudest up to 95% rated power
Ground attenuation:
General, terrain specific
Ground factor for porous ground: 1.0
Area object with hard ground: Project Wizard Roughness Areas (GlobCover 20
Area type with hard ground: 0,0000m(cl.0,0) Water bodies
Meteorological coefficient, C0:
0.0 dB
Type of demand in calculation:
1: WTG noise is compared to demand (DK, DE, SE, NL etc.)
Noise values in calculation:
All noise values are 90% exeedance values (L90)
Pure tones:
Fixed penalty added to source noise of WTGs with pure tones: 5.0 dB(A)
Height above ground level, when no value in NSA object:
1.0 m Don't allow override of model height with height from NSA object
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0.0 dB(A)

Scale 1:400 000
New WTG   Noise sensitive area

WTGs

	Easting	Northing	Z [m]	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data Creator	Name	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones
1	258 055	641 160	2.3	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 1- Calculated- SO1 - 11.02.2016	10.0	104.4	No
2	258 190	640 980	5.9	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 1- Calculated- SO1 - 11.02.2016	10.0	104.4	No
3	258 343	640 859	11.5	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 1- Calculated- SO1 - 11.02.2016	10.0	104.4	No
4	258 484	640 670	2.2	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 1- Calculated- SO1 - 11.02.2016	10.0	104.4	No
5	258 621	640 508	0.2	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 1- Calculated- SO1 - 11.02.2016	10.0	104.4	No
6	258 778	640 360	1.0	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 1- Calculated- SO1 - 11.02.2016	10.0	104.4	No
7	258 930	640 197	2.3	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 1- Calculated- SO1 - 11.02.2016	10.0	104.4	No
8	259 077	640 040	0.9	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 1- Calculated- SO1 - 11.02.2016	10.0	104.4	No
9	261 900	639 088	0.0	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 1- Calculated- SO1 - 11.02.2016	10.0	104.4	No
10	262 408	639 139	0.0	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 1- Calculated- SO1 - 11.02.2016	10.0	104.4	No
11	262 917	639 190	0.0	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 1- Calculated- SO1 - 11.02.2016	10.0	104.4	No
12	263 425	639 242	2.3	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 1- Calculated- SO1 - 11.02.2016	10.0	104.4	No
13	263 934	639 293	4.5	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 1- Calculated- SO1 - 11.02.2016	10.0	104.4	No
14	264 442	639 344	2.3	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 1- Calculated- SO1 - 11.02.2016	10.0	104.4	No
15	264 951	639 395	0.8	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 1- Calculated- SO1 - 11.02.2016	10.0	104.4	No
16	265 459	639 446	1.2	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 1- Calculated- SO1 - 11.02.2016	10.0	104.4	No
17	265 967	639 498	5.3	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 1- Calculated- SO1 - 11.02.2016	10.0	104.4	No
18	266 476	639 549	6.3	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 1- Calculated- SO1 - 11.02.2016	10.0	104.4	No
19	266 984	639 600	5.4	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 1- Calculated- SO1 - 11.02.2016	10.0	104.4	No
20	267 493	639 651	0.5	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 1- Calculated- SO1 - 11.02.2016	10.0	104.4	No
21	268 001	639 702	0.0	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 1- Calculated- SO1 - 11.02.2016	10.0	104.4	No
22	259 223	639 867	3.0	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 1- Calculated- SO1 - 11.02.2016	10.0	104.4	No

Calculation Results

Sound level

Noise sensitive area No.	Name	Easting	Northing	Z [m]	Imission height [m]	Demands Noise [dB(A)]	Sound level From WTGs [dB(A)]	Distance to noise demand [m]	Demands fulfilled ? Noise
A	Noise sensitive point: User defined (1)	247 056	640 476	7.7	1.0	45.0	-2.0	10 792	Yes
B	Noise sensitive point: User defined (2)	248 022	641 929	7.2	1.0	45.0	0.4	9 846	Yes
C	Noise sensitive point: User defined (3)	248 289	640 061	0.9	1.0	45.0	1.3	9 592	Yes
D	Noise sensitive point: User defined (4)	248 970	641 756	2.6	1.0	45.0	3.0	8 889	Yes
E	Noise sensitive point: User defined (5)	248 997	640 221	5.1	1.0	45.0	3.3	8 873	Yes
F	Noise sensitive point: User defined (6)	249 771	640 012	9.2	1.0	45.0	5.4	8 125	Yes
G	Noise sensitive point: User defined (7)	250 228	639 732	10.6	1.0	45.0	6.7	7 712	Yes
H	Noise sensitive point: User defined (8)	250 804	639 783	9.8	1.0	45.0	8.4	7 136	Yes
I	Noise sensitive point: User defined (9)	251 412	639 569	6.0	1.0	45.0	10.1	6 581	Yes
J	Noise sensitive point: User defined (10)	253 617	638 680	9.8	1.0	45.0	16.4	4 814	Yes
K	Noise sensitive point: User defined (11)	255 693	644 057	1.4	1.0	45.0	19.6	3 525	Yes
L	Noise sensitive point: User defined (12)	255 767	638 564	6.2	1.0	45.0	23.5	3 073	Yes
M	Noise sensitive point: User defined (13)	256 642	638 627	2.9	1.0	45.0	26.8	2 368	Yes
N	Noise sensitive point: User defined (14)	258 286	639 176	-1.2	1.0	45.0	35.5	843	Yes

To be continued on next page...

Project:
VRA WPP1 (v2)

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Calculated:
07/12/2017 1:41 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP1 | Alternative | Mode SO1 | Loudest up to 95% rated power | LA90

...continued from previous page

Noise sensitive area						Demands	Sound level		Demands fulfilled ?
No.	Name	Easting	Northing	Z	Imission height	Noise	From WTGs	Distance to noise demand	Noise
				[m]	[m]	[dB(A)]	[dB(A)]	[m]	
O	Noise sensitive point: User defined (15)	259 173	639 472	1.8	1.0	45.0	41.5	170	Yes
P	Noise sensitive point: User defined (16)	259 729	639 505	5.7	1.0	45.0	38.0	408	Yes
Q	Noise sensitive point: User defined (17)	260 367	639 740	0.1	1.0	45.0	34.2	953	Yes
R	Noise sensitive point: User defined (18)	260 982	639 111	2.9	1.0	45.0	33.8	767	Yes
S	Noise sensitive point: User defined (19)	261 591	639 271	2.6	1.0	45.0	40.4	275	Yes
T	Noise sensitive point: User defined (20)	261 857	639 479	4.2	1.0	45.0	40.4	245	Yes
U	Noise sensitive point: User defined (21)	262 163	639 475	3.4	1.0	45.0	41.3	197	Yes
V	Noise sensitive point: User defined (22)	262 388	639 685	2.5	1.0	45.0	39.2	358	Yes
W	Noise sensitive point: User defined (23)	263 152	639 772	4.3	1.0	45.0	39.4	393	Yes
X	Noise sensitive point: User defined (24)	263 978	639 723	3.5	1.0	45.0	41.1	236	Yes
Y	Noise sensitive point: User defined (25)	264 462	639 785	0.6	1.0	45.0	40.9	222	Yes
Z	Noise sensitive point: User defined (26)	265 204	639 846	1.9	1.0	45.0	41.0	275	Yes
AA	Noise sensitive point: User defined (27)	266 060	639 903	4.4	1.0	45.0	41.4	204	Yes
AB	Noise sensitive point: User defined (28)	267 435	640 192	6.3	1.0	45.0	39.1	316	Yes
AC	Noise sensitive point: User defined (29)	267 454	639 756	5.9	1.0	45.0	48.0	-88	**No**
AD	Noise sensitive point: User defined (30)	267 992	640 117	5.4	1.0	45.0	39.8	210	Yes
AE	Noise sensitive point: User defined (31)	268 091	639 901	8.3	1.0	45.0	44.0	57	Yes

Distances (m)

	WTG																					
NSA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A	11020	11145	11293	11430	11565	11723	11877	12029	14909	15410	15913	16415	16919	17423	17928	18432	18936	19442	19947	20454	20959	12182
B	10062	10212	10376	10537	10694	10870	11045	11215	14166	14654	15145	15636	16129	16622	17118	17613	18109	18607	19104	19604	20103	11389
C	9827	9944	10086	10213	10342	10493	10642	10788	13646	14149	14654	15158	15664	16169	16675	17181	17687	18194	18701	19208	19715	10936
D	9104	9253	9416	9576	9731	9907	10081	10252	13202	13690	14181	14672	15165	15659	16154	16650	17146	17645	18143	18642	19142	10426
E	9106	9224	9368	9498	9628	9782	9933	10082	12953	13455	13958	14461	14966	15470	15975	16480	16985	17492	17998	18505	19011	10232
F	8363	8474	8614	8738	8864	9014	9161	9306	12164	12667	13172	13676	14181	14686	15193	15698	16204	16711	17218	17726	18233	9453
G	7956	8059	8193	8309	8429	8573	8714	8854	11690	12194	12701	13206	13713	14219	14727	15234	15741	16249	16757	17265	17773	8996
H	7380	7482	7615	7731	7851	7995	8137	8277	11118	11622	12128	12633	13139	13645	14152	14659	15166	15674	16181	16690	17197	8419
I	6831	6923	7050	7157	7270	7408	7544	7679	10499	11004	11511	12017	12525	13032	13540	14048	14555	15064	15572	16081	16590	7817
J	5084	5119	5204	5258	5327	5428	5525	5627	8293	8803	9314	9824	10335	10845	11357	11867	12377	12888	13399	13910	14420	5730
K	3738	3963	4153	4389	4601	4815	5038	5252	7951	8323	8711	9109	9519	9938	10366	10800	11240	11687	12139	12596	13056	5479
L	3460	3422	3450	3438	3453	3506	3560	3624	6155	6666	7177	7688	8199	8710	9222	9732	10243	10754	11265	11776	12287	3693
M	2900	2817	2806	2751	2730	2751	2775	2815	5278	5789	6300	6811	7322	7833	8344	8855	9366	9877	10388	10899	11410	2863
N	1997	1807	1684	1507	1373	1282	1207	1171	3615	4122	4631	5139	5649	6158	6669	7178	7688	8198	8708	9219	9729	1164
O	2025	1800	1616	1382	1174	972	765	576	2754	3252	3755	4258	4764	5271	5779	6286	6794	7303	7812	8322	8831	398
P	2354	2132	1938	1705	1495	1279	1057	843	2211	2704	3204	3705	4210	4716	5223	5730	6238	6747	7256	7765	8274	622
Q	2713	2505	2313	2100	1907	1706	1508	1324	1666	2128	2609	3098	3595	4094	4597	5100	5605	6112	6618	7127	7634	1151
R	3573	3360	3165	2945	2743	2533	2322	2119	918	1426	1937	2447	2958	3468	3979	4490	5000	5511	6022	6533	7044	1915
S	4009	3806	3615	3407	3217	3016	2818	2629	359	828	1328	1834	2343	2852	3362	3872	4382	4893	5403	5914	6424	2442
T	4157	3962	3775	3577	3396	3203	3014	2836	393	647	1099	1586	2085	2589	3095	3602	4110	4620	5128	5639	6148	2662
U	4440	4249	4063	3868	3690	3499	3313	3137	468	416	806	1283	1780	2283	2789	3296	3804	4314	4823	5333	5842	2966
V	4577	4393	4212	4026	3856	3673	3496	3330	771	546	724	1128	1595	2082	2579	3080	3584	4090	4597	5105	5613	3170
W	5283	5107	4930	4754	4590	4413	4243	4084	1427	977	628	596	917	1359	1838	2330	2828	3331	3836	4343	4850	3930
X	6095	5923	5748	5575	5414	5239	5070	4911	2173	1675	1187	733	432	599	1027	1507	2002	2504	3009	3516	4023	4757
Y	6553	6385	6213	6043	5886	5713	5547	5391	2655	2153	1656	1171	722	441	625	1053	1532	2028	2529	3034	3540	5240
Z	7269	7105	6935	6770	6616	6447	6284	6130	3390	2884	2379	1879	1385	912	517	474	839	1306	1797	2297	2801	5981
AA	8103	7943	7776	7615	7464	7296	7136	6984	4239	3731	3223	2717	2212	1712	1220	755	416	546	972	1455	1951	6837
AB	9430	9279	9116	8964	8820	8659	8505	8359	5644	5136	4628	4121	3615	3111	2609	2112	1624	1155	744	544	749	8218
AC	9504	9345	9178	9016	8865	8697	8535	8382	5594	5084	4572	4062	3550	3040	2529	2019	1509	1000	495	112	550	8232
AD	9992	9840	9677	9524	9379	9217	9062	8915	6178	5669	5159	4650	4141	3633	3126	2620	2117	1619	1133	683	415	8773
AE	10115	9960	9795	9638	9489	9324	9166	9015	6244	5734	5223	4712	4201	3691	3181	2671	2162	1653	1147	648	218	8868

Project:
VRA WPP1 (v2)

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480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
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Nicolette / nicolette@airshed.co.za
Calculated:
07/12/2017 11:55 AM/3.1.617

DECIBEL - Main Result

Calculation: WPP1 | Original | LNTE mode1 | Loudest up to 95% rated power | LA90

Noise calculation model:
ISO 9613-2 General
Wind speed:
Loudest up to 95% rated power
Ground attenuation:
General, terrain specific
Ground factor for porous ground: 1.0
Area object with hard ground: Project Wizard Roughness Areas (GlobCover 20
Area type with hard ground: 0,0000m(cl.0,0) Water bodies
Meteorological coefficient, C0:
0.0 dB
Type of demand in calculation:
1: WTG noise is compared to demand (DK, DE, SE, NL etc.)
Noise values in calculation:
All noise values are 90% exeedance values (L90)
Pure tones:
Fixed penalty added to source noise of WTGs with pure tones: 5.0 dB(A)
Height above ground level, when no value in NSA object:
1.0 m Don't allow override of model height with height from NSA object
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0.0 dB(A)

Scale 1:400 000
New WTG   Noise sensitive area

WTGs

	Easting	Northing	Z [m]	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data Creator	Name	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones
1	248 191	641 106	-0.7	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
2	248 247	640 900	-0.4	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
3	248 294	640 680	4.3	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
4	249 222	640 914	-13.3	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
5	249 439	640 871	0.7	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
6	249 764	640 802	-2.1	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
7	250 090	640 743	-4.6	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
8	250 304	640 697	0.3	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
9	250 519	640 653	-3.7	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
10	250 730	640 607	1.9	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
11	250 948	640 567	-0.2	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
12	258 213	640 838	-1.9	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
13	258 362	640 707	0.1	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
14	258 548	640 539	-2.1	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
15	258 638	640 361	2.5	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
16	258 779	640 208	-0.1	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
17	258 973	640 063	3.1	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
18	259 068	639 896	0.5	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
19	259 221	639 744	-0.1	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
20	261 954	638 988	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
21	262 252	639 025	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
22	262 552	639 055	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
23	262 888	639 090	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
24	263 187	639 121	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
25	263 682	639 155	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
26	263 981	639 189	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
27	264 284	639 214	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
28	264 747	639 241	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
29	265 376	639 310	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
30	265 676	639 337	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
31	266 006	639 371	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
32	266 308	639 394	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
33	266 861	639 453	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
34	267 156	639 483	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
35	267 451	639 509	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
36	267 792	639 548	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
37	268 185	639 582	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No
38	265 039	639 271	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 1	10.0	103.8	No

Calculation Results

Project:
VRA WPP1 (v2)

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
07/12/2017 11:55 AM/3.1.617

DECIBEL - Main Result

Calculation: WPP1 | Original | LNTE mode1 | Loudest up to 95% rated power | LA90

Sound level

Noise sensitive area						Demands	Sound level		Demands fulfilled ?
No.	Name	Easting	Northing	Z	Imission height	Noise	From WTGs	Distance to noise demand	Noise
				[m]	[m]	[dB(A)]	[dB(A)]	[m]	
A	Noise sensitive point: User defined (1)	247 056	640 476	7.7	1.0	45.0	32.0	998	Yes
B	Noise sensitive point: User defined (2)	248 022	641 929	7.2	1.0	45.0	34.8	649	Yes
C	Noise sensitive point: User defined (3)	248 289	640 061	0.9	1.0	45.0	37.5	420	Yes
D	Noise sensitive point: User defined (4)	248 970	641 756	2.6	1.0	45.0	36.8	645	Yes
E	Noise sensitive point: User defined (5)	248 997	640 221	5.1	1.0	45.0	38.8	470	Yes
F	Noise sensitive point: User defined (6)	249 771	640 012	9.2	1.0	45.0	38.8	491	Yes
G	Noise sensitive point: User defined (7)	250 228	639 732	10.6	1.0	45.0	37.1	633	Yes
H	Noise sensitive point: User defined (8)	250 804	639 783	9.8	1.0	45.0	37.3	526	Yes
I	Noise sensitive point: User defined (9)	251 412	639 569	6.0	1.0	45.0	33.3	869	Yes
J	Noise sensitive point: User defined (10)	253 617	638 680	9.8	1.0	45.0	22.0	3 062	Yes
K	Noise sensitive point: User defined (11)	255 693	644 057	1.4	1.0	45.0	18.7	3 903	Yes
L	Noise sensitive point: User defined (12)	255 767	638 564	6.2	1.0	45.0	23.2	3 056	Yes
M	Noise sensitive point: User defined (13)	256 642	638 627	2.9	1.0	45.0	26.3	2 326	Yes
N	Noise sensitive point: User defined (14)	258 286	639 176	-1.2	1.0	45.0	35.7	761	Yes
O	Noise sensitive point: User defined (15)	259 173	639 472	1.8	1.0	45.0	43.6	72	Yes
P	Noise sensitive point: User defined (16)	259 729	639 505	5.7	1.0	45.0	38.4	369	Yes
Q	Noise sensitive point: User defined (17)	260 367	639 740	0.1	1.0	45.0	34.0	915	Yes
R	Noise sensitive point: User defined (18)	260 982	639 111	2.9	1.0	45.0	33.9	796	Yes
S	Noise sensitive point: User defined (19)	261 591	639 271	2.6	1.0	45.0	39.2	319	Yes
T	Noise sensitive point: User defined (20)	261 857	639 479	4.2	1.0	45.0	39.6	293	Yes
U	Noise sensitive point: User defined (21)	262 163	639 475	3.4	1.0	45.0	41.2	212	Yes
V	Noise sensitive point: User defined (22)	262 388	639 685	2.5	1.0	45.0	39.3	380	Yes
W	Noise sensitive point: User defined (23)	263 152	639 772	4.3	1.0	45.0	39.3	405	Yes
X	Noise sensitive point: User defined (24)	263 978	639 723	3.5	1.0	45.0	40.8	264	Yes
Y	Noise sensitive point: User defined (25)	264 462	639 785	0.6	1.0	45.0	40.4	365	Yes
Z	Noise sensitive point: User defined (26)	265 204	639 846	1.9	1.0	45.0	40.8	288	Yes
AA	Noise sensitive point: User defined (27)	266 060	639 903	4.4	1.0	45.0	40.9	250	Yes
AB	Noise sensitive point: User defined (28)	267 435	640 192	6.3	1.0	45.0	38.8	434	Yes
AC	Noise sensitive point: User defined (29)	267 454	639 756	5.9	1.0	45.0	45.1	-3	**No**
AD	Noise sensitive point: User defined (30)	267 992	640 117	5.4	1.0	45.0	39.1	366	Yes
AE	Noise sensitive point: User defined (31)	268 091	639 901	8.3	1.0	45.0	42.1	149	Yes

Distances (m)

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	1298	840	1050	1015	1197	1922	2457	2929	3569	5944	8062	7991	8807	10278	11103	11649	12253	12946	13525	13763	14067	14268
2	1264	1053	840	1121	1012	1764	2300	2791	3434	5811	8088	7875	8698	10186	11019	11567	12176	12860	13443	13684	13989	14193
3	1254	1278	619	1271	840	1621	2154	2666	3310	5687	8134	7767	8597	10105	10946	11496	12110	12785	13372	13616	13922	14129
4	2210	1571	1264	879	729	1056	1552	1945	2570	4931	7194	6954	7765	9229	10055	10601	11207	11898	12478	12717	13021	13224
5	2415	1768	1406	1001	786	921	1386	1746	2364	4718	7019	6736	7545	9008	9834	10381	10987	11677	12257	12496	12801	13004
6	2727	2074	1650	1241	962	790	1166	1456	2059	4399	6764	6407	7214	8676	9503	10049	10656	11345	11926	12166	12470	12674
7	3045	2384	1925	1510	1211	797	1020	1197	1768	4086	6510	6081	6886	8345	9172	9719	10326	11014	11595	11835	12140	12344
8	3255	2593	2113	1703	1391	868	968	1042	1581	3879	6351	5865	6668	8126	8954	9500	10109	10796	11377	11617	11922	12127
9	3467	2804	2307	1901	1582	985	966	916	1405	3673	6194	5649	6450	7907	8735	9282	9891	10576	11158	11399	11704	11909
10	3676	3013	2501	2102	1775	1128	1009	827	1242	3471	6045	5436	6235	7691	8519	9067	9676	10361	10943	11184	11489	11695
11	3893	3227	2706	2308	1981	1301	1102	797	1101	3269	5891	5219	6016	7469	8298	8845	9456	10139	10722	10963	11268	11474
12	11163	10249	9954	9288	9236	8482	8061	7483	6918	5077	4088	3340	2712	1664	1670	2019	2418	3264	3724	3890	4179	4332
13	11308	10412	10093	9450	9377	8619	8192	7614	7042	5160	4283	3365	2699	1533	1478	1821	2226	3068	3534	3705	3996	4154
14	11492	10618	10270	9655	9556	8793	8359	7781	7202	5270	4531	3411	2700	1388	1236	1569	1987	2822	3296	3474	3768	3934
15	11582	10731	10353	9768	9642	8874	8433	7855	7269	5295	4726	3387	2644	1236	1038	1387	1837	2657	3148	3338	3635	3811
16	11726	10893	10491	9930	9782	9010	8564	7986	7394	5383	4933	3431	2658	1144	835	1182	1656	2461	2964	3164	3463	3647
17	11924	11109	10684	10145	9977	9202	8751	8174	7577	5532	5168	3539	2738	1122	624	940	1431	2223	2735	2943	3244	3436
18	12026	11231	10780	10268	10076	9297	8841	8264	7663	5585	5357	3559	2738	1063	437	768	1309	2069	2600	2820	3124	3327
19	12187	11410	10936	10446	10235	9453	8993	8417	7811	5704	5572	3650	2810	1094	276	562	1146	1872	2417	2650	2955	3168
20	14972	14239	13707	13275	13015	12226	11749	11178	10558	8342	8055	6201	5324	3672	2822	2284	1756	979	460	500	530	821
21	15265	14523	14001	13560	13308	12520	12044	11473	10853	8642	8267	6501	5624	3969	3111	2568	2016	1273	705	601	459	674
22	15561	14811	14298	13848	13605	12816	12342	11770	11152	8943	8489	6802	5925	4267	3404	2858	2290	1571	985	814	572	651
23	15892	15134	14631	14171	13937	13149	12676	12104	11486	9280	8743	7140	6263	4602	3734	3186	2603	1906	1309	1102	821	777
24	16187	15422	14927	14459	14232	13445	12973	12400	11783	9580	8973	7441	6563	4901	4029	3479	2887	2205	1603	1377	1083	978
25	16678	15903	15419	14940	14723	13937	13466	12893	12277	10076	9373	7937	7059	5396	4520	3968	3366	2700	2094	1853	1552	1398
26	16974	16192	15716	15229	15019	14233	13763	13190	12574	10376	9612	8237	7360	5695	4816	4263	3655	3000	2391	2143	1840	1668
27	17274	16487	16017	15523	15320	14535	14065	13492	12877	10680	9862	8541	7664	5998	5117	4564	3952	3303	2693	2441	2137	1953
28	17734	16939	16478	15976	15780	14995	14527	13953	13339	11144	10255	9005	8128	6461	5578	5025	4408	3767	3156	2899	2594	2400
29	18357	17550	17103	16587	16404	15620	15154	14579	13966	11776	10784	9638	8760	7091	6205	5650	5027	4398	3785	3523	3217	3011
30	18654	17843	17402	16880	16702	15919	15453	14878	14266	12077	11042	9939	9062	7391	6504	5949	5324	4699	4085	3821	3515	3306
31	18982	18165	17730	17202	17030	16247	15782	15207	14595	12408	11327	10270	9393	7722	6833	6278	5651	5030	4416	4150	3844	3631

To be continued on next page...

Project:
VRA WPP1 (v2)

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
07/12/2017 11:55 AM/3.1.617

DECIBEL - Main Result

Calculation: WPP1 | Original | LNTE mode1 | Loudest up to 95% rated power | LA90

...continued from previous page

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
32	19282	18461	18031	17498	17330	16548	16083	15509	14897	12711	11594	10573	9696	8025	7135	6580	5951	5333	4718	4451	4145	3930
33	19831	19001	18582	18038	17880	17099	16635	16060	15449	13266	12079	11129	10252	8579	7688	7132	6500	5889	5273	5004	4698	4479
34	20124	19289	18876	18327	18174	17393	16929	16354	15744	13562	12342	11426	10548	8875	7983	7427	6794	6185	5569	5299	4993	4772
35	20418	19579	19170	18617	18467	17687	17224	16649	16039	13858	12607	11722	10845	9171	8278	7722	7087	6481	5864	5594	5288	5066
36	20756	19913	19509	18951	18807	18027	17565	16989	16380	14201	12912	12065	11188	9513	8619	8063	7427	6824	6207	5935	5629	5405
37	21148	20299	19901	19337	19198	18419	17957	17382	16773	14596	13269	12459	11582	9907	9012	8456	7819	7218	6601	6329	6023	5798
38	18023	17223	16768	16260	16070	15286	14818	14244	13630	11437	10500	9299	8421	6753	5869	5315	4695	4060	3448	3188	2883	2683

WTG	W	X	Y	Z	AA	AB	AC	AD	AE
1	15021	15848	16325	17060	17910	19266	19311	19826	19937
2	14948	15775	16254	16990	17841	19201	19241	19761	19869
3	14886	15714	16193	16931	17783	19148	19183	19706	19813
4	13977	14804	15282	16018	16869	18228	18269	18787	18897
5	13757	14585	15063	15799	16650	18009	18050	18569	18678
6	13428	14255	14734	15470	16321	17682	17721	18241	18349
7	13098	13926	14404	15141	15992	17354	17392	17913	18021
8	12882	13709	14188	14925	15776	17139	17176	17698	17805
9	12664	13491	13970	14708	15559	16923	16959	17482	17588
10	12450	13278	13757	14494	15347	16711	16746	17269	17376
11	12230	13058	13537	14275	15127	16492	16526	17050	17156
12	5053	5872	6338	7061	7903	9245	9305	9806	9923
13	4881	5702	6170	6896	7740	9088	9142	9648	9763
14	4667	5491	5962	6692	7539	8894	8940	9453	9564
15	4553	5378	5853	6587	7436	8799	8837	9358	9465
16	4395	5222	5699	6436	7288	8656	8687	9214	9317
17	4189	5017	5496	6235	7089	8463	8487	9019	9120
18	4086	4913	5395	6137	6992	8373	8388	8927	9023
19	3931	4757	5242	5984	6841	8227	8233	8779	8872
20	1432	2154	2632	3362	4207	5612	5554	6143	6205
21	1170	1862	2337	3064	3908	5313	5253	5843	5905
22	935	1575	2045	2768	3609	5014	4952	5543	5604
23	731	1261	1721	2437	3275	4679	4615	5207	5266
24	652	994	1438	2144	2978	4381	4314	4907	4966
25	813	641	1003	1672	2493	3894	3820	4416	4472
26	1013	534	766	1389	2198	3597	3519	4117	4172
27	1262	594	598	1116	1905	3300	3216	3817	3869
28	1681	907	614	758	1471	2852	2756	3361	3409
29	2271	1457	1030	563	905	2240	2126	2738	2779
30	2561	1741	1294	694	684	1956	1827	2444	2480
31	2882	2058	1598	932	535	1648	1499	2122	2152
32	3178	2353	1887	1193	566	1381	1202	1833	1854
33	3722	2895	2422	1703	918	936	666	1312	1309
34	4014	3187	2711	1985	1173	762	404	1049	1024
35	4307	3479	3001	2272	1445	683	247	814	751
36	4645	3818	3338	2605	1768	736	397	603	463
37	5036	4209	3728	2992	2149	966	751	569	332
38	1952	1153	772	598	1201	2567	2464	3072	3117

Project:
VRA WPP1 (v2)

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ZA-1685 Halfway House
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Nicolette / nicolette@airshed.co.za
Calculated:
07/12/2017 1:52 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP1 | Alternative | Mode SO2 | Loudest up to 95% rated power | LA90

Noise calculation model:
ISO 9613-2 General
Wind speed:
Loudest up to 95% rated power
Ground attenuation:
General, terrain specific
Ground factor for porous ground: 1.0
Area object with hard ground: Project Wizard Roughness Areas (GlobCover 20
Area type with hard ground: 0,0000m(cl.0,0) Water bodies
Meteorological coefficient, C0:
0.0 dB
Type of demand in calculation:
1: WTG noise is compared to demand (DK, DE, SE, NL etc.)
Noise values in calculation:
All noise values are 90% exeedance values (L90)
Pure tones:
Fixed penalty added to source noise of WTGs with pure tones: 5.0 dB(A)
Height above ground level, when no value in NSA object:
1.0 m Don't allow override of model height with height from NSA object
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0.0 dB(A)

Scale 1:400 000
New WTG   Noise sensitive area

WTGs

					WTG type						Noise data				
	Easting	Northing	Z	Row data/Description	Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Creator	Name	Wind speed	LwA,ref	Pure tones
			[m]					[kW]	[m]	[m]			[m/s]	[dB(A)]	
1	258 055	641 160	2.3	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 2- Calculated- SO2 - 11.02.2016	10.0	103.5	No
2	258 190	640 980	5.9	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 2- Calculated- SO2 - 11.02.2016	10.0	103.5	No
3	258 343	640 859	11.5	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 2- Calculated- SO2 - 11.02.2016	10.0	103.5	No
4	258 484	640 670	2.2	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 2- Calculated- SO2 - 11.02.2016	10.0	103.5	No
5	258 621	640 508	0.2	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 2- Calculated- SO2 - 11.02.2016	10.0	103.5	No
6	258 778	640 360	1.0	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 2- Calculated- SO2 - 11.02.2016	10.0	103.5	No
7	258 930	640 197	2.3	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 2- Calculated- SO2 - 11.02.2016	10.0	103.5	No
8	259 077	640 040	0.9	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 2- Calculated- SO2 - 11.02.2016	10.0	103.5	No
9	261 900	639 088	0.0	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 2- Calculated- SO2 - 11.02.2016	10.0	103.5	No
10	262 408	639 139	0.0	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 2- Calculated- SO2 - 11.02.2016	10.0	103.5	No
11	262 917	639 190	0.0	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 2- Calculated- SO2 - 11.02.2016	10.0	103.5	No
12	263 425	639 242	2.3	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 2- Calculated- SO2 - 11.02.2016	10.0	103.5	No
13	263 934	639 293	4.5	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 2- Calculated- SO2 - 11.02.2016	10.0	103.5	No
14	264 442	639 344	2.3	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 2- Calculated- SO2 - 11.02.2016	10.0	103.5	No
15	264 951	639 395	0.8	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 2- Calculated- SO2 - 11.02.2016	10.0	103.5	No
16	265 459	639 446	1.2	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 2- Calculated- SO2 - 11.02.2016	10.0	103.5	No
17	265 967	639 498	5.3	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 2- Calculated- SO2 - 11.02.2016	10.0	103.5	No
18	266 476	639 549	6.3	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 2- Calculated- SO2 - 11.02.2016	10.0	103.5	No
19	266 984	639 600	5.4	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 2- Calculated- SO2 - 11.02.2016	10.0	103.5	No
20	267 493	639 651	0.5	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 2- Calculated- SO2 - 11.02.2016	10.0	103.5	No
21	268 001	639 702	0.0	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 2- Calculated- SO2 - 11.02.2016	10.0	103.5	No
22	259 223	639 867	3.0	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 2- Calculated- SO2 - 11.02.2016	10.0	103.5	No

Calculation Results

Sound level

Noise sensitive area						Demands	Sound level		Demands fulfilled ?
No.	Name	Easting	Northing	Z	Imission height	Noise	From WTGs	Distance to noise demand	Noise
				[m]	[m]	[dB(A)]	[dB(A)]	[m]	
A	Noise sensitive point: User defined (1)	247 056	640 476	7.7	1.0	45.0	-2.9	10 835	Yes
B	Noise sensitive point: User defined (2)	248 022	641 929	7.2	1.0	45.0	-0.5	9 885	Yes
C	Noise sensitive point: User defined (3)	248 289	640 061	0.9	1.0	45.0	0.4	9 635	Yes
D	Noise sensitive point: User defined (4)	248 970	641 756	2.6	1.0	45.0	2.1	8 928	Yes
E	Noise sensitive point: User defined (5)	248 997	640 221	5.1	1.0	45.0	2.4	8 915	Yes
F	Noise sensitive point: User defined (6)	249 771	640 012	9.2	1.0	45.0	4.5	8 167	Yes
G	Noise sensitive point: User defined (7)	250 228	639 732	10.6	1.0	45.0	5.8	7 754	Yes
H	Noise sensitive point: User defined (8)	250 804	639 783	9.8	1.0	45.0	7.5	7 178	Yes
I	Noise sensitive point: User defined (9)	251 412	639 569	6.0	1.0	45.0	9.2	6 623	Yes
J	Noise sensitive point: User defined (10)	253 617	638 680	9.8	1.0	45.0	15.5	4 852	Yes
K	Noise sensitive point: User defined (11)	255 693	644 057	1.4	1.0	45.0	18.7	3 552	Yes
L	Noise sensitive point: User defined (12)	255 767	638 564	6.2	1.0	45.0	22.6	3 130	Yes
M	Noise sensitive point: User defined (13)	256 642	638 627	2.9	1.0	45.0	25.9	2 424	Yes
N	Noise sensitive point: User defined (14)	258 286	639 176	-1.2	1.0	45.0	34.6	897	Yes

To be continued on next page...

Project:
VRA WPP1 (v2)

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
07/12/2017 1:52 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP1 | Alternative | Mode SO2 | Loudest up to 95% rated power | LA90

...continued from previous page

Noise sensitive area						Demands	Sound level		Demands fulfilled ?
No.	Name	Easting	Northing	Z	Imission height	Noise	From WTGs	Distance to noise demand	Noise
				[m]	[m]	[dB(A)]	[dB(A)]	[m]	
O	Noise sensitive point: User defined (15)	259 173	639 472	1.8	1.0	45.0	40.6	205	Yes
P	Noise sensitive point: User defined (16)	259 729	639 505	5.7	1.0	45.0	37.1	444	Yes
Q	Noise sensitive point: User defined (17)	260 367	639 740	0.1	1.0	45.0	33.3	995	Yes
R	Noise sensitive point: User defined (18)	260 982	639 111	2.9	1.0	45.0	32.9	871	Yes
S	Noise sensitive point: User defined (19)	261 591	639 271	2.6	1.0	45.0	39.5	371	Yes
T	Noise sensitive point: User defined (20)	261 857	639 479	4.2	1.0	45.0	39.5	344	Yes
U	Noise sensitive point: User defined (21)	262 163	639 475	3.4	1.0	45.0	40.4	271	Yes
V	Noise sensitive point: User defined (22)	262 388	639 685	2.5	1.0	45.0	38.3	401	Yes
W	Noise sensitive point: User defined (23)	263 152	639 772	4.3	1.0	45.0	38.5	439	Yes
X	Noise sensitive point: User defined (24)	263 978	639 723	3.5	1.0	45.0	40.2	291	Yes
Y	Noise sensitive point: User defined (25)	264 462	639 785	0.6	1.0	45.0	40.0	267	Yes
Z	Noise sensitive point: User defined (26)	265 204	639 846	1.9	1.0	45.0	40.1	323	Yes
AA	Noise sensitive point: User defined (27)	266 060	639 903	4.4	1.0	45.0	40.5	237	Yes
AB	Noise sensitive point: User defined (28)	267 435	640 192	6.3	1.0	45.0	38.2	350	Yes
AC	Noise sensitive point: User defined (29)	267 454	639 756	5.9	1.0	45.0	47.1	-59	**No**
AD	Noise sensitive point: User defined (30)	267 992	640 117	5.4	1.0	45.0	38.9	239	Yes
AE	Noise sensitive point: User defined (31)	268 091	639 901	8.3	1.0	45.0	43.1	78	Yes

Distances (m)

	WTG																					
NSA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A	11020	11145	11293	11430	11565	11723	11877	12029	14909	15410	15913	16415	16919	17423	17928	18432	18936	19442	19947	20454	20959	12182
B	10062	10212	10376	10537	10694	10870	11045	11215	14166	14654	15145	15636	16129	16622	17118	17613	18109	18607	19104	19604	20103	11389
C	9827	9944	10086	10213	10342	10493	10642	10788	13646	14149	14654	15158	15664	16169	16675	17181	17687	18194	18701	19208	19715	10936
D	9104	9253	9416	9576	9731	9907	10081	10252	13202	13690	14181	14672	15165	15659	16154	16650	17146	17645	18143	18642	19142	10426
E	9106	9224	9368	9498	9628	9782	9933	10082	12953	13455	13958	14461	14966	15470	15975	16480	16985	17492	17998	18505	19011	10232
F	8363	8474	8614	8738	8864	9014	9161	9306	12164	12667	13172	13676	14181	14686	15193	15698	16204	16711	17218	17726	18233	9453
G	7956	8059	8193	8309	8429	8573	8714	8854	11690	12194	12701	13206	13713	14219	14727	15234	15741	16249	16757	17265	17773	8996
H	7380	7482	7615	7731	7851	7995	8137	8277	11118	11622	12128	12633	13139	13645	14152	14659	15166	15674	16181	16690	17197	8419
I	6831	6923	7050	7157	7270	7408	7544	7679	10499	11004	11511	12017	12525	13032	13540	14048	14555	15064	15572	16081	16590	7817
J	5084	5119	5204	5258	5327	5428	5525	5627	8293	8803	9314	9824	10335	10845	11357	11867	12377	12888	13399	13910	14420	5730
K	3738	3963	4153	4389	4601	4815	5038	5252	7951	8323	8711	9109	9519	9938	10366	10800	11240	11687	12139	12596	13056	5479
L	3460	3422	3450	3438	3453	3506	3560	3624	6155	6666	7177	7688	8199	8710	9222	9732	10243	10754	11265	11776	12287	3693
M	2900	2817	2806	2751	2730	2751	2775	2815	5278	5789	6300	6811	7322	7833	8344	8855	9366	9877	10388	10899	11410	2863
N	1997	1807	1684	1507	1373	1282	1207	1171	3615	4122	4631	5139	5649	6158	6669	7178	7688	8198	8708	9219	9729	1164
O	2025	1800	1616	1382	1174	972	765	576	2754	3252	3755	4258	4764	5271	5779	6286	6794	7303	7812	8322	8831	398
P	2354	2132	1938	1705	1495	1279	1057	843	2211	2704	3204	3705	4210	4716	5223	5730	6238	6747	7256	7765	8274	622
Q	2713	2505	2313	2100	1907	1706	1508	1324	1666	2128	2609	3098	3595	4094	4597	5100	5605	6112	6618	7127	7634	1151
R	3573	3360	3165	2945	2743	2533	2322	2119	918	1426	1937	2447	2958	3468	3979	4490	5000	5511	6022	6533	7044	1915
S	4009	3806	3615	3407	3217	3016	2818	2629	359	828	1328	1834	2343	2852	3362	3872	4382	4893	5403	5914	6424	2442
T	4157	3962	3775	3577	3396	3203	3014	2836	393	647	1099	1586	2085	2589	3095	3602	4110	4620	5128	5639	6148	2662
U	4440	4249	4063	3868	3690	3499	3313	3137	468	416	806	1283	1780	2283	2789	3296	3804	4314	4823	5333	5842	2966
V	4577	4393	4212	4026	3856	3673	3496	3330	771	546	724	1128	1595	2082	2579	3080	3584	4090	4597	5105	5613	3170
W	5283	5107	4930	4754	4590	4413	4243	4084	1427	977	628	596	917	1359	1838	2330	2828	3331	3836	4343	4850	3930
X	6095	5923	5748	5575	5414	5239	5070	4911	2173	1675	1187	733	432	599	1027	1507	2002	2504	3009	3516	4023	4757
Y	6553	6385	6213	6043	5886	5713	5547	5391	2655	2153	1656	1171	722	441	625	1053	1532	2028	2529	3034	3540	5240
Z	7269	7105	6935	6770	6616	6447	6284	6130	3390	2884	2379	1879	1385	912	517	474	839	1306	1797	2297	2801	5981
AA	8103	7943	7776	7615	7464	7296	7136	6984	4239	3731	3223	2717	2212	1712	1220	755	416	546	972	1455	1951	6837
AB	9430	9279	9116	8964	8820	8659	8505	8359	5644	5136	4628	4121	3615	3111	2609	2112	1624	1155	744	544	749	8218
AC	9504	9345	9178	9016	8865	8697	8535	8382	5594	5084	4572	4062	3550	3040	2529	2019	1509	1000	495	112	550	8232
AD	9992	9840	9677	9524	9379	9217	9062	8915	6178	5669	5159	4650	4141	3633	3126	2620	2117	1619	1133	683	415	8773
AE	10115	9960	9795	9638	9489	9324	9166	9015	6244	5734	5223	4712	4201	3691	3181	2671	2162	1653	1147	648	218	8868

Project:
VRA WPP1 (v2)

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
07/12/2017 1:12 PM/3.1.617

DECIBEL - Main Result

Calculation: Copy of WPP1 | Original | LNTE mode2 | Loudest up to 95% rated power | LA90

Noise calculation model:
ISO 9613-2 General
Wind speed:
Loudest up to 95% rated power
Ground attenuation:
General, terrain specific
Ground factor for porous ground: 1.0
Area object with hard ground: Project Wizard Roughness Areas (GlobCover 20
Area type with hard ground: 0,0000m(cl.0,0) Water bodies
Meteorological coefficient, C0:
0.0 dB
Type of demand in calculation:
1: WTG noise is compared to demand (DK, DE, SE, NL etc.)
Noise values in calculation:
All noise values are 90% exeedance values (L90)
Pure tones:
Fixed penalty added to source noise of WTGs with pure tones: 5.0 dB(A)
Height above ground level, when no value in NSA object:
1.0 m Don't allow override of model height with height from NSA object
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0.0 dB(A)

Scale 1:400 000
New WTG
Noise sensitive area

WTGs

	Easting	Northing	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Noise data Creator	Name	Wind speed	LwA,ref	Pure tones
			[m]					[kW]	[m]	[m]			[m/s]	[dB(A)]	
1	248 191	641 106	-0.7	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
2	248 247	640 900	-0.4	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
3	248 294	640 680	4.3	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
4	249 222	640 914	-13.3	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
5	249 439	640 871	0.7	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
6	249 764	640 802	-2.1	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
7	250 090	640 743	-4.6	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
8	250 304	640 697	0.3	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
9	250 519	640 653	-3.7	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
10	250 730	640 607	1.9	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
11	250 948	640 567	-0.2	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
12	258 213	640 838	-1.9	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
13	258 362	640 707	0.1	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
14	258 548	640 539	-2.1	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
15	258 638	640 361	2.5	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
16	258 779	640 208	-0.1	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
17	258 973	640 063	3.1	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
18	259 068	639 896	0.5	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
19	259 221	639 744	-0.1	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
20	261 954	638 988	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
21	262 252	639 025	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
22	262 552	639 055	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
23	262 888	639 090	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
24	263 187	639 121	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
25	263 682	639 155	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
26	263 981	639 189	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
27	264 284	639 214	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
28	264 747	639 241	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
29	265 376	639 310	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
30	265 676	639 337	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
31	266 006	639 371	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
32	266 308	639 394	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
33	266 861	639 453	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
34	267 156	639 483	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
35	267 451	639 509	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
36	267 792	639 548	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
37	268 185	639 582	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No
38	265 039	639 271	0.0	VESTAS V110-2.0 200...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	USER	LNTE Mode 2	10.0	100.6	No

Calculation Results

Project:
VRA WPP1 (v2)

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
07/12/2017 1:12 PM/3.1.617

DECIBEL - Main Result

Calculation: Copy of WPP1 | Original | LNTE mode2 | Loudest up to 95% rated power | LA90

Sound level

Noise sensitive area						Demands	Sound level		Demands fulfilled ?
No.	Name	Easting	Northing	Z	Imission height	Noise	From WTGs	Distance to noise demand	Noise
				[m]	[m]	[dB(A)]	[dB(A)]	[m]	
A	Noise sensitive point: User defined (1)	247 056	640 476	7.7	1.0	45.0	28.8	1 122	Yes
B	Noise sensitive point: User defined (2)	248 022	641 929	7.2	1.0	45.0	31.6	802	Yes
C	Noise sensitive point: User defined (3)	248 289	640 061	0.9	1.0	45.0	34.3	567	Yes
D	Noise sensitive point: User defined (4)	248 970	641 756	2.6	1.0	45.0	33.6	752	Yes
E	Noise sensitive point: User defined (5)	248 997	640 221	5.1	1.0	45.0	35.6	638	Yes
F	Noise sensitive point: User defined (6)	249 771	640 012	9.2	1.0	45.0	35.6	626	Yes
G	Noise sensitive point: User defined (7)	250 228	639 732	10.6	1.0	45.0	33.9	788	Yes
H	Noise sensitive point: User defined (8)	250 804	639 783	9.8	1.0	45.0	34.1	661	Yes
I	Noise sensitive point: User defined (9)	251 412	639 569	6.0	1.0	45.0	30.1	976	Yes
J	Noise sensitive point: User defined (10)	253 617	638 680	9.8	1.0	45.0	18.8	3 153	Yes
K	Noise sensitive point: User defined (11)	255 693	644 057	1.4	1.0	45.0	15.5	4 051	Yes
L	Noise sensitive point: User defined (12)	255 767	638 564	6.2	1.0	45.0	20.0	3 203	Yes
M	Noise sensitive point: User defined (13)	256 642	638 627	2.9	1.0	45.0	23.1	2 476	Yes
N	Noise sensitive point: User defined (14)	258 286	639 176	-1.2	1.0	45.0	32.5	912	Yes
O	Noise sensitive point: User defined (15)	259 173	639 472	1.8	1.0	45.0	40.4	180	Yes
P	Noise sensitive point: User defined (16)	259 729	639 505	5.7	1.0	45.0	35.2	447	Yes
Q	Noise sensitive point: User defined (17)	260 367	639 740	0.1	1.0	45.0	30.8	1 011	Yes
R	Noise sensitive point: User defined (18)	260 982	639 111	2.9	1.0	45.0	30.7	919	Yes
S	Noise sensitive point: User defined (19)	261 591	639 271	2.6	1.0	45.0	36.0	407	Yes
T	Noise sensitive point: User defined (20)	261 857	639 479	4.2	1.0	45.0	36.4	403	Yes
U	Noise sensitive point: User defined (21)	262 163	639 475	3.4	1.0	45.0	38.0	344	Yes
V	Noise sensitive point: User defined (22)	262 388	639 685	2.5	1.0	45.0	36.1	551	Yes
W	Noise sensitive point: User defined (23)	263 152	639 772	4.3	1.0	45.0	36.1	752	Yes
X	Noise sensitive point: User defined (24)	263 978	639 723	3.5	1.0	45.0	37.6	384	Yes
Y	Noise sensitive point: User defined (25)	264 462	639 785	0.6	1.0	45.0	37.2	483	Yes
Z	Noise sensitive point: User defined (26)	265 204	639 846	1.9	1.0	45.0	37.6	505	Yes
AA	Noise sensitive point: User defined (27)	266 060	639 903	4.4	1.0	45.0	37.7	393	Yes
AB	Noise sensitive point: User defined (28)	267 435	640 192	6.3	1.0	45.0	35.6	576	Yes
AC	Noise sensitive point: User defined (29)	267 454	639 756	5.9	1.0	45.0	41.9	141	Yes
AD	Noise sensitive point: User defined (30)	267 992	640 117	5.4	1.0	45.0	35.9	559	Yes
AE	Noise sensitive point: User defined (31)	268 091	639 901	8.3	1.0	45.0	38.9	436	Yes

Distances (m)

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	1298	840	1050	1015	1197	1922	2457	2929	3569	5944	8062	7991	8807	10278	11103	11649	12253	12946	13525	13763	14067	14268
2	1264	1053	840	1121	1012	1764	2300	2791	3434	5811	8088	7875	8698	10186	11019	11567	12176	12860	13443	13684	13989	14193
3	1254	1278	619	1271	840	1621	2154	2666	3310	5687	8134	7767	8597	10105	10946	11496	12110	12785	13372	13616	13922	14129
4	2210	1571	1264	879	729	1056	1552	1945	2570	4931	7194	6954	7765	9229	10055	10601	11207	11898	12478	12717	13021	13224
5	2415	1768	1406	1001	786	921	1386	1746	2364	4718	7019	6736	7545	9008	9834	10381	10987	11677	12257	12496	12801	13004
6	2727	2074	1650	1241	962	790	1166	1456	2059	4399	6764	6407	7214	8676	9503	10049	10656	11345	11926	12166	12470	12674
7	3045	2384	1925	1510	1211	797	1020	1197	1768	4086	6510	6081	6886	8345	9172	9719	10326	11014	11595	11835	12140	12344
8	3255	2593	2113	1703	1391	868	968	1042	1581	3879	6351	5865	6668	8126	8954	9500	10109	10796	11377	11617	11922	12127
9	3467	2804	2307	1901	1582	985	966	916	1405	3673	6194	5649	6450	7907	8735	9282	9891	10576	11158	11399	11704	11909
10	3676	3013	2501	2102	1775	1128	1009	827	1242	3471	6045	5436	6235	7691	8519	9067	9676	10361	10943	11184	11489	11695
11	3893	3227	2706	2308	1981	1301	1102	797	1101	3269	5891	5219	6016	7469	8298	8845	9456	10139	10722	10963	11268	11474
12	11163	10249	9954	9288	9236	8482	8061	7483	6918	5077	4088	3340	2712	1664	1670	2019	2418	3264	3724	3890	4179	4332
13	11308	10412	10093	9450	9377	8619	8192	7614	7042	5160	4283	3365	2699	1533	1478	1821	2226	3068	3534	3705	3996	4154
14	11492	10618	10270	9655	9556	8793	8359	7781	7202	5270	4531	3411	2700	1388	1236	1569	1987	2822	3296	3474	3768	3934
15	11582	10731	10353	9768	9642	8874	8433	7855	7269	5295	4726	3387	2644	1236	1038	1387	1837	2657	3148	3338	3635	3811
16	11726	10893	10491	9930	9782	9010	8564	7986	7394	5383	4933	3431	2658	1144	835	1182	1656	2461	2964	3164	3463	3647
17	11924	11109	10684	10145	9977	9202	8751	8174	7577	5532	5168	3539	2738	1122	624	940	1431	2223	2735	2943	3244	3436
18	12026	11231	10780	10268	10076	9297	8841	8264	7663	5585	5357	3559	2738	1063	437	768	1309	2069	2600	2820	3124	3327
19	12187	11410	10936	10446	10235	9453	8993	8417	7811	5704	5572	3650	2810	1094	276	562	1146	1872	2417	2650	2955	3168
20	14972	14239	13707	13275	13015	12226	11749	11178	10558	8342	8055	6201	5324	3672	2822	2284	1756	979	460	500	530	821
21	15265	14523	14001	13560	13308	12520	12044	11473	10853	8642	8267	6501	5624	3969	3111	2568	2016	1273	705	601	459	674
22	15561	14811	14298	13848	13605	12816	12342	11770	11152	8943	8489	6802	5925	4267	3404	2858	2290	1571	985	814	572	651
23	15892	15134	14631	14171	13937	13149	12676	12104	11486	9280	8743	7140	6263	4602	3734	3186	2603	1906	1309	1102	821	777
24	16187	15422	14927	14459	14232	13445	12973	12400	11783	9580	8973	7441	6563	4901	4029	3479	2887	2205	1603	1377	1083	978
25	16678	15903	15419	14940	14723	13937	13466	12893	12277	10076	9373	7937	7059	5396	4520	3968	3366	2700	2094	1853	1552	1398
26	16974	16192	15716	15229	15019	14233	13763	13190	12574	10376	9612	8237	7360	5695	4816	4263	3655	3000	2391	2143	1840	1668
27	17274	16487	16017	15523	15320	14535	14065	13492	12877	10680	9862	8541	7664	5998	5117	4564	3952	3303	2693	2441	2137	1953
28	17734	16939	16478	15976	15780	14995	14527	13953	13339	11144	10255	9005	8128	6461	5578	5025	4408	3767	3156	2899	2594	2400
29	18357	17550	17103	16587	16404	15620	15154	14579	13966	11776	10784	9638	8760	7091	6205	5650	5027	4398	3785	3523	3217	3011
30	18654	17843	17402	16880	16702	15919	15453	14878	14266	12077	11042	9939	9062	7391	6504	5949	5324	4699	4085	3821	3515	3306
31	18982	18165	17730	17202	17030	16247	15782	15207	14595	12408	11327	10270	9393	7722	6833	6278	5651	5030	4416	4150	3844	3631

To be continued on next page...

Project:
VRA WPP1 (v2)

Licensed user:
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480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
07/12/2017 1:12 PM/3.1.617

DECIBEL - Main Result

Calculation: Copy of WPP1 | Original | LNTE mode2 | Loudest up to 95% rated power | LA90

...continued from previous page

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
32	19282	18461	18031	17498	17330	16548	16083	15509	14897	12711	11594	10573	9696	8025	7135	6580	5951	5333	4718	4451	4145	3930
33	19831	19001	18582	18038	17880	17099	16635	16060	15449	13266	12079	11129	10252	8579	7688	7132	6500	5889	5273	5004	4698	4479
34	20124	19289	18876	18327	18174	17393	16929	16354	15744	13562	12342	11426	10548	8875	7983	7427	6794	6185	5569	5299	4993	4772
35	20418	19579	19170	18617	18467	17687	17224	16649	16039	13858	12607	11722	10845	9171	8278	7722	7087	6481	5864	5594	5288	5066
36	20756	19913	19509	18951	18807	18027	17565	16989	16380	14201	12912	12065	11188	9513	8619	8063	7427	6824	6207	5935	5629	5405
37	21148	20299	19901	19337	19198	18419	17957	17382	16773	14596	13269	12459	11582	9907	9012	8456	7819	7218	6601	6329	6023	5798
38	18023	17223	16768	16260	16070	15286	14818	14244	13630	11437	10500	9299	8421	6753	5869	5315	4695	4060	3448	3188	2883	2683

WTG	W	X	Y	Z	AA	AB	AC	AD	AE
1	15021	15848	16325	17060	17910	19266	19311	19826	19937
2	14948	15775	16254	16990	17841	19201	19241	19761	19869
3	14886	15714	16193	16931	17783	19148	19183	19706	19813
4	13977	14804	15282	16018	16869	18228	18269	18787	18897
5	13757	14585	15063	15799	16650	18009	18050	18569	18678
6	13428	14255	14734	15470	16321	17682	17721	18241	18349
7	13098	13926	14404	15141	15992	17354	17392	17913	18021
8	12882	13709	14188	14925	15776	17139	17176	17698	17805
9	12664	13491	13970	14708	15559	16923	16959	17482	17588
10	12450	13278	13757	14494	15347	16711	16746	17269	17376
11	12230	13058	13537	14275	15127	16492	16526	17050	17156
12	5053	5872	6338	7061	7903	9245	9305	9806	9923
13	4881	5702	6170	6896	7740	9088	9142	9648	9763
14	4667	5491	5962	6692	7539	8894	8940	9453	9564
15	4553	5378	5853	6587	7436	8799	8837	9358	9465
16	4395	5222	5699	6436	7288	8656	8687	9214	9317
17	4189	5017	5496	6235	7089	8463	8487	9019	9120
18	4086	4913	5395	6137	6992	8373	8388	8927	9023
19	3931	4757	5242	5984	6841	8227	8233	8779	8872
20	1432	2154	2632	3362	4207	5612	5554	6143	6205
21	1170	1862	2337	3064	3908	5313	5253	5843	5905
22	935	1575	2045	2768	3609	5014	4952	5543	5604
23	731	1261	1721	2437	3275	4679	4615	5207	5266
24	652	994	1438	2144	2978	4381	4314	4907	4966
25	813	641	1003	1672	2493	3894	3820	4416	4472
26	1013	534	766	1389	2198	3597	3519	4117	4172
27	1262	594	598	1116	1905	3300	3216	3817	3869
28	1681	907	614	758	1471	2852	2756	3361	3409
29	2271	1457	1030	563	905	2240	2126	2738	2779
30	2561	1741	1294	694	684	1956	1827	2444	2480
31	2882	2058	1598	932	535	1648	1499	2122	2152
32	3178	2353	1887	1193	566	1381	1202	1833	1854
33	3722	2895	2422	1703	918	936	666	1312	1309
34	4014	3187	2711	1985	1173	762	404	1049	1024
35	4307	3479	3001	2272	1445	683	247	814	751
36	4645	3818	3338	2605	1768	736	397	603	463
37	5036	4209	3728	2992	2149	966	751	569	332
38	1952	1153	772	598	1201	2567	2464	3072	3117

Project:

VRA WPP1 (v2)

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Calculated:
07/12/2017 2:03 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP1 | Alternative | Mode SO3 | Loudest up to 95% rated power | LA90

Noise calculation model:
ISO 9613-2 General
Wind speed:
Loudest up to 95% rated power
Ground attenuation:
General, terrain specific
Ground factor for porous ground: 1.0
Area object with hard ground: Project Wizard Roughness Areas (GlobCover 20
Area type with hard ground: 0,0000m(cl.0,0) Water bodies
Meteorological coefficient, C0:
0.0 dB
Type of demand in calculation:
1: WTG noise is compared to demand (DK, DE, SE, NL etc.)
Noise values in calculation:
All noise values are 90% exeedance values (L90)
Pure tones:
Fixed penalty added to source noise of WTGs with pure tones: 5.0 dB(A)
Height above ground level, when no value in NSA object:
1.0 m Don't allow override of model height with height from NSA object
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0.0 dB(A)

Scale 1:400 000
New WTG   Noise sensitive area

WTGs

	Easting	Northing	Z [m]	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data Creator	Name	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones
1	258 055	641 160	2.3	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 3- Calculated- SO3 - 11.02.2016	6.0	101.9	No
2	258 190	640 980	5.9	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 3- Calculated- SO3 - 11.02.2016	6.0	101.9	No
3	258 343	640 859	11.5	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 3- Calculated- SO3 - 11.02.2016	6.0	101.9	No
4	258 484	640 670	2.2	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 3- Calculated- SO3 - 11.02.2016	6.0	101.9	No
5	258 621	640 508	0.2	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 3- Calculated- SO3 - 11.02.2016	6.0	101.9	No
6	258 778	640 360	1.0	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 3- Calculated- SO3 - 11.02.2016	6.0	101.9	No
7	258 930	640 197	2.3	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 3- Calculated- SO3 - 11.02.2016	6.0	101.9	No
8	259 077	640 040	0.9	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 3- Calculated- SO3 - 11.02.2016	6.0	101.9	No
9	261 900	639 088	0.0	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 3- Calculated- SO3 - 11.02.2016	6.0	101.9	No
10	262 408	639 139	0.0	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 3- Calculated- SO3 - 11.02.2016	6.0	101.9	No
11	262 917	639 190	0.0	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 3- Calculated- SO3 - 11.02.2016	6.0	101.9	No
12	263 425	639 242	2.3	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 3- Calculated- SO3 - 11.02.2016	6.0	101.9	No
13	263 934	639 293	4.5	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 3- Calculated- SO3 - 11.02.2016	6.0	101.9	No
14	264 442	639 344	2.3	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 3- Calculated- SO3 - 11.02.2016	6.0	101.9	No
15	264 951	639 395	0.8	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 3- Calculated- SO3 - 11.02.2016	6.0	101.9	No
16	265 459	639 446	1.2	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 3- Calculated- SO3 - 11.02.2016	6.0	101.9	No
17	265 967	639 498	5.3	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 3- Calculated- SO3 - 11.02.2016	6.0	101.9	No
18	266 476	639 549	6.3	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 3- Calculated- SO3 - 11.02.2016	6.0	101.9	No
19	266 984	639 600	5.4	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 3- Calculated- SO3 - 11.02.2016	6.0	101.9	No
20	267 493	639 651	0.5	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 3- Calculated- SO3 - 11.02.2016	6.0	101.9	No
21	268 001	639 702	0.0	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 3- Calculated- SO3 - 11.02.2016	6.0	101.9	No
22	259 223	639 867	3.0	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 3- Calculated- SO3 - 11.02.2016	6.0	101.9	No

Calculation Results

Sound level

Noise sensitive area No.	Name	Easting	Northing	Z [m]	Imission height [m]	Demands Noise [dB(A)]	Sound level From WTGs [dB(A)]	Distance to noise demand [m]	Demands fulfilled ? Noise
A	Noise sensitive point: User defined (1)	247 056	640 476	7.7	1.0	45.0	-4.5	10 912	Yes
B	Noise sensitive point: User defined (2)	248 022	641 929	7.2	1.0	45.0	-2.1	9 954	Yes
C	Noise sensitive point: User defined (3)	248 289	640 061	0.9	1.0	45.0	-1.2	9 711	Yes
D	Noise sensitive point: User defined (4)	248 970	641 756	2.6	1.0	45.0	0.5	8 997	Yes
E	Noise sensitive point: User defined (5)	248 997	640 221	5.1	1.0	45.0	0.8	8 992	Yes
F	Noise sensitive point: User defined (6)	249 771	640 012	9.2	1.0	45.0	2.9	8 243	Yes
G	Noise sensitive point: User defined (7)	250 228	639 732	10.6	1.0	45.0	4.2	7 830	Yes
H	Noise sensitive point: User defined (8)	250 804	639 783	9.8	1.0	45.0	5.9	7 254	Yes
I	Noise sensitive point: User defined (9)	251 412	639 569	6.0	1.0	45.0	7.6	6 698	Yes
J	Noise sensitive point: User defined (10)	253 617	638 680	9.8	1.0	45.0	13.9	4 919	Yes
K	Noise sensitive point: User defined (11)	255 693	644 057	1.4	1.0	45.0	17.1	3 600	Yes
L	Noise sensitive point: User defined (12)	255 767	638 564	6.2	1.0	45.0	21.0	3 213	Yes
M	Noise sensitive point: User defined (13)	256 642	638 627	2.9	1.0	45.0	24.3	2 510	Yes
N	Noise sensitive point: User defined (14)	258 286	639 176	-1.2	1.0	45.0	33.0	967	Yes

To be continued on next page...

Project:
VRA WPP1 (v2)

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
07/12/2017 2:03 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP1 | Alternative | Mode SO3 | Loudest up to 95% rated power | LA90

...continued from previous page

Noise sensitive area						Demands	Sound level		Demands fulfilled ?
No.	Name	Easting	Northing	Z	Imission height	Noise	From WTGs	Distance to noise demand	Noise
				[m]	[m]	[dB(A)]	[dB(A)]	[m]	
O	Noise sensitive point: User defined (15)	259 173	639 472	1.8	1.0	45.0	39.0	268	Yes
P	Noise sensitive point: User defined (16)	259 729	639 505	5.7	1.0	45.0	35.5	514	Yes
Q	Noise sensitive point: User defined (17)	260 367	639 740	0.1	1.0	45.0	31.7	1 069	Yes
R	Noise sensitive point: User defined (18)	260 982	639 111	2.9	1.0	45.0	31.3	1 821	Yes
S	Noise sensitive point: User defined (19)	261 591	639 271	2.6	1.0	45.0	37.8	1 316	Yes
T	Noise sensitive point: User defined (20)	261 857	639 479	4.2	1.0	45.0	37.9	1 074	Yes
U	Noise sensitive point: User defined (21)	262 163	639 475	3.4	1.0	45.0	38.8	777	Yes
V	Noise sensitive point: User defined (22)	262 388	639 685	2.5	1.0	45.0	36.7	677	Yes
W	Noise sensitive point: User defined (23)	263 152	639 772	4.3	1.0	45.0	36.9	509	Yes
X	Noise sensitive point: User defined (24)	263 978	639 723	3.5	1.0	45.0	38.5	390	Yes
Y	Noise sensitive point: User defined (25)	264 462	639 785	0.6	1.0	45.0	38.4	474	Yes
Z	Noise sensitive point: User defined (26)	265 204	639 846	1.9	1.0	45.0	38.5	380	Yes
AA	Noise sensitive point: User defined (27)	266 060	639 903	4.4	1.0	45.0	38.9	298	Yes
AB	Noise sensitive point: User defined (28)	267 435	640 192	6.3	1.0	45.0	36.6	409	Yes
AC	Noise sensitive point: User defined (29)	267 454	639 756	5.9	1.0	45.0	45.5	-6	**No**
AD	Noise sensitive point: User defined (30)	267 992	640 117	5.4	1.0	45.0	37.3	289	Yes
AE	Noise sensitive point: User defined (31)	268 091	639 901	8.3	1.0	45.0	41.4	115	Yes

Distances (m)

	WTG																					
NSA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A	11020	11145	11293	11430	11565	11723	11877	12029	14909	15410	15913	16415	16919	17423	17928	18432	18936	19442	19947	20454	20959	12182
B	10062	10212	10376	10537	10694	10870	11045	11215	14166	14654	15145	15636	16129	16622	17118	17613	18109	18607	19104	19604	20103	11389
C	9827	9944	10086	10213	10342	10493	10642	10788	13646	14149	14654	15158	15664	16169	16675	17181	17687	18194	18701	19208	19715	10936
D	9104	9253	9416	9576	9731	9907	10081	10252	13202	13690	14181	14672	15165	15659	16154	16650	17146	17645	18143	18642	19142	10426
E	9106	9224	9368	9498	9628	9782	9933	10082	12953	13455	13958	14461	14966	15470	15975	16480	16985	17492	17998	18505	19011	10232
F	8363	8474	8614	8738	8864	9014	9161	9306	12164	12667	13172	13676	14181	14686	15193	15698	16204	16711	17218	17726	18233	9453
G	7956	8059	8193	8309	8429	8573	8714	8854	11690	12194	12701	13206	13713	14219	14727	15234	15741	16249	16757	17265	17773	8996
H	7380	7482	7615	7731	7851	7995	8137	8277	11118	11622	12128	12633	13139	13645	14152	14659	15166	15674	16181	16690	17197	8419
I	6831	6923	7050	7157	7270	7408	7544	7679	10499	11004	11511	12017	12525	13032	13540	14048	14555	15064	15572	16081	16590	7817
J	5084	5119	5204	5258	5327	5428	5525	5627	8293	8803	9314	9824	10335	10845	11357	11867	12377	12888	13399	13910	14420	5730
K	3738	3963	4153	4389	4601	4815	5038	5252	7951	8323	8711	9109	9519	9938	10366	10800	11240	11687	12139	12596	13056	5479
L	3460	3422	3450	3438	3453	3506	3560	3624	6155	6666	7177	7688	8199	8710	9222	9732	10243	10754	11265	11776	12287	3693
M	2900	2817	2806	2751	2730	2751	2775	2815	5278	5789	6300	6811	7322	7833	8344	8855	9366	9877	10388	10899	11410	2863
N	1997	1807	1684	1507	1373	1282	1207	1171	3615	4122	4631	5139	5649	6158	6669	7178	7688	8198	8708	9219	9729	1164
O	2025	1800	1616	1382	1174	972	765	576	2754	3252	3755	4258	4764	5271	5779	6286	6794	7303	7812	8322	8831	398
P	2354	2132	1938	1705	1495	1279	1057	843	2211	2704	3204	3705	4210	4716	5223	5730	6238	6747	7256	7765	8274	622
Q	2713	2505	2313	2100	1907	1706	1508	1324	1666	2128	2609	3098	3595	4094	4597	5100	5605	6112	6618	7127	7634	1151
R	3573	3360	3165	2945	2743	2533	2322	2119	918	1426	1937	2447	2958	3468	3979	4490	5000	5511	6022	6533	7044	1915
S	4009	3806	3615	3407	3217	3016	2818	2629	359	828	1328	1834	2343	2852	3362	3872	4382	4893	5403	5914	6424	2442
T	4157	3962	3775	3577	3396	3203	3014	2836	393	647	1099	1586	2085	2589	3095	3602	4110	4620	5128	5639	6148	2662
U	4440	4249	4063	3868	3690	3499	3313	3137	468	416	806	1283	1780	2283	2789	3296	3804	4314	4823	5333	5842	2966
V	4577	4393	4212	4026	3856	3673	3496	3330	771	546	724	1128	1595	2082	2579	3080	3584	4090	4597	5105	5613	3170
W	5283	5107	4930	4754	4590	4413	4243	4084	1427	977	628	596	917	1359	1838	2330	2828	3331	3836	4343	4850	3930
X	6095	5923	5748	5575	5414	5239	5070	4911	2173	1675	1187	733	432	599	1027	1507	2002	2504	3009	3516	4023	4757
Y	6553	6385	6213	6043	5886	5713	5547	5391	2655	2153	1656	1171	722	441	625	1053	1532	2028	2529	3034	3540	5240
Z	7269	7105	6935	6770	6616	6447	6284	6130	3390	2884	2379	1879	1385	912	517	474	839	1306	1797	2297	2801	5981
AA	8103	7943	7776	7615	7464	7296	7136	6984	4239	3731	3223	2717	2212	1712	1220	755	416	546	972	1455	1951	6837
AB	9430	9279	9116	8964	8820	8659	8505	8359	5644	5136	4628	4121	3615	3111	2609	2112	1624	1155	744	544	749	8218
AC	9504	9345	9178	9016	8865	8697	8535	8382	5594	5084	4572	4062	3550	3040	2529	2019	1509	1000	495	112	550	8232
AD	9992	9840	9677	9524	9379	9217	9062	8915	6178	5669	5159	4650	4141	3633	3126	2620	2117	1619	1133	683	415	8773
AE	10115	9960	9795	9638	9489	9324	9166	9015	6244	5734	5223	4712	4201	3691	3181	2671	2162	1653	1147	648	218	8868

Project:
VRA WPP1 (v2)

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Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
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Nicolette / nicolette@airshed.co.za
Calculated:
07/12/2017 2:21 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP1 | Alternative | Mode SO4 | Loudest up to 95% rated power | LA90

Noise calculation model:
ISO 9613-2 General
Wind speed:
Loudest up to 95% rated power
Ground attenuation:
General, terrain specific
Ground factor for porous ground: 1.0
Area object with hard ground: Project Wizard Roughness Areas (GlobCover 20
Area type with hard ground: 0,0000m(cl.0,0) Water bodies
Meteorological coefficient, C0:
0.0 dB
Type of demand in calculation:
1: WTG noise is compared to demand (DK, DE, SE, NL etc.)
Noise values in calculation:
All noise values are 90% exeedance values (L90)
Pure tones:
Fixed penalty added to source noise of WTGs with pure tones: 5.0 dB(A)
Height above ground level, when no value in NSA object:
1.0 m Don't allow override of model height with height from NSA object
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0.0 dB(A)

Scale 1:400 000
New WTG   Noise sensitive area

WTGs

	Easting	Northing	Z [m]	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data Creator	Name	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones
1	258 055	641 160	2.3	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 4- Calculated- SO4 - 11.02.2016	10.0	98.0	No
2	258 190	640 980	5.9	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 4- Calculated- SO4 - 11.02.2016	10.0	98.0	No
3	258 343	640 859	11.5	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 4- Calculated- SO4 - 11.02.2016	10.0	98.0	No
4	258 484	640 670	2.2	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 4- Calculated- SO4 - 11.02.2016	10.0	98.0	No
5	258 621	640 508	0.2	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 4- Calculated- SO4 - 11.02.2016	10.0	98.0	No
6	258 778	640 360	1.0	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 4- Calculated- SO4 - 11.02.2016	10.0	98.0	No
7	258 930	640 197	2.3	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 4- Calculated- SO4 - 11.02.2016	10.0	98.0	No
8	259 077	640 040	0.9	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 4- Calculated- SO4 - 11.02.2016	10.0	98.0	No
9	261 900	639 088	0.0	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 4- Calculated- SO4 - 11.02.2016	10.0	98.0	No
10	262 408	639 139	0.0	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 4- Calculated- SO4 - 11.02.2016	10.0	98.0	No
11	262 917	639 190	0.0	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 4- Calculated- SO4 - 11.02.2016	10.0	98.0	No
12	263 425	639 242	2.3	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 4- Calculated- SO4 - 11.02.2016	10.0	98.0	No
13	263 934	639 293	4.5	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 4- Calculated- SO4 - 11.02.2016	10.0	98.0	No
14	264 442	639 344	2.3	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 4- Calculated- SO4 - 11.02.2016	10.0	98.0	No
15	264 951	639 395	0.8	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 4- Calculated- SO4 - 11.02.2016	10.0	98.0	No
16	265 459	639 446	1.2	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 4- Calculated- SO4 - 11.02.2016	10.0	98.0	No
17	265 967	639 498	5.3	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 4- Calculated- SO4 - 11.02.2016	10.0	98.0	No
18	266 476	639 549	6.3	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 4- Calculated- SO4 - 11.02.2016	10.0	98.0	No
19	266 984	639 600	5.4	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 4- Calculated- SO4 - 11.02.2016	10.0	98.0	No
20	267 493	639 651	0.5	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 4- Calculated- SO4 - 11.02.2016	10.0	98.0	No
21	268 001	639 702	0.0	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 4- Calculated- SO4 - 11.02.2016	10.0	98.0	No
22	259 223	639 867	3.0	VESTAS V136-3.45 3450 1...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	112.0	EMD	Level 4- Calculated- SO4 - 11.02.2016	10.0	98.0	No

Calculation Results

Sound level

Noise sensitive area No.	Name	Easting	Northing	Z [m]	Imission height [m]	Demands Noise [dB(A)]	Sound level From WTGs [dB(A)]	Demands fulfilled ? Noise
A	Noise sensitive point: User defined (1)	247 056	640 476	7.7	1.0	45.0	-8.4	Yes
B	Noise sensitive point: User defined (2)	248 022	641 929	7.2	1.0	45.0	-6.0	Yes
C	Noise sensitive point: User defined (3)	248 289	640 061	0.9	1.0	45.0	-5.1	Yes
D	Noise sensitive point: User defined (4)	248 970	641 756	2.6	1.0	45.0	-3.4	Yes
E	Noise sensitive point: User defined (5)	248 997	640 221	5.1	1.0	45.0	-3.1	Yes
F	Noise sensitive point: User defined (6)	249 771	640 012	9.2	1.0	45.0	-1.0	Yes
G	Noise sensitive point: User defined (7)	250 228	639 732	10.6	1.0	45.0	0.3	Yes
H	Noise sensitive point: User defined (8)	250 804	639 783	9.8	1.0	45.0	2.0	Yes
I	Noise sensitive point: User defined (9)	251 412	639 569	6.0	1.0	45.0	3.7	Yes
J	Noise sensitive point: User defined (10)	253 617	638 680	9.8	1.0	45.0	10.0	Yes
K	Noise sensitive point: User defined (11)	255 693	644 057	1.4	1.0	45.0	13.2	Yes
L	Noise sensitive point: User defined (12)	255 767	638 564	6.2	1.0	45.0	17.1	Yes
M	Noise sensitive point: User defined (13)	256 642	638 627	2.9	1.0	45.0	20.4	Yes
N	Noise sensitive point: User defined (14)	258 286	639 176	-1.2	1.0	45.0	29.1	Yes
O	Noise sensitive point: User defined (15)	259 173	639 472	1.8	1.0	45.0	35.1	Yes
P	Noise sensitive point: User defined (16)	259 729	639 505	5.7	1.0	45.0	31.6	Yes

To be continued on next page...

Project:
VRA WPP1 (v2)

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
07/12/2017 2:21 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP1 | Alternative | Mode SO4 | Loudest up to 95% rated power | LA90

...continued from previous page

Noise sensitive area						**Demands**	**Sound level**	**Demands fulfilled ?**
No.	Name	Easting	Northing	Z [m]	Imission height [m]	Noise [dB(A)]	From WTGs [dB(A)]	Noise
Q	Noise sensitive point: User defined (17)	260 367	639 740	0.1	1.0	45.0	27.8	Yes
R	Noise sensitive point: User defined (18)	260 982	639 111	2.9	1.0	45.0	27.4	Yes
S	Noise sensitive point: User defined (19)	261 591	639 271	2.6	1.0	45.0	34.0	Yes
T	Noise sensitive point: User defined (20)	261 857	639 479	4.2	1.0	45.0	34.0	Yes
U	Noise sensitive point: User defined (21)	262 163	639 475	3.4	1.0	45.0	34.9	Yes
V	Noise sensitive point: User defined (22)	262 388	639 685	2.5	1.0	45.0	32.8	Yes
W	Noise sensitive point: User defined (23)	263 152	639 772	4.3	1.0	45.0	33.0	Yes
X	Noise sensitive point: User defined (24)	263 978	639 723	3.5	1.0	45.0	34.7	Yes
Y	Noise sensitive point: User defined (25)	264 462	639 785	0.6	1.0	45.0	34.5	Yes
Z	Noise sensitive point: User defined (26)	265 204	639 846	1.9	1.0	45.0	34.6	Yes
AA	Noise sensitive point: User defined (27)	266 060	639 903	4.4	1.0	45.0	35.0	Yes
AB	Noise sensitive point: User defined (28)	267 435	640 192	6.3	1.0	45.0	32.7	Yes
AC	Noise sensitive point: User defined (29)	267 454	639 756	5.9	1.0	45.0	41.6	Yes
AD	Noise sensitive point: User defined (30)	267 992	640 117	5.4	1.0	45.0	33.4	Yes
AE	Noise sensitive point: User defined (31)	268 091	639 901	8.3	1.0	45.0	37.6	Yes

Distances (m)

	WTG																					
NSA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A	11020	11145	11293	11430	11565	11723	11877	12029	14909	15410	15913	16415	16919	17423	17928	18432	18936	19442	19947	20454	20959	12182
B	10062	10212	10376	10537	10694	10870	11045	11215	14166	14654	15145	15636	16129	16622	17118	17613	18109	18607	19104	19604	20103	11389
C	9827	9944	10086	10213	10342	10493	10642	10788	13646	14149	14654	15158	15664	16169	16675	17181	17687	18194	18701	19208	19715	10936
D	9104	9253	9416	9576	9731	9907	10081	10252	13202	13690	14181	14672	15165	15659	16154	16650	17146	17645	18143	18642	19142	10426
E	9106	9224	9368	9498	9628	9782	9933	10082	12953	13455	13958	14461	14966	15470	15975	16480	16985	17492	17998	18505	19011	10232
F	8363	8474	8614	8738	8864	9014	9161	9306	12164	12667	13172	13676	14181	14686	15193	15698	16204	16711	17218	17726	18233	9453
G	7956	8059	8193	8309	8429	8573	8714	8854	11690	12194	12701	13206	13713	14219	14727	15234	15741	16249	16757	17265	17773	8996
H	7380	7482	7615	7731	7851	7995	8137	8277	11118	11622	12128	12633	13139	13645	14152	14659	15166	15674	16181	16690	17197	8419
I	6831	6923	7050	7157	7270	7408	7544	7679	10499	11004	11511	12017	12525	13032	13540	14048	14555	15064	15572	16081	16590	7817
J	5084	5119	5204	5258	5327	5428	5525	5627	8293	8803	9314	9824	10335	10845	11357	11867	12377	12888	13399	13910	14420	5730
K	3738	3963	4153	4389	4601	4815	5038	5252	7951	8323	8711	9109	9519	9938	10366	10800	11240	11687	12139	12596	13056	5479
L	3460	3422	3450	3438	3453	3506	3560	3624	6155	6666	7177	7688	8199	8710	9222	9732	10243	10754	11265	11776	12287	3693
M	2900	2817	2806	2751	2730	2751	2775	2815	5278	5789	6300	6811	7322	7833	8344	8855	9366	9877	10388	10899	11410	2863
N	1997	1807	1684	1507	1373	1282	1207	1171	3615	4122	4631	5139	5649	6158	6669	7178	7688	8198	8708	9219	9729	1164
O	2025	1800	1616	1382	1174	972	765	576	2754	3252	3755	4258	4764	5271	5779	6286	6794	7303	7812	8322	8831	398
P	2354	2132	1938	1705	1495	1279	1057	843	2211	2704	3204	3705	4210	4716	5223	5730	6238	6747	7256	7765	8274	622
Q	2713	2505	2313	2100	1907	1706	1508	1324	1666	2128	2609	3098	3595	4094	4597	5100	5605	6112	6618	7127	7634	1151
R	3573	3360	3165	2945	2743	2533	2322	2119	918	1426	1937	2447	2958	3468	3979	4490	5000	5511	6022	6533	7044	1915
S	4009	3806	3615	3407	3217	3016	2818	2629	359	828	1328	1834	2343	2852	3362	3872	4382	4893	5403	5914	6424	2442
T	4157	3962	3775	3577	3396	3203	3014	2836	393	647	1099	1586	2085	2589	3095	3602	4110	4620	5128	5639	6148	2662
U	4440	4249	4063	3868	3690	3499	3313	3137	468	416	806	1283	1780	2283	2789	3296	3804	4314	4823	5333	5842	2966
V	4577	4393	4212	4026	3856	3673	3496	3330	771	546	724	1128	1595	2082	2579	3080	3584	4090	4597	5105	5613	3170
W	5283	5107	4930	4754	4590	4413	4243	4084	1427	977	628	596	917	1359	1838	2330	2828	3331	3836	4343	4850	3930
X	6095	5923	5748	5575	5414	5239	5070	4911	2173	1675	1187	733	432	599	1027	1507	2002	2504	3009	3516	4023	4757
Y	6553	6385	6213	6043	5886	5713	5547	5391	2655	2153	1656	1171	722	441	625	1053	1532	2028	2529	3034	3540	5240
Z	7269	7105	6935	6770	6616	6447	6284	6130	3390	2884	2379	1879	1385	912	517	474	839	1306	1797	2297	2801	5981
AA	8103	7943	7776	7615	7464	7296	7136	6984	4239	3731	3223	2717	2212	1712	1220	755	416	546	972	1455	1951	6837
AB	9430	9279	9116	8964	8820	8659	8505	8359	5644	5136	4628	4121	3615	3111	2609	2112	1624	1155	744	544	749	8218
AC	9504	9345	9178	9016	8865	8697	8535	8382	5594	5084	4572	4062	3550	3040	2529	2019	1509	1000	495	112	550	8232
AD	9992	9840	9677	9524	9379	9217	9062	8915	6178	5669	5159	4650	4141	3633	3126	2620	2117	1619	1133	683	415	8773
AE	10115	9960	9795	9638	9489	9324	9166	9015	6244	5734	5223	4712	4201	3691	3181	2671	2162	1653	1147	648	218	8868

13. ANNEX C – WINDPRO SHADOW REPORTS

Project:
VRA WPP1 (Final)

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
14/06/2017 12:03/3.1.617

SHADOW - Main Result

Calculation: WPP1 | Original

Assumptions for shadow calculations

Maximum distance for influence
Calculate only when more than 20 % of sun is covered by the blade
Please look in WTG table

Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

Sunshine probability S (Average daily sunshine hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
9.90	9.70	8.60	8.90	8.30	5.40	4.90	4.20	5.90	8.00	9.80	10.40

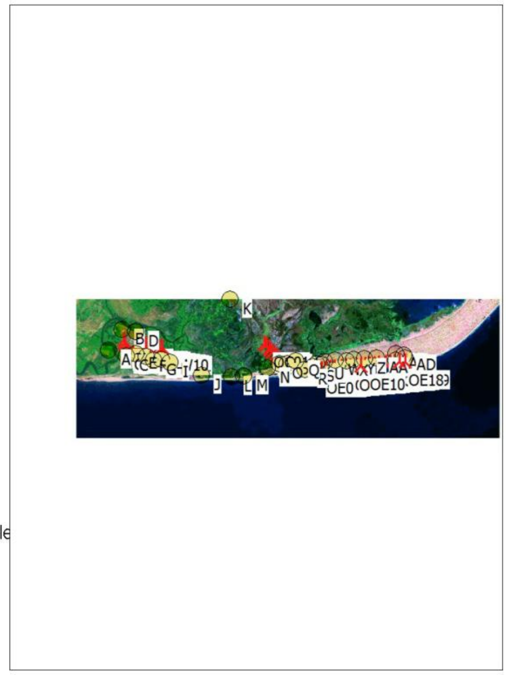
Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
105	70	35	61	105	123	482	2 990	3 911	561	167	149	8 759

Idle start wind speed: Cut in wind speed from power curve

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:
Height contours used: Project Wizard Elevation Data Grid (SRTM: Shuttle
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 50.0 m
Topographic shadow included in calculation

All coordinates are in
UTM (north)-WGS84 Zone: 31



Scale 1:400 000
New WTG   Shadow receptor

WTGs

	Easting	Northing	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Shadow data Calculation distance	RPM
			[m]					[kW]	[m]	[m]	[m]	[RPM]
OC01	258 113	640 938	5.4	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OC02	258 262	640 807	0.9	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OC03	258 448	640 639	2.6	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OC04	258 538	640 461	0.0	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OC05	258 679	640 308	1.7	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OC06	258 873	640 163	0.3	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OC07	258 968	639 996	2.9	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OC08	259 121	639 844	-0.2	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OE01	261 854	639 088	0.0	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OE02	262 152	639 125	0.0	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OE03	262 452	639 155	0.0	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OE04	262 788	639 190	0.0	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OE05	263 087	639 221	0.0	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0

To be continued on next page...

Project:
VRA WPP1 (Final)

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
14/06/2017 12:03/3.1.617

SHADOW - Main Result

Calculation: WPP1 | Original

...continued from previous page

	Easting	Northing	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Shadow data Calculation distance	RPM
			[m]					[kW]	[m]	[m]	[m]	[RPM]
OE06	263 582	639 255	6.4	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OE07	263 881	639 289	6.6	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OE08	264 184	639 314	0.6	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OE09	264 647	639 341	0.0	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OE10	264 939	639 371	0.0	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OE11	265 276	639 410	0.6	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OE12	265 576	639 437	0.0	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OE13	265 906	639 471	0.0	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OE14	266 208	639 494	2.7	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OE15	266 761	639 553	7.8	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OE16	267 056	639 583	2.5	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OE17	267 351	639 609	2.1	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OE18	267 692	639 648	0.9	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OE19	268 085	639 682	0.0	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OW01	248 091	641 206	-1.0	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OW02	248 147	641 000	3.0	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OW03	248 194	640 780	4.8	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OW04	249 122	641 014	-0.2	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OW05	249 339	640 971	5.7	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OW06	249 664	640 902	1.1	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OW07	249 990	640 843	2.4	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OW08	250 204	640 797	-1.6	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OW09	250 419	640 753	3.7	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OW10	250 630	640 707	-0.5	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0
OW11	250 848	640 667	0.4	VESTAS V110-2.0 20...	Yes	VESTAS	V110-2.0-2 000	2 000	110.0	95.0	1 516	0.0

Shadow receptor-Input

No.	Easting	Northing	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
			[m]	[m]	[m]	[m]	[°]	[°]	
A	247 056	640 478	7.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
B	248 002	641 929	12.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
C	248 292	640 080	1.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
D	248 959	641 773	3.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
E	248 997	640 236	4.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
F	249 754	640 015	8.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
G	250 219	639 741	14.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H	250 791	639 793	8.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
I	251 402	639 584	3.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
J	253 621	638 711	8.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
K	255 676	644 075	-2.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
L	255 762	638 580	5.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
M	256 626	638 631	2.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
N	258 289	639 191	-0.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"

To be continued on next page...

Project:
VRA WPP1 (Final)

Licensed user:
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480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
14/06/2017 12:03/3.1.617

SHADOW - Main Result

Calculation: WPP1 | Original

...continued from previous page

No.	Easting	Northing	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
			[m]	[m]	[m]	[m]	[°]	[°]	
O	259 167	639 490	1.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
P	259 725	639 502	5.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
Q	260 337	639 737	4.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
R	260 987	639 124	3.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
S	261 573	639 293	1.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
T	261 839	639 489	1.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
U	262 158	639 475	3.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
V	262 371	639 684	2.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
W	263 155	639 787	4.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
X	263 953	639 722	4.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
Y	264 432	639 800	0.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
Z	265 203	639 852	1.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AA	266 067	639 916	4.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AB	267 425	640 197	6.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AC	267 446	639 760	4.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AD	267 989	640 119	5.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AE	268 084	639 910	8.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

	Shadow, worst case			**Shadow, expected values**
No.	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]
A	8:20	37	0:17	2:53
B	0:00	0	0:00	0:00
C	0:00	0	0:00	0:00
D	0:00	0	0:00	0:00
E	9:53	69	0:11	3:34
F	0:00	0	0:00	0:00
G	0:00	0	0:00	0:00
H	0:00	0	0:00	0:00
I	0:00	0	0:00	0:00
J	0:00	0	0:00	0:00
K	0:00	0	0:00	0:00
L	0:00	0	0:00	0:00
M	0:00	0	0:00	0:00
N	0:00	0	0:00	0:00
O	0:00	0	0:00	0:00
P	0:00	0	0:00	0:00
Q	6:29	53	0:11	1:43
R	15:56	47	0:26	5:14
S	55:51	118	0:43	17:19
T	27:11	100	0:23	8:30

To be continued on next page...

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SHADOW - Main Result

Calculation: WPP1 | Original

...continued from previous page

No.	Shadow, worst case: Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow, expected values: Shadow hours per year [h/year]
U	59:28	139	0:39	18:44
V	9:01	41	0:16	2:49
W	14:34	50	0:19	4:41
X	28:23	120	0:21	11:52
Y	40:59	118	0:34	14:43
Z	28:32	92	0:27	12:36
AA	35:15	108	0:38	12:37
AB	0:00	0	0:00	0:00
AC	308:18	174	2:32	131:24
AD	8:11	39	0:14	5:26
AE	46:26	112	0:31	28:37

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
OC01	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (14)	0:00	0:00
OC02	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (15)	0:00	0:00
OC03	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (16)	0:00	0:00
OC04	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (17)	0:00	0:00
OC05	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (18)	0:00	0:00
OC06	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (19)	0:00	0:00
OC07	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (20)	2:46	0:37
OC08	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (21)	3:43	1:06
OE01	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (24)	13:31	4:23
OE02	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (25)	44:37	13:32
OE03	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (26)	26:30	8:34
OE04	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (27)	68:55	25:05
OE05	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (28)	24:33	9:18
OE06	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (29)	13:02	4:07
OE07	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (30)	11:12	7:13
OE08	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (31)	14:34	4:41
OE09	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (32)	0:00	0:00
OE10	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (46)	18:49	7:30
OE11	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (34)	28:04	8:53
OE12	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (35)	8:50	2:45
OE13	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (36)	6:30	2:01
OE14	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (37)	20:12	7:18
OE15	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (38)	50:16	26:01
OE16	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (39)	110:21	65:41
OE17	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (40)	42:26	25:03
OE18	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (41)	171:00	52:59
OE19	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (42)	26:14	8:32
OW01	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (1)	0:00	0:00
OW02	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (2)	0:00	0:00

To be continued on next page...

Project:
VRA WPP1 (Final)

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
14/06/2017 12:03/3.1.617

SHADOW - Main Result

Calculation: WPP1 | Original

...continued from previous page

No.	Name	Worst case [h/year]	Expected [h/year]
OW03	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (3)	8:20	2:53
OW04	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (4)	0:00	0:00
OW05	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (5)	0:00	0:00
OW06	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (6)	0:00	0:00
OW07	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (7)	0:00	0:00
OW08	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (8)	2:53	0:56
OW09	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (9)	7:00	2:36
OW10	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (10)	0:00	0:00
OW11	VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (11)	0:00	0:00

Total times in Receptor wise and WTG wise tables can differ, as a WTG can lead to flicker at 2 or more receptors simultaneously and/or receptors may receive flicker from 2 or more WTGs simultaneously.

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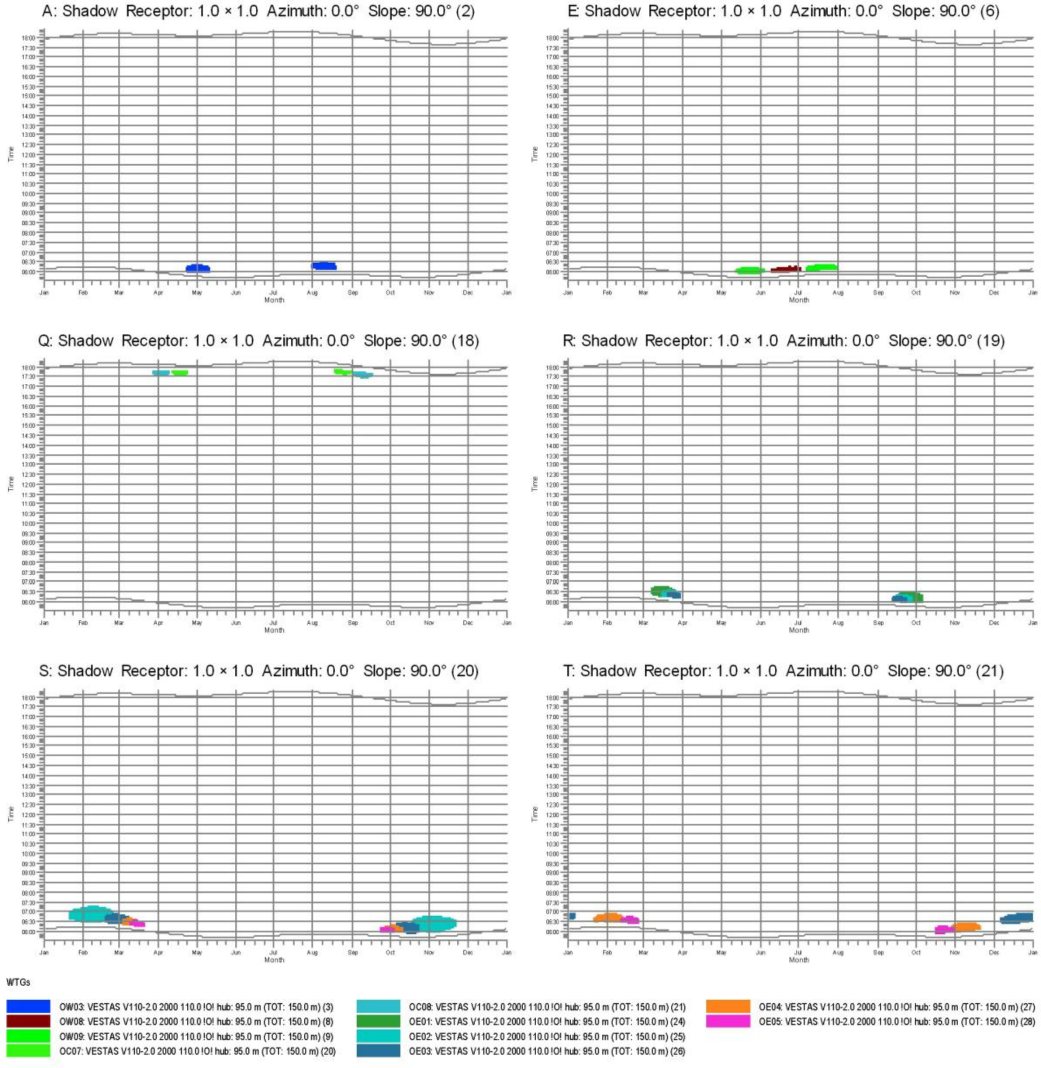
SHADOW - Calendar, graphical

Calculation: WPP1 | Original



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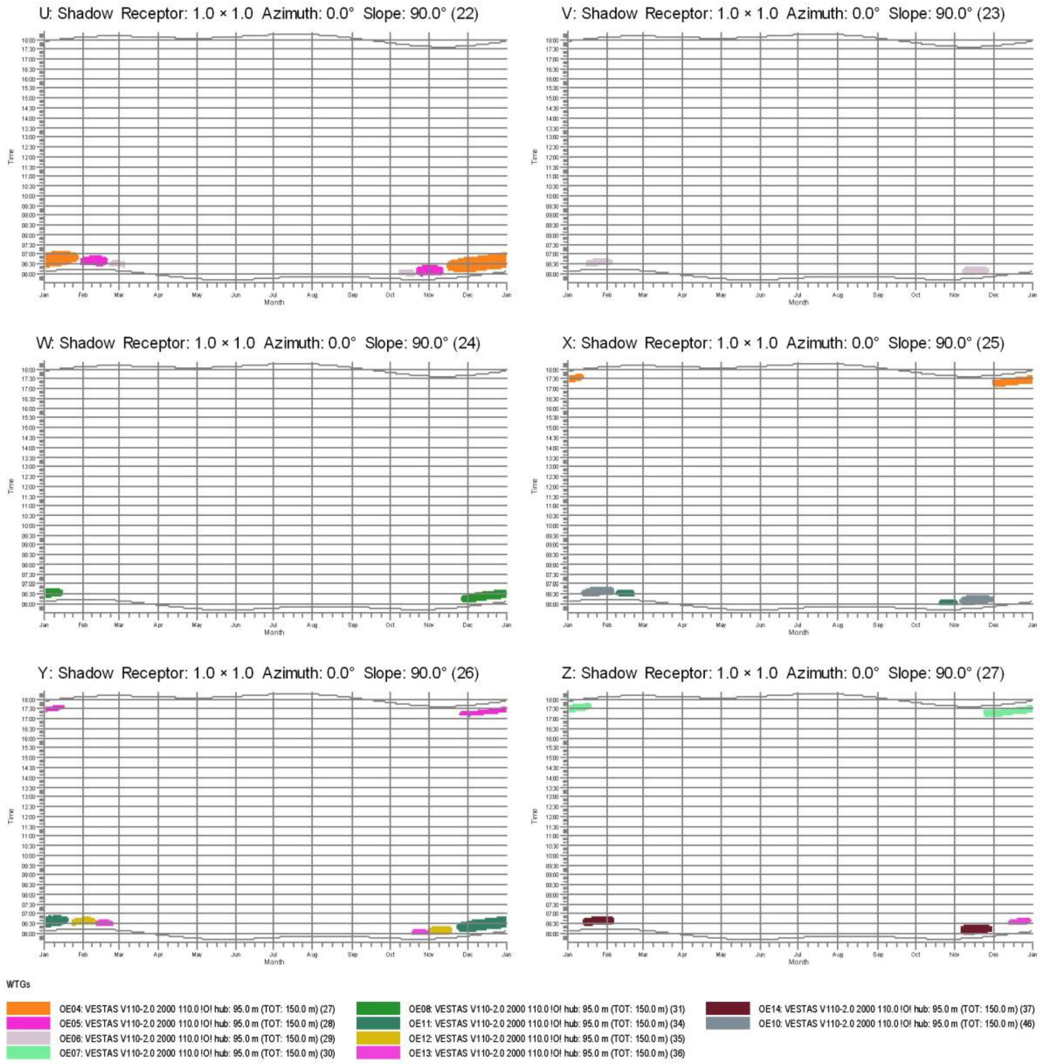
SHADOW - Calendar, graphical

Calculation: WPP1 | Original



Project:
VRA WPP1 (Final)

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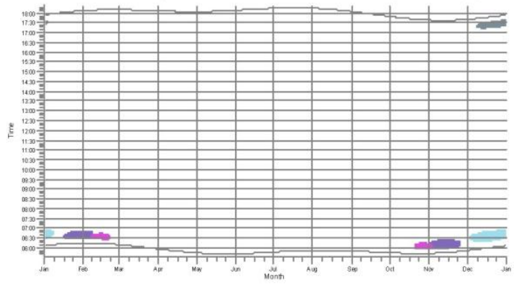
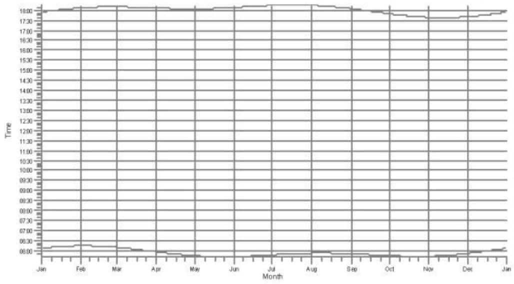
SHADOW - Calendar, graphical

Calculation: WPP1 | Original

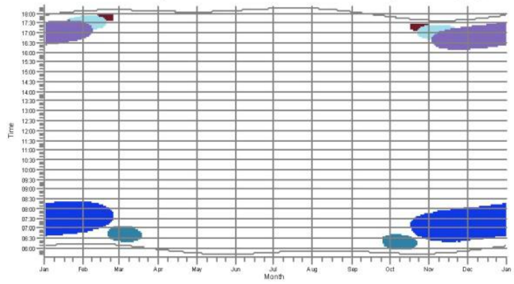
AA: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (28)



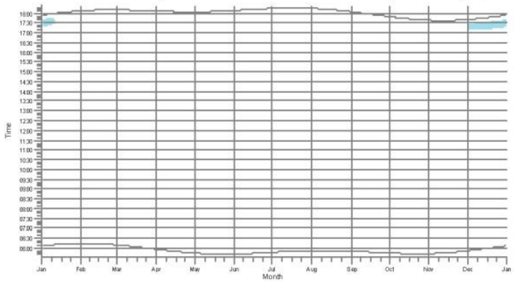
AB: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (29)



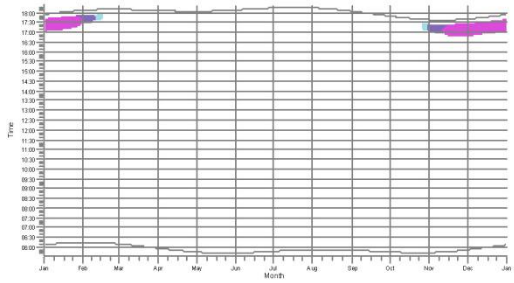
AC: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (30)



AD: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (31)



AE: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (32)



WTGs

OE14: VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (37)
OE15: VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (38)
OE16: VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (39)
OE17: VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (40)
OE18: VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (41)
OE19: VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (42)
OE10: VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (46)

Project:
VRA WPP1 (Final)

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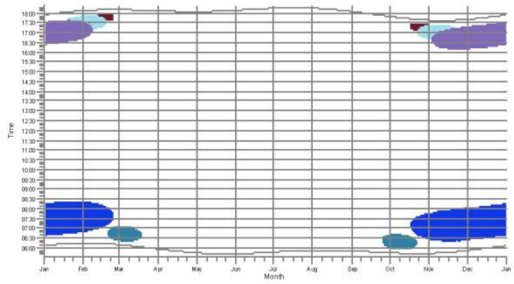
SHADOW - Calendar, graphical

Calculation: WPP1 | Original

AC: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (30)



WTGs

- OE14: VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (37)
- OE15: VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (38)
- OE16: VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (39)
- OE18: VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (41)
- OE19: VESTAS V110-2.0 2000 110.0 !O! hub: 95.0 m (TOT: 150.0 m) (42)

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SHADOW - Main Result

Calculation: WPP1 | Alternative

Assumptions for shadow calculations

Maximum distance for influence
Calculate only when more than 20 % of sun is covered by the blade
Please look in WTG table

Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

Sunshine probability S (Average daily sunshine hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
9.90	9.70	8.60	8.90	8.30	5.40	4.90	4.20	5.90	8.00	9.80	10.40

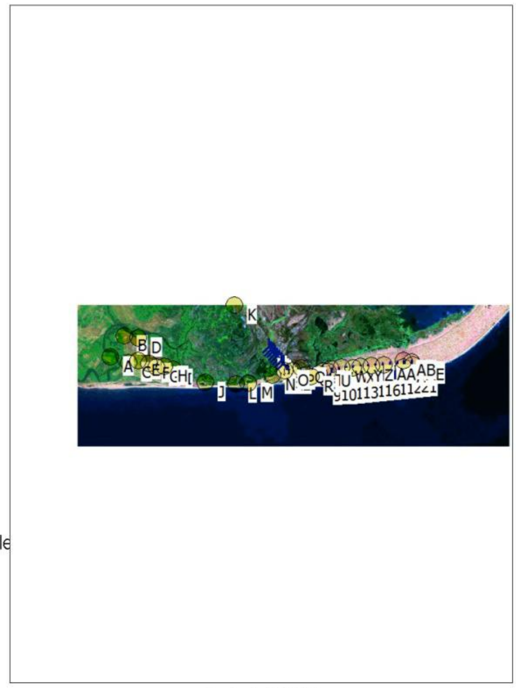
Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
105	70	35	61	105	123	482	2 990	3 911	561	167	149	8 759

Idle start wind speed: Cut in wind speed from power curve

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:
Height contours used: Project Wizard Elevation Data Grid (SRTM: Shuttle
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 50.0 m
Topographic shadow included in calculation

All coordinates are in
UTM (north)-WGS84 Zone: 31



Scale 1:400 000
New WTG   Shadow receptor

WTGs

	Easting	Northing	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Shadow data Calculation distance	RPM
			[m]					[kW]	[m]	[m]	[m]	[RPM]
1	258 055	641 160	2.3	VESTAS V136-3.45 3...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	132.0	1 814	11.7
2	258 190	640 980	5.9	VESTAS V136-3.45 3...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	132.0	1 814	11.7
3	258 343	640 859	11.5	VESTAS V136-3.45 3...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	132.0	1 814	11.7
4	258 484	640 670	2.2	VESTAS V136-3.45 3...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	132.0	1 814	11.7
5	258 621	640 508	0.2	VESTAS V136-3.45 3...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	132.0	1 814	11.7
6	258 778	640 360	1.0	VESTAS V136-3.45 3...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	132.0	1 814	11.7
7	258 930	640 197	2.3	VESTAS V136-3.45 3...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	132.0	1 814	11.7
8	259 077	640 040	0.9	VESTAS V136-3.45 3...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	132.0	1 814	11.7
9	261 900	639 088	0.0	VESTAS V136-3.45 3...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	132.0	1 814	11.7
10	262 408	639 139	0.0	VESTAS V136-3.45 3...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	132.0	1 814	11.7
11	262 917	639 190	0.0	VESTAS V136-3.45 3...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	132.0	1 814	11.7
12	263 425	639 242	2.3	VESTAS V136-3.45 3...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	132.0	1 814	11.7
13	263 934	639 293	4.5	VESTAS V136-3.45 3...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	132.0	1 814	11.7

To be continued on next page...

Project:
VRA WPP1 (Final)

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Calculated:
14/06/2017 12:35/3.1.617

SHADOW - Main Result

Calculation: WPP1 | Alternative

...continued from previous page

	Easting	Northing	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Shadow data Calculation distance	RPM
			[m]					[kW]	[m]	[m]	[m]	[RPM]
14	264 442	639 344	2.3	VESTAS V136-3.45 3...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	132.0	1 814	11.7
15	264 951	639 395	0.8	VESTAS V136-3.45 3...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	132.0	1 814	11.7
16	265 459	639 446	1.2	VESTAS V136-3.45 3...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	132.0	1 814	11.7
17	265 967	639 498	5.3	VESTAS V136-3.45 3...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	132.0	1 814	11.7
18	266 476	639 549	6.3	VESTAS V136-3.45 3...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	132.0	1 814	11.7
19	266 984	639 600	5.4	VESTAS V136-3.45 3...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	132.0	1 814	11.7
20	267 493	639 651	0.5	VESTAS V136-3.45 3...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	132.0	1 814	11.7
21	268 001	639 702	0.0	VESTAS V136-3.45 3...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	132.0	1 814	11.7
22	259 223	639 867	3.0	VESTAS V136-3.45 3...	No	VESTAS	V136-3.45 -3 450	3 450	136.0	132.0	1 814	11.7

Shadow receptor-Input

No.	Easting	Northing	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
			[m]	[m]	[m]	[m]	[°]	[°]	
A	247 056	640 478	7.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
B	248 002	641 929	12.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
C	248 292	640 080	1.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
D	248 959	641 773	3.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
E	248 997	640 236	4.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
F	249 754	640 015	8.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
G	250 219	639 741	14.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H	250 791	639 793	8.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
I	251 402	639 584	3.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
J	253 621	638 711	8.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
K	255 676	644 075	-2.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
L	255 762	638 580	5.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
M	256 626	638 631	2.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
N	258 289	639 191	-0.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
O	259 167	639 490	1.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
P	259 725	639 502	5.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
Q	260 337	639 737	4.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
R	260 987	639 124	3.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
S	261 573	639 293	1.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
T	261 839	639 489	1.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
U	262 158	639 475	3.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
V	262 371	639 684	2.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
W	263 155	639 787	4.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
X	263 953	639 722	4.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
Y	264 432	639 800	0.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
Z	265 203	639 852	1.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AA	266 067	639 916	4.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AB	267 425	640 197	6.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AC	267 446	639 760	4.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AD	267 989	640 119	5.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
AE	268 084	639 910	8.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"

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Calculated:
14/06/2017 12:35/3.1.617

SHADOW - Main Result

Calculation: WPP1 | Alternative

Calculation Results

Shadow receptor

	Shadow, worst case			Shadow, expected values
No.	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]
A	0:00	0	0:00	0:00
B	0:00	0	0:00	0:00
C	0:00	0	0:00	0:00
D	0:00	0	0:00	0:00
E	0:00	0	0:00	0:00
F	0:00	0	0:00	0:00
G	0:00	0	0:00	0:00
H	0:00	0	0:00	0:00
I	0:00	0	0:00	0:00
J	0:00	0	0:00	0:00
K	0:00	0	0:00	0:00
L	0:00	0	0:00	0:00
M	0:00	0	0:00	0:00
N	0:00	0	0:00	0:00
O	0:00	0	0:00	0:00
P	0:00	0	0:00	0:00
Q	60:57	234	0:24	14:34
R	22:55	49	0:37	7:30
S	104:41	147	1:12	32:57
T	22:02	70	0:28	6:43
U	65:46	153	0:40	20:59
V	38:58	105	0:30	12:17
W	13:19	44	0:22	4:09
X	42:43	128	0:42	17:40
Y	38:47	130	0:34	15:14
Z	76:27	130	1:02	30:30
AA	60:33	135	0:48	27:05
AB	5:49	28	0:15	3:55
AC	332:41	192	2:36	162:29
AD	15:32	70	0:17	9:48
AE	86:07	127	0:51	53:06

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
1	VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (94)	0:00	0:00
2	VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (95)	0:00	0:00
3	VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (96)	0:00	0:00
4	VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (97)	0:00	0:00
5	VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (98)	0:00	0:00
6	VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (99)	15:36	2:42
7	VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (100)	10:52	2:08
8	VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (101)	10:37	2:11

To be continued on next page...

Project:
VRA WPP1 (Final)

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
14/06/2017 12:35/3.1.617

SHADOW - Main Result

Calculation: WPP1 | Alternative

...continued from previous page

No.	Name	Worst case [h/year]	Expected [h/year]
9	VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (102)	106:01	33:14
10	VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (103)	42:02	16:21
11	VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (104)	83:57	30:42
12	VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (105)	44:03	14:03
13	VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (106)	30:42	16:09
14	VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (107)	21:00	8:44
15	VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (108)	39:37	18:33
16	VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (109)	28:31	8:56
17	VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (110)	61:14	22:38
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19	VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (112)	158:19	83:48
20	VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (113)	229:09	119:05
21	VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (114)	50:16	16:11
22	VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (121)	12:28	3:28

Total times in Receptor wise and WTG wise tables can differ, as a WTG can lead to flicker at 2 or more receptors simultaneously and/or receptors may receive flicker from 2 or more WTGs simultaneously.

Project:
VRA WPP1 (Final)

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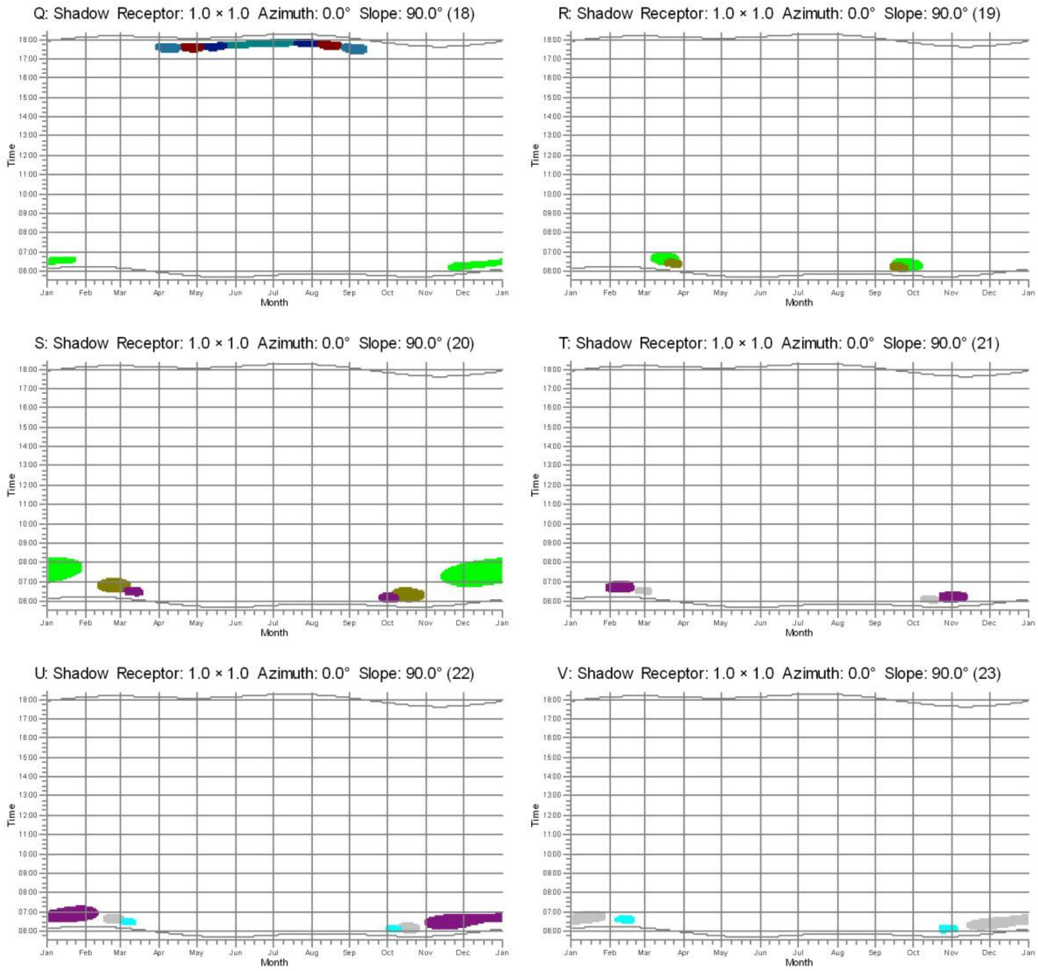
Nicolette / nicolette@airshed.co.za
Calculated:
14/06/2017 12:35/3.1.617

SHADOW - Calendar, graphical

Calculation: WPP1 | Alternative



WTGs

- 6: VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (99)
- 7: VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (100)
- 8: VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (101)
- 9: VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (102)
- 10: VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (103)
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- 13: VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (106)
- 22: VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (121)

Project:
VRA WPP1 (Final)

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480 Smuts Drive, Halfway Gardens PO Box 5260
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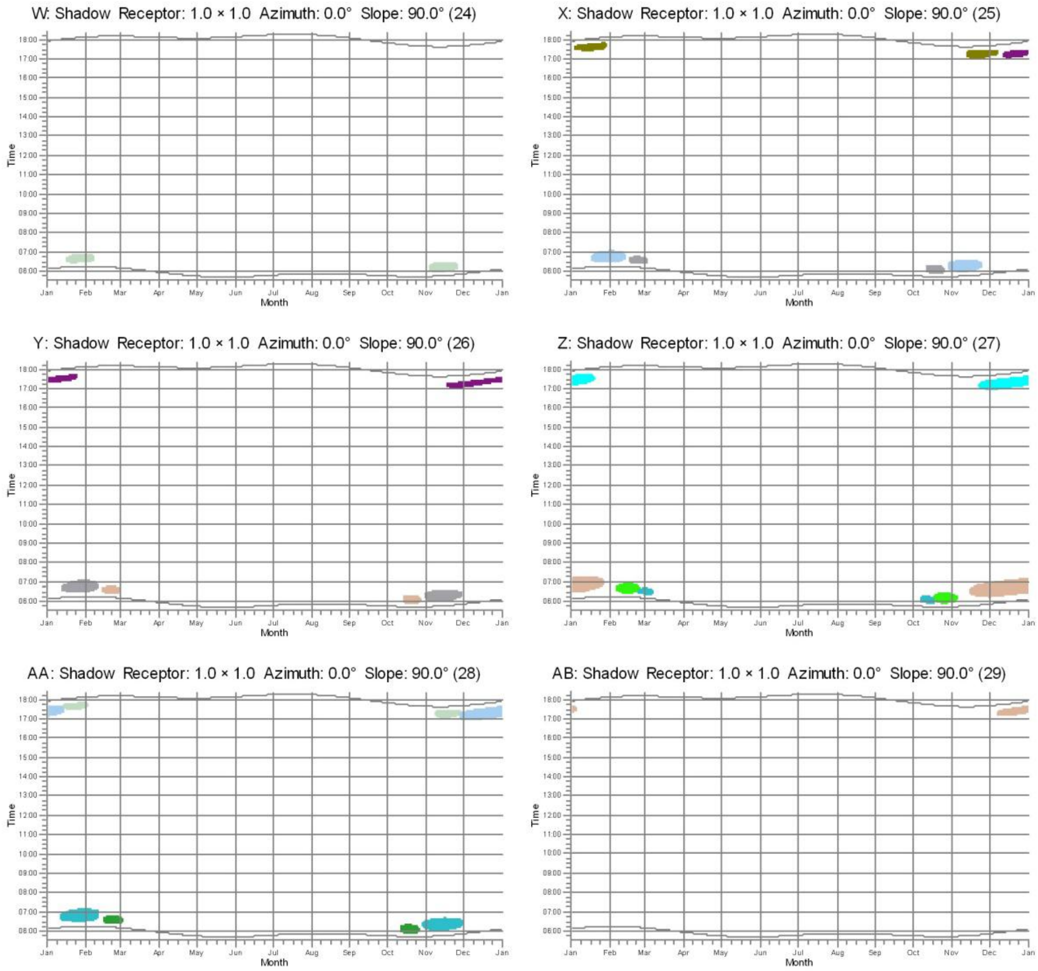
Nicolette / nicolette@airshed.co.za
Calculated:
14/06/2017 12:35/3.1.617

SHADOW - Calendar, graphical

Calculation: WPP1 | Alternative



WTGs

- 10: VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (103)
- 11: VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (104)
- 13: VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (106)
- 14: VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (107)
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- 16: VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (109)
- 17: VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (110)
- 18: VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (111)
- 19: VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (112)
- 20: VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (113)

Project:
VRA WPP1 (Final)

Licensed user:
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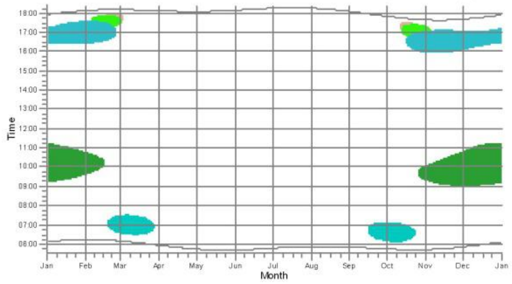
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
14/06/2017 12:35/3.1.617

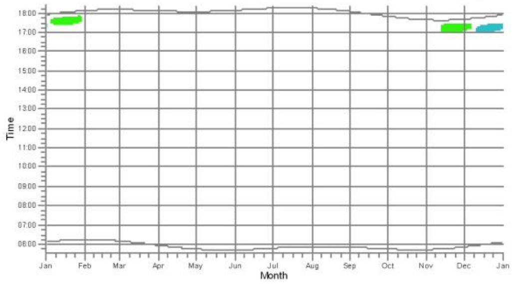
SHADOW - Calendar, graphical

Calculation: WPP1 | Alternative

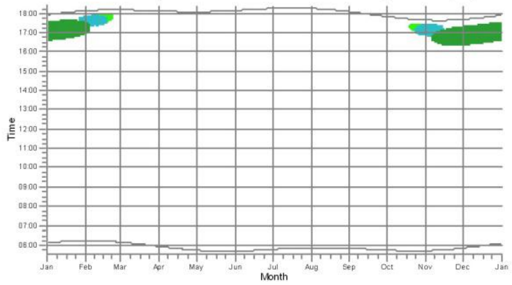
AC: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (30)



AD: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (31)



AE: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (32)



WTGs

17: VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (110)
18: VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (111)
19: VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (112)
20: VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (113)
21: VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (114)

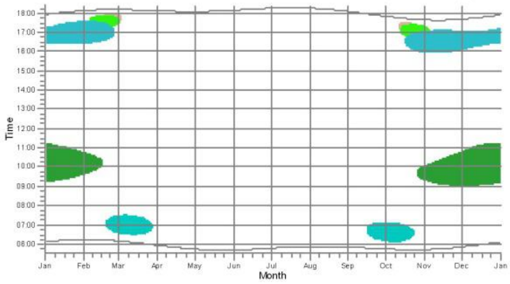
Project:
VRA WPP1 (Final)

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
14/06/2017 12:35/3.1.617

SHADOW - Calendar, graphical

Calculation: WPP1 | Alternative

AC: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (30)



WTGs

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19: VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (112)
20: VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (113)
21: VESTAS V136-3.45 3450 136.0 !O! hub: 132.0 m (TOT: 200.0 m) (114)

14. ANNEX D – NOISE SURVEY DATA

14.1 FIELDWORK PHOTOGRAPHS

Figure 22: Photographs of noise survey site "Airshed Site 1, central"

Figure 23: Photographs of noise survey site "Airshed Site 2, Anyanui"

Figure 24: Photographs of noise survey site "Airshed Site 3, Anloga"

14.2 DETAILED SURVEY RESULTS

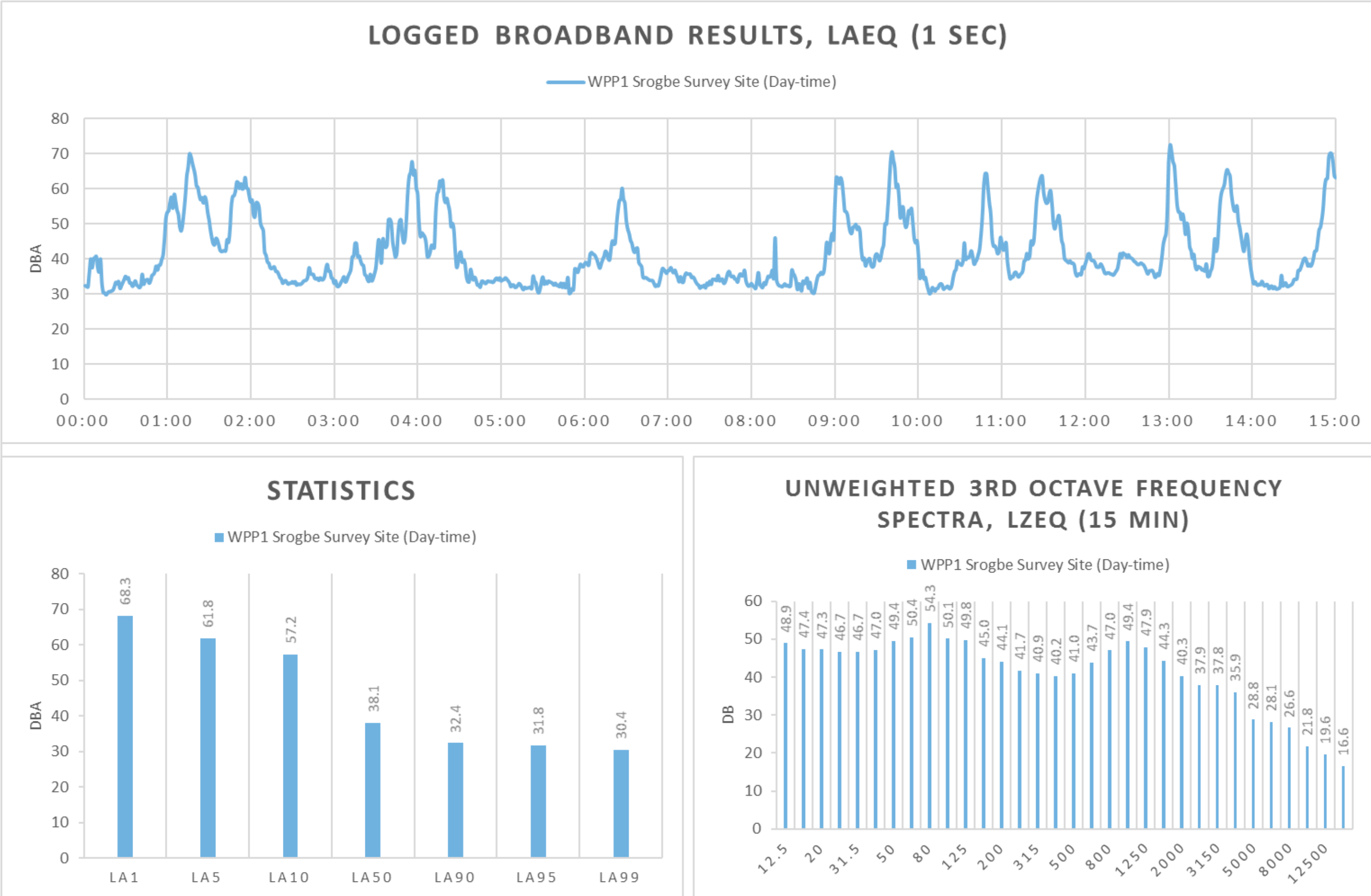

Figure 25: Detail day-time survey results, WPP1, Airshed site 1, central, near Srogbe

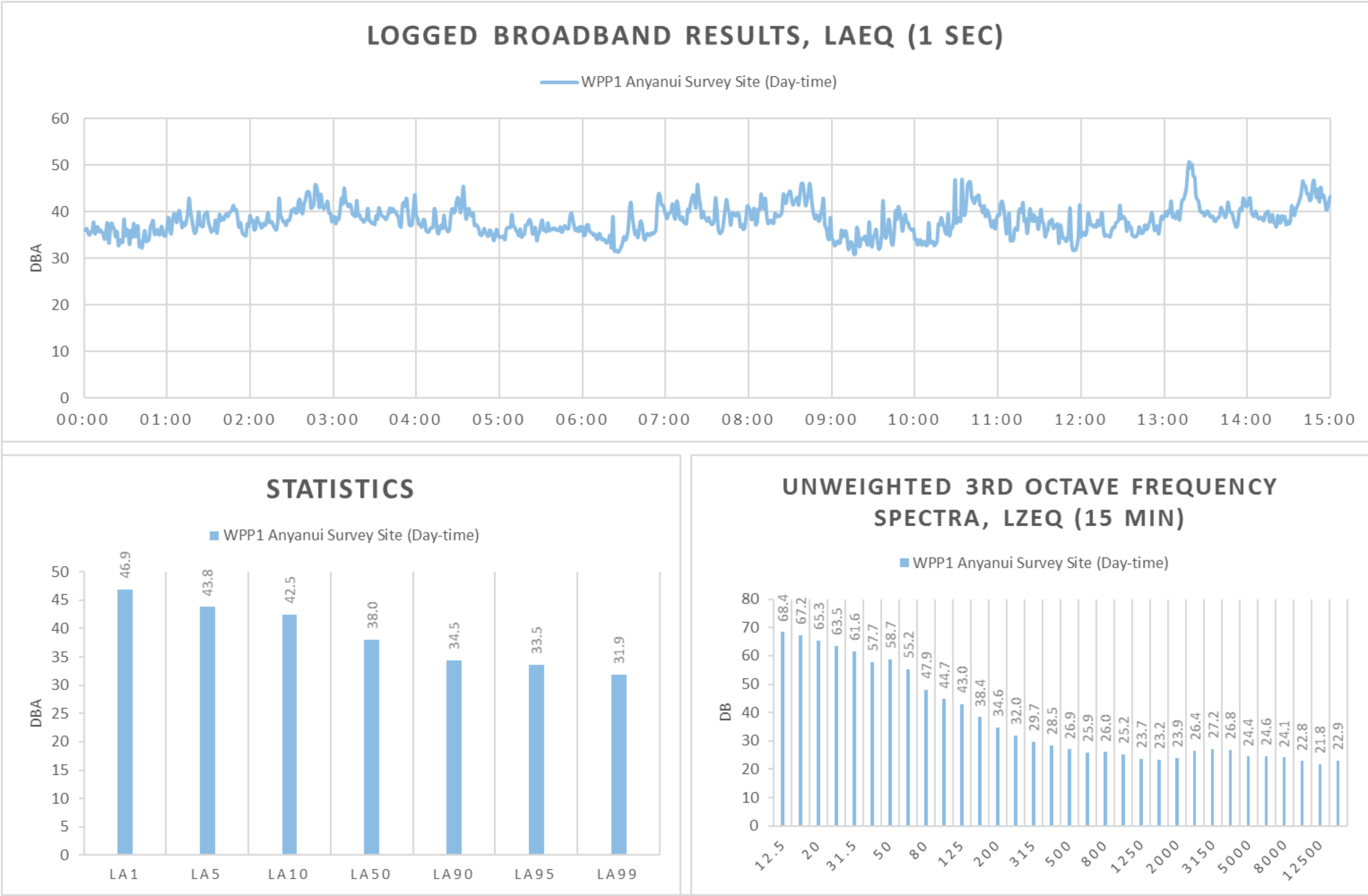

Figure 26: Detail day-time survey results, WPP1, Airshed site 2, Anyanui

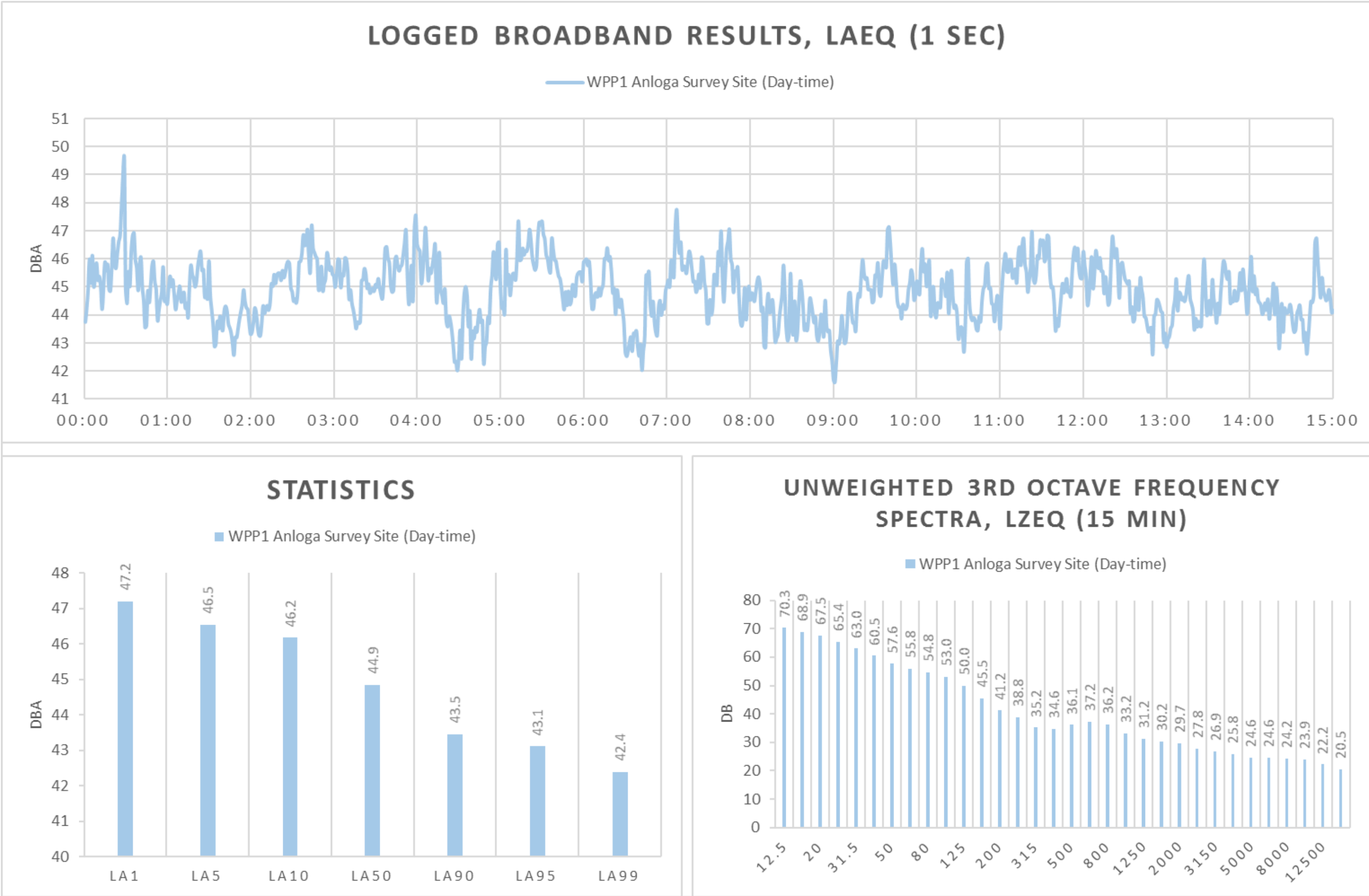

Figure 27: Detail day-time survey results, WPP1, Airshed site 3, Anloga

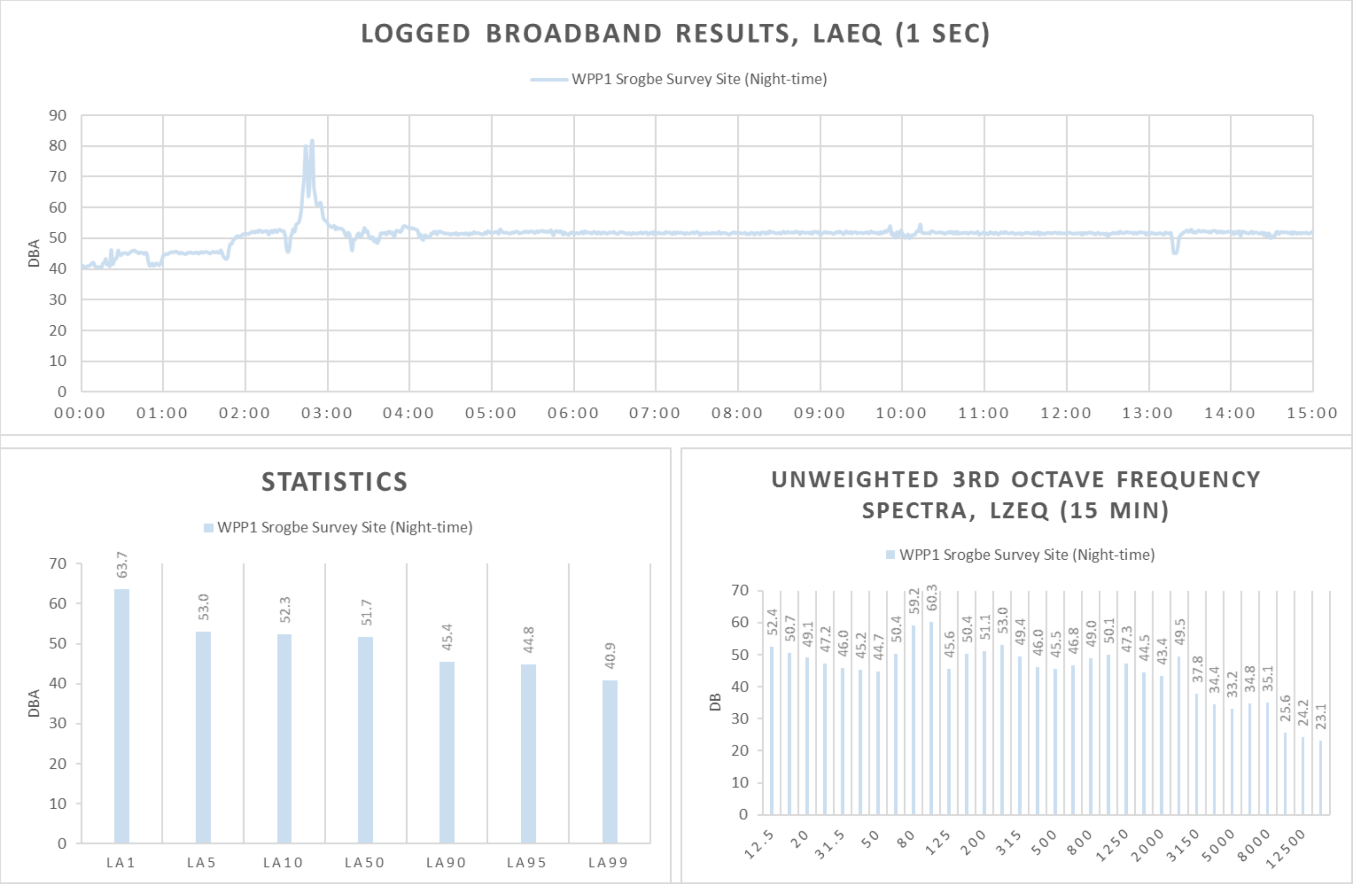

Figure 28: Detail night-time survey results, WPP1, Airshed site 1, central, near Srogbe

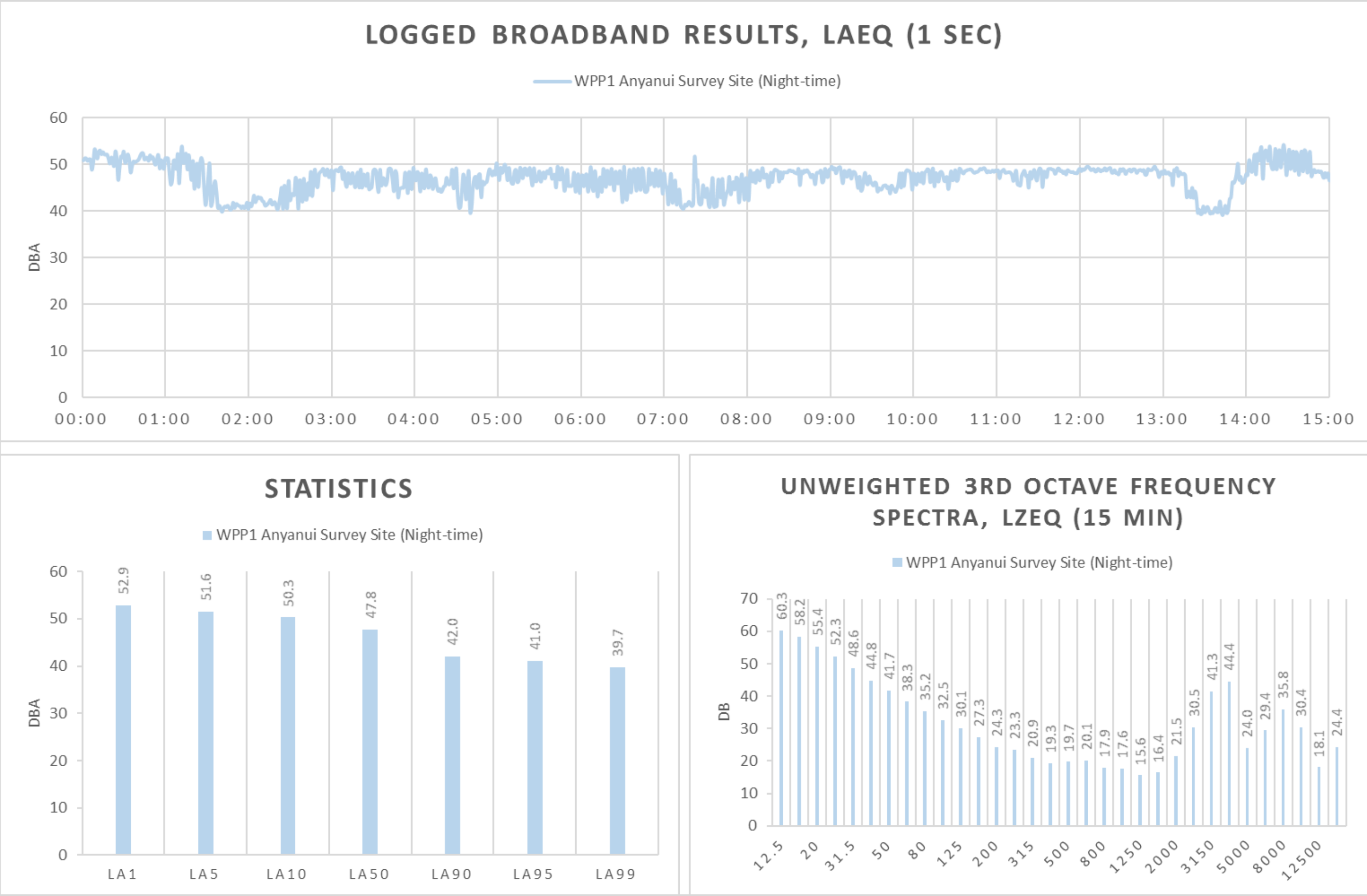

Figure 29: Detail night-time survey results, WPP1, Airshed site 2, Anyanui

Environmental & Social Impact Assessment

for the proposed development of a Wind Energy Facility in Anloga Extension (WPP1)

APPENDIX 8:

Visual Impact Assessment Study

VISUAL IMPACT ASSESSMENT:

Scoping and Environmental and Social Impact Assessment for the proposed Development of the 76MW Wind Power Project situated at Anloga, Srogbe & Anyanui (Anloga Extension) in the Volta Region of Ghana

Report prepared for:	*Report prepared by:*
Seljen Consult Limited P. O. Box AT 140 Achimota-Accra Ghana-West Africa CSIR – Environmental Management Services P O Box 320 Stellenbosch, 7599 South Africa	SRK Consulting (South Africa) (Pty) Ltd Postnet Suite #206 Rondebosch, 7701 South Africa

DECEMBER 2017

EXECUTIVE SUMMARY

Scott Masson from SRK Consulting (South Africa) (Pty) Ltd (SRK) was appointed by the Council for Scientific and Industrial Research (CSIR) to conduct a specialist study on the visual and aesthetic impacts (Visual Impact Assessment (VIA)) of the project through the proposed construction, operation and decommissioning of a 76 Megawatt (MW) Wind Energy Facility (WEF) ("WPP1") in Anloga Extension areas in the Volta Region, Ghana. Two layout alternatives were considered in the VIA.

The primary aims of the VIA are to describe the visual baseline, assess the visual impacts of the WEF and identify effective and practicable mitigation measures. The focus of the VIA study is on the very visible wind turbines.

The basis for the visual character of the study area is provided by the topography, vegetation and land use of the area, giving rise to a generally flat landscape with a mosaic of waterbodies, mud flats and salt marshes with low-intensity cultivated fields and villages on higher ground, with significant influence from the sea. The open topography, varied vegetation and traditional forms of crop farming integrated into the landscape are visually appealing, but not necessarily regionally distinctive. In this sense there is an element of sameness and predictability about the visual quality of the area. However, Keta Lagoon, Volta River Estuary and other open waterbodies are distinct natural features in the landscape. The areas' sense of place is also highly influenced by the coast.

The visibility of WPP1 is high, due to the high visibility of the turbines in a flat landscape and the close proximity of receptors to the turbines. Potential visual receptors include residents of surrounding villages, visitors to Keta lagoon, road users, farmers, and fishermen.

Visual impacts will be generated in the Construction, Operations and Decommissioning Phases of the project. Table A below summarises:

- The impacts assessed in the VIA;

- Their significance before and following the implementation of essential mitigation measures; and
- The key mitigation measures on which the significance rating is based (where applicable).

Note that the impact ratings for the layout alternatives in Table A are the same.

Table A: Summary of Impacts

Impact	**Significance rating**		**Key mitigation/optimisation measures (summarised)**
	Without	***With***	
CONSTRUCTION PHASE IMPACTS			
Altered Sense of Place and Visual Intrusion from Construction Activities	Medium (-ve)	Low (-ve)	• Limit and phase vegetation clearance; • Utilise existing access roads as far as possible; • Avoid excavation, handling and transport of materials which may generate dust under very windy conditions; • Enforce speed limit of 30km/hr on site; • Consolidate the footprint of the construction camp to a functional minimum and screen the yard; • Keep construction sites tidy and all activities, material and machinery contained within an area that is as small as possible; • Rehabilitate disturbed areas incrementally and as soon as possible; and • Set targets for the use of local labour to give locals a sense of ownership and pride in the project.
Altered Sense of Place from Increased Traffic	Medium (-ve)	Low (-ve)	• Limit construction activities to Mondays to Saturdays between the hours of 07h00 and 18h00; and • Maintain all vehicles and equipment in good working order.
OPERATIONS PHASE IMPACTS			
Altered Sense of Place and Visual Intrusion from the WEF	High (-ve)	High (-ve)	• Minimise associated infrastructure on site; • Plant large indigenous trees around receptors in the immediate vicinity of the WEF to provide visual screening; and • Maintain a uniform size (height) and colour (white) of the turbine towers, nacelles and blades and avoid any markings.
Altered Sense of Place and Visual Character caused by	Medium (-ve)	Low (-ve)	• Clarify the requirements of the Ghana Civil Aviation Authority and clarify if pilot activated lighting is possible;

Impact	**Significance rating**		**Key mitigation/optimisation measures (summarised)**
	Without	***With***	
Light Pollution at Night			• Direct security lighting inwards and downwards to avoid light spillage and trespass; and • Avoid working at night unless absolutely necessary
Altered Sense of Place from Shadow Flicker	High (-ve)	Low (-ve)	• Calculate the effects of shadow flicker on those residents located within 1 km of the wind turbines.
DECOMMISSIONING PHASE IMPACTS			
Altered Sense of Place and Visual Intrusion from Decommissioning Activities	Mediu m (-ve)	Low (-ve)	• Utilise existing access roads as far as possible; • Avoid handling and transport of materials which may generate dust under very windy conditions; • Enforce speed limit of 30km/hr on site; • Consolidate the footprint of the site camp to a functional minimum and screen the yard; • Keep all activities, material and machinery contained within an area that is as small as possible; and • Rehabilitate disturbed areas incrementally.
Altered Sense of Place from Increased Traffic	Mediu m (-ve)	Low (-ve)	• Limit decommissioning activities to Mondays to Saturdays between the hours of 07h00 and 18h00; and • Maintain all vehicles and equipment in good working order.

Although the significance rating for both alternatives is the same according to the impact rating methodology, the significance of the visual impacts for the Alternative Layout will be marginally lower (even though the height of the turbines will be ~ 20 m higher than the Preferred Alternative), particularly for the residents of Anyanui, because turbines are not proposed north of Anyanui.

It should be recognised, however, that there is a degree of subjectivity in determining receptors' responses to WEFs - wind turbines may be perceived as negative or positive, majestic or dominant, depending on receptors' perception of the landscape and the value they ascribe to 'green energy'. Many societies acknowledge that renewable energy projects reduce dependency on fossils fuels (and associated carbon emissions / climate change) and are therefore more tolerant of visual and sense of place impacts that there would be for other similar scale projects.

LIST OF ABBREVIATIONS

EHS	Environmental, Health and Safety
ESIA	Environmental and Social Impact Assessment
GIS	Geographic Information Systems
SRK	SRK Consulting (South Africa) (Pty) Ltd
VAC	Visual Absorption Capacity
VIA	Visual Impact Assessment
VRA	Volta River Authority
WEF	Wind Energy Facility

GLOSSARY

DEFINITIONS	
Aspect	The direction a slope faces with respect to the sun.
Landscape Integrity	The relative intactness of the existing landscape or townscape, whether natural, rural or urban, and with an absence of intrusions or discordant structures (Oberholzer, 2005).
Nacelle	The casing that houses all of the generating components in a wind turbine.
Sense of Place	The unique quality or character of a place, whether natural, rural or urban. Relates to uniqueness, distinctiveness or strong identity. Sometimes referred to as genius loci meaning 'spirit of the place' (Oberholzer, 2005).
Viewshed	The topographically defined area from which the project could be visible.
Visibility	The area from which the project components would actually be visible and which depends upon topography, vegetation cover, built structures and distance.
Visual Absorption Capacity	The potential for the area to conceal the proposed development.
Visual Character	The elements that make up the landscape including geology, vegetation and land-use of the area.
Visual Exposure	The zone of visual influence or viewshed. Visual exposure tends to diminish exponentially with distance.
Visual Impact	A description of the effect of an aspect of the development on a specified

	component of the visual, aesthetic or scenic environment within a defined time and space (Oberholzer, 2005).
Visual Intrusion	The nature of intrusion of an object on the visual quality of the environment resulting in its compatibility (absorbed into the landscape elements) or discord (contrasts with the landscape elements) with the landscape and surrounding land uses.
Visual Quality	The experience of the environment with its particular natural and cultural attributes.
Visual Receptors	Individuals, groups or communities who are subject to the visual influence of a particular project (Oberholzer, 2005).

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VISUAL IMPACT ASSESSMENT

1. INTRODUCTION & METHODOLOGY

Scott Masson from SRK Consulting (South Africa) (Pty) Ltd (SRK) was appointed by the Council for Scientific and Industrial Research (CSIR) to conduct a specialist study on the visual and aesthetic impacts (Visual Impact Assessment (VIA)) of the project through the proposed construction, operation and decommissioning of a 76 Megawatt (MW) Wind Energy Facility (WEF) ("WPP1") in Anloga Extension areas in the Volta Region, Ghana (Figure 1).

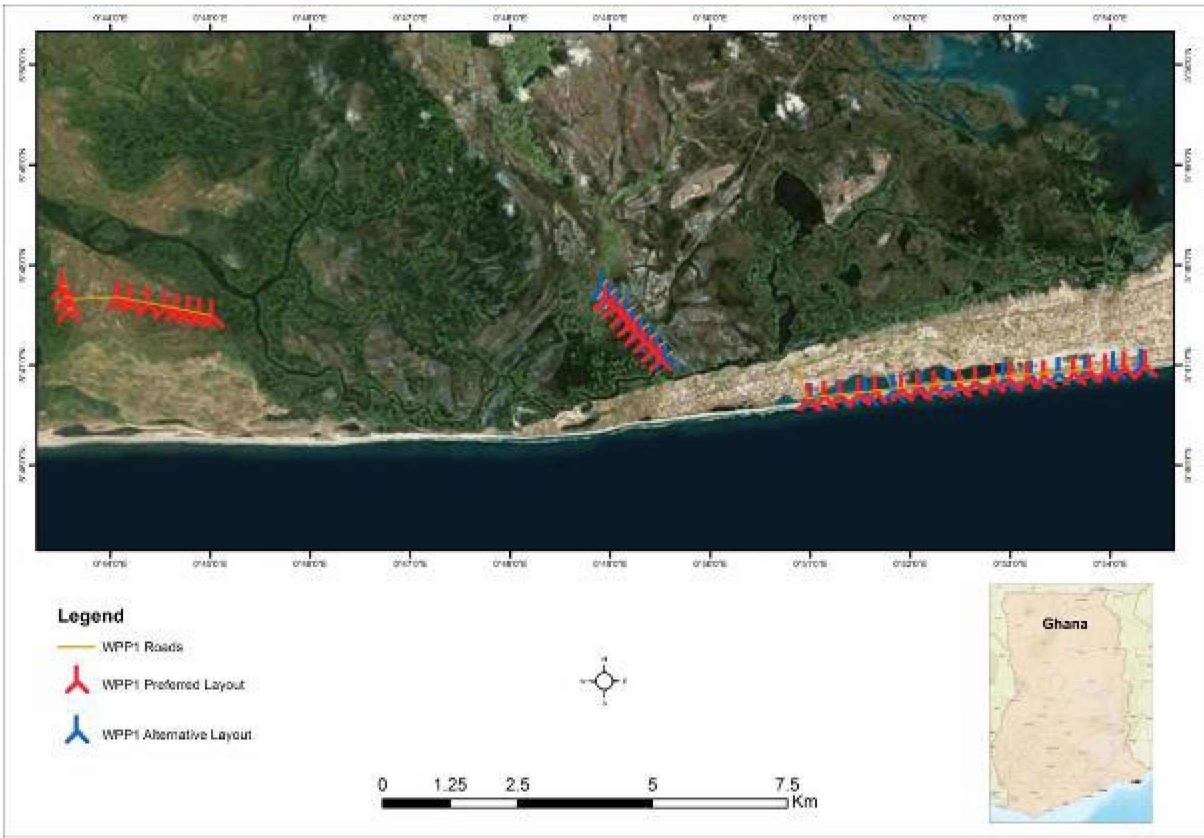


Figure 1: Location of the site for WPP1 with preferred and alternative layouts

The primary aims of the VIA are to describe the visual baseline, assess the visual impacts of the project and identify effective and practicable mitigation measures. More specifically, the aims are to:

- Determine the character and sensitivity of the visual environment;
- Identify visual resources and key viewing corridors / viewpoints;
- Determine and groundtruth the existing visual character and visual quality in order to understand the sensitivity of the landscape;
- Identify potential impacts of the project on the visual environment through analysis and synthesis of the following factors:
    - Visual exposure;
    - Visual absorption capacity;
    - Sensitivity of viewers (visual receptors);
    - Viewing distance and visibility; and
    - Landscape integrity;
- Assess the impacts of the project on the visual environment and sense of place using the prescribed impact assessment methodology; and
- Recommend practicable mitigation measures to avoid and/or minimise / reduce impacts and enhance benefits. Assess the effectiveness of proposed mitigation measures using the prescribed impact assessment methodology.

2. TERMS OF REFERENCE

The following broad terms of reference were specified for the visual specialist study:

- A desktop review of any existing data and literature relevant to the specialist field of expertise which will inform the rest of the assessment process in terms of documentation (e.g., legislation, national and international examples of similar developments) and availability of data (sensitive landscapes and visual receptors, spatial data for visibility analyses and landscape assessment). The desktop review also provides a basis for evaluating the confidence levels for the overall assessment.

- A desktop analysis using GIS and available spatial data was used during the preliminary study to determine:
    - Potential sensitive visual receptors (viewpoints, residences, tourists);
    - Preliminary zone of visual influence; and
    - Principal representative viewpoints.
- A photographic survey which used results of the desktop analyses to provide the following:
    - Photographic record of the visual baseline for views from principal viewpoints.
    - The actual zone of visual influence by determining the effect of vegetation, buildings and topography on visibility in the study area.
    - Identification of sensitive receptors (viewers and landscape elements that will be affected by the proposed development).
- The landscape baseline incorporated results from the desktop review and field survey to provide a description of the existing character and condition of the landscape. Factors such as geology, topography, land cover and human settlements that combine in particular ways to form the landscape are described, as well as the ways they combine to create unique landscape types within the study area. `
- The visual baseline information gathered during the field survey on the influence of vegetation and topography on the potential visibility of the wind farm provides a basis for determining the Zone of Visual Influence and the practical extents of the area for which the visibility analyses was done. The visual absorption capacity (VAC) for the area was determined to aid in site selection and mitigation.
- The following criteria were used to assess the magnitude and significance of the potential visual impact of a development:
    - Potential visibility of the development;
    - Sensitivity of visual receptors to changes in the quality of their views;
    - Distance of the development from sensitive viewers (visual exposure); and
    - Compatibility of the development with the 'sense of place' of the area (visual intrusion).

- Photo-montage and 3D modelling were used to compare existing visual conditions with probable scenarios if the development is introduced to the landscape.
- Develop a monitoring programme to be included in the EMP, if applicable.

3. PROJECT DESCRIPTION

This project referred to as WPP1 will have the following main components which will impact on the visual and aesthetic aspects:

- **Wind turbine area:**
  - Wind turbines; and
  - Hard standing areas;
- **Building Infrastructure:**
  - Offices;
  - Operational and maintenance control centre;
  - Warehouse/workshop;
  - Ablution facilities;
  - Converter/Inverter stations;
  - On-site substation building; and
  - Guard Houses.
- **Associated Infrastructure:**
  - Transmission lines;
  - On-site substation;
  - Access roads;
  - Internal gravel roads;
  - Fencing;
  - Stormwater channels; and
  - Temporary work area during the construction phase (i.e. laydown area).

The proposed project will include 38 individual wind turbines with an approximate generation capacity of 2 MW each for the preferred layout and 22 wind turbines of 3.45 MW for the alternative layout. The turbines will have a hub height of up to 95 m and a rotor diameter of 110 m for the preferred layout and hub height of 112 m for the alternative layout. A detailed description of the proposed project can be found in Chapter 3 of the ESIA report.

4. APPLICABLE LEGISLATION AND PERMIT REQUIREMENTS

There are very few guidelines that provide direction for visual assessment and none for Ghana. In their absence, this VIA has been guided by the international Landscape Institute's "Guideline for Landscape and Visual Impact Assessments" (2013) and the South African Department of Environmental Affairs and Development Planning's "Guideline for Involving Visual and Aesthetic Specialists in EIA Processes" (2005), both of which have been considered in the VIA study.

The World Bank Group's Environmental, Health and Safety (EHS) Guidelines for Wind Energy (2015) identify environmental issues specific to wind energy projects. Guidelines for landscape and visual impacts are provided, as follows:

- A WEF may have an impact on viewscapes, especially if visible from or located near residential areas or tourism sites. Visual impacts typically concern the turbines (e.g. colour, height, and number of turbines).
- Impacts may also arise in relation to the WEF's interaction with the character of the surrounding landscape. Impacts on Legally Protected and Internationally Recognized Areas of importance to biodiversity and cultural heritage features are also a consideration. Preparing zone of visual influence maps and photomontages from key viewpoints is recommended to inform both the assessment and the consultation processes.
- Avoidance and minimisation measures to address landscape and visual impacts are largely associated with the siting and layout of wind turbines and associated infrastructure (e.g. access tracks, substations).

- Consideration should be given to turbine layout, size, and scale in relation to the surrounding landscape character and surrounding visual receptors (e.g., residential properties, users of recreational areas/routes).
- Consideration should also be given to the proximity of turbines to settlements, residential areas, and other visual receptors, to minimise visual impacts and impacts on residential amenity, where possible. All relevant viewing angles should be considered when considering turbine locations, including viewpoints from nearby settlements.
- Other factors can be considered in relation to minimizing visual impacts:
  - Incorporate community input into wind energy facility layout and siting;
  - Maintain a uniform size and design of turbines (e.g., type of turbine and tower, as well as height);
  - Adhere to country-specific standards for marking turbines, including aviation/navigational and environmental requirements, where available;
  - Minimize presence of ancillary structures on the site by minimizing site infrastructure, including the number of roads, as well as by burying collector system power lines, avoiding stockpiling of excavated material or construction debris, and removing inoperative turbines; and
  - Erosion measures should be implemented and cleared land should be promptly re-vegetated with local seed stock of native species.

The EHS Guidelines for Wind Energy has been considered in the VIA study.

5. METHODOLOGY

5.1 APPROACH TO THE VIA STUDY

Wind turbines are significant vertical elements in the landscape and the default is that the associated visual impact is always anticipated to be high. It should be recognised, however, that there is a degree of subjectivity in determining receptors' responses to WEFs - wind turbines may be perceived as negative or positive, majestic or dominant, depending on receptors' perception of the landscape and the value they ascribe to 'green energy'.

Given the nature of visual issues, assessing the visual impacts of WEFs in absolute and objective terms is not achievable. Thus, qualitative as well as quantitative techniques are required. In this VIA, emphasis is placed on ensuring that the methodology and rating criteria are clearly stated and transparent.

The approach adopted for the VIA study is intended to be as accurate and thorough as possible. Analytical techniques are selected so as to endorse the reliability and credibility of the assessment.

The approach to and reporting of the VIA study comprise three major, phased elements (as depicted in Figure 2 below):

1. A description of the visual context (baseline);

2. The identification and discussion of the potential visual impacts; and

3. An assessment of those potential impacts.

Visual impacts are assessed as one of many interrelated effects on people (i.e. the viewers and the impact of an introduced object into a particular view or scene) (Young, 2010). In order to assess the visual impact the project has on the affected environment, the visual context (baseline) in which the project is located must be described. The inherent value of the visual landscape to viewers is informed by geology / topography, vegetation and land-use and is expressed *as Visual Character* (overall impression of the landscape), *Visual Quality* (how the landscape is experienced) and *Sense of Place* (uniqueness and identity).

Visual impact is measured as the change to the existing visual environment caused by the project as perceived by the viewers (Young, 2010). The visual impact(s) may be negative, positive or neutral (i.e. the visual quality is maintained). The magnitude or intensity of the visual impacts is determined through analysis and synthesis of the visual absorption capacity (VAC) of the landscape (potential of the landscape to absorb the project), zone of visual influence or exposure, visibility (viewing distances), compatibility of the project with landscape integrity (congruence), and the sensitivity of the viewers (receptors).

Sources of visual impacts are identified for the construction, operations and decommissioning phases of the project. The significance of those visual impacts is then assessed using the prescribed impact rating methodology.

Mitigation measures recommended to avoid and/or reduce the significance of negative impacts, or to optimise positive impacts, are identified for the project. Impact significance is re-assessed assuming the effective implementation of mitigation measures.

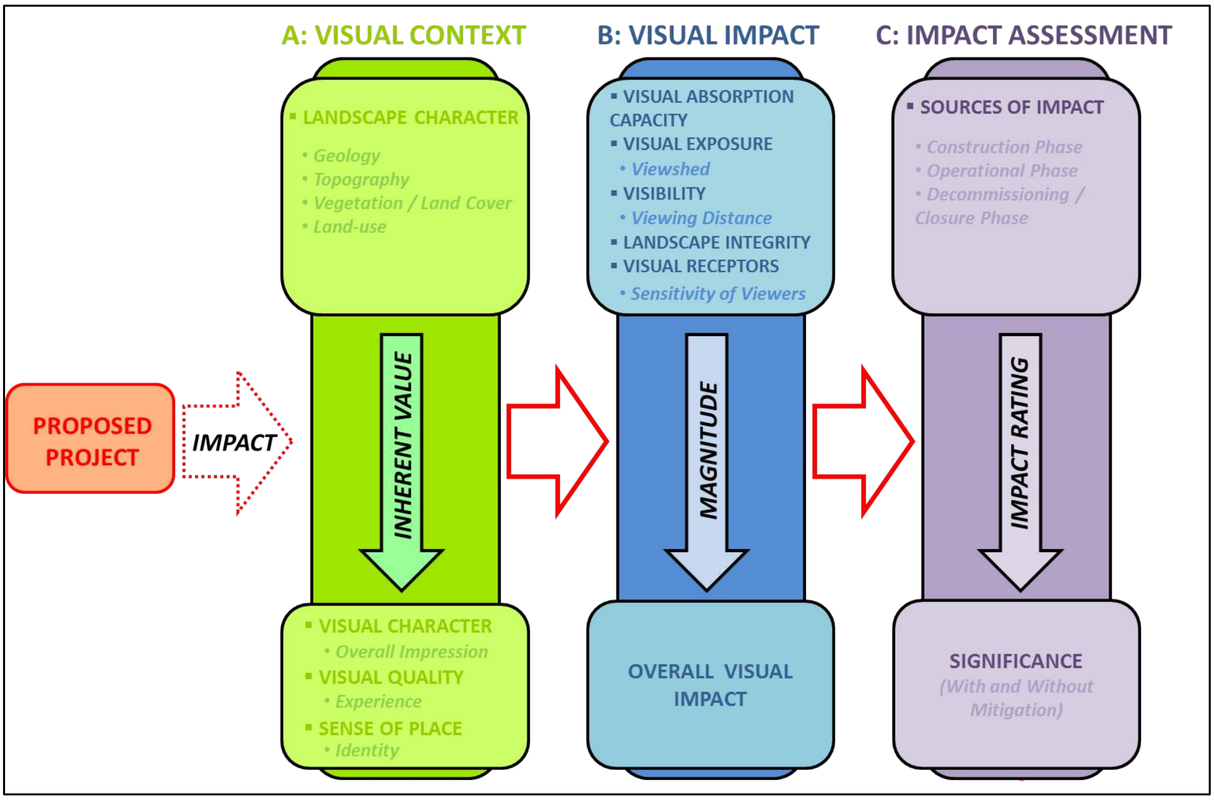


Figure 2: Schematic Approach to the VIA study

5.2 METHOD

The following method was used to assess the visual baseline for the project:

- Collect and review visual data, including data on topography, vegetation cover, land-use, and other background information;
- Undertake fieldwork (16 – 20 October 2016), comprising an extensive reconnaissance of the study area, particularly the project site and key viewpoints. The objectives of the fieldwork were to:
    - Familiarise the specialist with the site and its surroundings;
    - Identify key viewpoints / corridors; and
    - Determine and groundtruth the existing visual character and quality in order to understand the sensitivity of the landscape;

Visual 'sampling' using photography was undertaken to illustrate the likely zone of influence and visibility. The location of the viewpoints was recorded with a GPS.

- Undertake a mapping exercise using ArcGIS to identify:
    - Potential visual resources; and
    - Potential visual receptors.

The following method was used to assess the visual impact of the project:

- Make field observations at key viewpoints to determine the likely distance at which visual impacts will become indistinguishable;
- Rate impacts on the visual environment and sense of place based on a professional opinion and the prescribed impact rating methodology (refer to Chapter 2 of the ESIA report); and
- Recommend mitigation measures to and/or reduce the significance of negative impacts or optimise positive impacts.

5.3 ASSUMPTIONS AND LIMITATIONS

As is standard practice, the VIA study is based on a number of assumptions and is subject to certain limitations, which should be borne in mind when considering information presented in this report.

- VIA is not, by nature, a purely objective, quantitative process, and depends to some extent on subjective judgments. Where subjective judgments are required, appropriate criteria and motivations for these are clearly stated;
- The assessment is based on technical information supplied to SRK, which is assumed to be accurate. This includes the proposed locations, dimensions and layouts of the project;
- Contour detail at the scale required to generate a viewshed was not available at the time of the study;
- A study by Visual Resource Analysis at Argonne National Laboratory (Sullivan, date unknown) determined that, under favourable viewing conditions, WEFs are judged to be major foci of visual attention at up to 19 km, the facilities would be unlikely to be missed by casual observers at up to 32 km and could be major sources of visual contrast at up to 16 km. For the purposes of this study, a radius of 30 km is used to define the study area for WPP1;
- The focus of the VIA study will be on the very visible wind turbines;
- Simulations of the turbines were produced for the preferred layout only as the visual intrusion of both alternatives is considered to be similar;
- The photograph simulations are only intended to provide stakeholders with an indication of the visibility of the turbines in the landscape. The representation of the turbines in the simulated photographs is based on the accuracy of the information provided by the client and the computer software (ArcGIS, AutoCAD, Google Earth, Sketchup and Adobe Photoshop) used to generate the simulated photographs; and
- This study does not motivate for or against the project, but rather seeks to give insight into the visual character and quality of the area.

6. DESCRIPTION OF THE AFFECTED VISUAL ENVIRONMENT

The following description of the affected environment focuses on the *Visual Character* of the area surrounding and including the project area and discusses the *Visual Quality* and *Sense of Place*[1]. A more comprehensive baseline description of the area is provided in Chapter 4 of the ESIA Report. This baseline information provides the context for the visual analysis.

6.1 LANDSCAPE CHARACTER

Landscape character is the description of the pattern of the landscape, resulting from particular combinations of natural (physical and biological) and cultural (land use) characteristics. It focuses on the inherent nature of the land rather than the response of a viewer (Young, 2000). Each of the key characteristics is discussed below.

6.1.1 Topography

The topography of the area, together with the tropical climate and the proximity to the coast, provide the framework for the basic landscape features and visual elements of the study area.

WPP1 is located on a relatively flat depositional coastline characterised by sandy beaches and with surrounding floodplains and closed lagoons behind narrow sand bars. From the coastline, the topography rises gently across coastal plains consisting of waterways, mudflats and salt marshes (Figure 3).

The WEF is located within the braided Volta River delta and west of Keta Lagoon. Keta Lagoon, a declared Ramsar site, is an extensive shallow brack-water lagoon closed to the sea (www.birdlife.org).

According to the project Draft Feasibility Study (Lahmeyer International, 2015), the soils throughout the coastal savannah zone are predominantly black tropical earths, tropical grey earths,

[1] These terms are explained in the relevant sections below.

acid vleisols and sodium vleisols. Except for tropical black earths, known locally as Akuse clays, most of these soils have only limited agricultural potential.

Figure 3: Floodplains inland of the project area (left) and coastal lagoon (right)

6.1.2 Vegetation

The main vegetation type in the study area is saline marsh, with mangrove stands (mainly *Avicennia sp.*) and waterlogged grassland along the margins of waterbodies (birdlife.org) (Figure 4).

On higher ground, terrestrial vegetation largely consists of degraded coastal savanna, characterised by farmland, secondary vegetation on abandoned farms and eroded lands with small shrubs and isolated trees (Figure 4) such as *Borassus aethiopum* (fan palm), *Mangifera indica* (mango), *Ceiba pentandra* (silk cotton tree) and *Adansonia digitate* (baobab) (www.birdlife.org).

Figure 4: Saline marsh and a stand of mangroves in the background (left) and a mosaic of degraded savannah vegetation and farmland (right)

6.1.3 Land Use

Anthropogenic activities in and around the project area comprise mainly crop farming and fishing. The area surrounding WPP1 has large tracts of natural vegetation cover where the soils are too wet for agriculture.

Agricultural activity (mostly small crops) is at a subsistence level, in small fields generally located on higher (dry) ground. The patchwork of fields is interspersed with trees and shrubby vegetation (Figure 5).

Landscape degradation is widespread, caused by harvesting of the mangroves for fuel, extensive drainage/damming and cultivation for agriculture, heavy grazing by cattle and livestock, and rubbish dumping.

Communities in the densely populated area are largely poor. The villages of Agbletokwei, Anyanui, Salo and Anloga are the most significant settlements in the study area. A surfaced (tarred) road provides access to WPP1 from the N1 past Salo.

Figure 5: Crop farming along the lagoon (left) and crop fields located on higher ground around Anyanui (right)

6.2 VISUAL CHARACTER

Visual character is descriptive and non-evaluative, which implies that it is based on defined attributes that are neither positive nor negative. A change in visual character cannot be described as having positive or negative attributes until the viewer's response to that change has been taken into consideration. The probable change caused by the project is assessed against the existing degree of change caused by previous development.

Typical character attributes, used to describe the visual character of the affected area and to give an indication of potential value to the viewer, are provided in Table 1.

The basis for the visual character of the overall area is provided by the topography, vegetation and land use of the study area, giving rise to a generally flat landscape with a mosaic of waterbodies, mud flats and salt marshes with low-intensity cultivated fields and villages on higher ground, and significant influence from the sea and coastline.

The WPP1 area can be described as a *natural transition landscape* associated with the interface between the coastline, the villages interspersed within cultivated fields and natural wetter areas further inland.

6.3 VISUAL QUALITY

Aesthetic value is an emotional response derived from our experience and perceptions. As such, it is subjective and difficult to quantify in absolute terms. Studies in perceptual psychology have shown that humans prefer landscapes with higher complexity (Crawford, 1994). Landscape quality can be said to increase when:

- Topographic ruggedness and relative relief increases;
- Water forms are present;
- Diverse patterns of grasslands, shrubs and trees occur;
- Natural landscape increases and man-made landscape decreases; and
- Where land-use compatibility increases.

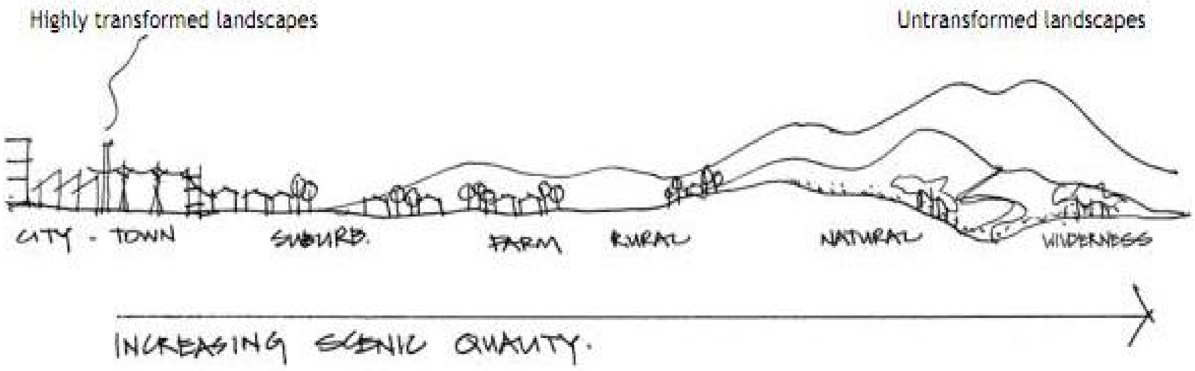
The visual quality of the study area is largely ascribable to the diverse patterns of grassland and salt marsh interspersed with irregularly shaped fields and wetlands. Views over the ocean contribute to a sense of ‘openness’ and underpin the visual quality of the area. The open topography, varied vegetation and traditional forms of crop farming that have been integrated into the landscape are visually appealing, but not necessarily regionally distinctive.

The Volta River delta drainage network, Keta Lagoon and coastline provide visual interest in the landscape surrounding WPP1.

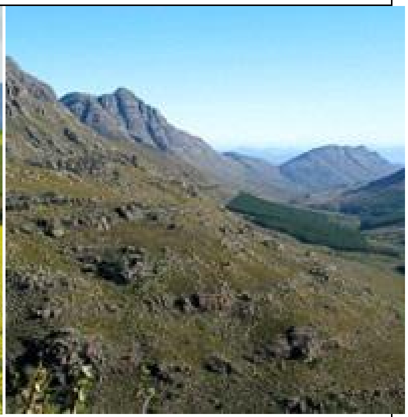
Some elements detract slightly from visual quality in the project area, notably the degraded (and abandoned) farmlands and eroded areas. Nevertheless the visual quality of the study area is considered to be *high*.

Table 1: Typical Visual Character Attributes

Highly Transformed Landscape – Urban/Industrial	Transition Landscape	Modified Rural Landscape	Natural Transition Landscape	Untransformed Landscape – Natural
Substantially developed landscape. High levels of visual impact associated with buildings, factories, roads and other related infrastructure (e.g. powerlines).	Transitional landscape associated with the interface between, rural, agricultural area and more developed suburban or urban zones.	Typical character is rural landscape, defined by field patterns, forestry plantations and agricultural areas and associated small-scale roads and buildings.	A changing landscape character associated with the interface between natural areas and modified rural / pastoral or agricultural zones.	No / minimal impact associated with the actions of man. National parks, coastlines, pristine forest areas.



Source: CNDV, 2006



http://www.shandinglu.org *http://www.nightjartravel.com* *http://www.boschkloof.com*

6.4 SENSE OF PLACE

Our sense of a place depends not only on spatial form and quality, but also on culture, temperament, status, experience and the current purpose of the observer (Lynch, 1992). Central to the idea of 'sense of place' or *Genius Loci* is identity. An area will have a stronger sense of place if it can easily be identified, that is to say if it is unique and distinct from other places. Lynch defines 'sense of place' as "the extent to which a person can recognise or recall a place as being distinct from other places – as having a vivid or unique, or at least a particular, character of its own" (Lynch, 1992:131).

It is often the case that sense of place is linked directly to visual quality and that areas/spaces with high visual quality have a strong sense of place. However, this is not an inviolate relationship and it is plausible that areas of low visual quality may have a strong sense of place or – more commonly – that areas of high visual quality have a weak sense of place. The defining feature of sense of place is uniqueness, generally real or biophysical (e.g. trees in an otherwise treeless expanse), but sometimes perceived (e.g. visible but unspectacular sacred sites and places which evoke defined responses in receptors). Tourism can sometimes serve as an indicator of sense of place insofar as it is often the uniqueness (and accessibility) of a space/place which attracts tourists.

Land uses or activities that occur in an area contribute to the sense of place which is fairly similar to the wider region. In this sense, there is an element of sameness and predictability about the visual quality of the area. However, the Keta Lagoon, Volta River Estuary and other open waterbodies are distinct natural features in the landscape. The area's sense of place is also highly influenced by the coast.

7. ANALYSIS OF THE MAGNITUDE OF THE VISUAL IMPACT

The following section outlines the analysis that was undertaken to determine the magnitude or intensity of the overall visual impact resulting from the project. Various factors were considered in the assessment, including:

- Visual exposure;
- Visual absorption capacity;
- Potential visual receptors;
- Visibility and viewing distance; and
- Integrity with existing landscape.

The analysis of the magnitude or intensity of the visual impact, as described in this section, is summarized and integrated in Table 7 and forms the basis for the assessment and rating of the impact as documented in Section 8.

7.1 VISUAL EXPOSURE

Visual exposure is determined by the zone of visual influence. Visual exposure analysis assumes maximum visibility of the project in an environment stripped bare of vegetation and structures. It is therefore important to remember that the project is not necessarily visible from all points within the zone of visual influence as views may be obstructed by elements such as trees, dense scrub, built structures and/or localised variations or irregularities in topography.

Overall, the visual exposure of the WEF (for the preferred layout and alternative layout) will be *high* as the wind turbines will be exposed across an extensive area. The turbines, with a vertical height of > 95 m (from ground level to turbine nacelle), will be clearly visible in a flat landscape (represented in Figure 6 and Figure 7).

The viewing distance and likely visibility of the turbines are discussed in Section 7.4.

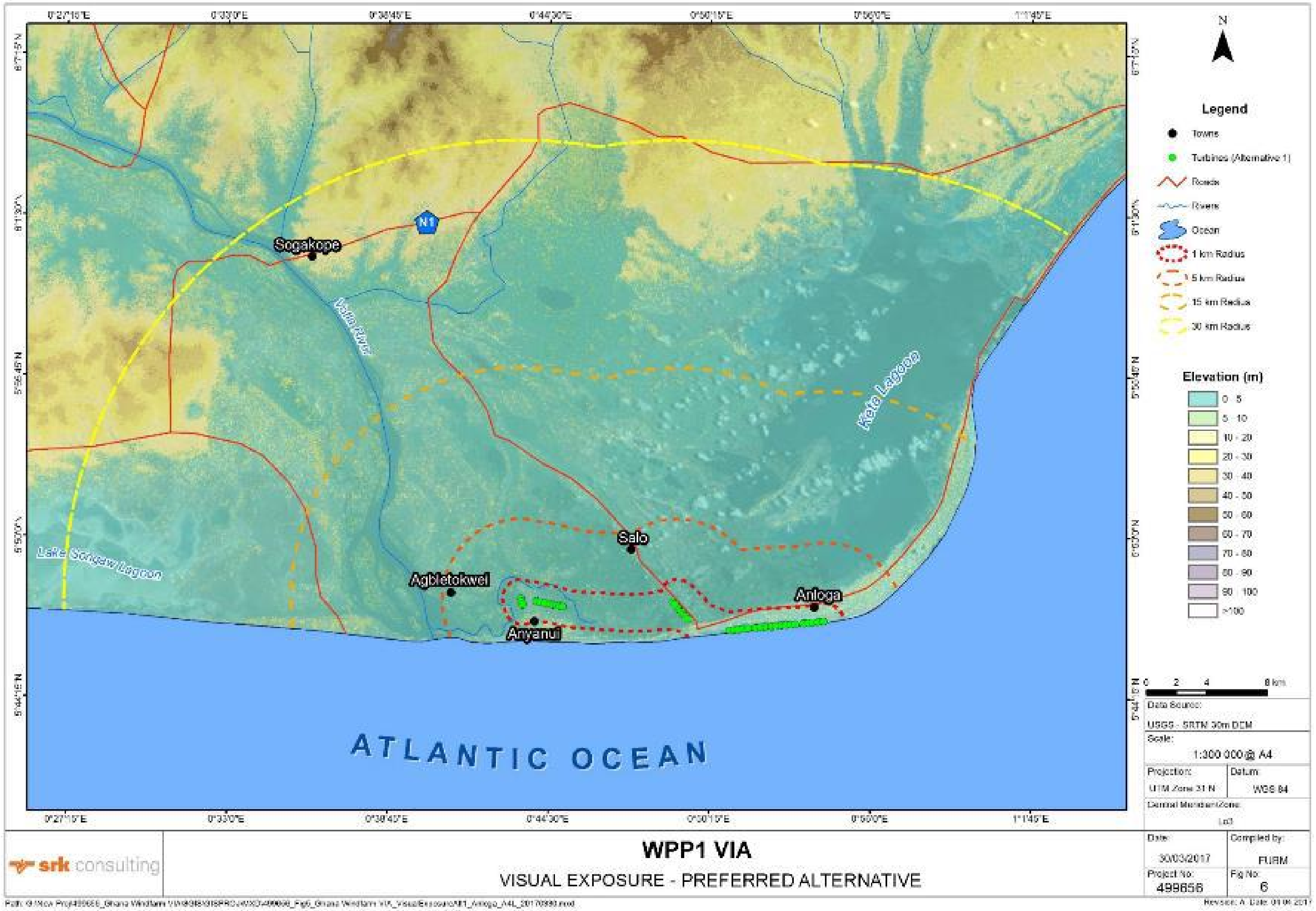


Figure 6: Visual Exposure (Preferred Layout)

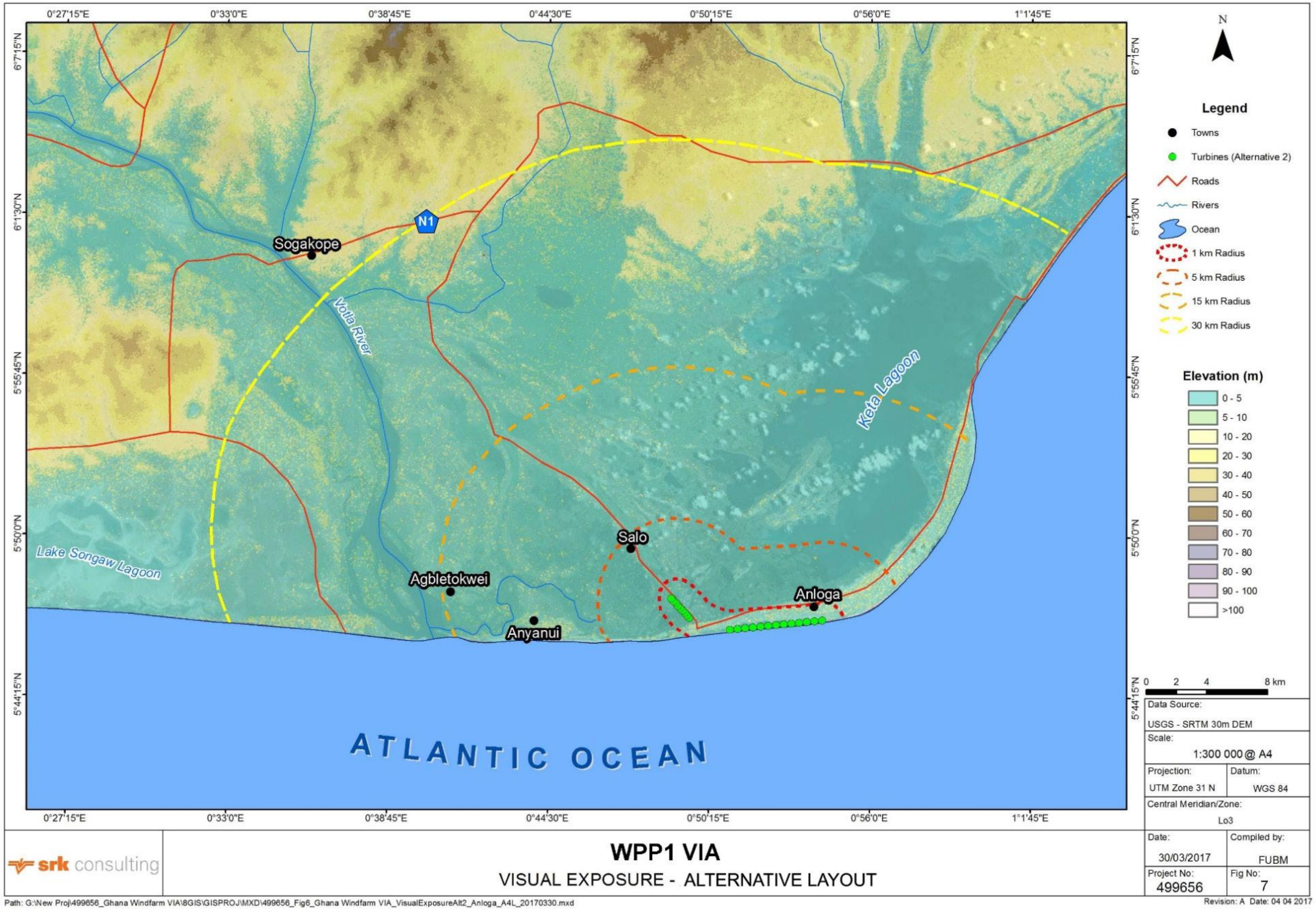


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Figure 7: Visual Exposure (Alternative Layout)

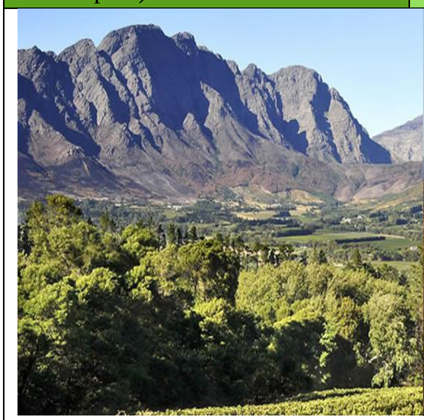
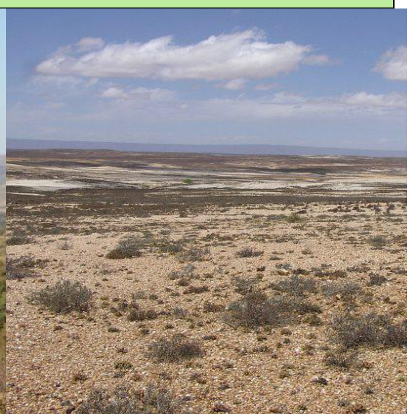
7.2 VISUAL ABSORPTION CAPACITY

The VAC is the potential for the area to conceal the proposed project. Criteria used to determine the VAC of the affected area are defined in Table 2. The VAC of the area is increased by:

- Local topographical variations in a flat and open landscape which provide limited screening;
- Vegetation (and crops) of the study area is generally low, but isolated stands of shrubs and trees provide limited screening. The large stands of mangroves provide more effective screening; and
- Existing urban fabric along the coastline.

Overall, the area is rated as having a low VAC due to the relatively flat landscape (including vegetation) providing ineffective screening of the wind turbines.

Table 2: Visual Absorption Capacity Criteria

High	Moderate	Low
The area is able to absorb the visual impact as it has: ▪ Undulating topography and relief ▪ Good screening vegetation (high and dense) ▪ Is highly urbanised in character (existing development is of a scale and density to absorb the visual impact).	The area is moderately able to absorb the visual impact, as it has: ▪ Moderately undulating topography and relief ▪ Some or partial screening vegetation ▪ A relatively urbanised character (existing development is of a scale and density to absorb the visual impact to some extent.	The area is not able to absorb the visual impact as it has: ▪ Flat topography ▪ Low growing or sparse vegetation ▪ Is not urbanised (existing development is not of a scale and density to absorb the visual impact to some extent.)
		
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http://commons.wikimedia.org

http://blogs.agu.org

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7.3 VISUAL RECEPTORS

Receptors are important insofar as they inform visual sensitivity. The sensitivity of viewers is determined by the number of viewers and by how likely they are to be impacted upon. Potential viewers include the following:

- **Residents:** Residents within the study area are concentrated along the coastline. Visibility from individual households within the larger villages is likely to be lower, since the peri-urban fabric of structures obstructs views beyond the very immediate foreground. Although the turbines along the beach at Anloga would be particularly obtrusive (and intrusive) to views over the ocean, local communities seem to place less value on the visual amenity of the beach, evidenced by the inward orientation of households towards roads or over crop fields (and away from the coast).

  Village residents spend a large proportion of their day outdoors, often at or beyond the village edge (where there are no screening structures), which increases their sensitivity as visual receptors. Viewers from the abovementioned villages are considered highly sensitive receptors.

- **Visitors/tourists:** Visitors to the Keta Lagoon protected area are particularly sensitive receptors. These receptors will have clear views of the WEF across the open waterbodies and flat landscape.
- **Road users:** The Salo Road from the N1 (Accra – Aflao Rd) is the main access road to the Anloga area. This road then runs parallel to the coast between Keta Lagoon and the

coast through the village of Anloga, where road use is particularly intensive - road users along this section of the road include pedestrians and motorcyclists and many small businesses and shops are located along the road.

A number of less significant unsurfaced roads also fall within the study area. The number of motorists travelling along these roads is low; motorists are transient (and moving at speed) and so are exposed to visual impacts for a relatively short period. In summary, road users, are considered moderately sensitive receptors.

- **Farmers and fishermen:** Farmers in the project area work in cultivated open fields where the screening effects of vegetation are curtailed and visibility is raised. Farmers are considered as moderately sensitive receptors. Although fishermen will have clear views of many of the turbines, views from the open ocean towards the coast are generally less meaningful (except in/from very busy water ways). Note again that farmers and fishermen mostly are residents in the villages described above.

The sensitivity of viewers or visual receptors potentially affected by the visual impact of the project is considered to be *moderate*.

7.4 VIEWING DISTANCE AND VISIBILITY

The distance of a viewer from an object is an important determinant of the magnitude of the visual impact. This is because the visual impact of an object diminishes/attenuates as the distance between the viewer and the object increases. Thus the visual impact at 1 000 m would, nominally, be 25% of the impact as viewed from 500 m. At 2 000 m it would be 10% of the impact at 500 m (Hull and Bishop, 1988 in Young, 2000).

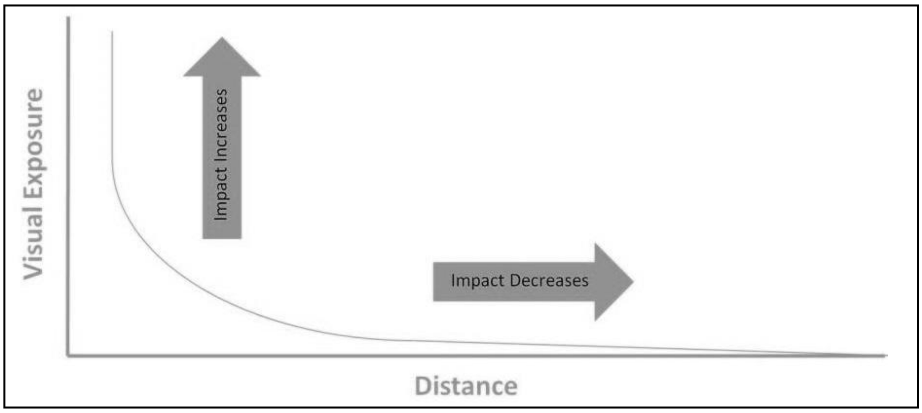

Figure 8: Visual Exposure vs Distance (Adapted from Hull and Bishop, 1998)

Three basic distance categories can be defined for a project of this scale (as discussed in Table 3):

- Foreground;
- Middleground; and
- Background.

A range of viewpoints were selected in order to identify potential receptors and to provide an indication of the likely visibility of the project. The viewpoints were not randomly selected, but were chosen because they are likely to best represent the visibility of the project to receptors.

Table 3: Distance Categories

FOREGROUND (0 – 5 km)	The zone where the turbines will dominate the frame of view. The WEF will be *highly visible* unless obscured.
MIDDLEGROUND (5 – 15 km)	The zone where colour and line are still readily discernible. The turbines will be *moderately visible* but will still be easily recognisable.
BACKGROUND (> 15 km)	This zone stretches from 15 km to the point from where the turbines can no longer be seen. Objects in this zone can be classified as *marginally visible*.

The selected viewpoints are shown in Figure 9 to Figure 11, and views from these viewpoints are shown in the accompanying photographs included as Appendix A. The criteria used to determine the visibility of the project are set out in Table 4 and the visibility of from each viewpoint is summarised in Table 5.

The visibility of the project can be summarised as follows:

- The turbines (for both alternatives) adjacent to Salo Road (north-west of Anloga) (Figure 9) will be highly visible to the limited number of receptors using this road. The mangroves west of these turbines will provide partial screening to receptors to the west (i.e. residents of Anyanui located ~7 km west). The turbines will be visible to residents on the northern edge of Anloga (located ~400 m south), but the peri-urban built fabric of Anloga will provide effective screening to many of the residents. The turbines will be highly visible to visitors to Keta Lagoon or fishermen on the lagoon although these receptors would be approximately 5 km east of the turbines;
- The turbines (for Preferred Alternative only) north of Anyanui (Figure 10) will be highly visible to residents and farmers on the northern edge of Anyanui (~ 1km south). The peri-urban built fabric of Anyanui and isolated stands of trees will provide effective screening to many of the residents in Anyanui. The mangroves east of these turbines will provide partial screening to residents of Anloga (~8 km east); and
- The turbines (for both alternatives) along the beach, south of Anloga (Figure 11) will be highly visible to residents and farmers on the southern edge of Anloga (~ 400 m north). The peri-urban built fabric of Anloga will provide partial screening to many of the residents in Anloga. The majority of Anloga residents are within 1 km of the turbines, and the turbines may be visually overpowering to these residents. However, many households are generally orientated towards the main road, away from the turbines.

Overall, the visibility of the project components is *high*, due to the high visibility of the turbines in a flat landscape and the close proximity of receptors to the turbines.

Table 4: Visibility Criteria

NOT VISIBLE	**Project cannot be seen**	
MARGINALLY VISIBLE	Project is only just visible / partially visible (usually in background zone)	
VISIBLE	Project is visible although parts may be partially obscured (usually in middleground zone)	
HIGHLY VISIBLE	Project is clearly visible (usually in foreground or middleground zone)	

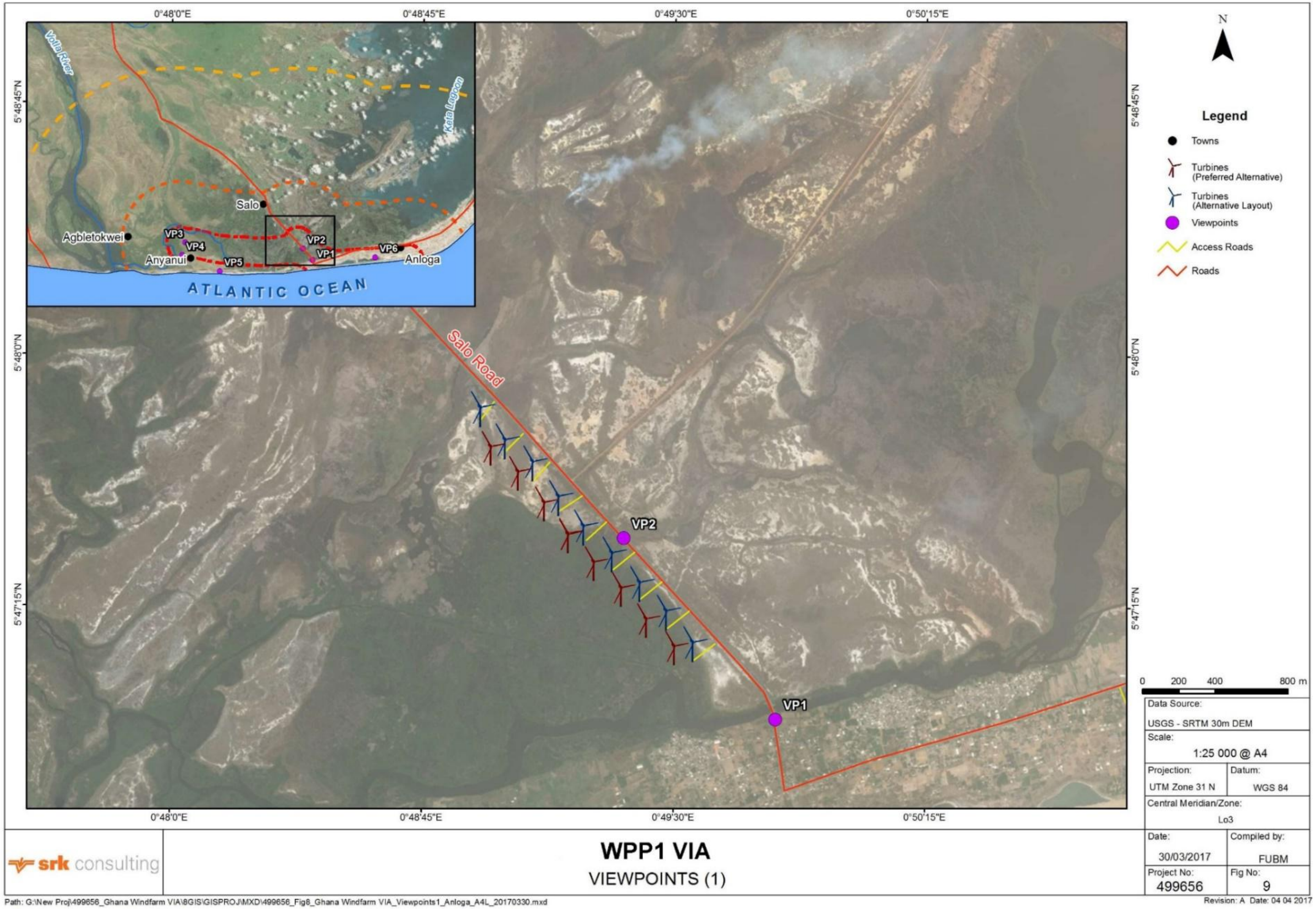

Figure 9: Viewpoints (1)

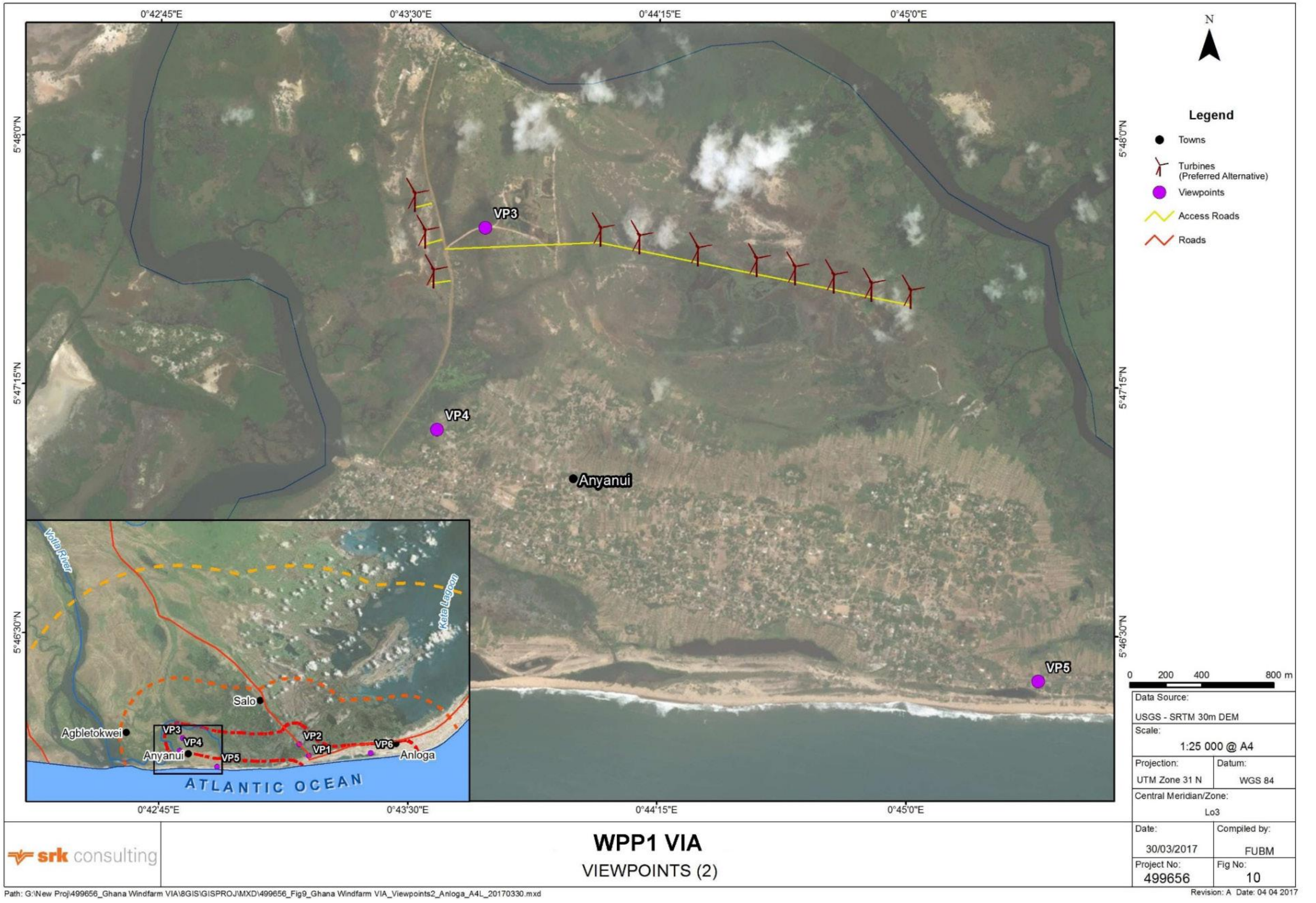

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Figure 10: Viewpoints (2)

APPENDIX 8 - VISUAL IMPACT ASSESSMENT

Figure 11: Viewpoints (3)

Table 5: Visibility from Viewpoints

Viewpoint #	Location	Co-ordinates	Direction of view from the viewpoint	Distance from the viewpoint to the nearest turbine	Time Photograph Taken	Potential Significant Receptors and Visibility
1a & b	Salo Road bridge outside Anloga	5°46'54.90"N; 0°49'48.47"E	North-west	550 m	09h30	• Users of Salo Road – *Highly Visible* • Residents of Anloga – *Highly Visible*
2a	Salo Road	5°47'27.26"N; 0°49'21.27"E	North-west	250 m	09h45	• Users of Salo Road – *Highly Visible*
2b			South-east			
3a	Outside village of Anyanui	5°47'43.50"N; 0°43'43.92"E	West	350 m	10h40	• Farmers - *Highly Visible*
3b			East			
4	Outskirts of Anyanui	5°47'6.98"N; 0°43'35.31"E	North	800 m	11h00	• Residents of Anyanui – *Highly Visible* to *Visible* • Farmers - *Highly Visible*
5	Outskirts of Anyanui	5°46'21.88"N; 0°45'24.06"E	North-west	2 200 m	11h10	• Residents of Anyanui – *Highly Visible* to *Visible* • Users of Anyanui Road - *Visible*
6a	Outskirts of Anloga	5°47'3.16"N; 0°52'47.74"E	South-east	370 m	12h45	• Residents of Anloga - *Highly Visible* to *Visible* • Fishermen / farmers – *Highly Visible*
6b			South-west			

7.5 LANDSCAPE INTEGRITY

Landscape (or townscape) integrity refers to the compatibility of the development/visual intrusion with the existing landscape. The landscape integrity of the project is rated based on the relevant criteria listed in Table 6.

Table 6: Landscape Integrity Criteria

HIGH	MODERATE	LOW
The project: ▪ Is consistent with the existing land use of the area; ▪ Is highly sensitive to the natural environment; ▪ Is consistent with the urban texture and layout; ▪ The buildings and structures are congruent / sensitive to the existing architecture / buildings; and ▪ The scale and size of the development is similar to nearby existing development.	The project: ▪ Is moderately consistent with the existing land use of the area; ▪ Is moderately sensitive to the natural environment; ▪ Is moderately consistent with the urban texture and layout; ▪ The buildings and structures are moderately congruent / sensitive to the existing architecture / buildings; and ▪ The scale and size of the development is moderately similar to nearby existing development.	The project: ▪ Is not consistent with the existing land use of the area; ▪ Is not sensitive to the natural environment; ▪ Is very different to the urban texture and layout; ▪ The buildings and structures are not congruent / sensitive to the existing architecture / buildings; and ▪ The scale and size of the development is different to nearby existing development.

Overall, WPP1 is generally considered to be visually inconsistent with the surrounding landscape. The project is considered to have low landscape integrity as the turbines will be of a scale very different to the current character of the study area.

A number of key viewpoints have been selected and simulated images of the turbines (Preferred Alternative) have been superimposed on the photographs taken from these viewpoints (Appendix B). The superimposed images show the dominance of the wind turbines in the landscape providing an indication of the visual intrusion of WPP1 on the surrounding area.

7.6 MAGNITUDE OF THE OVERALL VISUAL IMPACT

Based on the above criteria, the magnitude or intensity of the overall visual impact that is expected to result from the project has been rated. Table 7 provides a summary of the criteria, a descriptor summarizing the status of the criteria and projected impact magnitude ratings.

The overall magnitude of the visual impact that is expected to result from the project is rated as *high*. The low level of compatibility of the project and the high visibility of the turbines increases the intensity of the project.

Table 7: Magnitude of Overall Visual Impact

CRITERIA	RATING	COMMENTS
Visual Exposure	High	The project will be exposed across an extensive area.
Visual Absorption Capacity	Low	Relatively flat landscape (including vegetation) provides ineffective screening.
Viewer Sensitivity (Receptors)	Moderate	Sensitive receptors in close proximity to the WEF.
Viewing Distance and Visibility	High	High visibility of the turbines in a flat landscape and close proximity to receptors.
Landscape Integrity	Low	Scale of turbines incompatible with the existing nature of the area.

8. IMPACT ASSESSMENT AND MITIGATION MEASURES

Direct visual and aesthetic impacts in the construction / decommissioning and operations phases are likely to result from a number of project interventions and/or activities:

- Construction Phase:
  - Earthworks, vegetation clearance and resultant scarring;
  - Construction activities and presence of heavy construction vehicles and equipment;
  - Dust generation; and
  - Construction traffic.
- Operations Phase:
  - Change in character of the site and landscape caused by wind turbines;
  - Nightglow nuisance caused by security lighting and aviation warning lights; and
  - Change in character of the site and landscape caused by shadow flicker.
- Decommissioning Phase:
  - Decommissioning activities and presence of heavy construction vehicles and equipment;
  - Dust generation; and
  - Traffic.

The visual and aesthetic impacts generated by the project are likely to be associated with changes to sense of place and visual intrusion.

The following section describes the potential visual impacts during the construction, operations and decommissioning phases and assesses them utilising the impact rating methodology provided by the CSIR. Refer to the impact summary tables for the high level assessment of potential impacts (Table 8, Table 9 and Table 10).

8.1 CONSTRUCTION PHASE

8.1.1 Altered Sense of Place and Visual Intrusion from Construction Activities

Visual impacts will be generated by construction activities such as vegetation stripping and bulk earthworks, which can cause scarring, and from construction infrastructure, plant and materials on site (e.g. site camp, cranes and stockpiles). Dust generated at the site will be visually unappealing and may further detract from the visual quality of the area. Such impacts are typically limited to the immediate area surrounding the construction site and to the construction period.

Loss of sense of place is expected during construction since construction activities and the change in the state of the site (scarring, construction equipment and dust generation) are incongruent with the current character and nature of the surrounding area.

The impact for **both alternatives** is assessed to be of **medium** significance and with the implementation of mitigation, is reduced to **low** (Table 8).

The significance of the visual impact for the Alternative Layout will be marginally lower[2], particularly for the residents of Anyanui because turbines, and therefore construction activities, are not proposed north of Anyanui.

Essential mitigation measures include the following:

- Limit and phase vegetation clearance and the footprint of construction activities to what is absolutely essential;
- Utilise existing access roads as far as possible;
- Avoid excavation, handling and transport of materials which may generate dust under very windy conditions;

[2] The impact for the Alternative Layout is still assessed to be of *medium* significance without mitigation and of *low* significance with the implementation of mitigation.

- Enforce speed limit of 30km/hr on site;
- Consolidate the footprint of the construction camp to a functional minimum. Screen the yard with materials that blend into the surrounding area;
- Keep construction sites tidy and all activities, material and machinery contained within an area that is as small as possible;
- Rehabilitate disturbed areas incrementally and as soon as possible, not necessarily waiting until completion of the Construction Phase; and
- Set targets for the use of local labour to give locals a sense of ownership and pride in the project.

8.1.2 Altered Sense of Place from Increased Traffic

The increased number of construction vehicles on the road (and the related noise impacts) will reduce the sense of place to neighbouring receptors. The impaired sense of place will have a greater impact within the foreground as sensitive receptors in close proximity to the access roads will be particularly exposed to this impact.

The impact for **both alternatives** is assessed to be of **medium** significance and with the implementation of mitigation, is reduced to **low** (Table 8).

The significance of the visual impact for the Alternative Layout will be marginally lower[3], particularly for the residents of Anyanui because turbines, and therefore construction traffic, are not proposed north of Anyanui.

Essential mitigation measures include the following:

- Limit construction activities to Mondays to Saturdays between the hours of 07h00 and 18h00, or in accordance with relevant District bylaws, if applicable; and
- Maintain all generators, vehicles and other equipment in good working order.

[3] The impact for the Alternative Layout is still assessed to be of *medium* significance without mitigation and of *low* significance with the implementation of mitigation.

8.2 OPERATIONS PHASE

8.2.1 Altered Sense of Place and Visual Intrusion from the WEF

There is a degree of subjectivity in determining receptors' responses to WEFs - wind turbines may be perceived as negative or positive, majestic or dominant, depending on receptors' perception of the landscape and the value they ascribe to 'green energy'. Many societies acknowledge that renewable energy projects reduce dependency on fossils fuels (and associated carbon emissions / climate change) and are therefore more tolerant of visual and sense of place impacts that there would be for other similar scale projects.

The WEF will change the sites from unbuilt, predominantly natural to built sites.

The turbines at 95 m and 112 m (from ground level to turbine nacelle) for the Preferred Alternative and the Alternative Layout, respectively, will be prominent vertical elements in the landscape. The turbines will be visually overpowering and dominating to receptors within 1 km of the turbines. There are many receptors (residents) within 1 km of the WEF at Anloga and Anyanui (note, the closest receptor is within 200 m of a turbine). Visual intrusion is likely to be significant to these receptors.

WPP1 will be incompatible with the existing land use which is more rustic and natural. The beach is also a highly sensitive visual landscape.

The impact for **both alternatives** is assessed to be of **high** significance with and without the implementation of mitigation (Table 9). The significance of the visual impact for the Alternative Layout will be marginally lower[4] (even though the height of the turbines will be ~ 20 m higher than the Preferred Alternative), particularly for the residents of Anyanui, because turbines are not proposed north of Anyanui.

It is difficult to mitigate tall vertical elements in the landscape, but essential mitigation measures include:

[4] The impact for the Alternative Layout is still assessed to be of *high* significance with and without the implementation of mitigation.

- Minimise associated infrastructure on site (access roads, transformers, store rooms) to reduce visual clutter;
- Plant large indigenous trees around receptors in the immediate vicinity of the WEF to provide visual screening to partially reduce the visual impact on these receptors; and
- Maintain a uniform size (height) and colour (white) of the turbine towers, nacelles and blades and avoid any markings on the turbine (Figure 13).

Internationally it is recognised that coastlines are unique visual and tourism assets. Compliance with international best practice may require that turbines are not placed on the beach at Anloga. However, in Anloga, local communities seem to place less value on the visual amenity of the beach, evidenced by the inward orientation of households towards roads or over crop fields (and away from the coast). For the Alternative Layout, and as best practice, Volta River Authority (VRA) should consider relocating a number of proposed turbines from the beach at Anloga to the site north of Anyanui so as to create visual corridors through to the coastline (Figure 12).

srk consulting	**VIA SCOPING PHASE INPUT** Anloga WEF	Project No. 499656

Figure 12: Suggested layout amendments of Anloga WEF

Figure 12: Markings on the tower (or nacelle / blades) increase the visual intrusion of the turbine

8.2.2 Altered Sense of Place and Visual Character caused by Light Pollution at Night

According to the Draft Feasibility Study (Lahmeyer International, 2015), the Ghana Civil Aviation Authority may prescribe that one “Medium Intensity Light Type B/C” must be placed on top of the nacelle and one “Low Intensity Light Type A/B” must be placed 45 m up the wind turbine tower. In addition, security lighting may be installed at the WEF.

The lighting at the WEF may contribute to light pollution in the area, since existing ambient night time light in the area is low, in a relatively undeveloped area with minimal lighting. The additional lighting from the WEF will alter the visual character of the landscape at night.

Lighting is not easily screened by vegetation and topography, and receptors' experience of the impact is more intense. Good external security lighting design and lighting fixtures can restrict the upward emission of light into the atmosphere reducing the visual impact (altered sense of place).

The impact for **both alternatives** is assessed to be of **medium** significance and with the implementation of mitigation, is reduced to **low** (Table 9). The significance of the visual impact for the Alternative Layout will be marginally lower[5], particularly for the residents of Anyanui, because turbines are not proposed on the site north of Anyanui.

Essential mitigation measures include the following:

- Clarify the requirements of the Ghana Civil Aviation Authority and clarify if pilot activated lighting is possible;
- Direct security lighting inwards and downwards to avoid light spillage and trespass. External lights should be fitted with reflectors ("full cut-off" luminaires) to direct illumination downward and inward to the specific illuminated areas; and
- Avoid working at night unless absolutely necessary.

8.2.3 Altered Sense of Place from Shadow Flicker

Shadow flicker is the flicker of the sun through the turbine blades. Shadow flicker can be defined spatially but with some difficulty as sun angles, climate, and viewpoints determine the presence, duration and level of flicker (CNdV, 2006). Shadow flicker is considered significant within 1 km of a turbine (http://www.windvigilance.com).

Guidelines developed in Germany (WEA-Schattenwurf-Hinweise, date unknown) are the most widely adopted and state the following:

- Shadow flicker should not occur for more than 30 hours per annum; **and**
- Shadow flicker should not occur for more than 30 minutes per day.

[5] The impact for the Alternative Layout is still assessed to be of *medium* significance without mitigation and of *low* significance with the implementation of mitigation.

Shadow flicker will be significant for those residents located within 1 km of the wind turbines (unless screened by vegetation or structures).

The impact for **both alternatives** is assessed to be of **high** significance and with the implementation of mitigation, is reduced to **low** (Table 9).

Essential mitigation measures include the following:

- Calculate the effects of shadow flicker (taking account of local screening) on those residents located within 1 km of the wind turbines and relocate residents accordingly (in accordance with a Resettlement Action Plan).

8.3 DECOMMISSIONING PHASE

8.3.1 Altered Sense of Place and Visual Intrusion from Decommissioning Activities

Visual impacts generated during the Decommissioning Phase will be similar to those generated during the Construction Phase: from infrastructure, plant and materials on site (e.g. site camp, cranes) and dust. Such impacts are typically limited to the immediate area surrounding the WEF and to the decommissioning period.

Loss of sense of place is expected during decommissioning since activities and the change in the state of the site (decommissioning equipment and dust generation) are incongruent with the current character and nature of the surrounding area.

The impact for **both alternatives** is assessed to be of **medium** significance and with the implementation of mitigation, is reduced to **low** (Table 10).

The significance of the visual impact for the Alternative Layout will be marginally lower[6], particularly for the residents of Anyanui because turbines, and therefore decommissioning activities, are not proposed north of Anyanui.

Essential mitigation measures include the following:

- Utilise existing access roads as far as possible;
- Avoid handling and transport of materials which may generate dust under very windy conditions;
- Enforce speed limit of 30km/hr on site;
- Consolidate the footprint of the site camp to a functional minimum. Screen the yard with materials that blend into the surrounding area;
- Keep all activities, material and machinery contained within an area that is as small as possible; and
- Rehabilitate disturbed areas incrementally and as soon as possible, not necessarily waiting until completion of the Decommissioning Phase.

8.3.2 Altered Sense of Place from Increased Traffic

The increased number of heavy vehicles on the road (and the related noise impacts) will reduce the sense of place to neighbouring receptors. The impaired sense of place will have a greater impact within the foreground as sensitive receptors in close proximity to the access roads will be particularly exposed to this impact.

The impact for **both alternatives** is assessed to be of **medium** significance and with the implementation of mitigation, is reduced to **low** (Table 10).

The significance of the visual impact for the Alternative Layout will be marginally lower[7], particularly for the residents of Anyanui because turbines, and therefore construction traffic, are not proposed north of Anyanui.

[6] The impact for the Alternative Layout is still assessed to be of *medium* significance without mitigation and of *low* significance with the implementation of mitigation.

Essential mitigation measures include the following:

- Limit decommissioning activities to Mondays to Saturdays between the hours of 07h00 and 18h00, or in accordance with relevant District bylaws, if applicable; and
- Maintain all generators, vehicles and other equipment in good working order.

8.3.3 Cumulative Impacts

The visual quality of the study area is largely ascribable to the predominantly natural landscape interspersed with traditional forms of agriculture. There are some elements that detract slightly from the visual quality of the project area, but no industrial activities, renewable energy projects or prominent vertical elements were identified within the project's area of influence.

As there are no other large development projects in the project's area of influence, the cumulative impact for **both alternatives** is thus assessed to be of **very low** significance.

[7] The impact for the Alternative Layout is still assessed to be of *medium* significance without mitigation and of *low* significance with the implementation of mitigation.

Table 8: Impact assessment summary table for the Construction Phase

CONSTRUCTION PHASE															
Direct Impacts															
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Alternative Site**	**Status**	**Spatial Extent**	**Duration**	**Intensity**	**Probability**	**Reversibility of Impact**	**Irreplaceability**	**Can the Impact/Risk be Avoided?**	**Can the Impact/Risk be Mitigated/ Managed?**	**Essential Mitigation Measures**	**Significance of Impact and Risk**		**Confidence Level**
													Without Mitigation/ Management	***With Mitigation/ Management (Residual Impact/ Risk)***	
Earthworks and vegetation clearance Construction activities and presence of heavy construction vehicles and equipment Dust generation	Altered sense of place and visual intrusion from construction activities	Preferred Layout and Alternative Layout	Negative	Local	Temporary	Medium-Low	Definite	High	Moderate	No	Yes	• Limit and phase vegetation clearance and the footprint of construction activities to what is absolutely essential; • Utilise existing access roads as far as possible; • Avoid excavation, handling and transport of materials which may generate dust under very windy conditions; • Enforce speed limit of 30km/hr on site; • Consolidate the footprint of the construction camp to a functional minimum. Screen the yard with materials that blend into the surrounding area; • Keep construction sites tidy and all activities, material and machinery contained within an area that is as small as possible; • Rehabilitate disturbed areas incrementally and as soon as possible, not necessarily waiting until completion of the Construction Phase; and • Set targets for the use of local labour to give locals a sense of ownership and pride in the project.	Medium	Low	High
Construction traffic	Altered sense of place from increased traffic	Preferred Layout and Alternative Layout	Negative	Local	Temporary	Medium-Low	Definite	High	Moderate	No	Yes	• Limit construction activities to Mondays to Saturdays between the hours of 07h00 and 18h00, or in accordance with relevant District bylaws, if applicable; and • Maintain all generators, vehicles and other equipment in good working order.	Medium	Low	High

Table 9: Impact assessment summary table for the Operations Phase

OPERATIONS PHASE															
Direct Impacts															
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Alternative Site**	**Status**	**Spatial Extent**	**Duration**	**Intensity**	**Probability**	**Reversibility of Impact**	**Irreplaceability**	**Can the Impact/Risk be Avoided?**	**Can the Impact/Risk be Mitigated/ Managed?**	**Potential Mitigation Measures**	**Significance of Impact and Risk**		**Confidence Level**
													Without Mitigation/ Management	***With Mitigation/ Management (Residual Impact/ Risk)***	
Change in character of site caused wind turbines	Altered sense of place and visual intrusion from the WEF	Preferred Layout and Alternative Layout	Negative	Regional	Long-term	High	Probable	High	Low	No	No	• Minimise associated infrastructure on site (access roads, transformers, store rooms) to reduce visual clutter; • Plant large indigenous trees around receptors in the immediate vicinity of the WEF to provide visual screening to partially reduce the visual impact on these receptors; and • Maintain a uniform size (height) and colour (white) of the turbine towers, nacelles and blades and avoid any markings on the turbine.	High	High	High
Security lighting and aviation warning lights	Altered Sense of Place and Visual Character caused by Light Pollution at Night	Preferred Layout and Alternative Layout	Negative	Regional	Long-term	Medium-Low	Definite	High	Low	No	Yes	• Clarify the requirements of the Ghana Civil Aviation Authority and clarify if pilot activated lighting is possible; • Direct security lighting inwards and downwards to avoid light spillage and trespass. External lights should be fitted with reflectors ("full cut-off" luminaires) to direct illumination downward and inward to the specific illuminated areas; and • Avoid working at night unless absolutely necessary.	Medium	Low	High
Shadow flicker	Altered Sense of Place from Shadow Flicker	Preferred Layout and Alternative Layout	Negative	Local	Long-term	High	Highly Probable	High	Moderate	Yes	Yes	• Calculate the effects of shadow flicker (taking account of local screening) on those residents located within 1 km of the wind turbines and relocate residents accordingly (in accordance with a Resettlement Action Plan).	High	Low	High

Table 10: Impact assessment summary table for the Decommissioning Phase

DECOMMISSIONING PHASE

Direct Impacts

Aspect/ Impact Pathway	Nature of Potential Impact/ Risk	Alternative Site	Status	Spatial Extent	Duration	Intensity	Probability	Reversibility of Impact	Irreplaceability	Can the Impact/Risk be Avoided?	Can the Impact/Risk be Mitigated/ Managed?	Essential Mitigation Measures	Significance of Impact and Risk		Confidence Level
													Without Mitigation/ Management	*With Mitigation/ Management (Residual Impact/ Risk)*	
Construction activities and presence of heavy construction vehicles and equipment Dust generation	Altered sense of place and visual intrusion from decommissioning activities	Preferred Layout and Alternative Layout	Negative	Local	Temporary	Medium-Low	Definite	High	Moderate	No	Yes	• Utilise existing access roads as far as possible; • Avoid handling and transport of materials which may generate dust under very windy conditions; • Enforce speed limit of 30km/hr on site; • Consolidate the footprint of the site camp to a functional minimum. Screen the yard with materials that blend into the surrounding area; • Keep all activities, material and machinery contained within an area that is as small as possible; and • Rehabilitate disturbed areas incrementally and as soon as possible, not necessarily waiting until completion of the Construction Phase.	Medium	Low	High
Traffic	Altered sense of place from increased traffic	Preferred Layout and Alternative Layout	Negative	Local	Temporary	Medium-Low	Definite	High	Moderate	No	Yes	• Limit decommissioning activities to Mondays to Saturdays between the hours of 07h00 and 18h00, or in accordance with relevant District bylaws, if applicable; and • Maintain all generators, vehicles and other equipment in good working order.	Medium	Low	High

9. CONCLUSION AND RECOMMENDATIONS

The following findings are pertinent:

- The basis for the **visual character** of the overall area is provided by the topography, vegetation and land use of the area, giving rise to a generally flat landscape with a mosaic of waterbodies, mud flats and salt marshes with low-intensity cultivated fields and villages on higher ground, with significant influence from the sea.

- The WPP1 area can be described as a natural transition landscape associated with the interface between the coastline, the villages interspersed within cultivated fields and the natural water features and wetlands further inland.

- The **visual quality** of the overall area is largely ascribable to the diverse patterns of grassland interspersed with irregularly shaped fields and wetlands. Views over the ocean contribute to a sense of ‘openness’ and underpin the visual quality of the area. The open topography, varied vegetation and traditional forms of crop farming that have been integrated into the landscape are visually appealing, but not necessarily regionally distinctive.

- The Volta River delta drainage network provides visual interest in the landscape surrounding the WPP1.

- Some elements detract slightly from visual quality in the project area, notably the degraded (and abandoned) farmlands. Nevertheless the visual quality of the study area is considered to be high.

- Land uses or activities that occur in an area contribute to the **sense of place**, which is expected to be fairly similar to the wider region. In this sense there is an element of sameness and predictability about the visual quality of the area. However, Keta Lagoon, Volta River Estuary and other open waterbodies are distinct natural features in the landscape. The areas’ sense of place is also highly influenced by the coast.

- The **visual exposure** of the WEF will be high as the wind turbines will be exposed across an extensive area.

- The area is rated as having a low VAC due to the relatively flat landscape providing ineffective screening of the wind turbines.

- Potential **visual receptors** of the project include residents of surrounding villages, visitors to Keta lagoon, road users, farmers, and fishermen. The sensitivity of viewers or visual receptors potentially affected by the visual impact of the project is considered to be moderate.

- The **visibility** of the project components is high, due to the high visibility of the turbines in a flat landscape and the close proximity of receptors to the turbines.

- The project is considered to have low **landscape integrity** as the turbines will be of a scale very different to the current nature of the study area.

- Visual impacts will be generated by **construction activities**. Loss of sense of place is expected during construction since construction activities and the change in the state of the site (scarring, construction equipment and dust generation) are incongruent with the current nature of the surrounding area.

- The increased number of **construction vehicles** on the road and the related noise impacts will reduce the sense of place to neighbouring receptors. The loss of sense of place will have a greater impact within the foreground as sensitive receptors in close proximity to the access roads will be particularly exposed to this impact.

- There is a degree of subjectivity in determining receptors' responses to WEFs - wind turbines may be perceived as negative or positive, majestic or dominant, depending on receptors' perception of the landscape and the value they ascribe to 'green energy'. Many societies acknowledge that renewable energy projects reduce dependency on fossils fuels (and associated carbon emissions / climate change) and are therefore more tolerant of visual and sense of place impacts that there would be for other similar scale projects.

- The WEF will change the sites from unbuilt, predominantly natural to built sites. The **wind turbines** will be prominent vertical elements in the landscape. The turbines will be visually overpowering and dominating to those receptors within 1 km of the turbines. There are many receptors (residents) within 1 km of WPP1 (note, the closest receptor is within 200 m of a turbine).

- The **lighting** at the WEF may contribute to light pollution in the area, since existing ambient night time light in the area is low, in a relatively undeveloped area with minimal lighting. The additional lighting from the WEF will alter the visual character of the landscape at night.

- **Shadow flicker** is the flicker of the sun through the turbine blades and is considered significant within 1 km of a turbine, unless localised elements screen flicker.

- Although the significance rating for both alternatives is the same according to the impact rating methodology, the significance of the visual impacts for the Alternative Layout will be marginally lower (even though the height of the turbines will be ~ 20 m higher than the Preferred Alternative), particularly for the residents of Anyanui, because turbines are not proposed north of Anyanui.

- Internationally it is recognised that coastlines are unique visual and tourism assets. Compliance with international best practice may require that turbines are not placed on the beach at Anloga. However, in Anloga, local communities seem to place less value on the visual amenity of the beach, evidenced by the inward orientation of households towards roads or over crop fields (and away from the coast). For the Alternative Layout, and as best practice, VRA should consider relocating a number of proposed turbines from the beach at Anloga to the site north of Anyanui so as to create visual corridors through to the coastline.

- Visual impacts will be generated by **decommissioning activities**. Loss of sense of place is expected during decommissioning since activities and the change in the state of the site (decommissioning equipment and dust generation) are incongruent with the current nature of the surrounding area.

- The increased number of **heavy vehicles** on the road and the related noise impacts will reduce the sense of place to neighbouring receptors. The loss of sense of place will have a greater impact within the foreground as sensitive receptors in close proximity to the access roads will be particularly exposed to this impact.

- As there are no other large development projects in the project's area of influence, the cumulative impact is assessed to be of **very low** significance.

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11. APPENDICES

Appendix A – Viewpoint Photographs

Appendix B – Photograph Simulations

APPENDIX A: Viewpoint Photographs

Viewpoint 1

Viewpoint 2

Viewpoint 3

Viewpoint 4

Viewpoint 5

Viewpoint 6

APPENDIX B: Photograph Simulations

Viewpoint 1a (top) and Viewpoint 2a (bottom)

Viewpoint 4 (top) and Viewpoint 5 (bottom)

Viewpoint 6a

SPECIALIST EXPERTISE

Scott Masson

Profession	Senior Environmental Consultant and VIA Specialist
Education	MLA, L. Arch, Cape Town, 2008 BSc (Hons), Environmental Management, Cape Town, 2004 BSc, Environmental Management, Cape Town, 2003
Registrations / Affiliations	Certified Environmental Assessment Practitioner of South Africa Professionally Registered Landscape Architect
Specialisation	Visual impact assessments (VIA), environmental impact assessment, environmental planning and site sensitivity studies; and landscape architectural design and planning
Expertise	Scott has been involved in the field of environmental and landscape architecture for the past 9 years. His expertise includes: • environmental impact assessments and environmental management plans; • visual impact assessments; • integrated waste and water management plans; • environmental audits and due diligence; • environmental control officer work; • environmental planning and sensitivity studies; and • landscape architectural planning and design.
Employment	
2011 – present	SRK Consulting (Pty) Ltd, Environmental Consultant, Cape Town
2009 – 2011	Megan Anderson Landscape Architects, Candidate Landscape Architect
Publications	I have been interviewed and quoted in numerous environmental and sustainability articles published in the press and sector specific journals including *Civil Engineering Contractor*. *Position IT*, *Cape Business News* and *To Build*.

Visual Impact Assessment (VIA)

- CSIR, VIA for two wind energy facilities in the Greater Accra District, Ghana, 2016 - ongoing
- Mineral Sands Resources (Pty) Ltd, VIA for the extension of Tormin Mine, Western Cape, 2016 – ongoing
- Tronox Mineral Sands (Pty) Ltd, VIA for the Slimes Dam 6 at Tronox Namakwa Sands Mine, Western Cape, 2016
- Department of Forestry, Fisheries and Agriculture, VIA for a proposed Aquaculture Development Zone in Saldanha Bay, Western Cape, 2016
- Matzikama Municipality, VIA for the proposed construction of four abalone farms in Doringbaai, Western Cape, 2015 - 2016
- Eskom, VIA for the proposed Merino substation and Bon-Chretien-Merino powerline in Ceres, Western Cape, 2016
- Transnet Capital Projects, VIA for the construction of additional substations, transmission infrastructures and area lighting masts near the Port of Saldanha, Western Cape, 2015-2016
- EFG Engineers, VIA for a the proposed bypass road in Hermanus, Western Cape, 2015-2016
- Liesbeek Leisure Club (Pty) Ltd, VIA for a the proposed redevelopment of the River Club, Western Cape, 2015-2016
- Eskom, VIA for the proposed TISF at Koeberg, Western Cape, 2015-2016
- Tronox Mineral Sands (Pty) Ltd, VIA for a the proposed expansion of the Namakwa Sands Mine, Brand-se-Baai, Western Cape, 2012-2013
- Vale, VIA for a proposed phosphate mine in Mozambique, 2011-2012
- Courtrai Developments, VIA for a proposed retirement village in Paarl, 2011
- CSIR Environmental, VIA for an EIA proposal for four wind energy facilities, Swellendam, Mossel Bay, Heidelberg and Albertinia, Western Cape, 2010
- CSIR Environmental, VIA for a proposed eco-residential estate and nature reserve, Jacobsbaai, Western Cape, 2010
- Vodacom, VIA for a proposed cell phone mast at Hermanus golf course, on Graymead farm near Villiersdorp and on a farm in Klipdale, 2009

SPECIALIST DECLARATION

I, **SCOTT MASSON**, as the appointed independent specialist, hereby declare that:

- I act as the independent specialist in this application;
- I perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of any Acts, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Acts, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I will ensure that the comments of all interested and affected parties on the specialist input/study will be considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- I realise that a false declaration is an offence.

Signature of the Specialist:

Name of Specialist: Scott Masson

Date: 26 September 2017

Environmental & Social Impact Assessment

for the proposed development of a Wind Energy Facility in Anloga Extension (WPP1)

APPENDIX 9:

Public Participation Process

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List of participants at the public forum for WPP1 October 2016	**Appendix 9.1**

75 MW WIKND POWER PROJECT 1 STAKEHOLDERS' HEARI

Date: 19th October, 2016 Venue: Keta Municipal Asseml

Name	Designation	Community	Contact Number(s)	Signature
Ave Nkekeshi	chief fisherman	Anloga	0249180239	
Hon. Edwin Kwame	Assembly person	Anyanui	0547778585	
Agbenyadzi Thomas		Agbledomi	0246072112	
TOGBI SAMOR II	D ANYANUI	ANYANUI	0208789994	
Gershon Aveglo	"	"	0244787507	
JOHN K. TOGOBO	ANLOGA LAND OWNERS	ANLOGA	0246409066	
Rowland Tudzi	Anloga KEMVEFIMA chairman	ANLOGA	0242342566	
Edward Ahiabor	KEMVEFIMA	Anloga	0243207889	
Kofoku Vivor	Chief fisherman	SROGBE	02430744	
Benjamin Sagoe	Dept of Agric	ANLOGA	024 26353	
Michael Nanevi		Agbledomi	0243304468	
Agnes Vitasi		Agbledomi	0240902416	
Believer Ahiaku		Agbledomi	0243655340	
Dayo Solomon	Secretary Srogbe	Srogbe-Kliklui	0242862743	
Godson Agbeko	Anloga	Anloga	0248912510	
Dome Akevor				
Gabriel Agbedzi				
Amuzu Fangabo				
Afanator E.	Agbledomi		0240694941	
Gerry Akpadja			0246177093	
Togbi Azameti	"	Dzita	0246193304	

Dr. Simon Sorpe PPO		Adidome Area	0246099870	300	[signature]
Paulina Sedor NSP		//		~	
Aaron Ofei Driver		//		~	
GAGBLAH	BASSON	DZITA/ANYANUI	0243282995	50	
AHIAKU WILLIAM		✓		X	
AHIAKU DAVID		✓		X	
AHIAKU LIVINGSTONE		✓		X	
GAGBLAH CEPHAS		✓		X	STOOL FATHER
Stool Father	Srogbe	Srogbe	0244114493	50	(FRANCIS ATSULUMOR)
Albert	Dzagbui	Agbledomi	0242777831	50.00	
Ahiango	Gabriel	✓	0548670442	X	
Vitasi	Agines	✓	0240902015	X	
Rejoice	Ntsoni	Jubilee Radio	0286827923	40.00	[signature]
RAYMOND BOAH		AGBLEDOMI	0540707840	50.00	[signature]
JOSEPH AGBENYEKE		AGBLEDOMI	0246589604		[signature]
XEDZRO ASIMAH		ANLOGA	0249605984		
* Jenna B.B.	I.S.D.	Keta	0543049765	40.00	[signature]
Celestina Afli... Dept CD		Keta	0208166286	20.00	[signature]

SELJEN CONSULT

STAKEHOLDER ENGAGEMENT – Participants List

Title of Project: 150MW WIND POWER PROJECT Date: 13-04-2016

Project Proponent: Time:

Types of Stakeholder: Venue:

	Name	Agency	Position	Contact Number	Email
1	Dompre Samuel	KeMA	MUN. Engineer	0242906124	dompresamuel@yahoo.com
2	Nicholas Nai Adjei	KeMA	MCD	0246870470	nnaonick@gmail.
3	Lydia Cape	CSIR	Project Manager	0027218882429	lcape@csir.co.za
4	Abulele Adams	CSIR	Project Manager	0027218882408	aadams@csir.co.za
5	Abdul-Kareem Fuseini	WILDLIFE DIVISION OF FORESTRY COMM	Site Manager	0243168865	yambafuka@yahoo.com
6	Anttoinette Aheto	KeMA	Procurement Officer	0243576555	babyselikem@gmail.com
7	Kofi Gati	SELJEN	Tech Mech	0208434577	seljencon@gmail.com
8	Ebenezer Antwi	VRA	Prin. Elect. Eng.	0202625433	ebenezer.antwi@vra.com
9	Frank Cudjoe	SELJEN	Comp. Action Plan	0242807339	cudjoe.frank.88@yahoo.co
10	Jennifer Glover	Dept of Co-op	Asst Co-op Officer	0208831144	jennifer-glover65@yahoo.com
11	Ben A. Sackey	Mgr, ESI, VRA	Mgr. ESI	0243344775	ben.sackey@vra.com
12	Lloyd K. Sutherland	Environmental Officer, V.R.A	Env. Officer	0241370926	lloyd.sutherland@vra.com

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STAKEHOLDER ENGAGEMENT – Participants List

Title of Project: .... Date: ....
Project Proponent: .... Time: ....
Types of Stakeholder: .... Venue: ....

	Name	Agency	Position	Contact Number	Email
13	JERRY ZIDDAH	ENV'TAL HEALTH	MUNICIPAL OFFICER	0244864163	ziddahkay@yahoo.com
14	GODWIN K. AGBENYO	NCCE	MUNICIPAL DIRECTOR	0244414336	agbenyo2009@gmail.com
15	EDITH TAY	COMM. DEV	MUNICIPAL	0243226013	edithtay hayoo.com
16	DOMINIC KPODO	NADMO	ADMINISTRATION	0242120481	nyonyokpodo@gmail.com
17	Daniel Nyatsu	WORKS Estate	Asst. Chief Estate Offr	0542173584	2
18	Joana Bruce Dei	Information Services Dept Rep	Journalist	0543069765	brucejoydei@gmail.com
19	Faustina Baldee	Dept of Soc Welfare	MSWO	0208960858	faustinabaldee@yahoo.com
20	GIFTY TAGOE	FIRE SERVICE	2i/c / ADMIN	054 8851113	tagoeturner@yahoo
21	Celestina A Attipoe	Dept. Comm. Dev	Mun. Officer	0208166286	celesti@yahoo.com
22	Aaron Teku	Mun. Works Dept.	Engineer	0246229016	aarontek2006@yahoo.com
23.	SAGODO BENJAMIN	DEPT. OF AGRIC	MUN. DEVT. OFFICER	024 263 5303	bmksagodo@gmail.com

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Name	Organisation	Contact No	Signature
Anyigbaun Hoe	Anloga	0540329333	
Clemence Ahiamkui	Anyanui	0243245923	
Benjamin Oppong Darkwah	EPA (Ag. Regional Director) Ho	0208156955	
Adzeman Naa-Dei	E.P.A. (Ho) Regional Office	0272724744	
Aupor James	Anloga Land Owner	0248912510	
Kwakuvigah Simon	Anloga / Farmer	0548327861	
RAYMOND EDDAH	AGBLEDOMI	0540 707 840	
Celestina Adzoley-Attipoe	Dept. Comm. Dev (KeMA)	0208166286	
Hilda Dapaah Arthur	Asst. Municipal Planning Officer (KeMA)	0260575356	
Mr John Ntibrey	Municipal Planning Officer (KeMA)		
KOBLA Hofu	HOFU Anloga	0200124613	
John Logah	Anloga	0548096402	
Adzenyegah Kodzo	Togbi Badu family Rep	~~05488~~ 0548802664	
Hedzro Ashumedi	Anloga farmer	0249605984	

Name	Organization	Contact No	Signature
1. Simon C. Ahiada	Dzita	024514592	
2. Furguson Agbanyo	Anyanui Reg. Togbi Tsibli	~~054444443883~~ 0545443883	
3			
4. Dumega Gasu Agbedzi	Anloga	0542196587	
5. Mr. Gabriel K. Agbedzi	Anloga	0546622614	
6. Mr. Amuzu Kanaglo	Anloga	0540476264	
7. ~~[illegible]~~	~~Anloga~~	~~024~~	
8. T.K. Heletsi	Anyanui - Land owner	0243587291	
9. ERIC KWAKYE	E.C.G - KETA	0200200514	
10. TAGBLAH GODSON W.	ANYANUI	0243282995	
11. Mr. Alfred Gbeze	Anloga	0208128599	
12 Mr. moses Amevor	E.P.A.	0501301732	
13 Osei Aaron	E.P.A	0248844513	

Name	Organisation	Tel No	Sign
Solomon Aniyo	Torgbui Azokey Palace Srogboe Family Secretary	0242362743	[illegible]
Taviam ~~Fa/am~~	Agbenyegah ~~Agbenyegah~~	0241456996	[illegible]
KENNEDY SAICYI	I.S.D	0201546624	[illegible]
Regent Fatsuy - Agbanitor.	Agbanitor family.	0248890814	[illegible]
Egra Kuborgbor	Elder	0249938992	J.E.K.Kgo
Prince Agbanitor	Vice Secretary	024621568	[illegible]
Noble Agbanitor		0543642057	[illegible]
NYATSO DANIEL	WORKS (Kema.)	0547473584	[illegible]

Stakeholder database:

Stakeholder	Name	Position
Keta Municipal Assembly	Hon. Sylvester Tornyeava	Municipal Chief Executive
	Nicholas Niaje	Municipal Coordinating Director
	John Ntibere	Planning Officer
	Hilda Dapaah Arthur	Planning Officer
	Woanya Makafui	Development Committee Chairman (Assemblyman for Anloga)
	Richard Sefe	Presiding member
	Samuel Dompreh	Municipal Engineer
	Aaron Teku	Mun. Works Dept.
	Kennedy Sekyi	I S D
	Fabian Vorvoir	Budget Officer
	Anttoinette Aheto	Procurement Officer
	Benjamin Sagodo	Dept of Agric
	Freedom Vitashie	Information Officer
Keta Municipal Health Service	Dr. Andrews Ayaim	Municipal Health Director
	Grace Kpedadzah	Municipal Public Health Nurse
Keta Municipal Education Service	Derrick Vanlare	Public Relations Officer
	John Gbekor	Asst. Director, Monitoring & Supervision
Ghana Wildlife Division	Abdul-Kareem Fuseini	Supervisor
Dept. of Cooperatives	Jennifer Glover	Assistant Cooperative Officer
Dept. of Environmental Health	Jerry Ziddah	Municipal Environmental Health Officer
National Commission for Civic Education	Godwin Agbenyo	Municipal Director
Department for Comm. Development	Edith Tay	Municipal Dedevelopment Officer
NADMO	Dominic Kpodo	Municipal Administrator
Works Estate	Daniel Nyatso	Municipal Estate Officer
Information Serv. Dept	Freedom Vitashie	Municipal Informatioin Director
Dept. of Social Welfare	Faustina Barldee	Municipal Social Welfare Officer
Ghana Fire & Rescue Service	Gifty Tagoe	Municipal Fire Officer
Dept. Comm. Dev.	Celestina A. Attipoe	Municipal Community Development Officer

Stakeholder	Name	Position
Dept. Of Agriculture	Sagodo Benjamin	Municipal Agric Development Officer
Srogbe Community	Francis Atsu Lumor	Stool father
	Regent Fatsawu Dzoley Agbavitor	Regent
	Tsimenu Attipoe	Elder
	Shine Agbavitor	Family Assistant Secretary
	Kotoku Vivor	Chief Fisherman
	Solomon Danyo	Dzoke Family Secretary
	Taviam Agbenyega	Elder
	Kwadzo Fianyeku	Elder
	Apertorgbir Nuesedonu	Elder
	Eyra Kusorgbor	Elder
Anloga Community	Dumega Gasu Agbedzi	Head of Amevu clan
	Gabriel K. Agbedzi	Elder
	Regent Fatsawu Agbavitor	Agbavitor Family
	Kofi Agbedzi	Elder
	Kobla Hosu	Vegetable farmers Association
	John Logah	Vegetable farmers Association
	Agbenyegah Ladzekpo	Vegetable farmers Association
	Hedzro Ashimadi	Vegetable farmers Association
	Doe Nkekeshi	Chief Fisherman
	Noble Agbavitor	Elder
	Amuzu Kanagbo	Elder
	Alfred Gbeze	
	James Avevor	
	Avevor James	Landlord, Anloga
	Anyigbavor Doe	
	George Yaovi Sebuavah	Elder
	Togbe Gborsike	Fetish Priest
	Hon Woanya Makafui	Assemblyman, Anloga Lashibi
	Gasu Agbedzi	
	John K. Togobo	Landlord, Anloga
	Edward Ahiabor	KEMVEFA Chairman
	Roland Tudzi	KEMVEFA Chairman
	Jaspa Lavi	Dra/ Togobo family of Tovle Clan
	Anthony Kobla Agbedeka	
	Dr. Francis Ahiaku	

Stakeholder	Name	Position
Anyanui Community	Togbe Gamor	Chief of Anyanui
	Clement Ahiankui	
	William Ahiaku Ayedzinu	Regent - Klevie Clan
	Leo Daledor	Elder - Klevie Clan
	Cephas Gagblah	Elder - Klevie Clan
	T.K. Heletsi	Clan Elder
	David Ahiaku Adzieelder	Elder - Klevie Clan
	Johnson Ahiaku Believer	Elder - Klevie Clan
	WO1 (Rtd) Anyeku Kennedy	Elder - Klevie Clan
	Gboglah Godson	
	Edwin Kusime	Assemblyman
	Hon Godson Gagbla	Assemblyman
	Furguson Agbanyo	Togbe Tsidi Rep
	Gershon Anagli	Elder - Barteh Clan
	Samuel Anagli	Elder - Barteh Clan
	Gbeda gbologah	Elder-Barteh Clan
	Awushie Gbologah	Elder - Barteh Clan
Tunu Community (Anyanui)	Hunor Alloyito	Linguist
	Zatey Dagodzo	Elder
	Zikpi Francis	Elder
	Godwin Agbeyangah	Elder
Gblife Community (Anyanui)	Yaw Gbetsey Sampson	Acting Chief
	Kpetsi Kobla	Elder
	Kpetsi Kojo	Elder
	Christopher Kpondo	Elder
	Seth Akarwodo	Elder
	Akpatsu Vincent Kofi	Elder
Wededeanu (Anyanui)	Kutu Awumey	Elder
Wokumagbe	John Alipuiteye Sowa Narh	Linguist
	Kofi Samuel Akwetey	Regent
EPA	Benjamin Oppong Darkwah	Ag. Regional Director, EPA
	Osei Aaron	
	Moses Amevor	
	Adzeman Naa-Dei	
	Kwaku Digah Simon	
	Raymond Eddah	
Agbledomi	Agbenyadzi Thomas	Farmer

Stakeholder	**Name**	**Position**
	Agbanator E	Farmer
	Michael Nanevi	Elder
Dzita	Agnes Vitasi	
	Believer Ahiaku	
	Albert Dagbui	
	Ahianyo Gabriel	
	Joseph Agbenyese	
	Togbui Azametsi III	Chief of Dzita
	Gagbla Godson	
	Simon C. Ahiada	
	Ahiaku William	
	Ahiaku David	
	Ahiaku Livinston	
	Gagbla Cephas	
Adidome	Rejoice Ntsiri	Journalist, Jubille Radio
	Dr. Simon Soroe	PPO
	Paulina Seddor	National Service Person
	Aaron Osei	Driver

EPA's Response to the Project Registration	Appendix 9.2

Tel: (0302) 664697 / 664698 / 662465
667524 / 0289673960 / 1 / 2
Fax: 233 (0302) 662690
Email: info@epa.gov.gh

Environmental Protection Agency
P. O. Box MB 326
Ministries Post Office
Accra
Website: http://www.epa.gov.gh

CHIEF EXECUTIVE'S OFFICE RECEIVED 0 2 MAR 2016 VOLTA RIVER AUTHORITY

VOLTA RIVER AUTHORITY RECEIVED 0 3 MAR 2016 D.C.E. (E & O)

Our Ref: CE: 5641/01/02

February 26, 2016

The Chief Executive
Volta River Authority
P.O. Box MB 77
Accra-Ghana

Dear Sir,

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)
PROPOSED 75MW WIND POWER PROJECT LOCATED AT ANLOGA EXTENSION (ANLOGA, SROGBE AND ANYANUI) IN THE KETA MUNICIPALITY OF THE VOLTA REGION

We acknowledge receipt of the completed Environmental Assessment Registration Form (EA2) submitted to the Agency for the purpose of obtaining environmental approval for the above proposal in accordance with the Environmental Assessment Regulations 1999 (LI 1652).

The proposal falls in the category of undertakings (Regulation 3) for which Environmental Impact Assessment (EIA) is required to help understand the likely implications of the proposal, the relevant alternatives and mitigations to consider in order to ensure, sound decision-making and sustainable development of the projects.

In line with Regulations 11 of LI 1652 however, you are advised to carry out a scoping exercise to generate the relevant terms of reference (TOR) to guide satisfactory EIA study of the proposal.

Please note that scoping is meant to focus the EIA on the key issues, concerns and decision areas and solicit input and guidance of all relevant stakeholders on the TOR. Scoping notices must be served as appropriate to facilitate stakeholder involvement (see attached sample). Ten (10) hard copies of the scoping report must be submitted for study and agreement on the TOR, prior to the EIA studies.

It is important that the Scoping Report and Environmental Impact Statement contains information on the consultants who prepared the reports. This should include the names, address, email, telephone experience and their specific contribution to the study. Failure to provide this information would render the submission incomplete.

Do not hesitate to consult with the EPA Head Office (Room 305) and the EPA Central Regional Office, Cape Coast for any further guidance you may require in this regard.

Yours faithfully,

John Doghle
PO/EAA Division
For: Executive Director

(3) DESD TNO 4/3/16

(2) DCE (E&O)

copied

cc: The Regional Director, EPA, Volta Region, Ho

(4) Mgr ESI
Fyfa, P.S. 4/3/16

Energy Commission Provisional License, dated 27 July 2015	Appendix 9.3

ENERGY COMMISSION

PROVISIONAL

This is to certify that

VOLTA RIVER AUTHORITY (VRA)

Has been granted a:

PROVISIONAL GENERATION AND WHOLESALE SUPPLY LICENCE

To Generate and Supply Electricity from Wind energy at Anloga and Anyanui in the Keta District of the Volta Region

Licence Number: **EC/GWSL/07-15-073**

Licence valid until : **26TH JULY 2016**

Kwame Ampofo (Dr.)
Board Chairman

Michael Opam
Ag. Executive Secretary

Date: **27TH JULY 2015**

NB: THIS PROVISIONAL LICENCE IS A CONDITIONAL LICENCE AND DOES NOT MANDATE THE HOLDER TO CONSTRUCT OR OPERATE ANY WIND ENERGY PLANT . REFER TO ATTACHED SCHEDULE.

Minutes of the meeting between VRA and GNPC	Appendix 9.4

MINUTES OF THE GNPC SWAOCO (SWISS AFRICAN) PROJECT TEAM MEETING WITH THE VOLTA RIVER AUTHORITY (VRA)

DATE	:	1st November, 2016
VENUE	:	3rd Floor Conference Room, Petroleum House, Tema
TIME	:	10:37 GMT – 11:51 GMT
CHAIRMAN	:	Benjamin Asante, Geophysics and Exploration & Appraisal Manager
AGENDA	:	Discussion of the Impact of the planned Seismic Activities of the Swiss African Project on the VRA Wind Power Project in the Keta Delta area Southern Ghana

ATTENDANCE

GNPC Representatives

Benjamin Asante	Geophysics and Exploration & Appraisal Manager
Eben Apesegah	Geology Manager & Voltaian Basin Team Lead
Alex Prempeh Kwarteng	Chief Petroleum Engineer & OCTP Project Team lead
James K. Agbenorto	Chief Geologist & Keta Block Team Lead
Jochen Schade	Voltaian Basin Project Seismic Manager
Seth Foli	Senior HSE Officer
Kenneth Kofi Agbekomefa Edor	Senior HSE Officer
Edith Moses	HSE Officer
Uzziel Kumanor Tetteh	Voltaian Basin Project Engineer
Nana Adusei Poku	Senior Geomantic Engineer
Fredrick Kofi Osei-Poku	Geomantic Engineer
Joyce Akosua Odei	Voltaian Basin Secretary

VRA Representatives

Ebenezer Antwi	Principal Engineer (Renewable energy & Integrated Development)
Lloyd Kofi Sutherland	Environmental Officer
Kofi Gyekye-Adarkana	Mechanical Engineer

INTRODUCTION

The Chairman for the meeting introduced himself and welcomed both VRA representatives and GNPC staff to the meeting. All the members at the meeting introduced themselves to kick start after safety briefing from Seth Foli.

EPA DIRECTIVE

EPA upon reviewing the Scoping report submitted by VRA for the development of 75MW Wind Power Project has indicated that the location of the Wind Power Project in the Keta Municipality is within the Keta Basin, where seismic activities for Hydrocarbon Exploration are

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to be undertaken by GNPC and its Partners. The meeting will inform both parties (VRA and GNPC) to determine the compatibility of the two projects within the Keta Block.

VRA & GNPC Presentations

GNPC and VRA gave presentations detailing project descriptions, locations, timelines, coordinates of seismic lines and wind farms. Both parties concluded that the two projects were compatible despite difference in timelines.

Presentation Highlights

- The Keta Lagoon Ramsar Site which is an environmentally sensitive area falls within the location proposed for the Keta Delta Exploration as well as the Wind Farms.
- Hydrocarbon exploration targets in the Block are Paleozoic (Devonian) for Onshore areas) and Cretaceous to Devonian for Shallow Water/ Shelf Areas.
- GNPC and partners are aiming to shoot 2D seismic data in March – July 2017.
- GNPC will use explosives as source of energy for the onshore seismic acquisition.
- Access lines will be created for transporting materials and crew. Shot holes of 12m to 15m depths will be drilled for detonation of explosives. Crops destroyed along seismic lines will be compensated for but the destruction will not be permanent as it may be for VRA's transmission lines.
- The decision of GNPC and partners to conduct exploration drilling will depend on the seismic data processing and interpretation. Exploration drilling may have a more permanent footprint on the project area
- Both parties (GNPC/ Partners and VRA) agreed to cooperate as far as necessary to let both projects deliver desirable results in a win-win relationship.
- To make the best decisions concerning both projects, GNPC and VRA resolved to apprise each other and all other stakeholders involved on project plans and updates.
- Philomina Donkor and James Agbenorto were designated as GNPC's key contact representatives for the Swiss-African Keta Delta Project.
- GNPC asked VRA to inform them of any identified impacts of their activities and security and emergency plans for effective collaboration.
- Well Location Planning for new wells will be in 2018; but old well heads from previous exploration drilling have since remained on location.
- The siting of new hydrocarbon wells and Wind Farm structures is expected to be flexible, considering smooth collaboration and information sharing between GNPC/ Partners and VRA.

- VRA's Renewable Energy Development Programme is to be implemented in 2 Phases. The projection of 100-150MW Wind Power is for Phase 1 (2010-2015). Projections for Phase 2 will be determined after the review of the Renewable Energy Development Programme (REDP).
- Anloga, Anyanui and Srogbe sites have been chosen for development of Wind Power Project-1 and Wokumagbe and Goi sites for Wind Power Project -2.
- Noteworthy details of the Wind Power Project-1 Wind Farm include; the Wind Power Plant Capacity of 75MW, Vestas V110 Wind turbine with a diameter of 110m and a hub height of 95m.

- There will be one (1) collector substation at the Srogbe site. The voltage level selected for the electrical internal network is 33 kV.
- The implementation of the proposed project will result in the establishment of 38 individual wind turbines with an approximate generation capacity of 2 MW.
- The average wind speed measured by VRA is approximately 6m/s and the wind direction is predominantly from the South West. The wind speed and wind direction data will inform VRA during the feasibility study for locating each of the wind turbines.
- As per the Project Status:
    - A one year wind measurements was completed in 2014,
    - The Geotechnical Study is to commence in December 2016,
    - The update of the Feasibility Study is scheduled to be completed in Q1 2017 and Land Acquisition scheduled for Q2 2017.
- Feasibility Study and Land Acquisition processes have been initiated.
- It is anticipated that GNPC/ Partners will have finished shooting seismic data before commencement of the construction of the Wind Farm physical structures.
- Geotechnical Study should take VRA about 2 months and the information on subsurface characteristics and Wind speed will influence Geotechnical decisions to be taken.
- Plans and developments on sea defence any other local government infrastructural project should be considered by VRA in the Wind Farm Project.
- Each steel tower with about 3m width and 95m hub height will have a separate turbine.
- The Feasibility study estimates the long-term energy production of the wind farm by correlating the one year wind measurement with long term meteorological data. GNPC advised that solar radiation, atmospheric pressure change and climate change issues, etc. Must be considered as part of the overall environmental studies.
- GNPC indicated that from both presentations, the projects are not likely to interfere much, since the GNPC seismic activities do not affect their site much but indicated that further enquiries and communication between the GNPC and VRA are required.
- Logistic challenges especially transportation of equipment and materials to the Wind Farm project site have been envisaged by VRA.

Action Points

1. More collaboration and exchange of contacts of key persons from GNPC and VRA to ensure that both projects remain technically compatible.
2. Both parties to go through the permitting process with EPA.
3. VRA to submit a copy of the Technical aspects of the Feasibility study to GNPC
4. VRA to exchange key contacts for the VRA Wind Power Projects with GNPC.

Closing remarks

The Chairman thanked the representatives of VRA and GNPC for a successful meeting and encouraged both organizations to continue the good work and collaborate to make both projects succeed.

Recorded by: Joyce Akosua Odei (Voltaian Basin Secretary)

....	....
James K. Agbenorto	Ebenezer Antwi
(Chief Geologist & Keta Block Team Lead)	Principal Engineer (Renewable energy & Integrated Development)

4 | P a g e

VRA Stakeholder Meeting with GNPC on Impact of Oil and Gas exploration on Wind Power Project - 1

November 1, 2016

	Name	Signature	Organisation/Position	Telephone	Email
1.	James Agbenorto	[signature]	GNPC/Chief Geologist		jk.agbenorto@gnpcghana.com
2.	Eben Apesegah	[signature]	GNPC/Geology Manager	0243253515	e.apesegah@gnpcghana.com
3.	Benjamin Kwame Asante	[signature]	GNPC/Geophysics Mgr	0208983663	bk.asante@gnpcghana.com
4.	Alex Prempeh Kwarteng	[signature]	GNPC/Chief Pet Engr	0263010494	AP.KWARTENG@GNPCGHANA.COM
5.	Edith Moses	[signature]	GNPC / HSE	0244794447	e.moses@gnpcghana.com
6.	Fredrick Osei-Poku	[signature]	GNPC/Geomatic Eng.	0246648469	fk.oseipoku@gnpcghana.com
7.	Mana Poku	MHP	GNPC/Geomatic Eng.	0541000500	na.poku@gnpcghana.com
8.	JOCHEN SCHADE	[signature]	GAPS/Seismic Project Mgr		vspseismicpm@gnpcgaps.com
9.	Nii Kotey Amasa	[signature]	GNPC/EHS	0208944221	nk.amasa@gnpcghana.com
10.	Kenneth Edor	[signature]	GNPC EHS	0244403410	kka.edor@gnpcghana.com
11.	FRANCIS OBIRI-YEBOAH	[signature]	GNPC/NSP	0241697133	obiri44@gmail.com

VRA Stakeholder Meeting with GNPC on Impact of Oil and Gas exploration on Wind Power Project - 1

November 1, 2016

	Name	Signature	Organisation/Position	Telephone	Email
12.	Maxama Tali		GNPC/NSP	0267842069	ttufantali@gmail.com
13.	Skuggen Jerome		GNPC/NSP	0261478207	jeromeskuggen@gmail.com
14.	Abdulai S. Nantogmah		GNPC/Geophysicist	0244094240	as.nantogmah@gnpcghana.com
15.	UZZIEL TETTEH		GNPC/Project Engr.	0200029951	uzziel.tetteh@gnpcghana.com
16.	Kofi Gyekye-Adarkwa		VRA/Mech. Engineer		kofi.gyekye-adarkwa@vra.com
17.	Ebenezer Antwi		VRA/Prin. Elect Eng	0202625133	ebenezer.antwi@vra.com
18.	Lloyd Kofi Sutherland		VRA/Env. Officer	0241370926	lloyd.sutherland@vra.com
19.	SETH Foli		GNPC/HSE	0503883438	S.Foli@gnpcghana.com
20.	JOYCE AKOSUA ODEI		GNPC/VOLTAIAN	0572065964	joyceaodei@gmail.com
21.					
22.					

Copies of the correspondences between VRA and Ghana Civil Aviation Authority GCAA	Appendix 9.5

Ghana Civil Aviation Authority

GCAA

Our ref: GCAA/ASAS/813/Vol. 14/1 3rd February, 2014

Your ref:

The Chief Executive Officer
Volta River Authority
P. O. Box MB 77
Accra

ENG. SERVICES DEPT. P.O. Box 77, Akuse
RECEIVED
11 FEB 2014
VOLTA RIVER AUTHORITY

Attn: Director, Environment & Sustainable Development

Dear Sir,

File

RE: WIND POWER PROJECT – PHASE 1

Reference is made to your letter dated 21st January, 2014 on the above subject matter.

The request has been considered, however, before any such approval may be issued, you are to complete and return the attached Form GCAA/SRD/ASAS – 01 to enable Ghana Civil Aviation Authority (GCAA) safety inspectors conduct the necessary aeronautical assessment of the proposed site (s).

GCAA needs to satisfy itself fully that each site for proposed construction of the wind turbine would have no substantial adverse effect on the safe and efficient use of the navigable airspace by aircraft. You are therefore requested to make copies of the attached form for each request.

Yours faithfully,

DANIEL ACQUAH
DIRECTOR, SAFETY REGULATION
FOR: DIRECTOR - GENERAL

cc: Director-General

DCE (Exe)
11/2
2
DGA

3 Mgr Syst Rev
Pls liaise with Director, E+SD on this for early completion + submission
11/2

Private Mail Bag
Kotoka International Airport
Accra, Ghana

Tel: (233)-(30) 2776171
Fax: (233)-(30) 2773293
E-mail: info@gcaa.com.gh

Sita: ACCXTYF
AFTN: DGAAYFYX
Website: www.gcaa.com.gh

Safety & Security, Our Priority

FORM GCAA /SRD/ASAS - 01

OBSTRUCTION EVALUATION APPLICATION FORM (OE/AAA)

NOTICE OF PROPOSED CONSTRUCTION OR ALTERATION

(Failure To Provide All Requested Information May Delay Processing Of Your Notice)

FOR GCAA USE ONLY
Aeronautical Study No

1. Contact

1. Name (person, company, etc proposing this action) ____________

2. Attn. of: ____________

3. Name: ____________

4. Address: ____________

5. Telephone: ____________ 6. Fax: ____________

2. Nature of Proposal

A. Type

☐ New Construction ☐ Alteration

B. Class

☐ Permanent

☐ Temporary (_____ Months, _____ Days)

3. Complete Description of Structure

Description of proposed Construction or Alteration

☐ Mast ☐ Tower ☐ Crane ☐ Building

For Other Specify..

....

....

For Telecommunication Mast/Tower please specify frequency & power of transmission: (a). Frequency
(b). Power

4. Location of Structure (s)

NB: For more than one (1) Structure use additional sheet(s) to indicate requirements 4&5

A. Coordinates:

Latitude: ____° ____' ____"

Longitude: ____° ____' ____"

B. Nearest City/Town/Suburb:

C. Description of site. Please attach topographical map (scale ~1:50,000) from Surveys Dept., Ghana indicating location of proposed structure(s) on the map

5. Height and Elevation (to the nearest foot)

A. Height of Structure including all installations Above ground level (AGL) or water	
B. Elevation of ground above mean sea level (amsl)	
C. Overall Height (i.e. A+B)	

Note: Upon receipt of this proposal, the GCAA inspector will assess the application and provide the applicant with a quotation. If inspection of site (s) is deemed necessary, the applicant will provide transportation to and from the site

I hereby certify that all the above statements made by me are true, complete and correct to the best of my knowledge. In addition, I agree to mark and light the structure in accordance with guidelines provided by GCAA

Date	Name and Title of Person Filing Notice	Signature

FORM GCAA /SRD/AGA - 01

[illegible]	separate acknowledgement
[illegible]	

710/002/242/14

ENV. & SUST. DEV. DEPT.
RECEIVED
DATE 17/3/14

ENV. & SOC. IMPACT SECT.
RECEIVED
DATE 20/3/14

March 13, 2014

The Director General
Ghana Civil Aviation Authority
Private Mail Bag
Kotoka International Airport
Accra

Dear Sir,

RE: WIND POWER PROJECT – PHASE 1

We refer to your letter dated February 3 2014 and referenced GCAA/ASAS/813/Vol.14/1 on the above subject.

As required, we hereby submit eight completed Form GCAA/SRD/ASAS – 01 for each of the eight wind measurement sites with a cadastral map attached for seven sites. The cadastral map for Lekpogunu is not ready therefore there is no cadastral map attached to the filled form for Lekpogunu for your information.

We will resubmit the filled Form GCAA/SRD/ASAS-01 for the Lekpogunu site with the cadastral maps attached when it is ready.

Please contact us if you require any further information or clarification.

Yours faithfully,

INFORMATION COPY
ORIGINAL SIGNED BY
E. A. ASOMONTSI

pp Ing. William E. Sam-Appiah
DIRECTOR, ENGINEERING SERVICES

ENCL

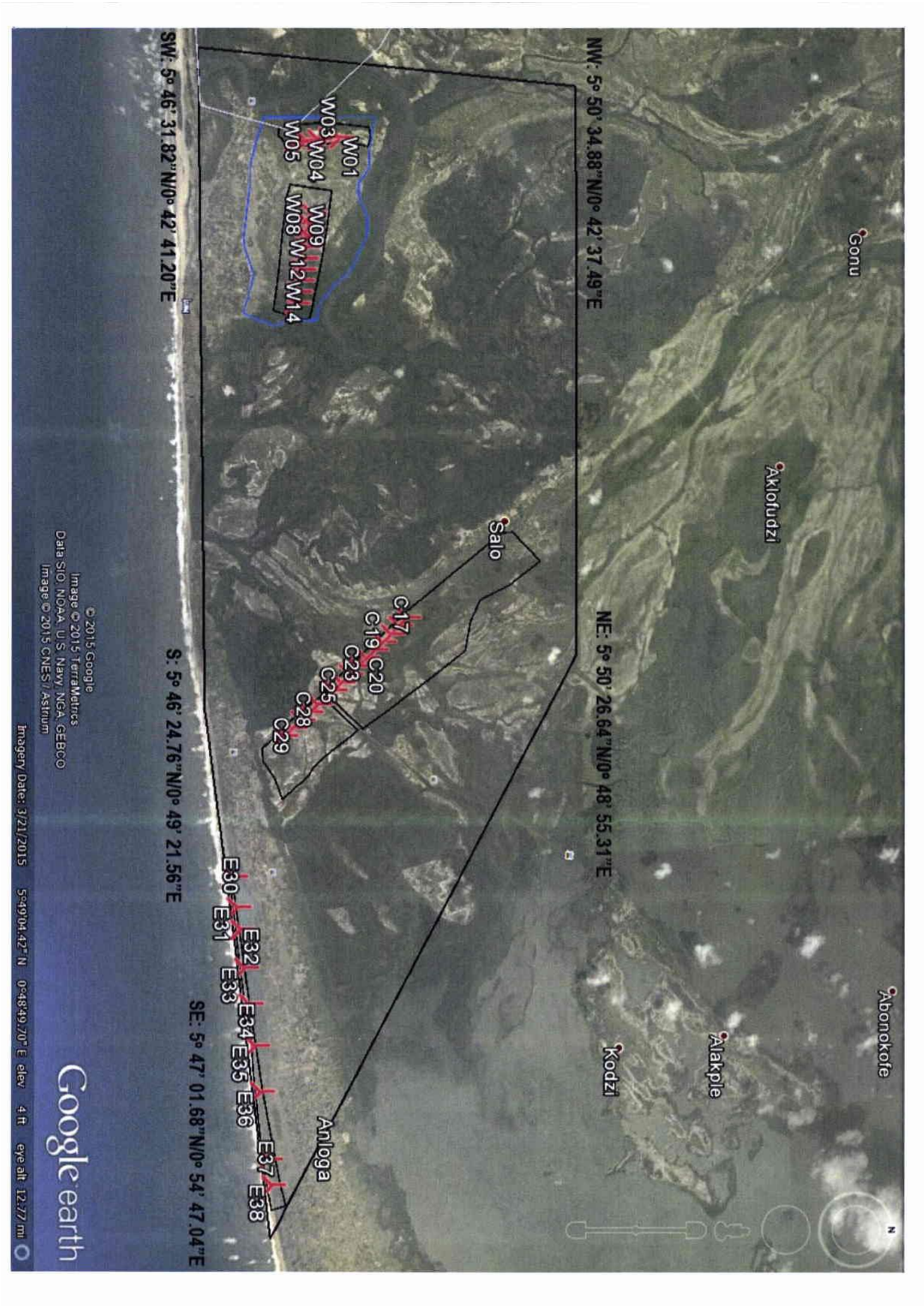
bcc: Deputy Chief Executive (E&O)
Director, E&SD ✓ TWO 20/3/14
Manager, System Development
Manager, Project Management
Corporate Registry

Mgr. ESI
Fyiwa DS. KAP 21/3/14
TWO 20/3/14

KG–A/kg-a

PBC
F. I, PF KAP 21/3/14


Windfarm information
Created by:
Lahmeyer Int. Ing.Gesellschaft
Friedberger Strasse 173
DE-61118 Bad Vilbel
Exported from WindPRO
http://www.WindPRO.com
Dawa
Sege
N:5° 51' 09.81"N/0° 17' 57.06"E
W: 5° 47' 56.41"N/ 0° 18' 15.07"E
S: 5° 47' 11.80"N/ 0° 19' 50.89"E
E: 5° 48' 34.52"N/ 0° 20' 19.90"E
W:5° 48' 09.51"N/0° 22' 28.31"E
N:5° 48' 57.80"N/0° 23' 32.59"E
S:5° 47' 23.61"N/0° 23' 28.45"E
Lek_A-01
Lek_A-02
Lek_A-03
Lek_A-04
Lek_A-05
Lek_A-07
Lek_A-08
Lek_A-09
Lek_A-10
Lek_B-11
Lek_B-12
Lek_B-13
Lek_B-14
Lek_B-15
Lek_B-16
Lek_B-17
Lek_B-18
Lek_B-19
Lek_B-20
Lek_B-21
Lek_B-22
Lek_B-23
Lek_B-24
Akl_C-26
Akl_C-29
Akl_C-30
Akl_D-31
Akl_D-34
Akl_D-37
Akl_D-38
Lekpoguno
Akplabnya
Image © 2015 TerraMetrics
© 2015 Google
Image © 2015 DigitalGlobe
Image © 2015 CNES / Astrium
Imagery Date: 3/21/2015
5°49'12.36" N 0°20'44.96" E elev 5 ft eye alt 40140 ft
2013
Google earth


NW: 5° 50' 34.88"N/0° 42' 37.49"E
NE: 5° 50' 26.64"N/0° 48' 55.31"E
SW: 5° 46' 31.82"N/0° 42' 41.20"E
S: 5° 46' 24.76"N/0° 49' 21.56"E
SE: 5° 47' 01.68"N/0° 54' 47.04"E
Gonu
Aklofudzi
Abonokofe
Alakple
Kodzi
Salo
Anloga
W01
W03
W04
W05
W08
W09
W12
W14
C17
C19
C20
C23
C25
C28
C29
E30
E31
E32
E33
E34
E35
E36
E37
E38
© 2015 Google
Image © 2015 TerraMetrics
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2015 CNES / Astrium
Imagery Date: 3/21/2015
Google earth

VOLTA RIVER AUTHORITY

710/002/242/14

ENCL

Ghana Civil Aviation Authority

GCAA

Our ref: CAA/FIN.ADMIN/104/16

Your ref:

1st September, 2016

The Ag. Director of Engineering Services
Volta River Authority
Electro Volta House
P. O. Box MB 77
Accra

Dear Sir,

RE: APPLICATION FOR AIRSPACE SAFETY PERMIT

We refer to your letter dated 12th June, 2015 referenced 710/002/419/2015 seeking advice on the lighting and painting requirements for wind turbines which will be located at Anloga-Anyanui and Wokumagbe-Goi sites.

Please be advised that the issuance of this Permit would attract a fee of **GH¢8,000.00.**

Please arrange payment of **GH¢8,000.00** at the GCAA headquarters Cash Office and submit a duplicate of the receipt to the ASAS section of the Safety Regulations Department for further processing.

In addition, Volta River Authority would be responsible for the Inspectors transportation to and fro.

Yours faithfully,

WILLIAM AFORTUDE
AG.DIRECTOR OF FINANCE
FOR: DIRECTOR-GENERAL

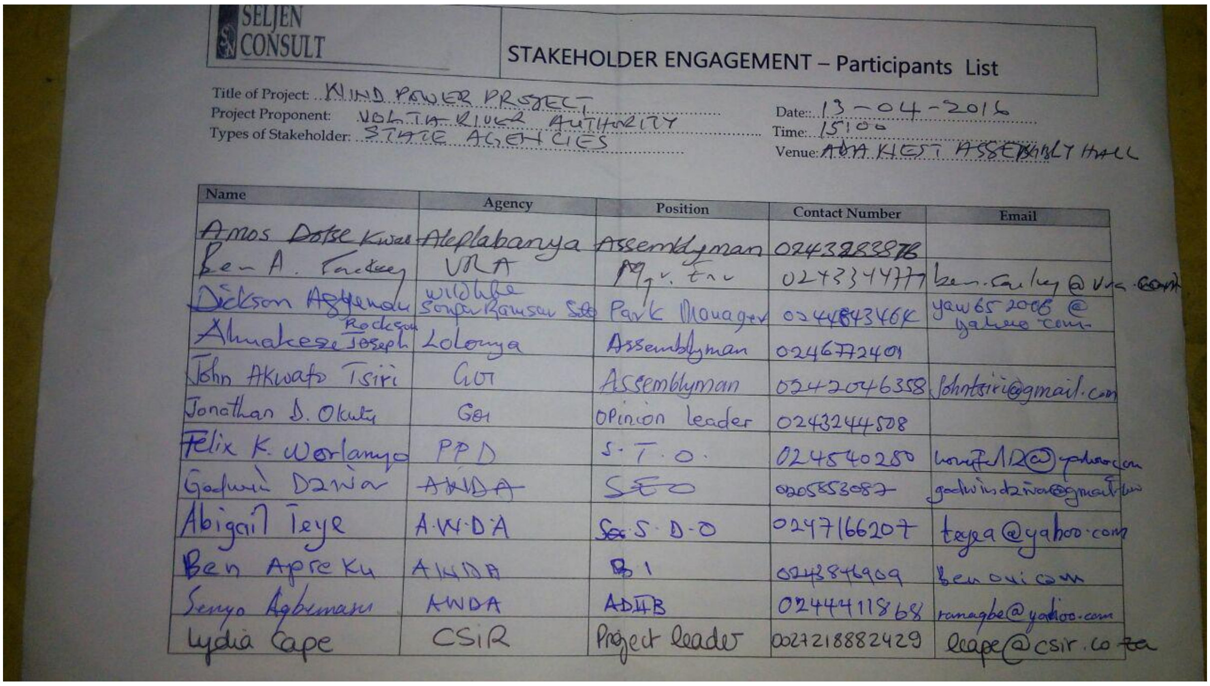
CC: Director-General
Deputy Director-General (Technical)
Director of Safety Regulations
Manager, ASAS

File
KGA 10/10/2016

KG-A 10/10/2016

Lets arrange for payment and find out about inspectors.
20/09/16

The signed List of participants at the State agency's forum	Appendix 9.6



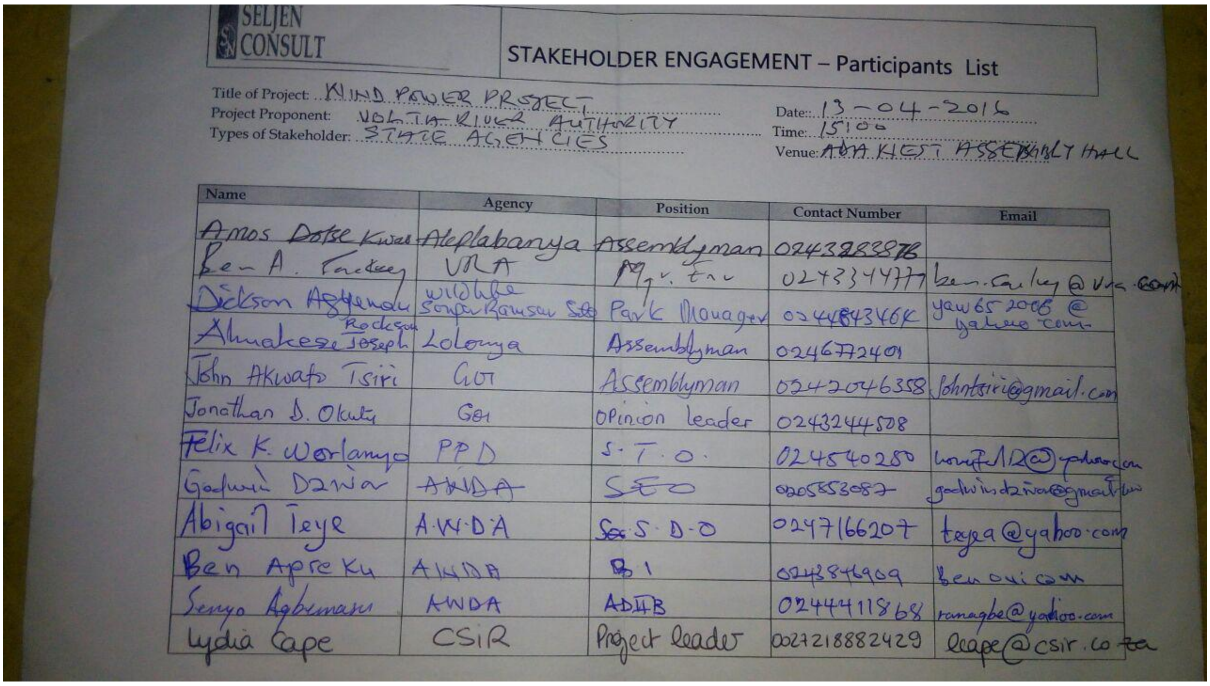
SELJEN CONSULT

STAKEHOLDER ENGAGEMENT – Participants List

Title of Project: WIND POWER PROJECT
Project Proponent: VOLTA RIVER AUTHORITY
Types of Stakeholder: STATE AGENCIES

Date: 13-04-2016
Time: 15:00
Venue: ADA KIEST ASSEMBLY HALL

Name	Agency	Position	Contact Number	Email
Amos ~~Dotse~~ Kwao	Aleplabanya	Assemblyman	0243283876	
Ben A. Tackey	VRA	Mgr. Env	0243344777	ben.tackey@vra.com
Dickson Agyenadu	Wildlife Songor Ramsar Site	Park Manager	0244843460	yaw65 2006 @ yahoo.com
Ahiakese Rockson Joseph	Lolonya	Assemblyman	0246772401	
John Akwafo Tsiri	GOT	Assemblyman	0242046358	Johntsiri@gmail.com
Jonathan D. Okutu	GOI	Opinion leader	0243244508	
Felix K. Worlanyo	PPD	S.T.O.	0245440280	[illegible]
Godwin Dzwiar	~~ANDA~~	SEO	0205853087	godwindzwiar@gmail.com
Abigail Teye	A.W.D.A	~~Sec~~ S.D.O	0247166207	teyea@yahoo.com
Ben Apreku	AWDA	B1	0243846909	ben oui com
Senyo Agbemasu	AWDA	ADIIB	0244411868	ranagbe@yahoo.com
Lydia Cape	CSIR	Project leader	0027218882429	lcape@csir.co.za



SELJEN CONSULT

STAKEHOLDER ENGAGEMENT – Participants List

Title of Project: WIND POWER PROJECT
Project Proponent: VOLTA RIVER AUTHORITY
Types of Stakeholder: STATE AGENCIES

Date: 13-04-2016
Time: 15:00
Venue: ADA KIEST ASSEMBLY HALL

Name	Agency	Position	Contact Number	Email
Amos ~~Dotse~~ Kwao	Aleplabanya	Assemblyman	0243283876	
Ben A. Tackey	VRA	Mgr. Env	0243344777	ben.tackey@vra.com
Dickson Agyenadu	Wildlife Songor Ramsar Site	Park Manager	0244843460	yaw65 2006 @ yahoo.com
Ahiakese Rockson Joseph	Lolonya	Assemblyman	0246772401	
John Akwafo Tsiri	GOT	Assemblyman	0242046358	Johntsiri@gmail.com
Jonathan D. Okutu	GOI	Opinion leader	0243244508	
Felix K. Worlanyo	PPD	S.T.O.	0245440280	[illegible]
Godwin Dzwiar	~~ANDA~~	SEO	0205853087	godwindzwiar@gmail.com
Abigail Teye	A.W.D.A	~~Sec~~ S.D.O	0247166207	teyea@yahoo.com
Ben Apreku	AWDA	B1	0243846909	ben oui com
Senyo Agbemasu	AWDA	ADIIB	0244411868	ranagbe@yahoo.com
Lydia Cape	CSIR	Project leader	0027218882429	lcape@csir.co.za

Name	Agency	Position	Contact Number	Email
ABULELE ADAMS	CSIR	PROJECT MANAGER	+27722398220	aadams1@csir.co.za
GILBERT AKABA	ADA WEST DA	AG. DCD	0243735536	akabagilbert@ymail.com
AYERTEY WILSON	NADMO	Dep. COORDINATOR	0243437531	
Kofi Gatu	SELJEN CON	Tech. Director	0208434557	kofi.gatu@gmail.com
Daniel Barkeley	AWDA	E.O	0240897980	danielbbort7@gmail.com
Frank Cudjoe	SELJEN Consult	Comp. Action Plan	0242807339	Cudjoefrank28@yahoo.com
REUBEN ADASE	AGRIC	DISTRICT DIRECTOR	0242116573	reudase@yahoo.com
YVONNE ARHIN	AWDA	Procurement	0242934631	yvonne.arhin@yahoo.com
Bernice Okornoe	AWDA	✓	0272188665	bbokornoe@yahoo.com
STEPHEN CHARWETEY	WOKUMA GBE	ASSEMBLY MEMBER	0502716326	Ksent2000@yahoo.com
SUMAILA TETTEH-KPAKPAH	"	OPINION LEADER	0242731752	
ASIEDU ASARE	AWDA	Tech. ENGINEER	0242963975	eugeneasiedu12@yahoo.com
Bosompem Cleopatra	AWDA	Works dept	0249391316	cleopatrab566@gmail.com
Dornu Reuben	AWDA	WORKS DEPT.	0242604798	dornureuben@yahoo.com

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SELJEN CONSULT | **STAKEHOLDER ENGAGEMENT – Participants List**

Title of Project: 150MW WIND POWER PROJECT Date: 13 - 04 - 2016
Project Proponent: .... Time: ....
Types of Stakeholder: .... Venue: ....

Name	Agency	Position	Contact Number	Email
1. Dompre Samuel	KeMA	MUN. Engineer	0242906124	dompresamuel@yahoo.com.
2 Nicholas Nai Adjei	KeMA	MCD	0246870470	quaonick@gmail.
3 Lydia Cape	CSIR	Project Manager	0027218882429	lcape@csir.co.za
4 Abulele Adams	CSIR	Project Manager	0027218882408	aadams@csir.co.za
5 Abdul-Kareem Fuseini	WILDLIFE DIVISION OF FORESTRY COMM	Site Manager	0243168865	yambafuka@yahoo.com
6 Anttoinette Aheto	KeMA	Procurement officer	0243576555	babyselikem@gmail.com
7 Kofi Gatu	SELJEN	Tech Director	0208434557	seljencon@gmail.com
8 Ebenezer Antwi	VRA	Prn. Elect. Eng.	0202625433	ebenezer.antwi@vra.com
9 Frank Cudjoe	SELJEN	Comp. Action Plan	0242807339	cudjoefrank28@yahoo.com
10 Jennifer Glover	Dept of Co-op	Ass Co-op Officer	0208831144	jennifer-glover15@yahoo.com
11 Ben A. Sackey	Mgr., ESI, VRA	Mgr. ESI	0243344779	ben.sackey@vra.com
12 Lloyd K. Sutherland	Environmental Officer, V.R.A	Env. Officer	0241370926	lloyd.sutherland@vra.com

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SELJEN CONSULT

STAKEHOLDER ENGAGEMENT – Participants List

Title of Project: ………………………………………… Date:: ……………………………
Project Proponent: ………………………………………… Time: ……………………………
Types of Stakeholder: ………………………………………… Venue: ……………………………

	Name	Agency	Position	Contact Number	Email
13	JERRY ZIDDAH	ENV'TAL HEALTH	MUNICIPAL OFFICER	0244864163	ziddahkay@yahoo.com
14	GODWIN K. AGBENYO	NCCE	MUNICIPAL DIRECTOR	0244414336	agbenyo2009@gmail.com
15	EDITH TAY	COMM. DEV	MUNICIPAL ~	0243226013	edithtay.hayoo.com
16	DOMINIC KPODO	NADMO	ADMINISTRATION	0242120481	nyonyokpodo@gmail.com
17	Daniel Nyatsu	WORKS Estate	Asst. Chief Estate Officer	0542173584	~
18	Joana Bruce Dei	Information Services Dept Rep	Journalist	0543069765	brucejoydei@gmail.com
19	Faustina Baddoo	Dept of Soc Welfare	MSWO	0208960858	faustinabaddoo@yahoo.com
20	GIFTY TAGOE	FIRE SERVICE	2 I/C / ADMIN	0548851113	tagoeturner@yahoo
21	Celestina A Attipoe	Dept. Comm. Dev	Mun. Officer	0208166286	celeati@yahoo.com
22	Aaron Teku	Mun. Works Dept.	Engineer	0246229016	aarontek2006@yahoo.com
23.	SAGODO BENJAMIN	DEPT OF AGRIC	MUN. DEVT. OFFICER	024 263 5303	bmksagodo@gmail.com

1 | Page

Comments from the EPA have been included in (letter dated September 14, 2016).	**Appendix 9.7**

Tel: (0302) 664697 / 664698 / 662465
667524 / 0289673960 / 1 / 2
Fax: 233 (0302) 662690
Email: info@epa.gov.gh

Environmental Protection Agency
P. O. Box MB 326
Ministries Post Office
Accra
Website: http://www.epa.gov.gh

Our Ref: CE: 5641/01/05

September 14, 2016

The Chief Executive
Volta River Authority
P.O. Box MB 37
Accra-Ghana

Dear Sir,

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)
PROPOSED 75MW WIND POWER PROJECT 1 LOCATED AT ANLOGA EXTENSION (ANLOGA, SROGBE AND ANYANUI) IN THE KETA MUNICIPALITY OF THE VOLTA REGION

We acknowledge receipt of the Scoping Report on the above proposal submitted to the Agency for the purpose of obtaining environmental approval in accordance with the Environmental Assessment Regulations 1999 (LI 1652).

The report has been reviewed and found to be generally satisfactory.You are therefore advised to proceed with the Environmental Impact Assessment study taking into consideration the attached comments and submit **Eight (8) hardcopies** of a draft Environmental Impact Statement (EIS) to the Agency.

You are by this letter reminded to make payment of the processing fee invoice issued to you earlier and submit the Ecobank payment receipt to the Agency.

Do not hesitate to contact the Agency for any further clarification you may require in this regard.

Yours Faithfully

KWABENA BADU-YEBOAH
AG. DIRECTOR/EAA DIVISION
FOR: EXECUTIVE DIRECTOR

Cc
The Regional Director, EPA, Volta Region, Ho

Tel: (0302) 664697 / 664698 / 662465
667524 / 0289673960 / 1 / 2
Fax: 233 (0302) 662690
Email: info@epa.gov.gh

Environmental Protection Agency
P. O. Box MB 326
Ministries Post Office
Accra
Website: http://www.epa.gov.gh

Our Ref: CE: 5639/01/05 **September 14, 2016**

The Chief Executive
Volta River Authority
P.O. Box MB 37
Accra-Ghana

Dear Sir,

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)
PROPOSED 75MW WIND POWER PROJECT 2 LOCATED AT WOKUMAGBE AND GOI IN THE ADA WEST DISTRICT OF THE GREATER ACCRA REGION

We acknowledge receipt of the Scoping Report on the above proposal submitted to the Agency for the purpose of obtaining environmental approval in accordance with the Environmental Assessment Regulations 1999 (LI 1652).

The report has been reviewed and found to be generally satisfactory. You are therefore advised to proceed with the Environmental Impact Assessment study and submit **Eight (8) hardcopies** of a draft Environmental Impact Statement (EIS) to the Agency.

You are by this letter reminded to make payment of the processing fee invoice issued to you earlier and submit the Ecobank payment receipt to the Agency.

Do not hesitate to contact the Agency for any further clarification you may require in this regard.

Yours Faithfully

KWABENA BADU-YEBOAH
AG. DIRECTOR/EAA DIVISION
FOR: EXECUTIVE DIRECTOR

Cc: The Regional Director, EPA, Accra East Region, Tema

SCOPING REVIEW COMMENTS: 75MW WIND POWER PROJECT 1 LOCATED AT ANLOGA EXTENSION (ANLOGA, SROGBE AND ANYANUI) IN THE KETA MUNICIPALITY OF THE VOLTA REGION.

- The project location falls within the Keta basin where seismic activities are ongoing for oil and gas. Consultation with Ghana National Petroleum Corporation (GNPC) to determine the compatibility of the two projects
- Provide the following information;
  - Attach evidence of legal acquisition of the Site to be used for the project since the report indicates that the site is yet to be acquired
  - Indicate the specific locations of turbines in the EIS
  - Carry out geotechnical survey of the proposed site and present the outcome in the EIS
- The advertisement on the scoping should have been done alongside the review. (submission). Attach a copy of the scoping notice to the EIS

ENVIRONMENTAL PROTECTION AGENCY

INVOICE FOR PROCESSING FEE

0004484

Department: EAA
Departmental Code: 107
Date: 27/9/16

EPA/HO/PAF0001

Billing Address: Volta River Authority
Company's Name:
Addresss: Anloga Extension

Phone No: 0244770526
Email Address:

For Processing fee only
Head Office
P.O. Box MB 326,
Ministries-Accra
Phone: +233-302-664697/8
+233-28-9673961-2
Email address: support@epaghana.org

NO.	DESCRIPTION	AMOUNT (Gh₵)
	Being payment of processing fee for wind power project (75 MW)	5,000
	TOTAL	5,000

Amount in words: Five thousand Ghana cedis

Issued by: Name: Maggie Adade Signature:

NOTES
1. Invoice remains valid for 90 days
2. Invoice number must be quoted at the back of any draft
3. All payments are payable to Environmental Protection Agency, Head Office
4. Use the contacts above if you have any questions concerning this invoice

Thank You

ENVIRONMENTAL PROTECTION AGENCY

INVOICE FOR PROCESSING FEE

0004485

EPA/HO/PAF0001

Department: EAD
Departmental Code: 107
Date: 27/9/16

Billing Address: Volta River Authority
Company's Name:
Addresss: Wokumagbe

Phone No: 0244370926
Email Address:

For Processing fee only

Head Office
P.O. Box MB 326,
Ministries-Accra
Phone: +233-302-664697/8
+233-28-9673961-2
Email address: support@epaghana.org

NO.	DESCRIPTION	AMOUNT (GH¢)
	Being payment of processing fee for wind power project (75 MW)	5,000
	TOTAL	5,000

Amount in words: Five thousand Ghana cedis

Issued by: Name: Margie Adadey **Signature:**

NOTES

1. Invoice remains valid for 90 days
2. Invoice number must be quoted at the back of any draft
3. All payments are payable to Environmental Protection Agency, Head Office
4. Use the contacts above if you have any questions concerning this invoice

Thank You

VRA to Ghana Highway Authority	Appendix 9.8

VOLTA RIVER AUTHORITY

Our Ref: 710/066/17
Your Ref:
Date: March 3, 2017

The Chief Executive Officer
Ghana Highway Authority
Post Office Box M57
Accra

Dear Sir,

VRA'S RENEWABLE ENERGY DEVELOPMENT PROGRAMME

150MW WIND POWER PROJECT

We refer to your letter referenced BD/230/Vo/4/17/1763 and dated February 19, 2017 on the above subject submitting cost estimate for the assessment of the bridges and other structures along the proposed route and also requesting for additional information.

We advise as follows:

- The height of loaded trailer: **5.5m**
- The width of the load and trailer: **5.5m**
- The axle configuration: refer to the attached document

We however wish to advise that we are currently at the planning stages of this project and will revert to you when the assessment of the bridges and other structures along the proposed route can be carried out more accurately with additional data from the prospective Contractor.

Thank you and we appreciate your prompt response and corporation.

Yours faithfully,

Ing. Charles K. O. Addo
Director, Engineering Services

Encl:

Received
7/03/2017

Electro Volta House - P. O. Box MB 77, Accra, Ghana. Phone: +233 30 - 2664941-9 Fax: +233 30 2662610

Comments received during the review of the BID and the Scoping Report	**Appendix 9.9**

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
January 12, 2016	Land owners	Keta Municipal Assembly	1. The landowners enquired about the distance of the buffer zones for the wind farms and how this will affect the land use in those areas. They explained that due to the limited available land, VRA should consider smaller buffer zones or an arrangement with farmers to farm in the buffer zones. They indicated that the project should be beneficial to the communities and that the project should not be unduly delayed.	The ESIA will determine the safe buffer zones for the wind farm and the Compensation Action Plan will determine any social interventions required by the project.
February 5, 2016	Klevi Clan of Anyanui	House of a Community Elder	2. They have been briefed on the project by the personnel from the VRA	No Response needed.
			3. They are glad that their community has been chosen for such a project	No Response needed.
			4. They want the negotiation for the acquisition of their land done quickly and the payment done promptly	This will be done after the project site has been properly demarcated and the total area clearly determined
			5. They expect the other packages such as scholarships and provision other social amenities for the people	The Compensation Action Plan and the VRA's Social Responsibility Program will adequately address this concern
			6. They want workers to be recruited from the community	The Local content policy of VRA will be applicable to the project and the contractor will be required to consider locals for recruitment. The contractor will also be advised to consider this proposal from the community. However, this will be dependent on the skill set available within the community and what is required to successfully execute the project.

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
			7. They want workers to respect their traditions and observe festivals	These issues are being captured during the ESIA study and will be made known to the contractor for adherence. The workers and the entire team will be adequately briefed on these traditional rights and festivals.
			8. They are prepared to share the compensation with the 'Bate' clan.	VRA is grateful for this decision
			9. They will allow the project to continue while they resolve the ownership issues.	VRA is grateful for this decision and would be most obliged if the process is facilitated
February 5, 2016	Community heads of Wededeanu (Anyanui)	Fetish Priest's House	1. They are happy that their community has been chosen	No Response needed.
			2. They will want adequate compensation for their farm lands and crop	Property evaluation will be done and payment effected in line with requirements of the Lands Commission.
			3. They are concerned that the presence of the project will affect their health and reduce the level of rain they receive.	Associated impacts like noise and shadow flicker are being investigated and the siting of the turbines will be done in order to mitigate these. Meanwhile, there is no evidence that the presence of the proposed wind power project will affect the level of rain receive in that community.
			4. They should be considered in the recruitment especially as securities, masons etc.	This will be dependent on the skill set available within the community and what is required to successfully execute the project. Meanwhile, the Local content policy of VRA will be applicable to the project and the contractor will be required to consider locals for recruitment
February 5, 2016	Community heads of Tunu (Anyanui)	Community Meeting Place	1. The community heads are not aware of the project development and what it entails.	Details of the project was explained to them
			2. If land is to be acquired, VRA should endeavour to pay adequate compensation for loss of farm lands and crops.	Development of the Compensation Action Plan will adequately address this concern

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
			3. The issue of local content be considered critically and local labour should be considered during recruitment.	The Local content policy of VRA will be applicable to the project and the contractor will be required to consider locals for recruitment. The contractor will also be advised to consider this proposal from the community. However, this will be dependent on the skill set available within the community and what is required to successfully execute the project.
			4. VRA should endeavor to provide other packages such as scholarships and provision other social amenities for the people	The community will benefit from the VRA's Community Development programme which provides among others, educational scholarships to needy students in project impacted communities.
February 7, 2016	Barteh Clan of Anyanui	Chief's House	1. They believe they are the true owners of the land as a result they are not happy that the Klevi clan has been consulted for the release of the land for the project instead of the Barteh Clan.	VRA requested them to resolve the land ownership issues with the Klevi Clan so that compensation would be paid to the rightful owner. Meanwhile, it is only when the rightful is determined that any money can be issued, thus, any delay in resolving the land ownership will also result in compensation payment delays.
			2. They were however, happy that their area is being considered for the siting of the project.	VRA is grateful for this decision
			3. They will allow the project to continue while they resolve the land ownership issues.	VRA is grateful for this decision and would be most obliged if the process is facilitated
February 7, 2016	Traditional Heads of Anloga	House of the Clan Head	1. They have been briefed on the project by the personnel from the VRA and have been promised an advance payment of 30% for lands to be acquired.	Any initial part payment to be made will be dependent on the completion of the land acquisition process which is currently being firmed up with the help of the Lands Commission.
			2. VRA should endeavor to provide other packages such as scholarships and provision other social amenities for the people.	The community will benefit from the VRA's Community Development programme which provides among others, educational scholarships to needy students in project impacted

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
				communities.
			3. The issue of local content be considered critically and local labour should be considered during recruitment.	The Local content policy of VRA will be applicable to the project and the contractor will be required to consider locals for recruitment. The contractor will also be advised to consider this proposal from the community. However, this will be dependent on the skill set available within the community and what is required to successfully execute the project.
			4. Construction workers should endeavor to respect traditions and observe festivals.	These issues are being captured during the ESIA study and will be made known to the contractor for adherence. The workers and the entire team will be adequately briefed on these traditional rights and festivals.
February 9, 2016	Keta Municipal Assembly	Office of Municipal Coordinating Director	1. Government was glad the power project is being brought to the country as it will augment power production in the country and that VRA has made the Keta Municipality aware of the wind power project since 2014	No Response needed.
			2. A forum was organized for land owners sometime in January 2016 and concerns raised at the forum is that the project implementation seems to delay and this is causing anxiety amongst the affected landowners	Projects development in the power sector is quite laborious and requires a number of studies to come to a final decision on exactly what is to be done. It is therefore important that land owners and the municipality in general exercise some patience since a project of such magnitude requires several processes including the Wind Measurement and ESIA before actual construction.

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
			3. As a Municipality, we are happy of this intention by the client/proponent and we are willing and ready to provide all the necessary support towards this project from our end.	VRA is grateful for this decision
			4. A key issue in our District is the acquisition of land and land ownership matters. We request this is taken into key considerations before the actual project development commences.	VRA recognises that compensation issues are key to the success of the project. To facilitate compensation payments, Land owners are urged to have a proper land title document to their property. VRA will also conduct further checks to determine the true owners of the land before compensations are paid.
			5. We request the client engage the assembly men to identify key hotspots for consideration in the project development. Also, there should be that corporate social responsibility effort from the client during the project development towards the affected communities.	It is planned to engage the assembly members specifically to serve as contact person for any grievances that will arise. The community will benefit from the VRA's Community Development programme which provides among others, educational scholarships to needy students in project impacted communities.
			6. Data on district is available in the Medium Term Development Plan and would be made available to SCL for use in the ESIA.	VRA is grateful for this decision
			7. VRA should also look at its impact on previous projects like the Akosombo hydropower which has resulted in sea erosion and the formation of sand bars of over 4-6m high along the shore at Keta.	This issue is well noted and there will be a flood risk assessment as well as wetland assessment to determine mitigative measures to be implemented during construction and operation of the project.
February 9, 2016	Keta Municipal Health Directorate	Office of Municipal Public Health Nurse	1. Accidents, robbery and baby delivery mostly happen during the nights, thus generation of electricity is very important to the health service.	No Response needed.

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
			2. Its good VRA is looking at alternative sources of power to supplement current supply as inadequate power supply is affecting health delivery in the district especially for storage of drugs.	No Response needed.
			3. They however haven't heard of the project and would be grateful if detail information so they can make informed input	Background information document on the project was made available to them at the meeting. This document contains all issues there is to the project
			4. Data on district health is available and would be made available to SCL for use in the ESIA	VRA is grateful for this decision
February 9, 2016	Keta Municipal Education Directorate	Office of Public Relations Officer	1. They haven't heard of the project and would be grateful if detail information so they can make informed input.	Background information document on the project was made available to them at the meeting. This document contains all issues there is to the project
			2. Data on district education is available and would be made available to SCL for use in the ESIA	VRA is grateful for this decision
February 9, 2016	Traditional Heads of Srogbe	Compound of House of Stool Father	1. They have been briefed on the project by the personnel from the VRA.	No Response needed.
			2. They are glad that their community has been chosen for such a project	No Response needed.
			3. They want the negotiation for the acquisition of their land done quickly and the payment done promptly.	This will be done after the project site has been properly demarcated and the total area clearly determined. VRA recognises that compensation issues are key to the success of the project. To facilitate compensation payments, Land owners are urged to have a proper land title document to their property. VRA will also conduct further checks to determine the true owners of the land before compensations are paid.

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
			4. They expect the other packages such as scholarships and provision other social amenities like schools, improvement in the road network for the people	The community will benefit from the VRA's Community Development programme which provides among others, support for educational activities including scholarships, community infrastructure, health, environmental management, among others in project impacted communities.
			5. They want workers to be recruited from the community	The Local content policy of VRA will be applicable to the project and the contractor will be required to consider locals for recruitment. The contractor will also be advised to consider this proposal from the community. However, this will be dependent on the skill set available within the community and what is required to successfully execute the project.
			6. They want workers to respect their traditions and observe festivals	These issues are being captured during the ESIA study and will be made known to the contractor for adherence. The workers and the entire team will be adequately briefed on these traditional rights and festivals.
February 9, 2016	Community heads of Gblife Community (Anyanui)	House of Acting Chief	1. They are not aware of the project and what it entails	Background information document on the project was made available to them at the meeting. This document contains all issues there is to the project
			2. They will want adequate compensation for their farm lands and crop	This will be done after the project site has been properly demarcated and the total area clearly determined. VRA recognises that compensation issues are key to the success of the project. To facilitate compensation payments, Land owners are urged to have a proper land title document to their property. VRA will also conduct further

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
				checks to determine the true owners of the land before compensations are paid.
			3. They are concern that the presence of the project will affect their health	Associated impacts like noise and shadow flicker are being investigated and the siting of the turbines will be done in order to mitigate these.
			4. They should be considered in the recruitment especially as securities, masons etc.	The Local content policy of VRA will be applicable to the project and the contractor will be required to consider locals for recruitment. The contractor will also be advised to consider this proposal from the community. However, this will be dependent on the skill set available within the community and what is required to successfully execute the project
			5. They expect the other packages such as scholarships and provision other social amenities for the people	The community will benefit from the VRA's Community Development programme which provides among others, support for educational activities including scholarships, community infrastructure, health, environmental management, among others in project impacted communities.
April 13, 2016	State Agencies within Keta Municipality	Office of the Municipal Coordinating Director	1. What are the impacts on the local people with respect to resettlements?	An area of approximately 177.46 ha of land is required and would be acquired for the projects. This will result in loss of livelihood for land owners and farmers who utilise the land for agricultural and other socio-economic activities. These lands will be valued and compensation paid for. A Compensation Action Plan will be developed to adequately address this concern.

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
			2. What will be the impact on power generations when the estimated wind speed reduces during project operations?	The project is expected to add on to the net power generated in the country. As with very other source of power, its ability to generate electricity will be affected by one factor or the other. VRA is developing a portfolio of power plants to ensure that there is back up in the event that any is affected.
			3. Compensation issues are very critical to the local people thus, the project should ensure adequate and prompt compensation.	Property evaluation will be done and payment effected in line with requirements of the Lands Commission.
			4. The development on the Akosombo Dam has negatively affected the socio-economic life of the people of Keta, and therefore how assured are they that this current project will not impact same?	The level of impact associated with hydro power is very different from that of the wind power. VRA is undertaken a socio-economic study of the project and all issues regarding this will be assessed and relevant mitigative measures provided and implemented.
			5. Can VRA help farmers who pump underground water for their crops have reduced electricity tariffs?	This will require an advocacy effort and farmer groups should lead the discussion with the Municipal Assembly
			6. Will the cost of wind power generated be very different from that of hydro and thermal power?	Each source of power has its own cost. Wind power is far more expensive that thermal which is also more expensive than hydro. However, PURC will consolidate the various costs within the energy mix and charge one fee to customers.
			7. Cant VRA provide solar energy in the communities?	VRA is mandated to supply bulk power and therefore does not undertake home connection. However, Energy Commission is now involved in the promotion of home solar panels and should be contacted on such issues.
			8. VRA should endeavour to adhere to all fire requirements associated with the project development	The project will require a Fire permit, thus, VRA will formally notify the GNFRS of the project development to enable them inspect and advise on fire requirements.

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
			9. How will the project mitigate the impact on birds, as the project is located close to the Keta Lagoon Complex Ramsar site, which is known to harbour significant number of birds?	A birds study is underway to assess the impacts on birds and provide mitigative measures as required.
			10. Has VRA considered boosting the tourism potential to be realised from the development of the project?	This will be the role of the Keta Municipal assembly and therefor there is the need to start considering its impact in the Municipal developmental agenda.
			11. Information sharing should be a key part of the project so that the Keta Municipal will be apprised with project development issues.	This is a key part of the project to ensure success and VRA will at every step make the affected assembly aware of project status and challenges

Correspondences between VRA and Ministry of Lands and Natural resources	Appendix 9.10

VOLTA RIVER AUTHORITY

Our Ref: EXE/1090/012/1074
Your Ref:
Date: November 15, 2016

The Minister
Ministry of Lands and Natural Resources
P.O. Box M212
Accra
Tel: 0302-672336

Attn: Hon. Nii Osah Mills

Dear Sir,

VRA RENEWABLE ENERGY DEVELOPMENT PROGRAMME:

WIND ENERGY DEVELOPMENT AT WOKUMAGBE AND GOI

We refer to the Stakeholder meeting which was held at the Ada West District Assembly on October 20, 2016 for the development VRA's 75MW Wind Power Project-2 at Wokumagbe and Goi. We note that the Hon. Minister for Lands and Natural Resources was in the district and was kind enough to grace the stakeholder meeting with his presence. He gave comments on environmental and socio-economic issues related to the Wind Power Project-2 and requested that a meeting should be held with the Ministry of Lands and Natural Resources to clarify the interest of Ghana Government in the lands in the Wind Power Project-2 project area.

As part of VRA's Renewable Energy Development Programme, VRA is developing two 75MW wind energy projects; Wind Power Project – 1 at Anloga, Srogbe and Anyanui and Wind Power Project – 2 at Wokumagbe and Goi. VRA has submitted the Scoping Report for the two wind energy projects to the Environmental Protection Agency (EPA) who reviewed the reports for the development of wind energy projects. A stakeholder meeting was held at the Ada West District Assembly as part of the Environmental and Social Impact Assessment (ESIA) study for Wind Power Project -2 (Wokumagbe and Goi) to inform the community of the environmental and socio-economic impacts that the ESIA study must assess.

ectro Volta House - P. O. Box MB 77, Accra, Ghana. Phone: +233 30 - 2664941-9 Fax: +233 30 2662610

At the stakeholder meeting the Hon. Minister indicated that Ghana Government has interests in the lands in the Wind Power Project-2 project area and that these should be clarified and confirmed with the Ministry of Lands and Natural Resources.

We propose to schedule the meeting for Wednesday, November 23, 2016 at 10:00AM with the Hon. Minister for Lands and Natural Resources at the Ministry of Lands and Natural Resources to discuss the impact of the project on lands and natural resources in the project area and to confirm that the sites for Wind Power Project-2 are not within the lands acquired for other projects. We have attached a copy of the Scoping Report for Wind Power Project -2 (Wokumagbe, Goi) which includes coordinates of the proposed sites and a layout for your study.

Please contact Ing. Charles Addo, the Director of our Engineering Services Department on 0343020705/0208149315 and dengsd@vra.com or sesd@vra.com for any clarifications on the wind energy project and to confirm the suitability of the proposed meeting date and time.

Yours faithfully,

Ing. Kirk-Koffi
CHIEF EXECUTIVE

Received
17/03/17

Correspondences between VRA and Land Owners	Appendix 9.11

VOLTA RIVER AUTHORITY RECEIVED 28 APR 2016 P.O. BOX 77 AKOSOMBO ENV & SUST. DEV. DEPT

ENV. & SOC. IMPACT SECT. RECEIVED DATE 29/4/2016

VOLTA RIVER AUTHORITY RECEIVED 27 APR 2016 D.C.E. SERVICES

C/O ANYANUI BASIC SCHOOL
ANYANUI.

8TH MARCH, 2016

THE CHIEF EXECUTIVE OFFICER
VOLTA RIVER AUTHORITY
ACCRA.

Director, Legal Services and Dir Env. & Sust.
Liaise with DRESD
Investigate this and advise
27/4

Dear Sir,

PROTEST AGAINST LEASE OR PURCHASE AGREEMENT BETWEEN VRA AND GADAGBI FAMILY

In Ghana family properties are legacies for all family members. Similarly Clan properties are also legacies for the Clan members. These legacies are shared among family members and if it is Clan property it is shared among the clan members. Klevie Clan in the Keta Municipality have properties in various places like Anyako, Anlo- Afiadenyigba, Anloga, Akplorwotorkor, Dzita, Anyanui and Fuveme to mention only a few.

No Klevie Clan member from Anyanui can go to sell or lease Klevie Clan property in Anyako. Neither can any Klevie Clan member from Anlo- Afiadenyigba sell or lease any Klevie Clan property at Anyako. Clan members of every community are the only legitimate members to lease or sell any property of the Clan where their grandfathers have ever worked. The lease or sale can only be effected by perfect agreement of the Clan members concerned with their head of family.

We in Anyanui have Clan property and everybody knows where his grandfather had ever worked.

Similarly, those in Dzita have their Clan property shared to their grandfathers and it is still in their possession.

There is no super- Klevie Clan member or members over all other Klevie clan members who can move from community to community to sell or lease Klevie Clan property.

In view of that there is no justification for Messers William Ahiaku, Leo Daledor, David Ahiaku and others concerned from Dzita to enter into any purchase or lease agreement with VRA and Gadagbi family what so ever.

I therefore challenged the candidature of the above mentioned signatories as very very fraudulent and I declared the agreement as null and void.

It will interest you to know that there is peaceful co-existence between the Klevie Clan in Anyanui and Kportufe family. For the fact that Anyanui land is a property of Klevie Clan but passed on to Kportufe family of Anyanui long long ago. This peaceful co-existence can never warrant any land litigation at the expense of development.

27/4

DCE (S)

29/4/16

cc DRESD
Dir Env. & Sust. Dev.

MGR ESI

impl 29/4

There is a mutual understanding between Klevie Clan in Anyanui to co- operate with each other and have a share in any proceed emanating from the sale or lease of any part of Anyanui land.

In view of the above, I wish VRA not to continue any business with those signatories concerned to avert the ensuing land litigation which could delay VRA and the proposed development.

Yours Faithfully,

GADAGBI FAMILY PROPERTY, DZITA

Head

TIMOTHY K. HELETSI

THE HEAD OF GADAGBI FAMILY

0243587291/0263024932

CC:-

JONES- MENSAH & CO
NO. 15 SHIPPI LINK
P.O. BOX CT 368
EAST CANTONMENT
ACCRA.

KPORTUFE FAMILY
ANYANUI

REGISTRATION AND COMMENT SHEET:

Should you have any queries, comments or suggestions regarding the proposed 75MW Wind Power Project 1 (Anloga Extension) and 75MW Wind Power Project 2 (Wokumagbe and Goi) being developed by the Volta River Authority respectively in the Keta Municipality and Ada West Districts in Ghana, please note them below and return this sheet to:

Name	Email	Mobile
Kofi Gatu	seljencon@gmail.com	+233-20-843-4557 / +233-24-206-3391
Dr. James Kojo Adomako	jadomak@yahooc.com	+233-20-818-0362 / +233-54-434-0346
Frank Cudjoe	cudjoefrank@yahoo.com	+233-50-973-8415 / +233-24-280-7339

		Yes	No
Please formally register me as stakeholder and provide further information and notifications during ESIA process			
I would like to receive my notifications by:	Fax	Post	Email ✓

Comments: Signatories to the lease or purchase agreement are not the rightful candidates

Please fill-in your contact details below for the project database:

Title & Name	Family Head; Timothy K. Heletsi		
Organisation	–		
Telephone	–	Fax	
Mobile Phone	0243587291	Email	c/o agbenyc2009@gmail.com
Postal Address	c/o L.A/J.H.S. Anyanui – Anloga V/R		
Name Timothy K. Heletsi	Signature [signature]	Date 15th Apr. 2016	

SELJEN CONSULT	Thank you for the Participation	CSIR

MARCH 2016

SCL Invitation letters to State Agencies	Appendix 9.12

SELJEN CONSULT

Experts in: Environmental Impact Assessment (EIA), Environmental Auditing and Certification to ISO Standards (9000, 14000, OHSAS 18000 Systems), Feasibility Studies, Project Proposals, Monitoring & Evaluation and Acquisition of Relevant Statutory Permits, E.g. EPA & Town and Country Planning Permits, etc

March 21, 2016

The Municipal Chief Executive,
Keta Municipal Assembly
P.O. Box 85
Keta - Volta Region

Dear Sir,

75MW WIND POWER PROJECT 1 (ANLOGA EXTENSION)
ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) STUDY:

REQUEST FOR MEETING

We write as a follow up to our initial discussion regarding the above study which is being undertaken by Seljen Consult Limited (SCL) in collaboration with the Council for Scientific & Industrial Research (CSIR) of South Africa (CSIR-SA), who are working as sub-consultants to SCL.

SCL will wish to inform you that specialists from CSIR-SA are expected in the country from April 10-14, 2016 to assist their Ghanaian counterparts to collect scientific and socio-economic data for use in preparing the ESIA Reports. In the light of this, we will like to schedule a meeting with your outfit on **Wednesday April 13, 2016 at 9:00 a.m.** at your office to, in the first instance, take the opportunity to introduce the CSIR-SA Team to you. The meeting is also expected to provide the opportunity for the South African specialists to discuss issues of interest that will be obtained from their site visits.

We would also be most grateful if your outfit would invite representatives from the following state agencies within your District to participate in the meeting:

- Ghana National Fire Service
- Town & Country Planning Department
- Ghana Wildlife Department
- Department of Urban Roads
- Department of Agriculture
- Department of Social Welfare
- National Commission of Civic Education

SELJEN CONSULT

Experts in: Environmental Impact Assessment (EIA), Environmental Auditing and Certification to ISO Standards (9000, 14000, OHSAS 18000 Systems), Feasibility Studies, Project Proposals, Monitoring & Evaluation and Acquisition of Relevant Statutory Permits, E.g. EPA & Town and Country Planning Permits, etc

May 2, 2016

The Director
National Communication Authority,
1st Rangoon Close
P. O. Box CT 1568,
Cantonment, Accra.

Dear Sir,

150MW WIND POWER PROJECT:
ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY

Seljen Consult Limited (SCL), a Ghanaian Environmental Consultancy Firm, working in collaboration with the Council for Scientific & Industrial Research (CSIR), a South African research council, is carrying out the Environmental & Social Impact Assessment (ESIA) for the under-listed wind energy facilities on behalf of the Volta River Authority (VRA):

- 75MW Wind Power Project 1 (Anloga Extension) located at Anloga, Anyanui & Srogbe communities in the Keta Municipal in the Volta Region
- 75MW Wind Power Project 2 (Wokumagbe and Goi) located in Wokumagbe and Goi communities in the Ada West District in the Greater Accra Region

A letter of Letter of Introduction, dated February 8, 2016, from VRA as well as a Project Background Information Document for the wind energy facilities are attached for your attention.

As part of the ESIA Study, SCL is required to engage with relevant stakeholders whose properties or services would be impacted upon during both project construction and operation. Inputs from consultations with such stakeholders is to assist the Environmental Protection Agency with their decision-making in terms of whether to grant or refuse an environmental permit for the proposed projects.

ASSOCIATES: Nana Adom Boakye II, Mr. F. K. Atubrah, Afia Bemah Berfi
LOC: SECOND FLOOR, QUEENSTAR BUILDING, LAST CHANCE DZORWULU P. O. BOX AT 140, ACHIMOTA – ACCRA
TEL: +233 208 434 557. E-mail: seljencon@gmail.com
BANKERS: Bank of Africa, Ghana Limited, Ridge West- Business Office, Accra

As you are aware, Electro-magnetic Interference (EMI) caused by the development of wind farms either from the Wind Turbine Generator placement in the direct line of sight of point-to-point communications, or too close to omni- (all) directional communications or radar equipment, could impact on communications equipment and therefore of critical interest to communications and radar operators. Subsequently, an "Aviation & Communication Impact Study" for the 2 wind power facilities are being investigated by SCL in order to inform the final design of the project or to generate relevant mitigative measures to eliminate or reduce impacts where appropriate.

In view of this, we are by this letter formally bringing the wind power projects to your attention and to solicit for any concerns from your outfit for consideration for input into the ESIA Report.

Your early response will be very much appreciated.

Yours Faithfully,

Kofi Gatu
TECHNICAL DIRECTOR

cc: The Director, Engineering Services
Volta River Authority,
P. O. Box MB 77,
Accra-Ghana

We have attached a Background Information Document (BID) for the wind power project as information source document. All Interested & Affected Persons are required to use the comment sheet of the BID to provide their comments on the project.

Thank you.

Yours Faithfully,

Kofi Gatu
TECHNICAL DIRECTOR