SELJEN CONSULT

Environmental Impact Assessment of the Proposed Development of 250MW Kumasi 1 Thermal Power Plant at Anwomaso, in the Oforikrom Municipality in the Ashanti Region of Ghana

FINAL

ENVIRONMENTAL IMPACT STATEMENT

MAY 2022

VOLTA RIVER AUTHORITY

CORPORATE ENVIRONMENTAL POLICY STATEMENT

The Volta River Authority (herein referred to as "the Authority") is a public power utility and supplies electricity to industries and mining companies as well as distribution companies in Ghana. The Authority commits to ensuring continuous improvement of environmental performance that minimizes potential impacts of all its operations on the environment in accordance with the principles of sustainable development and complying with national and international environmental protection regulations.

In respect of the above, VRA will:

1. Make environmental considerations a priority in all business planning and decision-making and comply with relevant national and international environmental protection regulations.
2. Take reasonable steps to mitigate the impact of its actions with regard to the development, operation and management of its assets.

VRA will thus pursue the following specific objectives:

a. Develop and implement Environmental Management Systems for all its business units to:

   i. Assess environmental impact of processes, operations and products.
   ii. Focus on pollution prevention and waste reduction.
   iii. Ensure compliance with national/international environmental protection regulations.
   iv. Set annual environmental targets to ensure continuous improvements.
   v. Monitor and report on environmental performance as required to the appropriate stakeholders.

b. Ensure minimum environmental impact of VRA's projects and take adequate steps to mitigate any such anticipated adverse impacts as far as is practicable.
c. Promote environmental awareness and individual sense of responsibility among its employees through print material for distribution, safety meetings, and the corporate website which will continue to be updated, and provide adequate empowerment and training for personnel to perform environmental jobs satisfactorily.
d. Support research efforts on materials, products, processes and pollution reduction techniques that are directly related to its operations.
e. Contribute to the development of public policy and programmes that enhance environmental awareness and protection.
f. Promote open communication on environmental issues.
g. Undertake projects and programmes in collaboration with relevant agencies to preserve the Volta Lake resource, and reasonably restore/mitigate ecological imbalance caused by the creation of the lake.
h. Undertake projects and programmes to mitigate the impact on the livelihood of individuals and communities displaced or affected by VRA's developmental projects.

VRA shall design evaluation procedures for all processes that fall under this policy to ensure that these processes comply. Deficiencies, in the policy or in the evaluation procedure, shall be addressed as required. Each employee of VRA is charged to exercise his or her responsibility on behalf of VRA to assure that the intentions of this Policy Statement are diligently carried out.

Approved: Date: 18 – 6 – 2019

Emmanuel Antwi-Darkwa
CHIEF EXECUTIVE

VOLTA RIVER AUTHORITY

SIGNATURE PAGE

PROJECT NAME	KUMASI 1 THERMAL POWER PLANT PROJECT		
CLIENT NAME	VOLTA RIVER AUTHORITY		
REPORT TYPE	DRAFT ENVIRONMENTAL IMPACT STATEMENT		
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Emmanuel Antwi-Darkwa	Chief Executive, VRA		

CORE EIA TEAM OF EXPERTS

Name	Specialization/ Position	Qualification/Experience	Assigned task
Kofi Gatu	Social Assessment Expert/ Project Manager and Director of Seljen Consult	MSc (Environmental Sustainability & Management), University of Ghana, Legon-Accra. M.A. Local Government Administration & Organisation, Institute of Local Government Studies, Accra. BSc (Hons) Business Studies, University of Cape Coast, Ghana. B.A (Hons) Psychology, University of Ghana, Legon *Over 14 years' experience as a social and environmental impact assessment practitioner*.	- Project Coordinator - Liaison between Proponent and EPA - Social and Stakeholders consultation - Community interactions and socioeconomic assessment - Project document review - Quality Assurance
Emmanuel Kofi Acquah	Environmental and Social Safeguards Specialist (EIA Team Lead)	MSc (Environmental Policy and Management), University of Hull, UK, BSc (Hons) and PgD (Mining Engineering) KNUST School of Mines, Tarkwa. *-About 20 years working experience in Environmental Impact Assessment (EIAs), Environmental Management Plans (EMPs), Baseline studies, Resettlement Action Plans among others*	- Collation, analysis and review of policies, legal and administrative frameworks. - Baseline desktop studies - Review of specialist reports - Impact analysis and evaluation - Development of monitoring and management plans - Drafting of scoping and EIA reports.
Mr. Emmanuel Boateng	Health/Safety Expert	MSc, Geographical Information System with Remote Sensing. From University of Greenwich, UK, 2006 B. Sc. (Hons) Geological Engineering from KNUST, Kumasi, Ghana, 2000 Nebosh National Diploma-Occupational Safety and Health, 2020-present Nebosh General Certificate – National Examination Board in Occupational Safety & Health (Nebosh) Greenwich Community College – London, UK (Sept-Dec 2006)	- Hazard assessment - Risk assessment - Health and safety risk assessment - Health and safety impact identification, assessment and provision of mitigation measures - Health and safety management plan for the construction phase - Health and safety management framework for the operational phase

Name	Specialization/ Position	Qualification/Experience	Assigned task
		-Over 19 years working experience in occupational health/safety assessment as well as public health and safety management practices.	
James Adomako (PhD)	Ecologist/Land use	PhD (Ecology)-Ghana, MPhil (Ecology)-Ghana, BSc Zoo/Bot. (Ghana), Cert (Diatom Taxonomy)-Univ. Co.-UK *-Over 23 years working experience in Ecological systems, Biodiversity conservation, Floral Profiling, Restoration of degraded areas, Plant Nomenclature and Classification, Landuse.*	- Classification of existing vegetation - Fauna inventory - Report on ecological findings
Sylvester Yenzanya	Emissions & Air Dispersion Modelling Expert	MPhil Mining Engineering, BSc Mining Engineering, University of Mines and Technology, Tarkwa-Ghana *-About 6 years of extensive experience in ambient air quality and noise monitoring and emissions/air dispersion modelling*	- Baseline Ambient Air Monitoring - Air quality evaluation - Emissions & Air Dispersion Modelling - Training of VRA Staff
Bright Akuinor	Noise Modelling Expert	BSc Mining Engineering, University of Mines and Technology, Tarkwa-Ghana *-About 6 years of extensive experience in Noise monitoring and modelling*	✓ Baseline ambient noise study ✓ Noise impact evaluation ✓ Noise dispersion modelling and develop a Noise Monitoring Programme.
Ishmael Lente (PhD)	Environmental Scientist and Health and Safety Expert	PhD (Environmental Science/Climate Change & Agriculture), University of Ghana, MPhil (Environmental Science/ Environmental Chemistry) University of Ghana *-Over 8 years working experience in Environmental and Health/Safety Assessment and Management*	Review of environmental and health/safety reports of Ameri Power Plant. Health/Safety Assessment of Project

Name	Specialization/ Position	Qualification/Experience	Assigned task
Anthonio Deborah	Assistant Social impact expert/ EIA Expert	MSc Environmental Sustainability and Management, Winsconsin International University College BSc Chemistry, University of Ghana *-About two years' experience in environmental/social assessment and management*	Baseline data collection Water sampling Stakeholder and community consultations

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LIST OF ABBREVIATIONS AND ACRONYMS

ACC	Air-Cooled Condenser
BID	Background Information Document
BoQ	Bill of Quantities
BSP	Bulk Supply Point
CSR	Corporate Social Responsibility
ECG	Electricity Company of Ghana
EHS	Environment Health and Safety
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESR	Environmental Scoping Report
OfMA	Oforikrom Municipal Assembly
GC	Grievance Committee
GNGCL	Ghana National Gas Company Limited
GNFS	Ghana National Fire Service
GoG	Government of Ghana
GRIDCo	Ghana Grid Company
GRM	Grievance Redress Mechanism
GS	Ghana Standards
GSA	Ghana Standards Authority
GTs	Gas Turbines
GWCL	Ghana Water Company Limited
HDPE	High Density Poly Ethylene
HIV/AIDS	Humano Immune Virus/Acquired Immune Deficiency Syndrom
HSMP	Health and Safety Management Plan
HSSE	Health Safety Security and Environment
I&APs	Interested & Affected Parties
IFC	International Finance Corporation
ISO	International Organization for Standardization
KMA	Kumasi Metropolitan Assembly
KNUST	Kwame Nkrumah University of Science and Technology

K1TPP	Kumasi 1 Thermal Power Plant
LI	Legislative Instrument
LP	Low Pressure
MMAs	Metropolitan and Municipal Assemblies
MMDA	Metropolitan Municipal and District Assembly
MoU	Memorandum of Understanding
MRP	Mines Reserve Power Plant
NG	Natural Gas
NITS	National Interconnected Transmission System
O&M	Operation and Maintenance
PM	Project Manager
PURC	Public Utilities Regulatory Commission
RCC	Regional Coordinating Council
R&D	Research & Development
STDs	Sexually Transmitted Diseases
SHE	Safety Health and Environment
ToR	Terms of Reference
TUC	Trade Union Congress
VRA	Volta River Authority

Units of Measure

dB	Decibel
dB(A)	Decibel on the A Scale
%	Percent
km	kilometer
km^2	square kilometer
μgm^{-3}	microgram per cubic meter
µS/cm	micro Siemens per centimeter
m	meter
mm	millimeter
mg/l	milligram per liter
ms^{-1}	meters per second
m^3	cubic meter
m^3/h	cubic meter per hour

EXECUTIVE SUMMARY

Project Description

The Ghana power system is currently having low voltages from Ashanti Region to the northern part of the country, and the provision of a power plant in the Ashanti Region of Ghana will help improve voltages of the Ghana power system. To resolve this, the Ministry of Energy and the Volta River Authority (VRA) plan to relocate the AMERI Power Plant from its Aboadze base in the Western Region to a site adjacent to the GRIDCo K2 BSP 161kV/330kV substation at Anwomaso in Kumasi, in the Ashanti Region as the Kumasi 1 Thermal Power Plant Project. The Plant will be located on a 15-acre parcel of land that belongs to the Kwame Nkrumah University of Science and Technology (KNUST).

The main access road to the proposed site and the existing GRIDCo Substation at Anwomaso is by a motorable asphaltic surfaced road, about 2.69km off the main Accra-Ejisu-Kumasi Highway. The project site can be accessed by two routes from the substation. The proposed site is situated between GRIDCo's 161kV and 330kV transmission lines right-of-way. It is bounded on the south by 161kV and 330kV substations of GRIDCo, north and west by fallow/farmlands and on to the east by fallow/farmlands.

The Kumasi 1 Thermal Power Plant is a 250MW plant comprising of ten (10) 25MW Gas Turbines (GTs), and will operate solely on natural gas. Each train of GT and power generator is mounted on mobile platform. The plant component consists of the following:

1. Substation;
2. Gas Turbine Island;
3. Warehouse/Workshop;
4. Office and Control Building;
5. Car Park;
6. Water Treatment and Storage Tank; and
7. On-base Gas Skid.

The power evacuation components include:

i. Equipment in prefabricated building;
ii. Mobile station service transformers;
iii. Emergency Diesel generators;

iv. 11kV medium voltage cables; and
v. All interconnecting cables with their cable trays.

The power production processes comprise of (a) Natural gas supply & conditioning; (b) Combustion; (c) Generation; and (d) Transmission. The 250 MW power to be produced will feed the 161KV GRIDCo substation at Anwomaso for evacuation of power to the national grid. The Gas Turbines runs on natural gas (NG). Each unit requires 5.5 mmscf of NG per day making a total of 55 mmscf per day for the ten (10) gas turbines. Ghana National Gas Company will supply gas to the site through a new gas infrastructure of pipelines, regasification and gas conditioning units to be constructed as a separate project, and a separate EPA permit will be obtained.

The Kumasi 1 Power Plant requires about 7.5 m3 of demineralized water per day for operations. A dedicated water treatment facility of 40m^3/h capacity will be installed at the station. The effluent from the demineralization system will be channeled to a neutralization sump and neutralized before discharge into the storm drain. The compressor wash water which is neutral will be discharged into the storm drain. A 1000m^3 water storage tank will be installed to provide water for the Plant firefighting system. The Ghana Water Company Limited (GWCL) plans to extend its water pipeline from Oduom to Anwomaso to provide potable water to the power plant site, and a separate EPA permit will be obtained.

A contractor will be procured for the construction and installation of the power plant. VRA will be responsible for the operation and maintenance of the power plant as it already has a thirty-three (33) Operating & Maintenance team to take over the operations of the Plant in Kumasi. It is expected to take about 15 months to complete the land acquisition, permitting, the construction and installation of the Kumasi 1 Thermal Power Plant.

Alternative Considerations

The following alternatives have been considered and analysed for the proposed project:

- Energy/Power source options;
- Cooling system options for the thermal power plant;
- A new air-cooled condenser (ACC) thermal power plant as against use of an existing ACC thermal power plant;
- Simple or single cylcle and combined cycle gas turbine plants;

- Site selection options;
- Water supply source options; and
- No Action Option.

Purpose of the EIA and Legal Framework

The purpose of the EIA is to identify and address significant adverse environmental impacts to arise from the proposed project for acceptability and sustainability; and to satisfy both legal and institutional obligations specified under the Environmental Protection Agency Act 1994 (Act 490), Environmental Assessment Regulations 1999 (LI 1652). The project will also ensure compliance with all relevant national laws and regulations as well as the IFC Performance Standards and the World Bank/IFC EHS Guidelines for Thermal Power Plants.

A number of national policies and legislations relevant to the proposed project implementation have been identified and reviewed as part of this EIA for its applicability and relevance to the implementation of the proposed project. The proposed project is expected to comply with the requirements of the EPA administered Ghana Standards (GS) as follows:

- GS 1236:2019 Environment and Health Protection –Requirements for Ambient Air Quality and Point Source/Stack Emissions
- GS 1219:2018 Environment and Health Protection–Requirements for Motor Vehicle Emissions
- GS 1222:2018 Health Protection –Requirements for Ambient Noise Control
- GS 1212:2019 Environment Protection –Requirements for Effluent Discharge

<u>Approach and Methodology for the EIA</u>

The approach and methodology adopted for the EIA included:

- Field inspections and trekking;
- Review of relevant literature and project related documents;
- Specialists studies for baseline information;
- Stakeholder consultations;
- Data analysis and assessment of potential environmental and social risks and impacts;
- Development of impact mitigation and control measures;
- Development of a provisional environmental management plan including monitoring; and

- Reporting.

Environmental Baseline Conditions

The project area falls within the wet sub-equatorial climatic zone. The project area experiences a double maxima rainfall regime in June and in September/October. The major rainy season starts from March to July with a peak usually in June. The minor season starts from September to November with a peak either in September or October. The main dry season occurs in December to March during which the desiccating harmattan winds blow over the area. The prevailing wind direction is NW.

Thirty (30) years meteorological data (from 1990-2020) about the project area from the Ghana Meteorological Service for the project area is summarized below.

Parameter	Minimum	Average	Maximum
Wet bulb temperature, ^{o}C	20.40	22.37	24.70
Dry temperatures, ^{o}C	36.9	31.55	27.1
Relative humidity, %	24	76.20	98
Rainfall, mm	0	113.65	534.50
Wind speed, knot	0	3.5 (1.8m/s)	5 (2.57 m/s)

The proposed site is on a low ridge and the topography is relatively flat with slight undulations. The existing ground surface at the project site is approximately 268 to 285 m above mean sea level. The project site is occupied by farms and farm re-growths with isolated trees. The major crops cultivated are cassava, maize and vegetables such as tomatoes. The farm re-growth is dominated by Panicum Maximum (guinea grass) and forbs which forms a dense thicket.

The Adote Stream drains the project area. The physiochemical parameters of the Stream were within acceptable limits of the Water Resources Commission Surface Water Quality Guidelines for raw water for agriculture use except for the downstream water quality which was slightly acidic (5.7 units) and outside the range of 6.5 and 8.5 units. The presence of life from zooplankton and plants to macroinvertebrates and fish, indicate that the Adote River maintains some minimum

ecological integrity. The river is used by some vegetable farmers for irrigation, drivers and contractors for their car washing and construction activities respectively.

The Particular Matter concentration levels of monitoring stations along road sides and the GRIDCo substations were above GS levels. The concentrations of Cl_2, NO_2, CO, SO_2, and VOC at the monitoring stations were relatively and below the Ghana standard. The sources of noise are vehicular traffic, loud music and noise from the community; and that of air pollution are fumes from vehicular movements, wind-blown dust and dust generation from unpaved roads in local community from movement of vehicles.

According to the 2010 Population and Housing Census, the Oforikrom Municipality recorded a population of 303,016 made up of 149,827 (49.45%) males and 153,189 (50.55%) females. The 2019 projected population is 373,055; 184,165 males and 188,890 females.

One of the dominant cultural practice in Oforikrom is the celebration of the Akwasi Dae festival, which is celebrated by the Asantes. There are various ethnic groups in the Municipality and this can be attributed to its strategic location and the University (KNUST), which provides teaching and learning to both Ghanaians and foreigners.

The inhabitants of Oforikrom Municipality are engaged in various economic activities, and these include transport services, scrap metal and e-waste, hospitality services, retail of products, hairdressing/barbering, dress making, financial services, furniture manufacturing, printing firms, food processing, chemical and pharmaceutical services, construction work, agricultural production, amongst others. There are about five daily markets in the Municipality. Unemployment is however an issue of concern.

The Municipality can boast of 85 pre-schools, which are all private; 109 KGs (22 public and 87 private); 114 primary schools (25 public and 89 private); 82 JHS (24 public and 58 private); 9 SHS/TVET (2 public and 7 private); and one public special school. There are seven tertiary schools in the Municipality.

The Municipality has in existence twenty-two (22) health facilities. Four (4) of the health facilities are government owned; one (1) is quasi-government and seventeen (17) privately owned. Malaria,

Hypertension and Upper Respiratory Tract Infections have been the dominant reported diseases from 2018 to 2020.

According to the 2019 data from the Ghana AIDS Commission, Oforikrom Municipal is not within the top 10 districts/municipalities with high HIV infection in the country but Kumasi Metropolist is within the top 10 districts. The Oforikrom Municipal has 1.75% prevalence rate and Kumasi Metropolis has 1.95% prevalence rate in the adult population. The Ashanti Region has 1.94% prevalence rate with estimated 76,672 living with the HIV virus.

With regard to COVID-19 infection and transmission, as at the middle of September 2021, the cumulative cases in the Oforikrom Municipality was 2,174, with 2,124 recovered, 29 active cases and 21 deaths recorded.

Stakeholder Consultations

A stakeholder engagement strategy has been developed to guide consultations under the project. A number of organisations and individuals have been consulted as part of this EIA. The stakeholder consultations is aimed at soliciting ideas that can help shape project design, resolve conflicts at an early stage, assist in implementing solutions and monitor activities.

Generally, stakeholders are willing to participate in project implementation to help ensure that the project is implemented in an environmentally friendly and socially acceptable manner to the benefit of the country. The stakeholders showed strong need for improvement of the power supply in the Kumasi area. The local communities expect that appropriate corporate social responsibility measures will be put in place to bring development to the communities and affected farmers currently on the land expect that their concerns will be addressed, especially compensation for destruction of their crops. The stakeholder concerns have been included in this EIS.

Potential Adverse Impacts and Proposed Mitigation Measures

The implementation of the proposed K1TPPP will result in a number of potential impacts during the preparatory, construction and operation & maintenance and decommissioning phases. The mitigation and management measures for the identified significant adverse impacts are provided in the tables below. The application of the mitigation measures in general is expected to reduce major and moderate impacts to within reasonable and acceptable limits.

Table 0-1: Proposed Mitigation Measures for the Preparatory Phase Adverse Impacts

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures
Preparatory/ Pre-Construction Phase				
1.	Land-take and displacement of farmers	KNUST as current land owner/ /farmers on the land	Moderate	• VRA will follow due process and engage KNUST on project land acquisition and documentation. • VRA will regularly engage affected farmers on project work plan for project implementation through an established communication channel. • All necessary documentation needed for acquiring land will be approved as mentioned during the stake-holder workshop for the EIA. • Ensure affected farmers are well informed and given adequate and agreed time to harvest vegetable and annual crops prior to the start of construction. • Any isolated perennial crops at the project site such as oil palm should be compensated. • Engage the Lands Commission to carry out valuation of affected standing crops if VRA fails to provide adequate time for crops to mature and be harvested. • VRA must liaise with the Lands Commission to ensure that all grievances/concerns related to affected standing crops are resolved. • VRA will disclose public information of the project.
2.	Anxiety on the part of local community leaders/ people and affected farmers and nearby organisations	Affected farmers/ local communities/ Anwomaso chief and elders, NVTI	Moderate	• VRA will maintain an open communication with stakeholders including KNUST, affected farmers, Anwomaso traditional leaders, Anwomaso Transport Associations, NVTI, GRIDCo/ ECG in the project area on the proposed project to avoid conflicts. • VRA will develop a program for periodic stakeholder interactions and education on proposed project activities, impacts and proposed mitigation measures. • VRA will implement grievance redress mechanism to enable institution and community concerns to be documented and resolved in a timely fashion. • VRA to ensure liaison with all stakeholders and affected persons/institutions, and local communities are maintained throughout project life.

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures
1.	Risk of not acquiring appropriate permits for project implementation	VRA, Ministry of Energy, Contractor	Major	VRA will ensure that it acquires relevant regulatory approvals prior to construction activities, including: • Approval from the EPA for the implementation of the Project. • Energy Commission siting, construction and operational permits/licenses. • Permit from the Water Resources Commission for drilling of borehole(s) at the site. • Fire permits from GNFS; Factories Inspectorate Department registration certificate; building/development permits from Oforikrom Municipal Assembly.
2.	Occupational Health & Safety	Technical staff/ Consulting teams	Moderate	• The Technical staff/Consultants will use appropriate personal protective equipment such as safety boots, reflectors, overalls, nose masks, hand gloves, and earplugs as appropriate when carrying out their field studies. • The Technical staff/Consultants involved with specialist studies will use first aid kit to treat minor ailments. However, major cases will be referred to selected public/ private Hospitals/ clinics in Kumasi for treatment. • VRA and subcontractors will ensure that survey teams are well-trained and experienced for the various pre-construction and survey activities. • Survey teams will be briefed by their employers on the presence of dangerous reptiles and animals such as snakes, insects etc at the site and need for safe work methods. • COVID-19 protocols especially wearing of nose masks and use of sanitizers will be followed during meetings with stakeholders. • Survey and technical teams will carry drinking water to the field, and will avoid working in the rain.
3.	Public/ community health and safety concerns	Local community members	Moderate	• Good conditioned as well as well-maintained vehicles will be used to avoid frequent breakdowns along the roads and to reduce noise nuisance and smoke emissions, which could otherwise affect community health and safety. • COVID-19 protocols especially wearing of nose masks and use of sanitizers will be followed during meetings with stakeholders.

Table 0-2: Proposed Mitigation Measures for the Construction Phase Adverse Impacts

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures
Construction Phase Mitigation Measures				
1.	Air Pollution	Nearby local community especially Anowmaso, Gridco office/substation and NVTI near project site; construction workers; trespassers/nearby farmers	Major	• The construction works will be done using mitigation and control techniques, such as standard dust suppression measures with water, e.g. All exposed surfaces, unpaved surfaces and aggregate stock-piles will be frequently dampened with water. • Vehicular/truck speed limits of between 30km/h and 50km/h will be the rule on any unpaved landscape to minimize dust generation. • The Contractor will implement the manufacturer recommended engine maintenance programs for all construction equipment and vehicles to minimize the emission of fumes into the environment. • The Contractor will monitor dust at NVTI whenever dust generating activities take place and remedial action will be taken whenever dust concentration levels exceed acceptable limits. • Dust-related grievances will be investigated and managed as part of the Grievance Redress Mecha-nism. • Earthworks and other construction activities will not be done during very windy conditions to mini-mize wind-blown dust from the site. • The Contractor will not burn cleared vegetation
2.	Noise and Vibration Nuisance	Anowmaso, Gridco office/substation and NVTI; construction workers; trespassers/ nearby farmers	Moderate	• The Contractor will employ standard noise abatement measures and engineering good practices to ensure that the impact of noise are minimized and reduced to acceptable limits. • All equipment/ machinery shall be operated and maintained in accordance with appropriate industry and equipment standards including specifications for noise levels and manufacturer's specifications (including regular checks and maintenance). • Machines in intermittent use shall be shut down in the intervening periods between works or throttled down to a minimum. • All construction and earthworks will be done during daytime to avoid disturbing the serene nights of local communities. Heavy equipment such as excavators, graders and compact rollers will be operated in the daytime to minimize the impact of high noise levels on the surrounding communities. • The Contractor will implement a policy of minimal or no tooting of horns unless in an emergency cases only. • Earplugs and Earmuffs will be provided for workers where necessary.

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures
3.	Impact on soil resources – loss of topsoil/ soil erosion/soil contamination	Soil resources, flora and fauna, Adote River	Major	• Topsoil will be stripped and stored for reclamation and landscaping activities after the construction works. • The topsoil stockpiles will be protected from erosion by constructing diversion channels and silt fences around stockpiles. • Clearance of vegetation will be limited to authorized or designated areas only. • Lubricant /oil and waste oil will be stored in drums that are not leaking and kept in contained areas. • The Contractor will use equipment that are in good condition and which do not leak oil. • On-site vehicles and equipment shall be inspected regularly for leaks and all leaks shall be immediately repaired. Incoming vehicles and equipment shall be checked for leaks. Leaking vehicles/equipment shall be repaired before allowed on-site. • Visual assessment of onsite erosion features after every significant rainy event will be carried out to provide evidence of where immediate control measures are needed or required to check erosion. • The Contractor will adopt erosion control practices such as re-grading, compaction, diversion of run-off. • Early re-vegetation of disturbed areas will be undertaken.
4.	Water pollution/ Siltation of Adote River	Adote River, and aquatic life; groundwater resources	Major	• Clearance of vegetation will be limited to authorized or designated areas only to avoid exposing unauthorized areas to soil erosion and transport of sediments to nearby stream. • Washroom wastewater/sewage from work camp will be discharged into septic tank. • Sediment barriers or traps will be constructed down gradient of construction sites to prevent sediment transport into Adote River or its wetland areas. • Lubricant /oil and waste oil will be stored in drums that are not leaking and kept in contained areas. • Construction equipment/ machines and vehicles will not be refueled at workplaces but on purpose-built designated area or commercial fuel stations in town. • The Contractor will avoid washing equipment/vehicles on site or near water bodies/wetlands or drains but at designated commercial washing bays. • The Contractor will use equipment that are in good condition, which do not leak oil. • The Contractor will provide temporary drainage channels to divert storm water away from excavated materials and stockpiles.

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures
				• The Contractor will not store solid wastes near water bodies nor dispose wastes into the stream/wetland areas.
5.	Waste Generation/ Disposal and Sanitation Concerns	Soil, flora and fauna, nearby stream/ wetland areas, local communities, construction workers	Major	<u>General Waste/ Garbage</u> • The Contractor will liaise with the Oforikrom Municipal Assembly to confirm approved waste disposal sites for use. • The Contractor will engage the services of a waste collection firm to assist with onsite waste collection and disposal. • The Contractor shall appoint a waste management coordinator, who will be responsible for tracking of loads, and protocols for the maintenance of records of the quantities of wastes generated, reused/recycled and disposed. • General domestic waste and refuse will be disposed of at the Municipal Assembly approved disposal sites. • The Contractor will provide adequate waste bins at the work camp and construction sites/workplaces to minimize littering of the environment. <u>Construction Waste</u> • There will be segregation of construction waste at the project sites. • All metal scraps will be collected and given to recognized scrap dealers to send to steel manufacturing companies in the Kumasi enclave for recycling. • Stripped topsoil will be stockpiled and used for reclamation and landscaping activities. • Excavated sub-soils will be reused to the extent practical for backfilling during construction to reduce waste. • Other construction wastes will be disposed of at the approved Municipal Assembly disposal sites. <u>Hazardous Waste</u> • The Contractor will liaise with the Regional EPA in Kumasi to obtain a list of at least two reputable hazardous waste collectors to work with. • The Contractor will engage one EPA approved hazardous waste collector for collection and disposal of all hazardous wastes during the construction period.

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures
				• All hazardous waste (e.g. oily waste/waste contaminated with oil, batteries etc) generated during construction will be temporarily stored as per manufacturer's instructions for collection and disposal by the EPA approved hazardous waste disposal firm. • Contaminated soil will be considered as hazardous waste and will be disposed of at the appropriate disposal site. • Hazardous waste tracking system will be put in place and this will be mandatory. <u>Human waste</u> • Toilet and washroom facilities will be provided for workers at the work camp and project site to discourage "free-range" defecation and its attendant public health concerns. • Workers will be educated to use the toilet/washroom facilities to be provided. • An approved cesspit emptier service provider from either the Municipal Assembly or privately operated ones will be engaged to empty septic tank as and when full or before decommissioned at the close of the project.
6.	Loss of vegetation/ habitat/ displacement of fauna/ risk of spread of invasive plant species	Terrestrial flora and fauna at project site and adjacent areas	Major	• Limit construction activities to only designated places and clearly mark out or delineated affected vegetation to be cleared especially around project site boundaries, so that they are clearly visible to construction staff/equipment operators so that they do not clear 'no go areas'. • The Contractor will remove vegetation only on areas needed for the proposed Project. • The Contractor will implement a wildlife animal protection policy on no hunting and killing of wildlife at the project sites and adjacent areas. • Stray wildlife will be given the right of passage at the project site and work camp and not killed. • Scheduled inspection and monitoring of trucks and their contents during transfer of construction materials from offsite to the project site to be carried out at the source and delivery ends to identify any fugitive invasive plant species. • Dismantle and remove all equipment and machinery after construction from site.
7.	Impact on aquatic organisms and biodiversity	Adote River and nearby wetlands, aquatic life in the stream	Moderate	• Construction workers and other staff will be instructed not to dispose or dump any kind of waste into the wetland areas of the Adote River or into the stream itself, but place them in waste storage bins or at designated temporary waste storage sites. • Water pollution measures as earlier presented above will be implemented to minimize adverse impact on aquatic life in the stream.

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures
8.	Visual intrusion/ aesthetics	Anwomaso community/ Local communities/ Trespassers /nearby farmers, KNUST Plant researchers	Moderate	• The project site is not located close to any major or busy access roads and cannot be viewed from such roads. It is also located about 600m from the nearest community. • The work camp will be fenced. • The Project site will be hoarded off from public view during construction. • VRA will make announcements, give notices and warning signs for the construction and installation activities and changes in landscape and would communicate clearly to Anwomaso community/ farmers. • Planting of landscape vegetation will be done as appropriate after construction in collaboration with the Parks and Gardens Department. • The design, colour and finish of the power plant will be carefully considered to enhance the beauty of the project area. • Heaping of remaining excavated material at project areas mostly damages landscape. In this respect, any remaining excavated material will be used in landscaping works and excavated materials left after landscaping works will be sent to offsite disposal areas.
9.	Labour influx	Local communities/ work camp/ site office	Moderate	• The Contractor will implement a recruitment policy that will encourage the engagement of most unskilled labour from the local communities. • The Contractor will implement a stakeholder engagement program that will include a feedback and grievance mechanism with the Anwomaso community. • The Contractor and VRA will put in measures to collect feedback or complaints related to project labour influx from the Anwomaso community and will resolve these labour influx related complaints with the community opinion leaders.
10.	Occupational health and safety concerns and labour right issues	Construction workers/ staff	Major	<u>Implementation of a Health and Safety Policy/Plan</u> • The Contractor will prepare and implement an occupational health and safety management plan, which shall conform to the health/safety standards of VRA for contractors and the provisions in this EIS. The provisional health and safety management plan provided in **Annex 8-1** to serve as guide for the preparation of the construction health/safety management plan. • The Contractor will educate its workers/ staff on the health/safety plan.

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures
				• An Environmental and Safety Officer will be appointed to ensure compliance with the Health and Safety Plan. • Contractor will organise weekly toolbox meetings for workers and brief them on EHS issues and what to do to safeguard the environment and avoid accidents or injuries. <u>First Aid Centre/Hospital</u> • The Contractor will have an on-site first aid centre with a site nurse to treat minor ailments. • Major cases will be referred to identified public/private hospitals/ clinics in the Kumasi area. • There will be at least one vehicle designated for emergency transfers, but not necessarily an ambulance. <u>Use of Qualified and Experienced Personnel</u> • The Contractor will ensure that experienced and well-qualified workers are engaged to operate any heavy machine or equipment. • Only drivers and equipment operators with the requisite licenses will be allowed to handle vehicles and earth-moving equipment. • Initial training and testing in machine/equipment handling and safe working procedures will be given to all new drivers, operators and other field workers. <u>Provision of Personal Protective Equipment (PPE)</u> • The Contractor will ensure that workers are provided with the appropriate PPEs such as safety boots, helmets, reflectors, overalls, rain-coats, hand gloves, earplugs and nose masks. • Supervisors will be mandated to ensure the use of the protective equipment and to impose agreed sanctions when necessary. <u>Use of Road Worthy Vehicles/Equipment</u> • Good conditioned vehicles will be used to avoid any breakdown along the roads. • The Contractor will ensure that well maintained vehicles/equipment are used in order to reduce noise nuisance and smoke emissions, which could affect equipment operators and other workers.

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures
				• Tools and equipment will be inspected to ensure they are in good working order, and are well maintained with maintenance records. <u>Use of warning signs and restricted access to dangerous sites</u> • Open trenches/excavations will be protected using indicator linings or illustrative warning notices or wire mesh (whichever best suits the situation) to prevent fall hazards. • Caution/warning signs will be placed and maintained at vantage points around the project site. • There will be restricted access to dangerous working areas and will be limited to authorized construction/electrical staff only. <u>Worker Rights and Wellbeing</u> • The Contractor will implement a Human Resource Policy that adheres to the requirements of IFC PS2 and the national labour laws, including requirements for all workers to have contracts/appointment letters; access to drinking water at workplaces; access to places of convenience/toilets at work sites etc. • The conditions for the engagement will be communicated and made clear to all workers. • Workers Grievance Redress Mechanism will be implemented to help minimize labour disputes during the construction period.
11.	Public/ community health & safety and security	Local communities, public, trespassers, farmers	Major	<u>Transport and public safety management measures</u> • Transport of the turbines and generators and other associated equipment from Aboadze to Anwomaso will be done under escort to avoid traffic incidents. • All the vehicles to be used for the project and especially for transporting equipment and materials will be serviced regularly and all the drivers to be engaged/ assigned would be required to hold the requisite driver's license as prescribed by the Drivers and Vehicles Licensing Authority (DVLA) and with at least three years' experience, • All drivers/operators will be educated on public safety issues and measures. • All project vehicles and trucks will observe existing traffic speed limits (e.g. within 50km/hr) when passing through communities as required. • Reckless tooting of horns will be prohibited.

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures
				• Trucks transporting quarry products and other friable materials to the sites will have these materials covered. • All trucks conveying materials to the project site will carry appropriate warning signals such as red flag and rotating amber lights. • Only roadworthy vehicles/trucks will be used. • A code of conduct for drivers on the road would be implemented. • Community complaints handling arrangements would be instituted. • Any accidents on the roads involving contractor vehicle/trucks would be investigated immediately and corrective actions taken to avert re-occurrence. • The transport of heavy equipment and loads of materials to site will avoid the usual working days rush hours of 6am to 8am and 4.30pm to 6.30pm. <u>Theft/security</u> • The Contractor will ensure that security personnel are recruited to protect lives and properties against theft and worker safety at the work camp and project site. • Due diligence will be carried out prior to recruiting any security person and a code of conduct will be developed to guide the conduct of all security personnel to ensure that these personnel do not become a threat to residents/ local community members, and do not manhandle prospective job seekers. • Security personnel to be engaged will be trained in human right issues to ensure that they do not abuse the human rights of the locals or job seekers. • Dangerous work sites and warehouse/storage facilities will have restricted access to authorized construction team members only <u>Provision of alternative foot or farm paths</u> • The contractor will be required to provide alternative farm paths or footpaths when any existing farm or foot paths are affected due to construction activities to enable farmers/pedestrians or residents to easily access their farms. <u>Public Health /Toilet facilities</u> • The Contractor will provide toilet facilities for workers during the construction phase.

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures
				Use of warning signs and restricted access to dangerous sites • Open trenches/excavations will be protected using indicator linings or illustrative warning notices or wire mesh (whichever best suits the situation) to ensure public safety and prevent fall hazards. • Caution/warning signs will be placed and maintained at vantage points around the project site. • There will be restricted access to dangerous working areas and will be limited to authorized construction staff only.
12.	Impact on cultural heritage and sociocultural norms	Anwomaso community	Minor	• There are no shrines, cemeteries nor sacred groves at the project site. However, the Contractor will establish and implement a chance find procedure and reporting system to ensure that any cultural heritage resources or antiquity chanced upon are handled properly. • Any antiquity found during the construction phase will be made known to the Ghana Museums and Monuments Board (GMMB) as required. • Where the observance of any traditional and cultural festivities/norms will affect project implementation timelines, the Contractor, and VRA/MoE will engage the traditional authorities for exemptions if possible.

Table 0-3: Proposed Mitigation Measures for Operational &Maintenance Phase Adverse Impacts

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures
Operation and Maintenance Phase Mitigation Measures				
1.	Noise and Vibration Nuisance	Nearby local communities, GRIDCo substation, NVTI	Major	• Exhaust stacks will be provided with silencers behind the exhaust gas diffusers to reduce noise levels at the plant fence line. • The gas turbines, which can generate as high as 120 dBA will be placed in acoustical enclosures to reduce noise levels to the allowable 85dBA at 1m distances from the enclosures. • The distance between the gas turbines and the NVTI facility will be at least 500m. • VRA will use sound absorbing or insulation materials in walls and ceilings. • Adequate noise reduction fixtures will be provided on heavy vehicles and hauling equipment, which will transport materials and other items to the site.

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures
				• Caution signs will be placed at all high noise zones, reminding workers of the mandatory use of ear protective equipment such as Earmuffs in those areas. • Adequate earplugs and training on their proper usage will be provided to all VRA and GRIDCo staff working in highly noisy areas on site. • A noise monitoring program will be instituted and data obtained will be analyzed and periodically reported on as required by the Regulators and VRA Management.
2.	Air Pollution	Public/ local communities and workers	Major	• The combustion system will have a suitable inlet air filters for the compressor to ensure efficient combustion system for the gas turbines. • VRA will use natural gas for the power generation, which is known to have minor air pollution impact due to its low sulphur content. Emissions of SO2 and Particulate Matter will be minimized by the use of natural gas. • For NOx, emissions will be minimized by the application of dry low NOx combustion system technology of the GE gas turbine. There will also be negligible ambient air quality via atmospheric dispersion from a stack height of 56m. • The stack height will be 56m high. This will enable high plume dispersal preventing fumes and heat from affecting the surrounding areas. • Stack emissions and ambient air quality will be monitored regularly as part of good environmental practice. • The Plant and its associated facilities especially turbines/generators will be operated efficiently and regular maintenance carried out to ensure that their combustion systems function properly. • VRA will procure and use modern equipment/ machinery and vehicles that meet applicable emission performance standards to minimize pollution. • All equipment/machines, trucks and vehicles will be maintained in good working order and turned off when not in use, to minimize emissions. • The exhaust emissions of heavy machinery will regularly be monitored by site staff. • There will be no burning of waste by VRA in the project area. • VRA will work closely with EPA to ensure compliance with emission limits through regular/continuous monitoring during operation.

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures
				• VRA will provide nose masks for use by workers in areas where fugitive dust/emissions pose a challenge.
3.	Greenhouse Gas Emissions and impact on climate change	Ozone layer, general climate	Moderate	• VRA will implement energy conservation and efficiency measures to check excessive combustion of fuels. • VRA will maintain and sustain the use of natural gas for the power plant to ensure that low emissions of GHGs are sustained throughout plant life. • VRA will put in place and carry out a scheduled and regimented maintenance program for its natural gas pipeline, and turbines to minimize fugitive gas emissions.
4.	Water Pollution/ impact on aquatic flora and fauna	Surface/ ground water, aquatic flora and fauna	Moderate	• Wastewater from washrooms/sanitary areas will be channeled into septic tanks and not into nearby water body. • Wastewater from the demineralization process will be treated in a neutralization sump prior to discharge into the storm drain. • Waste oils will be stored in separate drums and treated as hazardous wastes and not discharged directly or released into the environment. • Awareness creation on water pollution minimization will be organized for all categories of workers.
5.	Water consumption	Power Plant, workers/ local community	Major	• VRA will implement water conservation and efficiency measures to ensure effective optimization of water use and reduction of wastage. • VRA will drill one or two boreholes to supplement GWCL supplies so that available water for municipal and other community needs/usage is not compromised. • Water would be properly stored using the proposed facilities for use on the power plant site. • Water meters will be installed on GWCL pipelines leading to the office and plant and borehole line to monitor water usage. • Monitoring of water consumed and analysis of water consumption data with the assistance of GWCL would help to determine the need for an increased or decreased supply to the power plant station. • Awareness creation on water conservation practices will be organized for workers.
6.	Waste generation/ disposal and	General environment near project area/land;	Moderate	<u>Solid Waste Management</u>

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures
	sanitation concerns	nearby stream / local communities		• Reusing/Recycling/Recovering techniques will be employed where possible to minimize disposal re-quirements/cost (e.g. by waste segregation according to type, separation of recyclable materials such as metal, paper reuse of wood from site, plastics). • Waste materials will be collected and disposed of frequently to prevent odour nuisance, wind-blown materials causing litter on site and vermin infestation. • Adequate waste bins will be provided at the power plant site to avoid littering of the sites. • Solid wastes will be disposed of at approved Municipal Assembly dumpsites or landfill sites within the Kumasi Metropolis. • VRA will engage a solid waste management firm approved by the Municipal Assembly to collect and dispose of solid wastes regularly. • Scrap metals collection will be given to licensed dealers to send to steel recycling and manufacturing firms. <u>Liquid Waste Management</u> • Wastewater from washrooms/sanitary practices will be channeled into septic tanks, and dislodged by registered cesspit tank emptier. • Waste oil will be stored in drums kept in bunds. Waste oils will be collected and disposed of by EPA licensed waste oil companies. • Wastewater from the water treatment facility will be stored in a sump and neutralized prior to discharge into the storm drains. <u>Awareness creation</u> Awareness creation on waste minimization strategies will be organized for all workers.
7.	Disruption in landscape aesthetics	Farmers, KNUST Plant Research, Anwomaso community, NVTI	Moderate	• VRA will fence of the plant site appropriately to minimise visual intrusion. • VRA will engage the Parks and Gardens Department to enhance or improve upon the landscape of the area by planting appropriate trees along the fence lines. • The local communities and nearby institutions will get use to the power plant installations overtime.

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures
8.	Occupational health and safety concerns	Operational and maintenance workers and subcontractors/ consultants	Major	<u>Adoption of Health and Safety Policy and Plans</u> • VRA will educate all workers on the health and safety policy of VRA. • VRA will ensure that workers comply with the health and safety policy of the Company, and the EMP/ Health and Safety Plan for the power plant. • A health and safety officer will be appointed to ensure compliance with the Health and Safety requirements of the power plant. <u>Training in equipment and chemical handling</u> • VRA will ensure that workers involved in the operation and maintenance of equipment at the power house, switchyard station and the transmission lines are given adequate safety training. • Handlers of all anti-corrosion chemicals will also be trained and would have access to the materials safety data sheets (MSDS) on the dangers and ways of handling these chemicals safely. <u>Use of Qualified and Experienced Personnel</u> • VRA will ensure that experienced and well-qualified workers are engaged to operate any heavy machine or equipment. • Only drivers/operators with the requisite licenses will be allowed to handle vehicles and earth-moving equipment. • Training and testing in machine/equipment handling and safe working procedures will be given to all new drivers, and operators to help minimise the occurrence of accidents on site. • VRA will institute regular defensive driving training sessions for its drivers to ensure their safety and the safety of the general public. <u>Provision of appropriate PPE</u> • VRA will provide and enforce the use of all required personal protective equipment including overalls safety boots, rain-coats, hand gloves, earplugs, nose masks, anticorrosive gloves, full body harness and non-conductive hand tools rated for the voltage at which live electrical work is being performed. • The Company will ensure that all visitors at site wear appropriate safety materials at all times.

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures
				• Supervisors will be mandated to ensure the use of these protective devices and to implement agreed sanctions when necessary. <u>Emergency Provisions and Safety Precautions</u> Emergency Response plan will be developed for the operation and maintenance of the power plant, switchyard/substation, and high tension lines. The following safety precautions will be implemented: • As much as possible avoid working on live electrical parts except when de-energizing the equipment creates additional hazards or when the equipment must be energized to allow for testing that can only be performed live. • Ensure only qualified persons are allowed to work on live electrical parts. • Avoid ladders made from conductive materials such as aluminum or steel when working around over-head power lines. • Ensure that all staff working on live equipment or lines will be without conductive apparel (watches, bracelets, rings, key chains, necklaces, zippers, cloth with conductive thread, etc.). • Provide barricades and signage for all live electrical equipment. <u>Infirmary/Hospital</u> • VRA will have an on-site infirmary with a site nurse to treat minor ailments. • Major cases will be referred to selected public/private hospitals in the Kumasi area. • There will be an ambulance or a designated vehicle for emergency transfers.
9.	Labour right concerns	Workers, power beneficiaries	Moderate	• VRA will comply with the labour laws of the country. • Every worker will be given a letter of appointment and condition of service for the engagement. • Workers will be allowed to join the appropriate labour unions of the TUC. • Management and general workers will agree on welfare conditions. • VRA will implement Workers Grievance Mechanism to help minimize labour disputes at the power station.
10.	Public/ community health & safety	Local communities, public	Major	• VRA will ensure correct operation and maintenance of the installed equipment, including regular in-spections and maintenance regime. These measures will be defined in the operation and maintenance manual of the equipment/plant.

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures
	and security concerns			• VRA will minimise emergency response time through the provision of adequate emergency equipment, development of emergency response procedures and training of staff to respond to emergency situations such as falling of a live electrical conductor, fire outbreak, explosions etc. • VRA will ensure timely repair and replacement works on fuel pipelines and transfer facilities, equipment at the power plant and switchyard station. • VRA will secure and fence the power plant and switchyard to prevent direct public access. • Security Officers will be provided for the facilities at all times to ensure intruders are kept away and for them to report all incidents that might be out of the ordinary for prompt attention. • VRA will monitor the integrity of the stacks, high tension poles, conductors and transformers. • The switchyard will be clearly marked with a red inscription on white background - "DANGER – High Voltage" to ward off trespassers, etc.
11.	Emergency events and impacts on environment, properties and terrestrial/ aquatic ecology	Ecology, Power Plant and associated facilities, adjacent properties, workers, local communities	Major	• VRA will prepare and implement an emergency preparedness and response plan for the power plant. • The power plant will have a fire-fighting equipment installed at strategic areas of the power house.
12.	Impact due to lack of sustainability measures	Electricity beneficiaries in Ashanti and beyond, workers, local communities	Major	• VRA, GRIDCo and ECG will regularly engage the PURC to ensure that bulk power is sold and procured at realistic charges to ensure sustainability of the system. • VRA/GRIDCo will set up task force in the project area to sanction people who illegally vandalise any equipment. • Procedures for handling emergency situations such as equipment failure or falling of a live conductor will be put in place. • A comprehensive maintenance program will be put in place to avert any serious breakdowns or failures. The required maintenance for the systems will include among others: Environmental incident/accident investigation; Routine maintenance/inspection schedule; Annual equipment inspection and

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures
				maintenance record; Procedure for pre-arranged repair service; Procedure for preventive maintenance; Procedures for handling materials; Regular calibration; and Emergency response plans and procedure.

Provisional Environmental Management Plan

A Provisional Environmental Management Plan (PEMP) with budget is developed for the Project in accordance with the Environmental Assessment Regulations of 1999, LI 1652 to ensure the project is implemented in an environmentally safe and sustainable manner.

About **GH₵743,650** and **GH₵1,528,275** will be needed per annum during the pre-construction/construction and operational phases respectively for the implementation of the environmental management programmes including monitoring. These costs exclude Contractor BoQ costs and VRA annual recurrent operational costs. The pre-construction/construction phase cost include ambient air quality monitoring in November-December by VRA for air dispersion modelling for dry season scenario. A detailed EMP will be prepared and submitted to the EPA within 24 months of commencement of operations as required by law.

Conclusion

VRA is fully aware of its corporate responsibility to sound environmental practices. The VRA and the Ministry of Energy will ensure that the Project is implemented in line with all relevant national policies, laws and standards to enhance the intended benefits of the Project and reduce potential negative impacts to acceptable levels.

SELJEN CONSULT

CHAPTER ONE
INTRODUCTION

FINAL

ENVIRONMENTAL IMPACT STATEMENT

VOLTA RIVER AUTHORITY

1.0 INTRODUCTION

1.1 Background

The Government of Ghana (GoG) endorsed a Build, Own, Operate and Transfer (BOOT) agreement with AMERI Energy for a fast-track turnkey power generation solution in 2015. This was projected to be done through the construction of a power plant at Takoradi and the installation of 10 new GE TM 2500+ Aero Derivative Gas Turbines along with its related equipment as well as the provision of certain services related to the operation and maintenance of the power plant. The Agreement was scheduled to complete its 60-month tenure on January 31, 2021. As such the Volta River Authority as the Assignee has been mandated to perform the GoG's function including taking over the operation and maintenance of the AMERI Power Plant from February 1, 2021.

The Ghana power system is currently having low voltages from Ashanti Region to the northern part of the country. The Ghana Grid Company Limited (GRIDCo) which is the power system operator of Ghana, has indicated at several stakeholder fora that a power plant in the Ashanti Region of Ghana will help improve voltages of the Ghana power system a great deal.

The Bui Hydropower plant is the major power plant that helps in voltage support from the middle belt to the northern part of the country. As a result, in years where the Bui hydropower plant has low elevations the power system is constrained since dispatch from the Bui hydropower plant becomes limited. The Bui Hydropower plant is faced with a possible "running out of water" before the onset of the rains in the wet season from July 2021. Hence, having another power plant in Kumasi and its environs is a matter of urgency to relieve Bui Hydropower plant of the burden of being the only major source of power supply for voltage stability in the northern part of the country.

The Volta River Authority (VRA) is expected to take over the AMERI Power Plant in 2021 and looking at the urgency of deploying a power plant in Kumasi for voltage stability, the AMERI Power Plant is a quicker option of having a power plant in Kumasi. The plant is currently taken out of service for the condition assessment to be carried out prior to the takeover by VRA.

The AMERI Power Plant will be relocated to a site adjacent to the GRIDCo K2 BSP 161kV/330kV substation at Anwomaso in Kumasi, near Ejisu, in the Ashanti Region. A 15-acre parcel of land is required to accommodate the AMERI Power Plant, its associated Balance of Plant, Office building

and car park. Initial investigations revealed that the selected parcel of land for the proposed project belongs to the Kwame Nkrumah University of Science and Technology (KNUST). Following the relocation of the AMERI Power Plant, the facility's name would be changed to the Kumasi 1 Thermal Power Plant.

The project is being developed as part of efforts in addressing the domestic power shortage status in Kumasi, Ghana and its main advantages are:

a) To meet the electricity demand growth of the middle belt of Ghana.
b) To optimize the power generation portfolio to improve power supply reliability.
c) The Thermal generation units can run on baseload operation, resulting in high-capacity factor.
d) Based on the favorable fuel price of liquefied natural gas, the power generation units have electricity price advantage.

In accordance with the requirements of the Environmental Assessment Regulations, 1999 (LI 1652) as outlined in section 2.2.3 of the Environmental Impact Assessment (EIA) Guidelines for the Energy Sector, Volume 1, dated September 2011; natural gas fired electric power plant with installed capacity equal or exceeding 500 kVA such as the relocation and installation of the erstwhile AMERI Power Plant at Anwomaso as the Kumasi 1 Thermal Power Plant Project requires the undertaking of an environmental assessment studies and the preparation of an Environmental Impact Assessment (EIA) Report.

Consequently, the VRA registered the proposed project with the Environmental Protection Agency (EPA) in April 2021. The EPA in a response letter referenced CE:5327/02/03 and dated May 12, 2021, which is presented as **Annex 1-1** in the Volume II (EIA Annexes) of this EIS confirmed the preparation of an environmental impact assessment of the relocation of the Ameri Power Plant to Anwomaso as per the provisions of the Environmental Assessment Regulations 1999, LI 1652.

A Scoping Report with draft Terms of Reference (ToR) for the preparation of the EIA was subsequently submitted to the EPA. The Agency's response to the Scoping Report is provided in **Annex 1-2** in Volume II of this report. This Environmental Impact Statement (EIS) is the outcome of the EIA of the proposed Project in fulfilment of the permitting requirements/ Environmental Assessment procedures as depicted by the environmental assessment flow chart as shown in **Annex 1-3,** presented in the Volume II of this report. A draft EIS was submitted to the EPA for

review and the Agency's review comments are provided in **Annex 1-4.** This final EIS addresses the EPA review comments on the draft EIS, as provided in **Annex 1-5**, which is presented as part of the Volume II of this report.

1.2 Justification and Benefits of the Project

The Ghana Grid Company Limited (GRIDCo) who is the power system operator of Ghana, has indicated at several stakeholder fora that a power plant in the Ashanti Region of Ghana will help improve voltages of the Ghana power system a great deal and especially in the Greater Kumasi area.

Currently, Kumasi and the rest of the northern part of the country are experiencing very frequent power interruptions due to low voltages and other power transmission bottlenecks in the Kumasi area. This situation is not only affecting power transmission and distribution in Kumasi and Northern Ghana but also impeding the export of power to SONABEL in Burkina Faso. The situation has been aggravated due to the inability of the Bui power plant to operate at the desired level during peak and off-peak period due to insufficient inflows.

Relocating the AMERI Power Plant to Kumasi will also be the quickest solution to the challenges faced by the grid. This project would reduce transmission losses from 132.5 MW (3.74 % of total generation) to 107.6 MW (3.1 % of total generation) as stated in the 2020 Electricity Supply Plan for the Ghana Power System. This is a significant reduction of about 25MW (0.64% of total generation) in transmission losses.

The following benefits/opportunities are expected to be realized from the possible implementation of the proposed project in the area:

1. Improvement in the voltage stability of the NITS
2. Significant reduction in transmission system losses
3. Improvement in the quality of supply to end users through improved network voltage control via generators
4. Continuous supply of reliable power to end users.

1.3 Purpose/Objectives of the EIA

The purpose of the EIA is to identify both positive and negative significant environmental impacts and risks to be associated with the proposed Project from project preparation/design through

construction to operation as well as future decommissioning phase of the Project. The EIS addresses the adverse impacts and provides for the enhancement of positive impacts. The EIA is also to satisfy legal obligations given under Legislative Instrument (LI) 1652 including meeting EPA requirements.

The primary objective of the EIA is to identify key adverse biophysical, socio-economic and cultural risks and impacts associated with the project interventions that can affect project viability and sustainability, and to formulate appropriate mitigation and management measures required to address any adverse impacts/risks to acceptable limits to ensure project success. The outcome of the EIA is also to assist VRA and Ministry of Energy to consider the consequences of implementing the current project designs and actions in the planning process, to choose the most appropriate actions and to modify the designs where appropriate on environmental grounds, and to adopt the proposed mitigation measures to minimize any remaining impacts.

The specific objectives of the EIA are to:

- Adequately describe the proposed Project and identify activities of environmental concerns;
- Engage relevant stakeholders to gauge their levels of interest in the Project and incorporate their concerns in the EIA;
- Establish the baseline environmental conditions;
- Predict and examine the significant environmental and social impacts on the environment and communities during development and implementation of the Project and advise on appropriate mitigation and abatement measures against potentially adverse impacts;
- Document the Socio-economic and cultural benefits and disadvantages associated with the Project for stakeholders for an informed decision to be made on the level of environmental compromise and permitting;
- Propose appropriate pragmatic mitigation and abatement strategies for all identified adverse impacts on the immediate environment and nearby local communities during construction, implementation and decommissioning of the Project;
- Provide a Provisional Environmental Management Plan (PEMP) and monitoring programme for predicted impacts; and
- Provide a provisional decommissioning proposal for stakeholder considerations.

1.4 Methodology and Approach

The approach and methodology adopted for this EIA included:

- field inspections;
- specialist studies;
- desktop studies including previous Ameri Power Plant EMP /data review;
- consultations; and
- data analysis and report preparations.

1.4.1 Field Inspections

The field inspections of the project area, and trekking along the proposed project site and neighbouring areas were carried out to obtain first-hand information and to confirm baseline environmental issues and conditions to be affected or likely to develop from the implementation of the proposed project.

Various field visits to the project area were undertaken from August 2021 to November 2021. Site inspections, field investigations and environmental media monitoring were carried within this period. The team of EIA experts also used the 1:50,000 topographical maps, alongside with google maps/images for ground-thruthing to confirm the actual situations on the field.

Specifically, the site inspections and surveys were carried out to establish the following:

- Land use and in particular the physical setting of the local environment in the project area of influence;
- Physical characteristics viz. topography, relief and vegetation of the area;
- Water bodies within the project area;
- Socio-economic and cultural conditions of the project area;
- Current operations/activities and properties near the project site;
- Waste management issues within the proposed project area; and
- Public/community safety/health issues/concerns in the project area.

1.4.2 Specialist Studies/Surveys

Specialist studies and surveys were conducted to generate the required data/information as part of the EIA. Specialist studies carried out include:

- Baseline ambient air quality within the project area;

- Baseline noise levels within the project area;
- Surface water quality of the main nearby stream; and
- Terrestrial flora and fauna in the project area.

1.4.3 Desktop Study/Literature Review

Collection and review of available documentation relevant to the project and in particular project description information, the existing environment (biophysical, socioeconomic and cultural) conditions as well as relevant policies, laws and regulations were carried out.

Information/data gathered from various documents and reports from Seljen Consult library, VRA, Oforikrom Municipal Assembly' s websites, and other internet sources were reviewed as part of the EIA work. The key literature reviewed include:

- The 1992 Constitution of Ghana;
- Relevant Policies, Acts and Laws of Ghana;
- Environmental Impact Assessment Guidelines for the Energy Sector (September 2011), Volume 1. Volume 2 of the Guidelines provides systematic procedures on EIS/EMP preparations for the energy sector as well as guidelines on common potential impacts and mitigation measures;
- Environmental Impact Assessment Guidelines for the General Construction and Services Sector (2011);
- Ghana Environmental Impact Assessment Procedures;
- IFC Performance Standards, 2012;
- Feasibility Study Report on the Project [i.e. AMERI Power Plant – Relocation to Anwomase (Kumasi) Report], April 2021;
- The Site Geotechnical Investigation Report [i.e. Relocation of AMERI Thermal Plant, Anwomaso, Kumasi, Geotechnical Investigation Report, Revision 00 Draft], June 20, 2021;
- Topographical and Google maps of the Project area;
- VRA SHE Standards for Contractors, January, 2013;
- Annual Environmental Report for AMERI Power Plant, 2016;
- Annual Environmental Report for AMERI Power Plant, 2017;
- Annual Environmental Report for AMERI Power Plant, 2018;
- AMERI Power Plant EMP- 2019;
- AMERI Power Plant Decommissioning and Site Closure Plan, July 2021;

- Oforikrom Municipal Assembly Composite Budget for 2020-2023 Programme Based Budget Estimates for 2020;
- Profile of the Oforikrom Municipality obtained from OfMA in 2021.

1.4.4 Consultations

Consultations and discussions have been held with relevant government institutions, landowners, local community stakeholders and some project affected farmers. Information was obtained from the consultation process to confirm or otherwise information obtained from the desktop study or observations made from the field inspections.

Consultations have been held with the following stakeholders as part of the EIA process:

- Kwame Nkrumah University of Science and Technology (KNUST);
- Oforikrom Municipal Assembly;
- Ghana Grid Company (GRIDCo), Anwomaso;
- Ghana National Gas Company Ltd;
- National Vocational Training Institute (NVTI);
- Assemblyman of Anwomaso Electoral Area/Community;
- Anwomaso Traditional Authority;
- Farmers at the proposed site [i.e. Project Affected Person (PAPs)];
- Ghana Water Company Limited;
- Road Agencies - Ghana Highway Authority/Department of Urban Roads;
- Water Resources Commission (WRC);
- Environmental Protection Agency (EPA), Kumasi Regional Office;
- Ghana Police Service;
- Ghana Health Service;
- Electricity Company of Ghana (ECG);
- Ghana National Fire Service (GNFS).

Details of the stakeholder engagement are provided in Chapter 5 of this report.

1.4.5 Reporting

The data obtained from the desktop and field studies as well as literature reviews were analysed and have been presented in this Environmental Impact Statement (EIS). The key headings of the EIS or EIA Report is in line with the EPA EIS format issued in October 2018 as follows:

- Cover Page
- Signature Page
- Consultant's Team
- Executive Summary
- Introduction
- Policy, Legislative and Administrative Framework
- Project Description and Alternatives
- Description of the Existing Environment/Baseline
- Stakeholder Consultations and Public Involvement
- Impacts Identification and Significance
- Mitigation and Enhancement Measures
- Provisional Environmental Management Plan
- Decommissioning
- Conclusion
- Bibliography
- Annexes

SELJEN CONSULT

CHAPTER TWO

POLICIES, LEGAL AND ADMINISTRATIVE FRAMEWORK

FINAL

ENVIRONMENTAL IMPACT STATEMENT

VOLTA RIVER AUTHORITY

2.0 POLICIES, LEGAL AND ADMINISTRATIVE FRAMEWORK

The relevant national policies, legal and institutional frameworks that will be required to guide the proposed construction and operation of the Kumasi 1 Thermal Power Plant to ensure sustainable development and compliance with national and international regulations are briefly described below.

Relevant international standards include IFC Performance Standards (PS) for Environmental and Social Sustainability, IFC Environmental, Health & Safety Guidelines for Thermal Power Plants, and Electric Power Transmission & Distribution.

2.1 National and Sector Policies and Plans

The relevant national and sector policies and plans identified include:

- National Land Policy, 1999;
- National Environmental Policy, 2012;
- National Climate Change Policy, 2013;
- National Water Policy, 2007;
- Strategic National Energy Plan, 2006-2020;
- National Energy Policy, 2010; and
- Health, Safety and Environmental Policy for the Energy Sector, 2016.

The review of the national and sector policies and plans is provided in **Table 2-1.**

2.2 National Legal Framework

The relevant environmental and electricity laws and regulations to guide VRA from the conceptualization stage of the project to implementation and monitoring as well as decommissioning include the following:

- The Constitution of the Republic of Ghana, 1992;
- Volta River Development Act, 1961 (Act 46);
- Energy Commission Act 1997, Act 541;
- The Lands Act, 2020;
- The Lands (Statutory Wayleaves) Act, 1963;
- Electricity Regulations, 2008, (LI 1937);

- Electricity Transmission (Technical, Operational and Standards Of Performance) Rules, 2008, (LI 1934);
- The National Electricity Grid Code, 2009;
- Public Utilities Regulatory Commission Act, 1997 (Act 538);
- Public Utilities Regulatory Commission (Amendment) Act, 2010 (Act 800);
- Lands Commission Act 2008, Act 767;
- Land Use and Spatial Planning Authority (LUSPA) Act 2016, Act 925;
- Environmental Protection Agency (EPA) Act 1994, Act 490;
- Environmental Assessment Regulations 1999, LI 1652;
- Fees and Charges (Amendment) Instrument 2019 (L.I. 2386);
- Hazardous and Electronic Waste control and Management Act 2016 (Act 917) and Hazardous, Electronic and other waste (Classification), Control and Management Regulations 2016, LI2250;
- Local Governance Act 2016, Act 936;
- Water Resources Commission Act 1996 (Act 522);
- Water Use Regulation (WUR) 2001, LI 1692;
- Ghana Water Company Act 1993, Act 461;
- The Fire Precaution (Premises) Regulations 2003, LI 1724;
- Factories, Offices and Shops Act 1970, Act 328;
- The Labour Act 2003, Act 651;
- Workmen's Compensation Law 1987;
- Road Traffic Act 2004, Act 683;
- Persons with Disability Act 2006, (Act 715); and
- Public Health Act 2012, (Act 851).

The review of the legal framework is provided in **Table 2-1.**

Table 2-1: A Summary of National and Sector Policies and National Legal Framework

Policy and Legal Framework	Summary of core requirements/description	Relationship to proposed project
National and Sector Policies And Plans		
National Land Policy, 1999	The National Land Policy provides for the protection of water bodies and the environment in the long-term national interest under any form of land usage be it for human settlements, industry and commerce, agriculture, forestry and mining. Key aspects of Section 4.4 (Ensuring Sustainable Land Use) of the Policy relevant to the Project are provided below: The use of any land in Ghana for sustainable development, the protection of water bodies and the environment and any other socioeconomic activity will be determined through national land use planning guidelines based on sustainable principles in the long term national interest. Land categories outside Ghana's permanent forest and wildlife estates are available for such uses as agriculture, timber, mining and other extractive industries, and human settlement within the context of a national land use plan. Unless approved by the appropriate public authority, no land use change of any kind will be countenanced. All land and water resources development activities must conform to the environmental laws in the country and where Environmental Impact Assessment report is required this must be provided. Environmental protection within the 'polluter pays' principle will be enforced.	The Kumasi 1 Thermal Power Plant Project is an industrial undertaken that has the potential of polluting water bodies such as the Adote (also spelt as Adoti in some literature) Stream and associated wetlands in the project area.

Policy and Legal Framework	Summary of core requirements/description	Relationship to proposed project
National Water Policy, 2007	The National Water Policy, approved in June 2007, is to provide the framework for the sustainable development of water resources in Ghana. The overall goal of the policy is to "achieve sustainable development, management and use of Ghana's water resources to improve health and livelihoods, reduce vulnerability while assuring good governance for present and future generations." The relevant section of the Policy applicable to the proposed thermal plant is found in Section 2.2.4, Focus Area 4 –Water for Non-Consumptive and other uses. The key objectives of this section are to: i. ensure availability of water for hydropower generation, various industrial and commercial uses, mining operations, water transport and recreational purposes; and ii. ensure adequate protection of water sources in mining and other industrial areas. Relevant policy measures to be undertaken include: i. facilitate availability of water resources for industrial uses through sustainable resources management; ii. require industries, including mining operations, to develop and implement environmental management systems which take into account the impact of industry on the country's water resources; iii. fully implement the enacted requirements related to licensing of water uses (permits) and issuance of waste water (effluent) discharge permits; and iv. encourage development of codes of practice for efficient water use and cleaner production technologies in industrial activities.	The project will take water from Ghana Water Company Limited which has potential impacts on sustainable access to water by the Greater Kumasi area. Groundwater will be explored to augment the GWCL supplies.

Policy and Legal Framework	Summary of core requirements/description	Relationship to proposed project
Strategic National Energy Plan, 2006	The SNEP reiterates the sector Ministry's vision to develop an 'Energy Economy' that would ensure sustainable production, supply and distribution of high quality energy services to all sectors of the economy in an environmentally friendly manner for Ghana's future while making significant contribution to the country's export earnings. In this regard, the following broad objectives are highlighted by the policy: • Stimulate economic development by ensuring that energy plays a catalytic role in Ghana's economic development; • Consolidate, improve and expand existing energy infrastructure; • Increase access to modern energy services for poverty reduction in off-grid areas; • Secure and increase future energy security by diversifying sources of energy supply; • Enhance private sector participation in energy infrastructure development and service delivery; • Minimize environmental impacts of energy production, supply and utilization; • Strengthen institutional and human resource capacity and R & D in energy development; • Improve governance of the Energy Sector; and Sustain and promote commitment to energy integration as part of economic integration of West African states.	The proposed project is in response to the need for sustainable energy production and supply in the northern sector of Ghana to address shortfalls in the area. Identification and mitigation measures will be carried out as part of this EIA process to minimize any adverse environmental impacts.

Policy and Legal Framework	Summary of core requirements/description	Relationship to proposed project
National Energy Policy, 2010	The 2010 National Energy Policy outlines the Government of Ghana's policy direction regarding the current challenges facing the energy sector. The document provides a concise outline of the Government's policy direction in order to contribute to a better understanding of Ghana's Energy Policy framework. Within the context of energy sector vision, the goal of the energy sector is to make energy services universally accessible and readily available in an environmentally sustainable manner. The policy objectives to achieve this goal are to: i. Secure long term fuel supplies for the thermal power plants; ii. Reduce technical and commercial losses in power supply; iii. Support the modernisation and expansion of energy infrastructure to meet growing demands and ensure reliability; iv. Increase access to modern forms of energy; v. Improve the overall management, regulatory environment and operation of the energy sector; vi. Minimise the environmental impacts of energy supply and consumption through increased production and use of renewable energy and make energy delivery efficient; vii. Ensure cost recovery for energy supply and delivery; viii. Ensure the productive and efficient use of energy; ix. Promote and encourage private sector participation in the energy sector; and x. Diversify the national energy mix by promoting renewable energy sources nuclear and coal.	The relocation of the AMERI Power Plant to Kumasi area will increase generation capacity and increase access to energy in the Greater Kumasi area. The plant will operate principally on natural gas which is environmentally cleaner. There is a possible extension of natural gas from the Western Region to the proposed project site by the Ghana National Gas Company for sustainable fuel supplies for the thermal plant.
Health, Safety and Environmental Policy for the Energy Sector (2016)	The policy describes the elements necessary to develop, implement and maintain a high level of safety in all energy sector activities. The policy develops relevant regulations and standards, which will ensure that operators take into account relevant information about hazards, environmental effects, safety and security threats to their operations. To achieve this outcome, regulators are to ensure that, energy sector activities are carried out in an efficient manner that strives for continuous improvement of HSSE performance.	The proposed project is in line with the policy's objective to ensure that there is minimal harm to property, people and the environment.

Policy and Legal Framework	Summary of core requirements/description	Relationship to proposed project
National Environmental Policy, 2012	The Ghana National Environmental Policy was launched in November 2012 with the vision to manage the environment in a sustainable way to benefit Ghanaian society. The objective of this policy is to promote healthy lifestyles and reduce risk factors that arise from environmental, economic, social and behavioural causes thereby promoting healthy lifestyles in a healthy environment. The policy notes that proper management of Ghana's resources requires that efforts should be redirected into more environmentally sustainable programmes and practices. Such programmes should protect and preserve the resource base for use by present and future generations. Assessment of the potential environmental impacts of development projects and planning in advance to mitigate or eliminate these impacts will decrease environmental costs to the economy and make more cost-effective use of the country's resources. The ultimate aim of the National Environmental Policy of Ghana is to improve the surroundings, living conditions and the quality of life of the entire citizenry, both present and future. It seeks to promote sustainable development through ensuring a balance between economic development and natural resource conservation. The policy thus makes a high quality environment a key element supporting the country's economic and social development.	VRA has put in place an environmental policy that outlines various operational policies and strategies for the protection of the environment and resources. There is a monitoring system for resource utilization to safeguard all the resources and the environment.
National Climate Change Policy, 2013	The National Climate Change Policy provides strategic direction and coordinates issues of climate change in Ghana. The three objectives of the Policy are (1) effective adaptation, (2) social development and (3) mitigation. To address the adaptation issues in Ghana, five thematic areas have been prioritised. These are (1) energy and infrastructure, (2) natural resources management, (3) agriculture and food security, (4) disaster preparedness and response and (5) equitable social development.	The project will involve use of natural gas to generate energy. The power generation process will release gases such as carbon dioxide, methane and nitrous oxide.
NATIONAL LEGAL FRAMEWORK		

Policy and Legal Framework	Summary of core requirements/description	Relationship to proposed project
The Constitution of the Republic of Ghana, 1992	The Constitution includes some provisions to protect the right of individuals to private property, and also sets principles under which citizens may be deprived of their property in the public interest (described in Articles 18 and 20). Article 18 provides that "Every person has the right to own property either alone or in association with others." In Article 20, the Constitution describes the circumstances under which compulsory acquisition of immovable properties in the public interest can be done: "No property of any description, or interest in, or right over any property shall be compulsorily taken possession of or acquired by the State unless the following conditions are satisfied: i. The taking of possession or acquisition is necessary in the interest of defence, public safety, public order, public morality, public health, town and country planning or the development or utilization of property in such a manner as to promote the public benefit; and ii. The necessity for the acquisition is clearly stated and is such as to provide reasonable justification for causing any hardship that may result to any person who has an interest in or right over the property." Articles 268 and 269 make provision for the protection of natural resources of the country.	The proposed site for the power plant is for KNUST, which is part of Government or State land.
The Lands Act, 2020, Act 1036	The Lands Act (Act 1036) of 2020 repeals the State Lands Act (Act 125) of 1962, and other laws. The Lands Act (Act 1036) vests in the State the authority to compulsorily acquire land for public purposes via an Executive Instrument (EI) and shall ensure the prompt payment of fair and adequate compensation for the acquisition. It also declares that the Lands Commission shall act on behalf of the State with regard to the compulsory acquisition of land under the Act.	The proposed site for the Kumasi 1 Thermal Power Plant is part of KNUST lands, which has been acquired by the Government of Ghana. No compulsory acquisition of land will be necessary again under this project. The farmers on the land will be given ample time to harvest their crops and vacate the land.

Policy and Legal Framework	Summary of core requirements/description	Relationship to proposed project
The Lands (Statutory Wayleaves) Act, 1963	This Act describes the process involved in occupation of land for the purpose of the construction, installation and maintenance of works of public utility, and for creation of rights of way for such works. The provisions include among others: • 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 hour notice before actual entry; • Any damage due to entry must be compensated in accord with the procedures established by the Minister unless the land is restored or replaced; and • Where a right of way must be established in the public interest, the President may declare the land to be subject to such statutory wayleave.	Due process must be used to occupy the site for the construction, installation of the thermal plant.
Volta River Development Act 1961, Act 46	The Act establishes the Volta River Authority (VRA) and defines its functions and responsibilities. Part 4, Section 17 (2) (d) of the Act authorizes the VRA to acquire land necessary "for the proper discharge of the Authority's functions." Provision has, also, been made in the Act for the payment of compensation or resettlement of affected people as may be applicable.	The VRA is the key proponent for this project, and responsible for the operation of the facility when relocated to its proposed site at Anwomaso.
Energy Commission Act 1997, Act 541	The Energy Commission Act 1997 (Act 541) sets up the Energy Commission and defines its functions as relating to the regulation, management, development and utilization of energy resources in Ghana including the granting of licenses for the transmission, wholesale supply, distribution and sale of electricity and natural gas.	The proposed power plant falls in the category of projects regulated by the Energy Commission as per the Act.
Electricity Regulations, 2008, (LI 1937)	Electricity Regulations, 2008 (LI 1937) provides for the planning, reliability and cost effectiveness of the national interconnected transmission system.	Power from the Kumasi 1 Thermal Power Plant will be evacuated into the national interconnected transmission system at the GRIDCo substation.
Electricity Transmission (Technical, Operational and Standards Of Performance) Rules, 2008, (LI 1934)	The Electricity Transmission (Technical, Operational and Standards of Performance) Rules, 2008 (LI 1934) establishes the procedures for operating the high voltage national interconnected transmission system	VRA is required to comply with the rules of Electricity Transmission as Kumasi 1 Thermal Power Plant will be interconnected to the national transmission system. GRIDCo transmit and manages the NITS.

Policy and Legal Framework	Summary of core requirements/description	Relationship to proposed project
The National Electricity Grid Code, 2009	The National Electricity Grid Code of Ghana referred to in this document as the Grid Code, establishes the requirements, procedures, practices and standards that govern the development, operation, maintenance and use of the high voltage transmission system in Ghana. The purpose of the Grid Code is to ensure that the NITS provides fair, transparent, non-discriminatory, safe, reliable, secure and cost efficient delivery of electrical energy.	Power from Kumasi 1 Thermal Power Plant will be evacuated into the national interconnected transmission system at the GRIDCo substation.
Public Utilities Regulatory Commission Act, 1997 (Act 538)	The PURC Act, 1997 (Act 538) created PURC 'to provide guidelines on, and examine and approve, rates chargeable for the provision of utility services; protect the interest of consumers and providers of utility services; monitor standards of performance for provision of utility services; and promote fair competition among public utilities. The Act repeals VRA's power to set electricity rates contained in the VRA Act. It also includes the preparation of guidelines in fixing rates; a prohibition against demanding rates other than those approved by the Commission; notification to the Commission of any revision in rates; and publication of approved rates.	The operation of the proposed power plant will increase the electricity available for supply and distribution. The Kumasi 1 Thermal Power Plant will use water supplied by GWCL. The PURC will be involved with utility pricing or rates to be charged for electricity and water consumptions.
Lands Commission (LC) Act 2008, Act 767	This act 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 particular areas to ensure that the development of individual pieces of land is co-ordinated with the relevant development plan for the area concerned. The Minister may, with the approval of the President, give general directions in writing to the Commission on matters of policy in respect of the management of public lands. The commission has the following divisions: • Survey and Mapping; • Land Registration; • Land Valuation; • Public and Vested Lands Management; and • Any other Division the Commission may determine.	The Commission will be involved in the transfer of the proposed land for the Kumasi 1 Thermal Power Plant from KNUST to VRA/ Ministry of Energy as appropriate.

Policy and Legal Framework	Summary of core requirements/description	Relationship to proposed project
Land Use and Spatial Planning Authority (LUSPA) Act 2016, Act 925	The LUSPA Act 2016, Act 925 seeks to ensure the orderly and progressive development of land, town and other areas whether urban or rural for conserving and developing resources and to preserve and improve amenities thereof, and for related matters. It seeks to promote sustainable human settlements developments based on principles of efficiency, orderliness, safety and healthy growth of communities. This Act applies to both public and private institutions, which are responsible for human settlement, spatial planning and use of land, and issues development permit prior to undertaking any physical development of land within a district in which the land is situated.	LUSPA is a decentralised body at the MMDA level. The municipal assembly in which the proposed power plant is situated will be informed about the project to enable them incorporate or update their land use plans.
Environmental Protection Agency (EPA) Act 1994, Act 490	The Environmental Protection Agency (EPA) Act 1994 (Act 490) gives mandate to the Agency to ensure compliance of all investments and undertakings with laid down Environmental Assessment (EA) procedures in the planning and execution of development projects, including compliance in respect of existing ones	The EPA will issue an Environmental Permit prior to project implementation after the proponent, i.e. VRA/Ministry of Energy has followed the Environmental Assessment (EA) procedures for approval by the EPA
Environmental Assessment Regulations 1999, LI 1652	The regulations for undertakings requiring registration and issue of environmental permit may include: 1. (1) No person shall commence any of the undertakings specified in Schedule 1 to these Regulations or any undertaking to which a matter in the Schedule relates, unless prior to the commencement, the undertaking has been registered by the Agency and an environmental permit has been issued by the Agency in respect of the undertaking. 2. No person shall commence activities in respect of any undertaking which in the opinion of the Agency has or is likely to have adverse effect on the environment or public health, unless prior to the commencement, the undertaking has been registered by the Agency and an environmental permit has been issued by the Agency in respect of the undertaking. <u>Environmental impact assessment</u> 3. No environmental permit shall be issued by the Agency for any of the undertakings mentioned in Schedule 2 to these Regulations unless there is submitted by the responsible person to the Agency, an environmental impact assessment in accordance with these Regulations in respect of the undertaking.	The proposed project falls in the category for which an EIA is mandatory, as per the regulations.

Policy and Legal Framework	Summary of core requirements/description	Relationship to proposed project
Fees and Charges (Amendment) Instrument 2019 (L.I. 2386)	The Fees and Charges (Amendment) Instrument 2019 (L.I. 2386) provides comprehensive rates, fees and charges collectable by Ministries, Department and Agencies (MDAs) for goods and services delivered to the public. It contains the stipulated fees and charges to be paid by proponents with respect to Environmental Permits and Certificates or provides a guide for its determination.	All stipulated fees and charges shall be Paid in order to obtain the environmental permit from the EPA for project implementation.
Local Governance Act 2016, Act 936	This Act re-establishes and regulates the local government system and gives authority to the RCC and the Metropolitan, Municipal and District Assemblies to exercise political and administrative power in the Regions and Districts, provide guidance, give direction to, and supervise all other administrative authorities in the regions and districts respectively. The Assembly is mandated to initiate programmes for the development of basic infrastructure and provide municipal works and services as well as be responsible for the development, improvement and management of human settlements and the environment in the district.	The proposed site for the power plant is situated within the jurisdiction of the Oforikrom Municipal Assembly.
Water Resources Commission Act 1996 (Act 522)	The Water Resources Commission Act 1996 (Act 522) establishes and mandates the Water Resources Commission as the sole agent responsible for the regulation and management and the utilisation of water resources and for the co-ordination of any policy in relation to them. Section 13 prohibits the use of water (divert, dam, store, abstract or use water resources or construct or maintain any works for the use of water resources) without authority. Section 16 empowers the Commission to grant Water Rights (water use permits) to prospective users. The Act states under Section 24 that, except in accordance with the provisions of this Act or with the approval of the Environmental Protection Agency, any person who pollutes or fouls a water resource beyond the level that the EPA may prescribe, commits an offence and is liable on conviction to a fine or a term of imprisonment or both.	It is likely Section 13 of the Act [i.e. abstract or use water resources] will be triggered. Water use permit will be required for groundwater abstraction.
Water Use Regulation (WUR) 2001, LI 1692	The Water Use Regulations, 2001 (LI 1692) list such activities for which water use permit is required and this includes domestic, commercial, municipal, industrial water use among others. The Regulations also prescribe the raw water charges and processing fees to be paid by prospective water users with respect to the water use permits.	Any utilisation of raw water resources for the proposed project will require a water use permit including groundwater resources.
Ghana Water Company Act 1993, Act 461	GWCL is mandated by law, GWCL Act, 1993, (Act 461) to provide, distribute and conserve the supply of water in Ghana for public, domestic and industrial purposes.	The Kumasi 1 Thermal Power Plant will take water from the GWCL for its operations

Policy and Legal Framework	Summary of core requirements/description	Relationship to proposed project
Hazardous and Electronic Waste control and Management Act 2016 (Act 917) and Hazardous, Electronic and other waste (Classification), Control and Management Regulations 2016, LI 2250	The hazardous and Electronic waste and control ACT 2016 (Act 917) provides list of hazardous and other waste. It also provides control, management and disposal of electrical and electronic waste. Hazardous waste generally refers to waste with properties that makes it potentially dangerous or harmful to human health or the environment and they include liquids, solids or gases which cannot be treated or disposed of by common means. The Act will also ensure that harmful elements associated with hazardous and other waste products are captured and processed safely to preserve critical ecological components such as the soil, groundwater, flora and fauna.	The Act will guide the project on hazardous and electronic waste management and disposal during project implementation.
The Fire Precaution (Premises) Regulations 2003, LI 1724	The Fire Precaution (Premises) Regulations 2003 (LI 1724) requires all premises intended for use as workplaces to have Fire Certificates.	Fire certificate will be obtained for the operation of the power plant.
Factories, Offices and Shops Act 1970, Act 328	The Factories, Offices and Shops Act of 1970 (Act 328), as amended by the Factories Offices and Shops (Amendment) Law 1983 PNDCL 66, the Factories Offices and Shops (Amendment) Law 1991 PNDCL 275 s.1 (a), and the Ghana National Fire Service Act, 1997 (Act 537) requires all proponents to register every factory/workplace with the Chief Inspector of Factories Inspectorate Division. The Act requires all factories, offices and shops among others, notify the Chief Inspector of accidents, dangerous occurrences and industrial diseases, display at a prominent position in every factory the prescribed abstract of the Act and other notices and documentations, as well as outlines the regulations to safeguard the health and safety of workers.	The Kumasi 1 Thermal Power Plant will be registered with the Factories Inspectorate Division and any accident reported as per Act 328, 1970 during construction and operation.
The Labour Act 2003, Act 651	Section 118(1) of the Labour Act 2003 (Act 651) stipulates that it is the duty of an employer to ensure that every worker employed works under satisfactory, safe and healthy conditions. Act 651 contains a number of specific provisions relating to an employer's duty of care to its workers. These include providing and maintaining "at the workplace, plant and system of work that are safe and without risk to health" and taking "steps to prevent contamination of the workplaces by, and protect the workers from, toxic gases, noxious substances, vapours, dust, fumes, mists and other substances or materials likely to cause risk to safety or health". A worker is required to report situations that he believes may pose "an imminent and serious danger to his or her life, safety or health".	This Act is triggered for the Kumasi 1 Thermal Power Plant project. The provisions are incorporated into various policies and procedures of VRA such as environmental policy, occupational health and safety policy, Transport Policy, Risk Management Policy etc.
Workmen's Compensation Law 1987	It is to provide for the payment of compensation to workmen for personal injuries caused by accidents arising out and in the course of their employment. The tenets of the law places a large share of the burden of supporting workers injured at the workplace on the shoulders of the employers.	This will apply to the project and the safety of all workers will be the responsibility of the Contractor and VRA.

Policy and Legal Framework	Summary of core requirements/description	Relationship to proposed project
Road Traffic Act, 2004 (Act 683)	The 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. Under the Act, it is an offence for any drivers plying on the road to use a mobile phone, put a child on their lap whilst driving, put a child below the age of fifteen to sit on a passenger seat beside the driver. The Act also requires drivers 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.	The project will ensure that all drivers/ operators engaged are trained or have the necessary knowledge and experience to comply with the requirements of this law.
Persons with Disability Act 2006, (Act 715)	The Act covers key thematic provisions such as rights, accessibility, employment, education and transportation for PWDs amongst others. Section 6 states that The owner or occupier of a place to which the public has access shall provide appropriate facilities that make the place accessible to and available for use by a person with disability. Section 10 of the Act 10. (1) The Government shall grant a person who employs a person with disability an annual tax rebate of the taxable income in respect of each person with disability employed as shall be prescribed in Regulations made under this Act.	The project will ensure that its buildings have accesses that can be used by PWDs.
Public Health Act 2012, (Act 851)	This Act consolidates the laws relating to public health and is intended to prevent disease, promote, safeguard, maintain and protect the health of humans and animals and to provide for related matters. The Public Health Act 2012, Act 851 seeks to ensure disease prevention, promote, safeguard, maintain and protect the health of humans and animals and effectively regulate matters related to public health. It also provides temporary recommendations for the implementation of health measures and protection of all individuals from spread of diseases.	The Project will ensure that noxious or offensive practices that may cause damage to lands, crops cattle among others are prohibited.

2.3 National Institutional Framework for the implementation of the proposed Project

The proposed project falls directly under the jurisdiction of the Ministry of Energy. The key agencies whose mandates will be triggered by the implementation of the proposed Project are summarised in the table below.

Table 2-2: National Institutional Framework

Institutional Framework	Key objective /function	Relevance or relationship to Project
Ministry of Energy	The Ministry of Energy is responsible for formulating, monitoring and evaluating policies, programs and projects in the power sector. It is also the institution charged with the implementation of the National Electrification Scheme (NES) which seeks to extend the reach of electricity to all communities in the long term.	The proposed Project falls under this Ministry and the Ministry will be involved in project implementation and will be duly engaged.
Energy Commission	The Energy Commission is responsible for the regulation, management, development and utilization of energy resources in Ghana. The Commission, in addition to being responsible for technical regulations in the power sector, also advises the Minister for Energy on matters relating to energy planning and policy.	The construction and operation of the power plant will be under the technical regulation of the Energy Commission. The Commission will provide various licenses/permits including siting, construction, and operation.
Ghana Grid Company (GRIDCo)	The National Interconnected Transmission System (NITS) for electricity is owned and operated by the Ghana Grid Company (GRIDCo), which is a state-owned company. GRIDCo is responsible for transmission of electricity from facilities of wholesale suppliers to bulk customers or distribution companies and utilities in Ghana and West Africa without discrimination, among other functions.	GRIDCo is responsible for the operation and maintenance of the existing K2 BSP near the project site. GRIDCo transmit and manages the NITS, and thus will be responsible for transmission of power from the Kumasi 1 Thermal Power Plant to ECG and or any other bulk distribution company.
Electricity Company of Ghana (ECG)	Electricity Company of Ghana is a limited liability Company wholly owned by the Government of Ghana and operating under the Ministry of Energy. The Company was incorporated under the Companies Code, 1963 in February 1997. The Company is responsible for the distribution of electricity in the southern part of Ghana namely, Ashanti, Central, Eastern, Greater Accra, Volta, Oti, Western and Western North Regions.	The Low Voltage section of the associated BSP (i.e. K2 BSP at Anwomaso) is operated by ECG. ECG will play a key role in power outage management during project implementation.
Public Utilities and Regulatory Commission (PURC)	The Public Utilities Regulatory Commission of Ghana (PURC) is responsible for the economic regulation of the power sector with the mandate to provide guidelines for rates to be charged for the provision of utility services and approve rates for electricity sold by electricity	PURC will regulate the pricing of the utility services provided by GRIDCo, ECG and GWCL as utility service providers under this project

Institutional Framework	Key objective /function	Relevance or relationship to Project
	distribution utilities.	
Environmental Protection Agency	The EPA is the body responsible for regulating the environment and ensuring the implementation of government policies on the environment. The functions of the Agency include: ▪ ensuring compliance with any laid down environmental impact assessment procedures in the planning and execution of development projects, including compliance in the respect of existing projects; ▪ promoting effective planning in the management of the environment; ▪ imposing and collecting environmental protection levies in accordance with the Environmental Protection Agency Act 1994, Act 490 or regulations made under the Act; and ▪ acting in liaison and co-operation with government agencies, District Assemblies and other bodies and institutions to control pollution and generally protect the environment.	The EPA will ensure that the project follows the environmental assessment procedures, and will issue an environmental permit prior to project implementation. VRA will follow and abide by EPA requirements, and comply with the environmental permit conditions during project implementation.
Local Government Authority	The Metropolitan /Municipal/District Assemblies (MMDAs) are responsible for the overall development of the metropolis/ municipality/ district as established by Acts 936 and 480. With regard to environmental management at the MMDs level, the District Environmental Management Committees (DEMC) has been set up by law (Act 936) to among other things: ▪ Plan and recommend to the DA, strategies and activities for the improvement and protection of the environment with emphasis on fragile and sensitive areas, river courses etc.	The project is under the Oforikrom Municipal Assembly. The Assembly will play a key role in the successful implementation of the project especially with regard to providing building permits, waste management services, managing encroachers and resolving grievances.
Lands Commission	The functions of the Lands Commission include amongst others; ▪ advise the Government, local authorities and traditional authorities on the policy framework for the development of particular areas of the country to ensure that the development of individual pieces of land is coordinated with the relevant development plan for the area concerned; ▪ ensure that through sound, sustainable land use planning, socio-economic activities are consistent with sound land use through sustainable land use planning in the long term national development goals; and ▪ promote community participation and public awareness at all levels in sustainable land management and development practices to ensure the highest and best use of land.	The Lands Commission will be involved in the update of the lands documents and facilitate transfer land for the project from KNUST to Ministry of Energy as appropriate.

Institutional Framework	Key objective /function	Relevance or relationship to Project
Land Use and Spatial Planning Authority (LUSPA)	The LUSPA is the regulator for land use and spatial planning. It is the body that confirms zoning status of areas earmarked for development and provides development approvals for physical development of land within a district in the jurisdiction in which the land is situated.	LUSPA is decentralised at the MMDA level, and the project is situated within the jurisdiction of the Oforikrom Municipal Assembly. LUSPA will have to confirm any development approvals required.
Ghana National Fire Service (GNFS)	The GNFS is a national institution responsible for the prevention and management of undesired fire. GNFS is responsible to ensure that the facility has a fire permit/ certificate.	The GNFS should be informed about the project and any associated premises or workplaces. The Fire Service will provide fire permit for both construction and operation of the facility.
Department of Factories Inspectorate	Regulations for health and safety of workers.	The Department of Factories Inspectorate should be informed about the project and any workplaces associated with the project for registration and permitting purposes.
Ghana National Gas Company Limited	Ghana Gas is mandated to build, own and operate infrastructure required for the gathering, processing, transporting and marketing of natural gas resources in the country. The proposed thermal plant project uses natural gas as fuel.	The Kumasi 1 Thermal Power Plant is expected to operate on natural gas from the Ghana National Gas Company.
Ghana Water Company Limited	GWCL is mandated to provide, distribute and conserve the supply of water in Ghana for public, domestic and industrial purposes.	The Kumasi 1 Thermal Power Plant is expected to use water supplied by GWCL for its operations.
Anwomaso Traditional Authority	In Ghana, people of common descent owe allegiance to a symbol of collective authority, such as the 'stool' for the Akans of southern Ghana or the 'skin' for the northern peoples. Traditional authorities play a role in the administration of the area. At the village level, family and land disputes and development issues are also traditionally dealt with by the village chief and elders. In addition to providing an important leadership role, especially in the more rural areas, chiefs act as custodians of stool/skin land, can mobilise their people for developmental efforts and arbitrate in the resolution of local disputes. Although chiefs have no direct political authority, some are appointed by the Government to District Assemblies.	The proposed thermal power project is located at Anwomaso. The chief, elders and members of Anwomaso are in closest proximity to the project site and will be most influenced.

2.4 Key Guidelines for Environmental Impact Assessment

In addition to the policies and legislations above, the following environmental guidelines are considered:

- **Environmental Impact Assessment Guidelines for the Energy Sector (September 2011), Volume 1** ensures the sustainable use of energy resources and also contribute towards sound environmental management in the energy sector. Volume 2 of the Guidelines provides systematic procedures on EIS/EMP preparations for the energy sector as well as guidelines on common potential impacts and mitigation measures.
- **Environmental Impact Assessment Guidelines for the General Construction and Services Sector (2011)**, has been prepared to ensure the sustainable development of the general construction and services sector and also contribute towards sound environmental management in the general construction and services sector.

2.5 Key National Environmental Quality Standards/Guidelines

The Ghana Standard Authority (GSA) has issued standards for the environment and health protection with ambient air quality, motor vehicle emissions, ambient noise control, effluent discharges and building as follows:

- GS 1236:2019 Environment and Health Protection –Requirements for Ambient Air Quality and Point Source/Stack Emissions
- GS 1219:2018 Environment and Health Protection –Requirements for Motor Vehicle Emissions
- GS 1222:2018 Health Protection –Requirements for Ambient Noise Control
- GS 1253:2018 Acoustics Guide for Measurement of Outdoor A-Weighted Sound Levels
- GS 1212:2019 Environment Protection –Requirements for Effluent Discharge
- Target Water Quality Ranges (TWQR) of the Ghana Raw Water Quality Criteria and Guidelines (Volume 4(B): Agricultural Water Use (Irrigation)) this provides the national Ghana Raw Water Quality Criteria and Guidelines levels as administered by the Water Resources Commission.

2.5.1 *Ambient Air Quality*

Ghana Standard (GS 1236: 2019) for Environment and Health Protection - Requirement for Ambient Air Quality and Point Source/Stack Emissions

The Ghana Standard on Environment and Health Protection – Requirement for Ambient Air Quality and Point Source/Stack Emissions. It specifies the requirements and methods of analysis for ambient air (see **Table 2-3**). It also specifies the requirements and test methods for point source or stack emissions based on the sources of energy as shown in **Table 2-4**.

Table 2-3: Requirement for Ambient Air Pollutants (GS 1236: 2019)

Substance (µg/m$^{3)}$	Maximum Limits	Averaging Time	Test Method
Sulphur Dioxide (SO_2)	520 µg/m^3 50 µg/m^3	1 hr 24hr	AS 358.4.10 Determination by Direct reading instrumental method
Nitrogen Oxides (Measured as $N0_2$)	250 µg/m^3 150 µg/m^3	1 hr. 24 hr.	ISO 7996 Determination by Chemiluminiscence method
Total Suspended Particulate	150 µg/m^3 80 µg/m^3	24 hr 1 yr	ASTM D4096-17 determination by High Volume Sampler Method
PM_{10}	70 µg/m^3 70 µg/m^3	24 hr 1 yr	ASTM D4096-17 determination by High Volume Sampler Method
$PM_{2.5}$	35 µg/m^3	24 hr	ASTM D4096-17 determination by High Volume Sampler Method
Black Carbon	25 µg/m^3 25 µg/m^3	24 hr 24 min	ASTM D6602-13 Standard practice for sampling
Benzene, µg/m^3	5	1 yr	ASTM D5466 -15 determination by canister sampling method
Lead ,µg/m^3	0.5 µg/m^3 1	1 yr 24hr	ISO 9855 determination by Atomic absorption method

Table 2-4: Requirements for Point source/Stack Emissions

No.	Pollutants	Maximum Limits	Test Method
1	**Solid fuels**		
a.	Sulphur Dioxide (mg/Nm^3)	200	USEPA Method 6C
b.	Oxides of Nitrogen (mg/Nm^3)	200	ISO 10849
c.	Particulate Matter (mg/m^3)	50	ISO 9096
2	**Liquid fuels**		
a.	Sulphur Dioxide (mg/Nm^3)	500	USEPA Method 6C
b.	Oxides of Nitrogen (mg/Nm^3)	400	ISO 10849
c.	Particulate Matter (mg/m^3)	50	ISO 9096
3	**Gaseous fuels**		
a.	Sulphur Dioxide (mg/Nm^3)	100	USEPA Method 6C

No.	Pollutants	Maximum Limits	Test Method
b.	Oxides of Nitrogen (mg/Nm^3)	320	ISO 10849
c.	Particulate Matter (mg/m^3)	20	ISO 9096
4	**Electrical energy**		
a.	Sulphur Dioxide (mg/Nm^3)	200	USEPA Method 6C
b.	Oxides of Nitrogen (mg/Nm^3)	200	ISO 10849
c.	Particulate Matter (mg/m^3)	50	ISO 9096
5	**Incinerators**		
a.	Sulphur Dioxide (mg/Nm^3)	200	USEPA Method 6C
b.	Oxides of Nitrogen (mg/Nm^3)	400	ISO 10849
c.	Particulate Matter (mg/m^3)	70	ISO 9096
6	**Other parameters (that may apply)**		
a.	Carbon Monoxide (mg/Nm^3)	100	USEPA Method 10
b.	Hydrochloric Acid (HCl) (mg/Nm^3)	60	USEPA Method 0050
c.	Hydrogen Fluoride (mg/Nm^3)	4	ISO15713
d.	Mercury and mercury compounds (mg/Nm^3)	0.03	USEPA Method 29
e.	Particulate lead (mg/m^3) (expressed as lead)	0.50	USEPA Method 29
	Note: 1) Electrical Energy usage include induction/electric arc furnaces, dryers, oven and kilns, Alumina & Iron smelting among others 2)* N represents Normal atmosphere and pressure		

2.5.2 *Ambient Noise Level*

Ghana Standard (GS 1222: 2018) for Health Protection- Requirements for Ambient Noise Control

This Ghana Standard specifies the requirements for acceptable ambient noise levels within categorized locations. The ambient noise levels of the classified zones shall conform to the requirements given in the table below. According to the Standards, the test method should be in accordance with the relevant test methods given in GS 1253:2018 (Acoustics - Guide for the Measurement of Outdoor A-Weighted Sound Levels).

Table 2-5: Requirements for Noise Control (GS 1222: 2018)

ZONE/ Description of Area	PERMISSIBLE NOISE LEVEL IN dB(A)	
	DAY (6:00am – 10:00pm)	NIGHT (10:00pm – 6:00am)
A (Residential areas)	55	48
B (Educational and health facilities, office and law courts)	55	50
C (Mixed used)	60	55
D (Areas with some light industry)	65	60
E (Commercial areas)	75	65
F (Light industrial areas)	70	60

ZONE/ Description of Area	PERMISSIBLE NOISE LEVEL IN dB(A)	
	DAY (6:00am – 10:00pm)	NIGHT (10:00pm – 6:00am)
G (Heavy industrial areas)	70	70

Noise requirements for construction activities

According to the provisions of GS 1222:2018, an entity responsible for a construction site shall ensure that the maximum noise level near the construction site does not exceed:

- 75 dB (A) Leq (5 min.) in an industrial area; and
- 66 dB (A) Leq (5 min.) in other areas.

2.5.3 Effluent Quality

Ghana Standard (GS 1212: 2019) for Environmental Protection- Requirements for Effluent Discharge into Natural Water Bodies

The Environmental Protection Agency (EPA) through the Ghana Standards Authority (GSA) has issued formal standards on environment and health protection requirements. The effluent/ wastewater discharges into Natural Water Bodies provide maximum permissible concentrations for a number of parameters for various sectors. The thermal power plant and general industry standards are provided in the table below.

Table 2-6: Requirements for Effluent/Wastewater Discharge

No	Parameter	Thermal Power Plant	General Industries	Test Method
1	Colour (TCU)	-	200	ISO 7887
2	Conductivity (µS/cm)	-	1500	ISO 7888
3	Temperature (ºC)	≤ 3 above ambient	≤ 3 above ambient	-
4	Turbidity (NTU)	75	75	ISO 7027 (Quantitative methods)
5	pH	6.9	6-9	GS ISO 10523
6	TDS (mg/l)	-	1000	ASTM D5907
7	TSS (mg/l)	50	50	ASTM D5907
8	Nitrate as total Nitrogen (mg/l)	-	50	GS ISO 10304-1
9	BOD_5 (mg/l)	-	50	APHA 5210 method B or D
10	COD (mg/l)	250	250	ISO 6060/ ISO 15705
11	Oil and grease (mg/l)	5	5	US EPA 1664
12	Phosphorus Total (mg/l)	2	2	APHA method 4500-P
13	Iron Total (mg/l)	2	-	ASTM D1068
14	Copper (mg/l)	0.5	-	ISO 8288 Flame atomic absorption spectrometric methods
15	Selenium (mg/l)	0.1	-	US EPA 7742 Atomic absorption, Borohydride reduction

No	Parameter	Thermal Power Plant	General Industries	Test Method
				APHA 3113 B
16	Zinc (mg/l)	2	-	ISO 8288 Flame atomic absorption spectrometric methods
17	Chromium Total (mg/l)	0.05	-	ISO 9174 (Atomic absorption spectrometric methods)
18	Arsenic Total (mg/l)	0.01	-	GS ISO 17378-2 (Hydride Generation Atomic Absorption Spectrometry)
19	Mercury (mg/l)	0.005	-	ISO 12846 (Atomic absorption spectrometry (AAS)
20	Lead (mg/l)	0.1	-	ISO 8288 Flame atomic absorption spectrometric methods
21	Coliforms Total (MPN/ 100ml)	-	400	GS ISO9308-2

2.5.4 *Surface Water Quality Guidelines*

The Water Resources Commission (WRC) has developed the Target Water Quality Ranges (TWQR) of the Ghana Raw Water Quality Criteria and Guidelines (Volume 4(B): Protection of Agriculture Water Use) as provided in the table below. The Adote Stream in the project area is partly used for agriculture, mainly for small scale irrigation purposes, and the WRC TWQR can serve as a guide for the water quality.

Table 2-7: WRC Raw Surface Water Quality Guideline for Agriculture Water Use

Parameter (mg/L)	Ghana TWQR for agriculture water use
pH	6.5 – 8.5
Conductivity	-
Turbidity	-
Colour	-
Total Suspended Solids (TSS)	<50
Total Dissolved Solids (TDS)	<40
Alkalinity	-
Nitrate	-
Total phosphorus	-
Chloride	<100
Fluoride	<2
Sulphide	-
Total Iron	<5
Zinc	<1
Lead	<0.2
Biochemical Oxygen Demand (BOD)	-
Chemical Oxygen demand (COD)	-
Oil & grease	-
Total Coliform(cfu/100ml)	-
Faecal Coliform(cfu/100ml)	<1

2.6 International Standards/Guidelines

2.6.1 *IFC Performance Standards 2012*

International Finance Corporation (IFC) applies the Performance Standards to manage social and environmental risks and impacts and to enhance development opportunities in its private sector financing in its member countries eligible for financing.

The Performance Standards may also be applied by other financial institutions electing to apply them to projects in emerging markets. VRA may commit to meeting the requirements of the IFC Performance Standards as an international best industry practice. The eight Performance Standards are summarised in **Table 2-8**.

Table 2-8: Summary of IFC Performance Standards and Potential for Trigger under the Project

No	IFC Performance Standards	Summary of core requirements	Potential for Trigger under the project
PS1	***Assessment and Management of Environmental and Social Risks and Impacts***	Identify and evaluate environmental and social risks and impacts of the project and adopt measures to avoid and when avoidance is not possible, minimise and or compensate Project Affected People/Communities and Environmental Area of Influence. In the achievement of the above, Clients should establish an effective ESMS, which ensures stakeholders/community participation and grievance redress mechanisms.	Triggered
PS2	***Labour and Working Conditions of workers***	Management of projects should ensure workers safety, promote fair treatment, non-discriminatory and equal opportunity of workers. Management should also establish, maintain and improve the worker-management relationship, and comply with national employment and labour laws of host country.	Triggered
PS3	***Resource Efficiency and Pollution Prevention***	Avoid or minimise adverse impacts on human health and the environment through avoidance or minimisation of pollution including release of greenhouse gases from project and promote sustainable use of resources such as energy and water. Clients are also expected to ensure the use of efficient pollution abatement machinery to reduce pollution.	Triggered
PS4	***Community Health, Safety and Security***	To evaluate the risks and impacts to the health and safety of the Affected Communities during the project lifecycle and establish preventive and control measures consistent with Best International Practices and commensurate with their nature and magnitude of impacts.	Triggered
PS5	***Land Acquisition and Involuntary Resettlement***	As much as possible project siting and activities should not displace people. However, where avoidance is not possible, displacement should be minimised by alternative project design considerations. No force eviction should be undertaken by client. Land acquisition should be done in a manner as to minimise adverse social and economic	Triggered

No	IFC Performance Standards	Summary of core requirements	Potential for Trigger under the project
		impacts through the provision of compensation packages and to ensure a humane resettlement procedure, disclosure of information, consultation and participatory of PAPs. It should be the client's duty to ensure that the physical and economic wellbeing of displaced people are not worst of than their pre displaced lives.	
PS6	***Biodiversity Conservation and Sustainable Management of Living Natural Resources***	All clients should identify both direct and indirect project related impacts that could potentially threaten biodiversity and ecosystem services. The following indicators should be used as a guide: habitat loss, degradation and fragmentation, invasive alien species, overexploitation, hydrological changes, nutrient loading, and pollution.	Triggered
PS7	***Indigenous People***	The client will identify, through an environmental and social risks and impacts assessment process, all communities of Indigenous Peoples within the project area of influence who may be affected by the project, as well as the nature and degree of the expected direct and indirect economic, social, cultural (including cultural heritage), and environmental impacts on them. Adverse impacts on Affected Communities of Indigenous Peoples should be avoided where possible. Indigenous People are defined as a social group with identities that are distinct from mainstream groups in national societies, and are often among the most marginalized and vulnerable segments of the population.	Not triggered
PS8	***Preservation of Cultural Heritage***	Client must protect cultural heritage from the adverse impacts of project activities and support its preservation. Clients should also promote the equitable sharing of benefits from the use of cultural heritage.	No evidence for trigger observed during the EIA work including engagement with local community stakeholders.

IFC categorizes projects to determine the level of environmental and social assessment that will be required. The proposed power plant falls under Category B. That is a project "with potential limited adverse social or environmental impacts that are few in number, site-specific, largely reversible, and readily addressed through mitigation measures".

2.6.2 IFC EHS Guidelines

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP). These General EHS Guidelines are designed to be used together with the relevant Industry Sector EHS

Guidelines which provide guidance to users on EHS issues in specific industry sectors, and for this project the relevant specific guideline is the IFC EHS Guidelines for Thermal Power Plants.

The EHS Guidelines for Thermal Power Plants include information relevant to combustion processes fuelled by gaseous, liquid and solid fossil fuels and designed to deliver electrical or mechanical power, steam, heat or any combination of these, regardless of the fuel type. It applies to boilers, reciprocating engines, and combustion turbines in new and existing facilities. Annex A contains a detailed description of industry activities for this sector, and Annex B contains guidance for Environmental Assessment (EA) of thermal power projects.

2.6.2.1 *Air Emission Levels and Ambient Air Quality*

The air emission levels and ambient air quality guidelines recommended by IFC are that of the World Health Organization (WHO), and these are provided in the table below.

Table 2-9: WHO Ambient Air Quality Guidelines

WHO Ambient Air Quality Guidelines (also used by IFC)		
Substance or Parameter	Averaging Period	Guideline value in µg/m^3
Sulphur dioxide (SO2)	24-hour	20
	10 minutes	500
Nitrogen dioxide (NO2)	1-year	40
	1-hour	200
Particulate Matter (PM10)	1-year	20
	24-hour	50
Particulate Matter (PM2.5)	1-year	10
	24-hour	25
Ozone	8-hour daily maximum	100

2.6.2.2 *IFC Ambient Noise Level Guidelines*

The ambient noise level guidelines recommended by IFC are provided in the table below (i.e. noise levels measured out of doors). The noise impact should not exceed these levels. Highly intrusive noises, such as noise from aircraft flyovers and passing trains, should not be included when establishing background noise levels.

Table 2-10: IFC Ambient Noise Level Guidelines

	One Hour L_{Aeq} (dBA)	
Receptor	Day Time (07:00 – 22:00)	Night Time (22:00 - 07:00)
Residential; Institutional; Educational	55	45
Industrial; Commercial	70	70

2.6.2.3 *World Bank Group Stack Emission Guidelines*

The World Bank Group standards for emission levels are provided:

- Particulate < 50 mg/Nm^3
- NOx Emissions ≤ 750 mg/Nm^3
- SOx ≤ 500 mg/Nm^3

2.6.2.4 *Effluents from Thermal Power Plants*

The World Bank Group Guidelines for effluent from thermal power plants is provided in the table below.

Table 2-11: Effluents from Thermal Plants

Parameter	Maximum Value (mg/l)
pH	6-9
TSS	50
Oil and grease	10
Total residual chlorine	0.2
Chromium (total)	0.5
Copper	o.5
Iron	1.0
zinc	1.0
Temperature increases	≤ 3 ºC

b. The effluent should result in a temperature increase of no more than 3° C at the edge of the zone where initial mixing and dilution take place. Where the zone is not defined, use 100 meters from the point of discharge when there are no sensitive aquatic ecosystems within this distance.

2.6.3 *International Conventions*

Ghana is signatory to a number of international and regional conventions that have been established by the United Nations or its specialized agencies and African Union to sustainably manage and/or protect the environment and workers. The key ones considered for the Project are:

- African Charter on Human and Peoples' Rights (adopted 1998, entered into force 2005)
  - United Nations Framework Convention on Climate Change (UNFCCC), (adopted 1992, entered into force 1994);
  - Kyoto Protocol to the Convention United Nations Framework on Climate Change (adopted 1997, entered into force 2005);
  - The Paris Agreement

- GHA-Nationally Determined Contributions (NDCs): 2020 – 2030
- United Nations Convention on Biological Diversity (adopted 1992, entered into force 1994)
- ILO Conventions.
  - Convention Concerning the Protection of Workers against Occupational Hazards in the Working Environment due to Air Pollution, Noise, and Vibration (ILO No. 148) 1987;
  - Freedom of association and collective bargaining; conventions 87 (1950) and 98 (1951)
  - Elimination of forced and compulsory labour; conventions 29 (1932) and 105 (1959)
  - Elimination of discrimination in respect of employment and occupation; conventions 100 (1953) and 111 (1960)
  - Abolition of child labour; conventions 138 (1976) and 182 (2000)

United Nations Framework Convention on Climate Change (UNFCCC)

The United Nations Framework Convention on Climate Change (UNFCCC) provides the basis for global action to protect the climate system for present and future generations. The Convention on Climate Change sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. It recognizes that the climate system is a shared resource whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. The Convention enjoys near universal membership, with 189 countries having ratified.

The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

Under the Convention, governments:

- Gather and share information on greenhouse gas emissions, national policies and best practices.
- Launch national strategies for addressing greenhouse gas emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries; and

- Cooperate in preparing for adaptation to the impacts of climate change.

Paris Agreement

The Paris Agreement was adopted in 2015 as an international agreement to address climate change that required deeper emissions reduction commitments from all countries both developed and developing. It seeks to hold global warming to below 2.0°C above pre-industrial levels and pursue further to limit this to 1.5°C. The Paris Agreement calls for sustainable development by providing opportunities for the Parties to reduce their emissions through economy-wide and sectoral mitigation actions, in accordance with their state of development, their national circumstances, and in full compliance with the principles and provisions of the UN Framework Convention on Climate Change (UNFCCC) through their Nationally Determined Contributions (NDCs). In their NDCs, countries communicate actions they will take to reduce their Greenhouse Gas emissions in order to reach the goals of the Paris Agreement. Countries also communicate in the NDCs, actions they will take to build resilience to adapt to the impacts of rising temperatures.

The Volta River Authority 's (VRA) "Corporate Carbon Footprint Management Programme" (CFMP) was initiated in 2016 as part of its Corporate Strategic Objectives to allow for the measuring and reporting of Greenhouse Gases (GHG). The initial GHG Inventory Report, covering the period 2012 – 2015, was prepared using the GHG Protocol Corporate Accounting and Reporting Standard Methodology (Revised Edition).

VRA set 2012 as the baseline year in our GHG Inventory Reporting. Establishing a baseline year for GHG emissions is important because it provides the basis for measuring future successes in reducing emissions. The 2012-2015 GHG Inventory Report covered emissions from VRA's stationary and vehicle combustions. Experts from ICF International of USA in November 2017 reviewed the initial GHG Report and submitted their review comments in December 2017. The Ghana Environmental Protection Agency (EPA) also audited and verified the initial GHG report and submitted their comments in January 2020.

Based on these reviews, the initial report was updated to cover the period 2012-2018 for stationary and mobile combustions, covering thermal power plants, road and water transport. In addition, GHG savings from its "2.5 MW ***Navrongo Solar Power Station***", five (5No.) ***Mini Solar Grid with installed capacity totaling 237.5KW*** *and "****Office Paper Waste Recycling Programme****"* have been included in the updated report.

The Total GG emissions from 2012 – 2018 was 9,379,211.39 CO2 Equiv. Stationary combustion contributed 95.13%, whilst vehicle and water transport combustion contributed 0.13% and 3.74% respectively. The proposed Kumasi 1 TPP Project is not a new project but a relocation of the Ameri Plant, which was in operation from 2016 to 2020 to Anwomase near Kumasi. The proposed project is therefore not expected to significantly impact on VRA GHG emission footprint.

GHA-Nationally Determined Contributions (NDCs): 2020 – 2030

Ghana's NDCs sought to reduce emissions by 15% to 45% below business-as-usual scenario by 2030 and strengthen climate resilience in close alignment with its development priorities. In all, 20 mitigation and 11 adaptation actions were outlined to take place across seven priority economic sectors - energy, agriculture, industry, transport, waste, and forestry and other land uses. The 20 mitigation measures have strong development imperatives and aim to scale up renewable energy, promote clean cooking and lighting, double energy efficiency in households and industry, promote mass urban transportation, reduce emissions from deforestation and forest degradation (REDD+), and promote alternative solid waste management.

United Nations (UN) Convention on Biological Diversity 1994

The Convention on Biological Diversity (CBD) is an international legally binding treaty. The Convention has three main goals:

- conservation of biological diversity (or biodiversity);
- sustainable use of its components; and
- fair and equitable sharing of benefits arising from genetic resources

In other words, its objective is to develop national strategies for the conservation and sustainable use of biological diversity. It is often seen as the key document regarding sustainable development.

ILO Conventions

Convention Concerning the Protection of Workers against Occupational Hazards in the Working Environment due to Air Pollution, Noise, and Vibration (ILO No. 148) 1977

Article 9 of the 1977 Convention of ILO states that as far as possible, the working environment shall be kept free from any hazard due to air pollution, noise or vibration,

(a) by technical measures applied to new plant or processes in design or installation, or added to existing plant or processes; or, where this is not possible,

(b) by supplementary organisational measures.

ILO Convention 29 (1930) Forced Labour - Article 5: No concession to companies shall involve any form of forced or compulsory labour.

ILO Convention 105 (1957) Abolition of Forced Labour - Article 1: Not make use of any form of forced or compulsory labour.

ILO Convention 138 (1973) Minimum Age - Articles 1-3: Abolition of child labour and definition of national minimum age for labour not less than 15-18 years (depending on occupation).

ILO Convention 87 (1948) Freedom of Association and Protection of Right to Organise - Articles 2- 11: Freedom to join organisations, federations and confederations of their own choosing; with freely chosen constitutions and rules; measures to protect the right to organise.

ILO Convention 98 (1949) Right to Organise and Collective Bargaining - Articles 1-4: Protection against anti-union acts and measures to dominate unions; established means for voluntary negotiation of terms and conditions of employment through collective agreements.

ILO Convention 100 (1951) Equal Remuneration - Articles 1-3: Equal remuneration for men and women for work of equal value.

ILO Convention 111 (1958) Discrimination (Employment and Occupation): Equality of opportunity and treatment in respect to employment and occupation; no discrimination on the basis of race, colour, sex, religion, political opinion, national extraction or social origin.

UN Declaration on the Rights of Indigenous Peoples (2007) - Articles 2, 8(2e), 9, 15(2), 16(1), 21(2), 22, 24(1), 29(1), 46(3): No discrimination based on origin or identity; free to express identity based on custom; special attention to and full protection of rights of indigenous women.

2.7 VRA's Corporate Environmental Policy

The Volta River Authority (VRA) has a corporate environmental policy that commits to ensuring continuous improvement in environmental performance that minimizes potential impacts of all its

operations on the environment. The VRA adopts the principle of sustainable development and compliance with both national and international environmental protection regulations, which is important for the proposed Kumasi 1 Thermal Power Plant Project. These principles enables VRA to adopt good international industry practices for its construction and operational activities. The Authority has an Environment Department and a Health/Safety outfit to implement all Safety Health and Environment (SHE) actions and requirements including those conditions attached to the regulatory permits for the implementation of the proposed project.

The VRA has also developed a Safety Health and Environment (SHE) manual for contractors that provides a framework for better practices and continual improvement in the wellbeing of construction workers and for the elimination of injuries and fatalities through VRA's engagement in construction. The use of this manual will ensure that the construction and installation of the Kumasi 1 Thermal Power Plant is carried out efficiently and effectively in a duty of care and safe environment.

SELJEN CONSULT

CHAPTER THREE

DESCRIPTION OF THE PROPOSED PROJECT AND ALTERNATIVES

FINAL

ENVIRONMENTAL IMPACT STATEMENT

VOLTA RIVER AUTHORITY

3.0 DESCRIPTION OF THE PROPOSED PROJECT AND ALTERNATIVES

This Chapter provides a description of the proposed Kumasi 1 Thermal Power Plant Project. The project information herein provided is obtained mainly from the April 2021 Feasibility Study Report for the proposed Project, the 2016-2018 Annual Environmental Reports, and the 2019 Environmental Management Plan (EMP) of the AMERI Power Plant.

3.1 Location of Proposed Project Site

The proposed site for the Kumasi 1 Thermal Power Plant Project is at Anwomaso, in the Oforikrom Municipality of the Ashanti Region. The proposed site is located between latitudes 6°41'24"N and 6°42'20"N and longitudes 1°31'12"W and 1°30'36"W. The site is approximately 15 acres. The site plan is provided in **Annex 3-1** (presented in the Volume II of this report) and the site coordinates are provided in the table below.

Table 3-1: Site Coordinates

Ref. Point	Latitude	Longitude
Point 1	6°41'44.96"N	1°31'9.57"W
Point 2	6°41'53.31"N	1°31'4.92"W
Point 3	6°41'49.19"N	1°31'0.01"W
Point 4	6°41'41.89"N	1°31'4.62"W

The proposed site belongs to the Kwame Nkrumah University of Science and Technology (KNUST). The proposed site is situated between GRIDCo's 161kV and 330kV transmission lines right-of-way. It is bounded on the south by 161kV and 330kV substations of GRIDCo, north and west by fallow/farmlands and on to the east by fallow/farmlands as shown in **Figure 3-1.** The National Vocational Training Institute (NVTI) Complex of the Ministry of Education is located east of the GRIDCo substation.

The closest local communities to the proposed project site are Anwomaso and Bebre as shown in **Figure 3-1**. The Anwomaso Sand Winning Truck Station is about 600m from the proposed project site, whiles the Anwomaso Presby JHS is about 1279m from the proposed site. The Bebre community is about 923m from the proposed project site.

Figure 3-1: A Google Earth Map showing the Proposed Project Site and nearby existing facilities and neighbouring communities

3.2 Accessibility

The main access road to the proposed site and the GRIDCo Substations at Anwomaso is by a motorable asphaltic surfaced road, about 2.69km to the substation, off the main Accra-Ejisu-Kumasi Highway. The road, approximately 6m driveway is completed with necessary road furniture.

There are currently two main access routes to the proposed project site. One access route is to the right of the GRIDCo/ECG substations, where the 330 kv transmission line enters the substation (see **Plate 3-1**). This route is mainly concrete and wide enough to take two cars in opposite direction. VRA plans to construct this as its main access road to the project site.

The other route is to the left of GRIDCo substation (see **Plate 3-2**), where the 161 kv transmission line enters the substation. The route lies towards the NVTI buildings. The route starts from the main township road as a concrete road up to the GRIDCo substation. There is an unpaved route off this road that leads to the project site. This unpaved route is a single lane and cannot accommodate two cars in opposite direction, and also used by farmers and workers at the NVTI.

Plate 3-1: One access route to project site along the GRIDCo 330 kV Substation (right side of substation)

Plate 3-2: The other access route to project site between the GRIDCo 161 kv line and NVTI buildings

3.3 Main Features and Proposed Layout of the Plant

The Kumasi 1 Thermal Power Plant is a 250MW (ISO) plant comprising of ten (10) 25MW (ISO) GE TM 2500+ Aero Derivative Gas Turbines (GTs), and will operate solely on natural gas. Each train of GT and power generator is mounted on mobile platform. The proposed layout of the plant as shown in **Figure 3-2** consists of the following:

1) A – Substation
2) B – Gas Turbine Island
3) C – Warehouse/Workshop
4) D – Office and Control Building
5) E – Car Park
6) F – Water Treatment and Storage Tank
7) G – On-base Gas Skid.

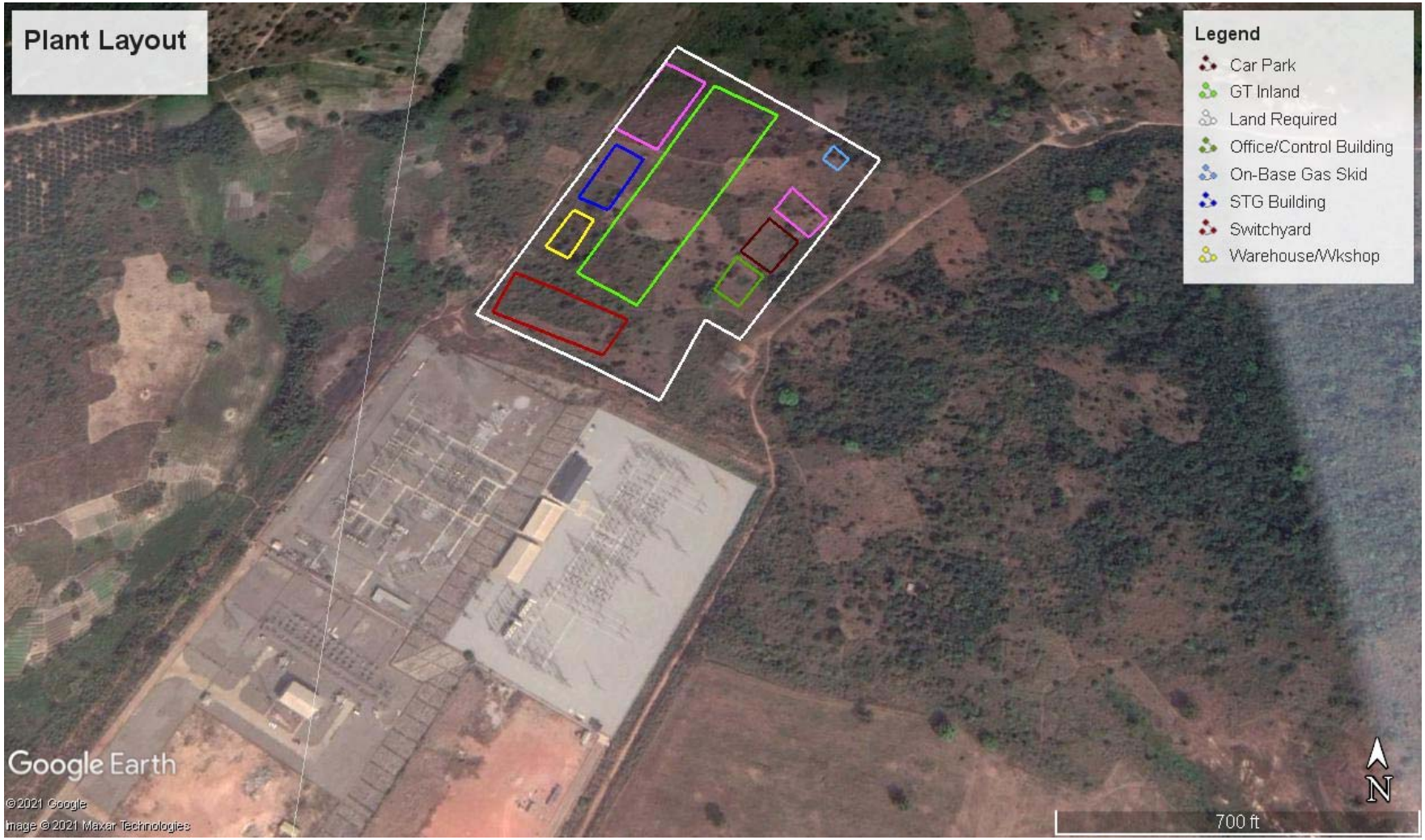


Figure 3-2: The proposed layout of the Kumasi 1 Thermal Power Plant

3.3.1 Power Evacuation Infrastructure/Substation

The Thermal Power Plant has ten GE TM2500 Gas Turbine Generators (GTGs) with a total installed capacity of 250MW. Each generator has a rated capacity of 29.111MVA, 11.5kV, 50Hz. The power evacuation components include:

- Equipment in prefabricated building;
- Mobile station service transformers;
- Emergency Diesel generators;
- 11kV medium voltage cables; and
- All interconnecting cables with their cable trays.

Other equipment are:

- Three Phase Transformers;
- Surge Arrestors;
- Three Phase Circuit Breakers;
- Current Transformers;
- Inductive Voltage Transformers;
- Three Phase Double Break Disconnects;
- Three Phase Centre Break Disconnects with Earthing Switch;
- Capacitive Voltage Transformers;
- Three Phase Busbars; and
- Three Phase Earthing Switches.

The 250 MW power from the thermal plant will feed the 161KV GRIDCo substation at Anwomaso for evacuation of power to the national grid.

Currently, the GRIDCo substation at Anwomaso consist of a 161kV substation and a 330kV substation both with breaker-and-a-half configuration. The 161kV substation has three step down transformers which serves the ECG substation adjacent to the GRIDCo 161kV substation. The 330kV substation has two auto transformers which steps down voltage from the 330kV transmission lines to feed the 161kV substation. The 161kV substation has six (6) bays and GRIDCo has given an indication of the availability of two free bays for use by the Kumasi 1 Thermal Power Plant for power evacuation into the national grid.

The existing AMERI Power Plant and substation equipment together with the prefabricated buildings, Mobile station service transformers, Emergency Diesel generators, 11kv medium voltage cables, all interconnecting cables with their cable trays will have to be decommissioned at Aboadze, transported, installed and commissioned to feed power into the existing 161kV GRIDCo substation at Anwomaso. VRA will obtain a separate permit from the EPA for the decommissioning of the AMERI Power Plant at its Aboadze site prior to relocation to its new site at Anwomaso.

3.3.2 Gas Turbine Island

The Gas Turbine Island will house the ten GE TM2500 Gas Turbine units. Each unit has a dedicated Balance of Plant (BOP) and an on-base gas skid. The BOP comprises of a lube oil skid and water wash equipment. There will be five (5) emergency diesel generator sets with each one dedicated to two (2) gas turbines. Each emergency diesel generator is of 1000kVA capacity.

3.3.3 Office and Control Building

A multipurpose office building which will have offices, a kitchenette and washroom facilities for the Plant Manager and staff as well as a control room will be constructed. A two (2) Storey Office/Control room building with a total floor area of about 600m^2 will be constructed for the 250MW Power Plant.

3.3.4 Workshop/Warehouse

A workshop/warehouse is almost an integral part of a thermal power plant. This facility is needed for the storage of spare parts and consumables and for carrying out repair works. A 90m.sq workshop/warehouse building will be constructed for the plant. The facility will either be made of brick and concrete or will be prefabricated.

3.4 Water Supply Requirements and Water Treatment System

3.4.1.1 *Water Supply Requirements*

Process water (demineralized water) is required for water injections to wash critical plant components such as the Gas Turbines and the Compressors. Unprocessed water is also required for service applications and firefighting on site. The Kumasi 1 Thermal Power Plant requires about 7.5 m3 of demineralized water per day for operations. Thermal power plant operations and maintenance requires storage of water in sufficient quantities for station firefighting and dedicated water supply. The raw water storage requirement for firefighting is estimated to be 1000m^3.

A dedicated water treatment facility will be installed at the station. The proposed water supply facilities include:

i. 40 m^3/h containerized water treatment plant;
ii. 2 x 100 m^3 demineralized water storage tank;
iii. 3 x 300 m^3 raw water tanks; and
iv. 1000 m^3 water storage tank for firefighting system.

The 40m^3/h containerized water treatment plant with a 2 x 100m^3 demineralized water storage tank and a 3x300m^3 raw water tanks for the Mines Reserve Plant site in Tema, which are still fit for purpose and have sufficient capacity to support the operations of the Kumasi 1 Thermal Power Plant will be serviced and relocated to the proposed project site to serve the Power Plant. A 1000m^3 water storage tank will be installed to provide water for the Plant firefighting system.

Currently there is no access to water from the Ghana Water Company Limited (GWCL) mains. GRIDCo depends on ground water mechanized borehole for the substation. The Ghana Water Company Limited (GWCL) proposes to lay a new 150mm (6-inch) diameter HDPE dedicated line from Oduom to Anwomaso to provide potable water to the power plant site at Anwomaso. The approximate length of the dedicated 6-inch pipeline will be 3km. GWCL will obtain a separate EPA permit for this sub-project activity. Raw water will also be sourced from Borehole to be drilled on site.

The raw water would be demineralised using a patent demineralised system. Rate of change/replacement of filters shall be depended on the operating regime of the plant. However, typically, filters for such plant are replaced monthly. Filters are expected to be disposed accordingly to the approved VRA Waste Disposal protocol. Effluent is expected to be neutralised using an approved treatment system and discharged into an accepted natural drainage system.

3.4.1.2 *Water Treatment*

The water treatment system would provide demineralized water for the plant. The treatment technology to be used would be the proven anion/cation exchanger technology. The water plant consists of the following:

- Pre-treatment unit;
- Anionic and cationic ion exchanger columns;

- Degasifier unit;
- Mixed bed columns; and
- Neutralization unit.

Water treatment for thermal power plants is conducted to prevent problems such as carryover to the turbine components, as well as corrosion and scale formation/deposition in the turbine systems. The main chemical treatment processes expected during operation is the demineralization of raw water (i.e. treated water from GWCL) for plant use. The resultant wastewater for the process will then undergo neutralization prior to disposal.

Demineralization

Demineralised water will be produced for plant operation by ion-exchange process. The water treatment plant (WTP) consists of 2 streams of metallic vessels in series operating as activated carbon filters, cation exchangers, anion exchangers and mixed bed exchangers and designed to treat incoming water at an expected flow of $40m^3$/hr. The system operates on three principles, ion-exchange, degasification and polishing. Raw water will be purified through the use of specially manufactured cation and anion exchange resins which when exhausted are regenerated with sodium hydroxide (caustic soda) and sulphuric acid. In this process, mineral salts (impurity ions such as Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, HCO_3^{-}, NO_3^{-}, CO_3^{2-} etc.) present in raw water are replaced by ions released by an ion-exchange resin.

The raw water from GWCL will pass through cation and anions exchange resins and finally through a mixed bed resins made up cation and anion resins all in one column but separated by inert resin buffer barriers. The demineralized water produced will be stored in two storage tanks each of capacity $100m^3$, whereas wastewater from the water treatment plant (WTP) is collected into a neutralization sump, where it is treated before discharged. The wastewater from this process, which can be either acidic or alkaline, is neutralized before discharged directly into a storm drain from the Plant site, which will empty into the Adote Stream.

3.4.1.3 *Wastewater Management System*

The wastewater or effluent from the water treatment plant will be treated to meet the Ghana Standards for effluent quality discharges prior to disposal into the storm drain. The effluent from the demineralization system will be channeled to a neutralization sump where the content is neutralized before discharge through a covered drain, which will empty into the Adote Stream.

The wastewater is generated from the regeneration of the resins used in cation, anion, and mixed bed ion exchange systems. The chemicals used to regenerate the resins have extreme pH levels. For example, hydrochloric acid, with a pH of 1-2, is used for regeneration of cation resin and sodium hydroxide, with a pH of 13-14, is used for regeneration of the anion resin. After the regeneration process, the water containing these chemicals must be disposed of. Due to its extreme pH, the wastewater cannot be sent directly to the drain, as this will typically violate EPA regulations regarding the pH of wastewater discharge. For example, the EPA's standard for pH of wastewater discharge into the environment is 6 -9. About 10,000 litres of demineralized water will be utilized in a year, and discharged as compressor wash water into the storm drain.

3.5 Fuel Supply Requirements

The GE's TM 2500+ Aero Derivative Gas Turbines runs solely on natural gas (NG). Each unit requires 5.5 mmscf of NG per day making a total of 55 mmscf per day for the ten (10) gas turbines. New gas infrastructure is required to ensure the operation of the thermal power plant. These include:

i. Pipelines;
ii. Regasification; and
iii. Gas conditioning units.

Ghana National Gas Company Limited is currently extending a pipeline from Prestea to Dawusaso. Further extension of the gas pipeline would be made to Nyinahin and then to the site at Anwomaso. The 330kV transmission line Right-of-Way (RoW) would be used for the construction of the gas pipeline. The On-base Gas Skid at site would be fed with gas from the pipeline and distributed to the various gas handling facilities of each gas turbine units.

3.6 Production Processes

The power production processes comprise of

- Natural gas supply & conditioning;
- Combustion;
- Generation; and
- Transmission.

The production processes are described in **Table 3-2**. The flow diagram of the production processes is provided in **Figure 3-3**. The proposed stack height is 56m.

Table 3-2: Description of the Power Production Processes

Process Stage /Unit Operation	**Description of process stage / unit operation**
Natural Gas Supply & Conditioning	The Kumasi 1 Power Plant will operate in a simple cycle mode or system. In this operation, natural gas will be received from the Ghana National Gas Company Ltd. The gas is then conditioned to the right temperature and pressure at the gas conditioning module attached to each gas turbine and sent to the combustion chamber.
Combustion	The compressor draws atmospheric air through the air inlet filters into the compressor. The hot air is introduced into the combustion chamber of the combustor at the same time as the pre-heated fuel from the fuel selection skid. The air-fuel mixture is ignited and the resultant combustion produces heat and exhaust gas. The efficiency of combustion is dependent upon the type of burners and the air-fuel ratio. The efficiency of the GE's TM 2500+ Aero Derivative Gas Turbines is 35%.
Generation	The resultant mass flow of the exhaust gas, which is appropriately directed unto the gas turbine blades, provides the necessary force to turn the gas turbine, which is in turn coupled to a generator through a shaft for power generation. The exhaust gas is then discharged into the atmosphere through the stack alongside the heat. The proposed height of the stack is 56m. The temperature of exhaust gases discharged to the environment varies but approximates 565°C during a simple cycle bypass operation. In July, 2020, flue gas monitoring of the Ameri Plant was carried out at its Aboadze site and the composition of exhaust gas emissions were: CO = 4 ppm; NOx= 172 ppm; NO= 168ppm; NO2= 4 ppm; CO2 = 2.98%; SO2=0; HC=678ppm.
Transmission	Power generated will be transmitted to the grid through the existing 161 KV substation at Anwomaso

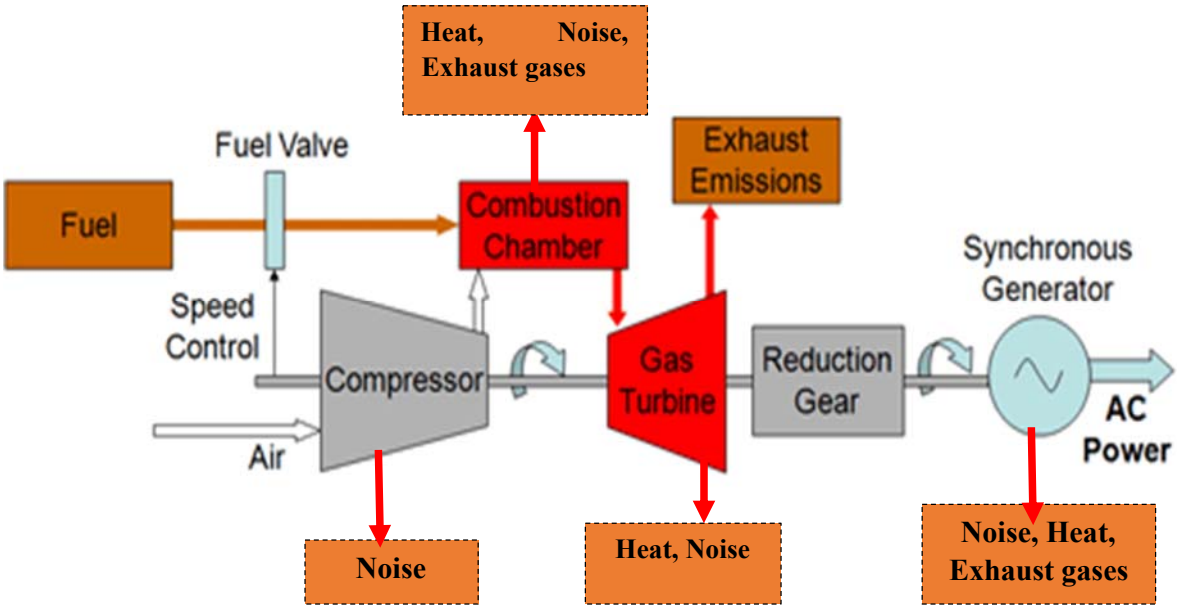


Figure 3-3: Environmentally-based Production Process Flow Diagram

3.7 Access Roads

All roads required for maintenance and operational access are expected to be designed appropriately for the site conditions and will be properly defined, excavated, trimmed, compacted and surfaced as required.

3.8 Site Drainage

The site shall be designed to effectively drain off storm water to avoid flooding. Adequate and appropriate type drainage channels shall be provided to ensure that the site is safe from flooding.

3.9 Operation and Maintenance (O & M) Requirements

The VRA already has an operation and maintenance (O&M) team to take over the operations of the plant in Kumasi. The team to operate the Power Plant will consist of thirty-three (33) man operating and maintenance crew. Sixteen (16) out of the 33 will be operators who will run four shift system. All the Operators will be supervised by one operations Engineer. The remaining seventeen (17) will be maintenance crew consisting of three sections (i.e. Mechanical-7, Electrical-5 and C&I-4) with their respective supervisors. The Plant will have a Plant Manager and some administrative staff to manage and support the work of the O&M team.

3.10 Project Schedule and Management

A contractor will be procured for the construction and installation of the power plant. VRA will be responsible for the operation and maintenance of the power plant as indicated above. The project implementation schedule is provided in **Table 3-3**. It is expected to take about 15 months to complete the surveys, land acquisition, permitting, and the construction and installation of the Kumasi 1 Thermal Power Plant.

Table 3-3: Project Implementation Schedule

		Time Schedule in Months														
Activities	**Duration**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Survey	1 month															
Land acquisition	3 months															
Gas infrastructure *	9 months															
Geotechnical investigations	3 months															
Permit/license acquisition	14 months															
Civil works	6 months															
Water supply infrastructure*	6 months															
Decommissioning of the Mine Reserve Plant water storage and treatment plant in Tema*	2 months															
*Decommissioning and transportation of plant	3 months															
Installation of plant	6 months															
Installation of water storage and treatment plant	3 months															
Power evacuation infrastructure	6 months															

* Separate EPA permits to be obtained for such activities

3.11 Alternative Considerations

The Ghana power system is currently having low voltages from Ashanti Region to the northern part of the country. Hence having another power plant in Kumasi and its environs is a matter of urgency to augment the Bui Hydropower plant, which is the only major source of power supply for voltage stability in the northern part of the country.

The alternatives considered to address the power supply challenges in the Ashanti and the northern part of the country included:

- Energy/Power source options;
- Cooling system options for the thermal power plant;
- A new air-cooled condenser (ACC) thermal power plant as against use of an existing ACC thermal power plant;
- Options for design of the gas combustion plant;
- Site selection options;
- Water supply source options; and
- No Action Option.

3.11.1 Alternative Energy/Power Sources

The alternative energy/power sources considered are discussed in the table below.

Table 3-4: Alternative Energy/Power Sources

Options	Potential Environmental Implications	Potential Socioeconomic Implication	Conclusion /Preferred Option
ENERGY/POWER SOURCES			
Thermal	**Advantages** 1. Environmentally, natural gas thermal plant in this case has the lowest air emissions compared to petroleum or coal. It is considered a very clean and safe fossil fuel. 2. Natural gas can easily be preserved. It can be stored and transported through pipelines, small storage units, cylinders or tankers on land and sea. **Disadvantages**	**Advantages** 1. Less initial cost as compared to other generating plants. 2. It requires less space as compared to Hydro and solar power plants. 3. Thermal power plant construction and operation creates employment opportunities for both skilled and unskilled people particularly for those from the local communities.	Thermal plant is the preferred option in this case because it reduces Ghana's reliance on hydro power that has proven to be limited over the years. The Bui Hydropower facility is the only major source of energy /power supply for voltage

Options	Potential Environmental Implications	Potential Socioeconomic Implication	Conclusion /Preferred Option
	1. It pollutes the atmosphere due to production of greenhouse gases though low. 2. Leaks of natural gas and oil spills are tremendously dangerous. Such leaks may cause explosions, fire or serious pollution. 3. Thermal plants add to the thermal burden of the earth.	**Disadvantages** 1. The global price of natural gas could be very unstable. 2. Though the initial cost is less, the running cost for a thermal plant is comparatively high due to fuel, maintenance etc.	stability in the northern part of the country. There is the need for the country to diversify its energy mix for the northern part of the country through the building of thermal plants to deliver adequate power to meet the increasing demand and ensure reliable electricity in the Ashanti Region and the northern part of the country.
Solar Power	**Advantages** 1. PV panels provide clean– green energy. During electricity generation with PV panels, there are no harmful greenhouse gas emissions thus solar PV is environmentally friendly. 2. Solar power is a renewable source of energy. 3. Produces no health-damaging air pollution or acid rain. 4. The power plants, once in place, do not create any waste by-products in their conversion. **Disadvantages** 1. Electricity generation depends entirely on a countries exposure to sunlight; this could be limited by the availability of regular sunshine. 2. Large areas of land are required to capture the suns energy. Collectors are usually arranged together especially when electricity is to be produced and used in the same location.	**Advantages** 1. Solar jobs come in many forms, from manufacturing, installation, monitoring and maintaining solar panels, to research and design, development, cultural integration, and policy jobs. 2. Solar energy has the ability to avoid the politics and price volatility that is increasingly characterizing fossil fuel markets. 3. Solar energy is energy supplied by nature – it is thus free and abundant. 4. Solar energy can be used in remote areas where it is too expensive to extend the electricity power grid. **Disadvantages** 1. Solar panels are bulky, less efficient and expensive. 2. Solar electricity storage technology has not reached its potential yet as solar energy supply is constant. 3. The cost involved in installing solar panels and storing of energy generated is very high.	
Wind Power	**Advantages** 1. Wind energy is friendly to the surrounding environment, as no fossil fuels are burnt to generate	**Advantages** 1. Wind turbines are a great resource to generate energy in remote locations, such as	

Options	Potential Environmental Implications	Potential Socioeconomic Implication	Conclusion /Preferred Option
	electricity from wind energy. 2. Wind turbines can also share space with other interests such as the farming of crops or cattle. 3. Wind power is a renewable energy source. 4. Produces no health-damaging air pollution or acid rain. 5. The power plants, once in place, do not create any waste by-products in their conversion. **Disadvantages** 1. Wind turbines generally produce a lot less electricity than the average fossil fuelled power station, requiring multiple wind turbines to be built in order to make an impact. This may disrupt land cover 2. Wind turbine construction can be very costly to surrounding wildlife during the building process.	mountain communities and remote countryside. 2. Wind energy has the ability to avoid politics and price volatility that is increasingly characterizing fossil fuel markets 3. Wind power construction and operation creates jobs and provides income for both skilled and unskilled people, particularly, those from the local communities. 4. Wind energy is energy supplied by nature – It is thus free and abundant **Disadvantages** 1. The wind velocities in the area can be sporadic and doesn't blow well at all locations. Research and maps are needed to identify the optimal locations, these may be costly. 2. Transmission of electricity from remote wind farms can be a major hurdle for utilities since many wind turbines are not located around urban centers. 3. The storage of excess energy from wind turbines in the form of batteries, hydrogen or other forms still needs research and development to become commercially viable	
Nuclear Power	**Advantages** 1. Production of electric energy is continuous. 2. The plant itself does not give off greenhouse gasses **Disadvantages** 1. Special precautions must be taken during the mining, transporting and	**Advantages** 1. With little fuel, large amounts of energy are obtained. 2. Nuclear power plant construction and operation creates employment opportunities and income for both skilled and unskilled people particularly for those	

Options	Potential Environmental Implications	Potential Socioeconomic Implication	Conclusion /Preferred Option
	storing of the uranium, as well as the storing of any waste product to prevent it from giving off harmful levels of radiation. 2. Accidental release of harmful radiation is one of the biggest drawbacks of nuclear energy. 3. There is generation of nuclear waste and managing it is difficult as it takes many years to lose its radioactivity and danger.	from the local communities. **Disadvantages** 1. Plant construction is highly politicized. 2. Nuclear Power Plant Accidents can cause health problems and radiation. 3. It requires large capital cost and the repay of the construction of the nuclear plant is significantly more expensive.	
Hydro power	**Advantages** 1. When in use, electricity produced by dam systems do not produce greenhouse gases. They do not pollute the atmosphere. 2. The power plants, once in place, do not create any waste by-products in their conversion. 3. Hydro Power is a renewable energy source 4. Produces no health-damaging air pollution or acid rain **Disadvantages** 1. The flooding of large areas of land means that several communities and properties may be displaced as a result. The natural environment and property of the affected persons are destroyed. 2. The building of large dams can cause serious geological damage. e.g. earthquakes 3. Building large dams can cause damage to water courses which affects people and wildlife and it can be difficult to find the right site. 4. Hydro power plants output are highly dependent on rain falls	**Advantages** 1. The lake's water can be used for irrigation purposes. 2. The lake that forms behind the dam can be used for water sports and leisure/pleasure activities. 3. Hydroelectric energy is more reliable than wind or solar power. 4. Hydro energy has the ability to avoid politics and price volatility that is increasingly characterizing fossil fuel markets 5. Hydro power construction and operation creates jobs and provides income for both skilled and unskilled people, particularly, those from the local communities. 6. Hydro energy is energy supplied by nature – It is thus free and abundant **Disadvantages** 1. Dams are extremely expensive to build and must be built to a very high standard. 2. Flooding of available land that could be used for agriculture.	

Options	Potential Environmental Implications	Potential Socioeconomic Implication	Conclusion /Preferred Option
		3. People living in villages and towns that are in the valley to be flooded, must move out. This means that they lose their farms and businesses. 4. Transmission of electricity from remote hydro power plants can be a major hurdle for utilities since many hydro power dams are not located around urban centers.	

3.11.2 Cooling system options for the thermal power plant

The VRA considered the cooling system options or methods suitable or appropriate for selecting a thermal power plant during the initial project feasibility studies in September 2020. The options considered are:

- Wet cooling system;
  - Once-through cooling
  - Recirculation using cooling towers with freshwater
- Dry/air-cooled condenser (ACC); and
- Hybrid cooling.

The wet cooling system generally is more efficient/has better performance than dry cooling system. The dry/air –cooled condenser (ACC) system returns a higher exhaust pressure than wet cooling options. It has the advantage, however, of requiring no water beyond the first fill. It presents the least efficient option for condenser cooling because the re-cooled water temperature cannot be lower than the dry bulb air temperature. Its use is generally limited to places where water is scarce and/or expensive. The hybrid cooling is a combination of both wet and dry cooling systems and therefore has a bit of both advantages and disadvantages of wet and dry cooling systems.

The wet and dry cooling options are discussed in the table below. The hybrid cooling is therefore not discussed further.

Table 3-5: Cooling System Options for a Thermal Power Plant

Options	Potential Environmental Implications	Potential Socioeconomic Implication	Conclusion /Preferred Option
COOLING SYSTEM OPTIONS CONSIDERED			
1. Once-through cooling systems (Wet cooling system)	**Advantages** 1. Little water is lost through evaporation. 2. Best power plant cooling efficiency of all the alternatives **Disadvantages** 1. Should be sited in areas with abundant water sources for cooling 2. Disruptions are caused to local ecosystems from the significant water withdrawals involved. 3. Returns water to the water source at a higher temperature than at withdrawal and risk impingement or entrainment of aquatic organisms. 4. Kills large numbers of marine life that get sucked into power plant turbines or engines and trapped by the force of rushing water against intake screens. 5. Thermal pollution to water bodies is high.	**Advantages** 1. It relies on a simple technique, and has low cost to build than recirculating systems. 2. Relatively low capital, and operation and maintenance cost. 3. No fan energy consumption (low parasitic load). **Disadvantages** 1. There is an increased difficulty in siting power plants near available water sources as energy demands has increased over the years and requires a lot more water treatment that is expensive. 2. High cost of pumping the required volumes of water to power plant sites.	The cooling system selection is first influenced by the availability of significant water source (freshwater or sea water) in the project area. The project area is landlocked and therefore not close to any sea water. The Adote Stream (fresh water) near the project site is small and seasonal and cannot provide adequate water for cooling of the power plant. The significant sources of water to aid wet cooling are Barekese Dam, about 25km from the project site, and Lake Bosomtwi, about 49km from the project site. The cost of pumping such water to the project site will be high such that it might not make economic sense. Moreover, routing of the pipelines through the numerous communities and city to the project site will result in major physical and economic
2. Wet recirculating system (Wet cooling system)	**Advantages** 1. Closed system and therefore very little amounts of water are required to maintain the system. There are no losses associated with evaporation 2. Reduction in water use drastically decreases the number of organisms that are killed in the intake process. 3. Reduced thermal pollution to water bodies 4. No vapour emissions result from this cooling system **Disadvantages** 1. Water from the system may be discharged to the environment after treatment in case of maintenance of the cooling system	**Advantages** 1. Reduced competition for water bodies for agricultural purposes and domestic purposes as compared with once-through systems. 2. Given the very low water consumption, water related expenses are minimal. 3. No fan energy consumption (low parasitic load). **Disadvantages** 1. It requires fans which blows air over cooling radiator. However, running those fans can require a significant	

Options	Potential Environmental Implications	Potential Socioeconomic Implication	Conclusion /Preferred Option
		amount of electricity that is costly.	displacement of affected persons, which will result in high resettlement and compensation cost.
3. Dry cooling system (Air Cooled Condenser)	**Advantages** 1. The "A" frame arrangement of bundles help to minimize land usage to some extent. 2. The combined cycle closed vacuum cooling system (incl. air cooled condenser) reduces water consumption with an overall water recuperation of 90-95%. 3. No cooling-tower or blowdown pond **Disadvantages** 4. Despite the 90-95% water recovery, the combined cycle system cooling system (incl. air cooled condenser) still requires makeup water for thermal plant operation due to the 5-10% losses. 5. The condenser is noisy as a result of the associated fans. 6. Generally has large footprints and will require large land area for installation.	**Advantages** 1. Air Cooled Condensers help reduce water consumption by thermal power plants. 2. Reduced competition for water bodies for agricultural purposes and domestic purposes. **Disadvantages** 1. High capital cost (Capex). Capital cost for the dry cooling system itself is 3 to 5 times higher than for a wet cooling tower. 2. High operation and maintenance cost. 3. It requires fans which blows air over cooling radiator. However, running those fans can require a significant amount of electricity that is costly, and also reduces the net power. 4. The makeup water associated with the condenser could lead to additional costs.	Due to the above constraints to achieve wet cooling which has a higher efficiency/ performance, the preferred cooling option is the dry/air cooled condenser.

3.11.3 Developing a new ACC Thermal Power Plant as against the use of an existing ACC Thermal Power Plant

The VRA also considered the development of a completely new ACC thermal power plant in Kumasi as against the relocation of an existing out-of-service ACC thermal power plant such as the AMERI Power Plant. The development of a completely new thermal power plant will have a huge capital outlay (involving procurement of a completely new power plant from outside the

country, transporting to the country, construction/installation cost), will take a much longer time to secure funding, longer time to carry out feasibility and environmental/social impact assessment and other permitting studies, and longer period for construction of the power plant. This is obviously a long term project and not a quick fix solution required to address the current power supply challenges in the Ashanti Region and the northern part of the country.

The option of relocation of the AMERI Power Plant from its Aboadze base in the Western Region to the Ashanti Region was considered. The AMERI Power Plant has been in use for some time in the country, and therefore its environmental impacts at its current base at Aboadze are fairly known. The operational and environmental performance monitoring results of the Plant at its current base are also known, and these provide a good background information to inform decision making when relocated to the Ashanti Region. It will also not involve a huge capital outlay as there is no procurement of a power plant but will involve decommissioning, relocation and construction/installation and possible replacement of worn-out parts of the existing plant. The cost/duration of EIA preparation for a new power plant are much higher/longer than the cost of preparing an EIA for an existing power plant that already has an EMP in place and will only have to be relocated to a new site. For a quick fix solution to the current power challenges experience in the Ashanti and northern part of the country, the most obvious feasible option is the relocation of the existing AMERI Power Plant.

3.11.4 Design of the gas combustion plant – simple/single cycle and combined cycle gas plant

The two options considered are the simple or single cycle and the combined cycle gas plant. The environmental and socio-economic implications for the choice of the preferred option are discussed in detail in the **Table 3-6** below. The design of the AMERI Power Plant which operates in a simple or single cycle mode will not be altered but maintained when relocated. It will help meet peaking power needs on the national electricity grid for the greater Kumasi area and up north. Therefore the simple or single cycle gas plant is the preferred option.

Table 3-6: Simple or single cycle verses combined cycle gas plants

Options	Potential Environmental Implications	Potential Socioeconomic Implication	Conclusion /Preferred Option
DESIGN OF THE GAS COMBUSTION PLANT			
1. Simple or Single cycle gas turbine	**Advantages** 1. The natural gas they run on is less carbon dioxide-intense than other fossil fuels. 2. Comparable with coal fired, Light Cycle Oil (LCO) and Heavy Fuel Oil (HFO), power plants burning natural gas is much cleaner. **Disadvantages** 3. High dependency on water to cool the plant if wet cooling is the option. 4. Greater heat loss to the environment due to its low efficiency. 5. Their waste heat is not supplied to another external heat engine	**Advantages** **1.** Higher temperatures generally mean higher efficiencies, which in turn, can lead to more economical operation. **2.** This type of electricity generation is typically favoured for meeting peak loads, as the turbines can quickly achieve full generation capability. They can be started up quickly because they have great operational flexibility. **3.** The cost for a simple cycle plant is less expensive than that of a combined cycle plant **Disadvantages** 1. Because of the power required to drive the compressor, energy conversion efficiency for a simple cycle gas turbine power plant is typically about 30%, with even the most efficient designs limited to 40%. **2.** Although increasing the firing temperature increases the output power at a given pressure ratio, there is also a sacrifice of efficiency due to the increase in losses due to the cooling air required to maintain the turbine components at reasonable working temperatures.	The simple or single cycle gas is the preferred option. The design of the AMERI Power Plant which operates in a simple or single cycle mode will not be altered but maintained when relocated. It will help meet peaking power needs on the national electricity grid for the greater Kumasi area and up north.
2.Combined Cycle Gas Turbine	**Advantages** 1. Less emissions since the exhaust gases are recycled in the HRSG. 2. Comparable with coal fired power plant burning of natural gas in CCGT is much cleaner.	**Advantages** 1. Excess heat during the combustion of natural gas is directed to generate steam and turn a steam turbine. Therefore, both the gas and steam turbines generate electricity, achieving efficiencies of up to 60%. 2. Designed for maximum efficiency in which the hot exhaust gases from the gas turbine are used to raise steam to power a steam turbine with both turbines being connected to electricity generators to make twice the use of the fuel they consume. 3. Gas turbines can be used for large scale power generation.	

3.11.5 Site Selection Options

Various sites were considered for the location of the AMERI Power Plant. As part of the site assessment, the following environmental/social and technical issues were considered for the selection of a suitable site for the project:

1. availability of power evacuation infrastructure
2. availability of water for plant operation (e.g. cooling for combined cycle operation)
3. access to land for gas pipeline infrastructure
4. other constraints such as socioeconomic use of land and environmental concerns.

The following major sites were assessed to aid in the selection process:

- **Site 1 – Kumasi Area GRIDCo Substation:** Two locations considered as
  - Site 1.A – Area within GRIDCo Right of Way
  - Site 1.B – VRA Emergency Power Plant
- **Site 2 – GRIDCo K2BSP Substation:** Two key locations considered
  - Site 2.A – Area within existing GRIDCo Substation land acquisition
  - Site 2.B – Area used by KNUST for Plant Research
- **Site 3** –GRIDCo Substation in Obuasi

3.11.5.1 *Site 1 – Kumasi Area GRIDCo Substation*

The GRIDCo Kumasi Area Substation is situated in Nhyieso, close to the Georgia Hotel. Two (2) locations were identified that could be used for the development of a thermal power plant.

3.11.5.1.1 Site 1.A – Area within GRIDCo Right of Way

Site1.A is a 5.83 acre piece of land that falls within the GRIDCo Right-of-Way for its 161kV pylons. It is near the Kumasi Area Substation. There is minimal vegetation on the land and portions of the land has been graded to be used by an unidentified private entity. The following challenges were identified:

1. There are oxidation ponds used by the Komfo Anokye Teaching Hospital for the treatment of their waste water, which would have to be relocated to allow for the site to be used for the development of a thermal power plant
2. There are private enterprises situated within the GRIDCo Right of Way that would also have to be relocated for the construction of the gas pipeline infrastructure.

3.11.5.1.2 Site 1.B – VRA Emergency Power Plant

This site currently accommodates VRA's emergency diesel generators. The estimated area of land available at the site is about 2 acres with about half of that available area used for a tank farm. The site also has an 11kV distribution line for evacuation of electricity from the 20MW diesel generator sets. There is an existing pipeline from Ghana Water Company that provides municipal water to the site. The challenges at the site include:

1. Routing a gas pipeline to the site would be challenging due to the market and other settlements around the site.
2. The 11kV evacuation infrastructure would have to be upgraded to safely and reliably send power to the nearby GRIDCo substation.

3.11.5.2 *Site 2 – GRIDCo K2BSP Substation*

The GRIDCo K2BSP Substation is situated in Anwomaso, a suburb close to Kwame Nkrumah University of Science and Technology. At this site, two main locations that could be used for the development of a thermal power plant were considered.

The substation is one of GRIDCo's 330kV substations feeders from the 330kV substations in Pokuase, Aboadze and Kintampo. The substation has both 20MVAR capacitor banks and reactors for regulation of voltages.

There is currently no access to municipal water at the substation so a borehole has been dug and it provides water for use by staff of GRIDCo at the substation. The Right-of-Way of the 330kV pylons is wide enough to accommodate a gas pipeline to supply fuel to a thermal plant that would be developed on any of the identified sites in this area.

3.11.5.2.1 Site 2.A – Area within existing GRIDCo Substation land acquisition

This site forms part of the land acquired for the construction of the GRIDCo K2BSP substation. Part of the land, about 6.7 acres, is fallow with no visible signs of economic or social use. Another part of the land, about 4.5 acres is currently used by the youth in the Anwomaso community as a football park. The challenge that was identified on site was the lack of a source of municipal water.

3.11.5.2.2 Site 2.B – Area used by KNUST for Plant Research

This is a 15 acre parcel of land that is currently used by the Faculty of Agriculture at KNUST for plant research. This site currently has minimal vegetation. The challenges on the site include:

1. No municipal water supply. However, boreholes can be sunk to provide for use at the proposed site.

2. The land is currently used by KNUST for teaching purposes, and there are some few farmers farming on part of the land.

3.11.5.3 *Site 3 – GRIDCo Substation in Obuasi*

This site lies adjacent the old GRIDCo Substation within the Obuasi Township. The power evacuation infrastructure operates at 161kV, 34kV and 11kV voltage levels and it provides electricity to the Obuasi Township and for the mining activities of Anglogold Ghana Limited. The challenges at the site include:

i) route for a gas pipeline to the site would be quite challenging due to the mountainous terrain and the urban development close to the site.
ii) access to the site for haulage of plant equipment would be quite challenging due to the urban development close to the site.

3.11.5.4 *Ranking of Sites*

The identified sites were ranked based on the following criteria:

i) Power evacuation infrastructure
ii) Availability of right of way for a gas pipeline
iii) Size and current use of land
iv) Availability of water
v) Access to the site for haulage of plant equipment

A mark of 1 to 3 was awarded, for each criterion, to each site. A mark of 3 for each criterion indicates that the site has no visible constraints. A mark of 2 indicates that the site has minimal constraints with respect to that criteria. A mark of 1 indicates that the site has a lot of constraints and resolving those issues is expected to be quite challenging. **Table 3-7** below are the marks awarded to each site.

The ranking of the sites, from the best site to the worst site, are as follows:

(1) Site 2.A – GRIDCo Substation land in Anwomaso
(2) Site 2.B – KNUST Land near GRIDCo Substation in Anwomaso
(3) Site 1.B – VRA's Emergency Diesel Generator Site
(4) Site 1.A – Location 1 at Kumasi Area GRIDCo Substation
(5) Site 3.A – Site adjacent Obuasi GRIDCo Substation

It can be noted from the ranking that the best two sites are located close to the GRIDCo Substation in Anwomaso.

3.11.5.5 *Final site selection*

Based on the site selection study report, it was decided at a meeting, on February 26, 2021, in Kumasi between VRA and other stakeholders including the Ministry of Energy, GRIDCo and Ghana Gas that the AMERI Power Plant would be moved to a site (Site 2.B, area used by KNUST for plant research) adjacent to the GRIDCo K2BSP 161kV/330kV substation at Anwomaso in Kumasi, in the Ashanti Region.

Table 3-7: Ranking of identified sites

Criteria	***Site 1.A***	***Site 1.B***	***Site 2.A***	***Site 2.B***	***Site 3.A***
Power Evacuation Infrastructure	**2** (Power evacuation at 161Kv possible)	**1** (Existing power evacuation at 11kV, upgrade required to evacuate power at 161kV	**3** (Power evacuation at 161kV and 330kV possible)	**3** (Power evacuation at 161kV and 330kV possible)	**2** (Power evacuation at 161kV possible)
Gas Pipeline Route	**2** (161kV Right-of-Way available for a gas pipeline however relocation of settlers would be required)	**1** (Gas pipeline to this site would require relocation of settlers and would be challenging due to the proximity of site to urban development)	**3** (161kV and 330kV Right-of-Way available for gas pipeline route)	**3** (161kV and 330kV Right-of-Way available for gas pipeline route)	**1** (Gas pipeline to this site would be challenging due to the complexity of the terrain and the proximity of the site to urban development)
Current Use of Land	**2** (settlers and business enterprises on site would have to be relocated)	**3** (site is already prepared and accommodates VRA's Emergency Diesel Generators)	**2** (No visible economic use of land. Part of land used as a football park by community)	**2** (site is used by KNUST for farming)	**2** (No visible economic use of land)
Availability of Water	**1** (No visible source of water)	**3** (Municipal water is available on site)	**2** (Municipal water is not available however, it is possible to sink boreholes for water)	**2** (Municipal water is not available however, it is possible to sink boreholes for water)	**3** (Municipal water is available on site)
Access to Site for haulage of Plant equipment	**3** (Access to the site is good, no Visible challenge identified)	**3** (Access to the site is good, no visible challenge identified)	**3** (Access to the site is good, no visible challenge identified)	**3** (Access to the site is good, no visible challenge identified)	**1** (Access to the site would be challenging due to the urban development close to the site)
TOTAL	**10**	**11**	**13**	**13**	**9**

3.11.6 Water Supply Source Options

Two water supply source options under consideration are

- Ghana Water Company Limited (GWCL); and
- Groundwater.

The table below provides a brief analysis in terms of the potential environmental and socioeconomic implications of each option, and the preferred proposal.

Table 3-8: Analysis of water supply options

Options	Potential Environmental Implications	Potential Socioeconomic Implication	Conclusion /Preferred Proposal
WATER SUPPLY SOURCES			
1. Ghana Water Company Limited (GWCL)	**Advantages** 1. Water supplied may be free from contaminants and toxins 2. Relatively cleaner effluent will be produced from the facility **Disadvantages** 1. It may be contaminated when water pipes burst; 2. Using water from GWCL may adversely affect supply to communities.	**Advantages** 1. Less sophisticated water treatment plant will be required for the production of demineralized water since the raw water source is relatively clean **Disadvantages** 1. Increased competition for water supplied to the populace/ residents. 2. Regularity of supply may be an issue since supply to the municipalities will be a priority. 3. GWCL may rather supply the plant at the expense of the populace. 4. The cost for water supply maybe high	The project will consider both GWCL source and augment with groundwater. The existing GRIDCo facility uses borehole. The distance from the site to the GWCL mains is about 3km.
2. Groundwater	**Advantages** 1. Water is not lost by evaporation. 2. It is a renewable resource. **Disadvantages** 1. There is a risk of withdrawing groundwater from aquifers faster than it is replenished because large volumes of water may be needed. 2. The water table may be	**Advantages** 1. Groundwater supply can be removed as needed year round. 2. More ethical since competition with communities is less. **Disadvantages** 1. High cost of pumping groundwater. 2. Risk of over abstraction	

Options	Potential Environmental Implications	Potential Socioeconomic Implication	Conclusion /Preferred Proposal
	significantly impacted.		

3.11.7 No Action Option

If no action is taken to address the power supply challenges in the Ashanti region and beyond, the challenges associated with the grid will persist and worsen. There will not be a reduction in transmission losses which the project would have brought. The implementation of the project would reduce transmission losses from 132.5 MW (3.74 % of total generation) to 107.6 MW (3.1 % of total generation) as stated in the 2020 Electricity Supply Plan for the Ghana Power System. This is a significant reduction of about 25MW (0.64% of total generation) in transmission losses, and this will not materialise if no action is taken.

The other benefits/opportunities expected to be realized from the possible implementation of the proposed project in the area will also not happen. There will not be any improvement in the voltage stability of the NITS; there will not be any improvement in the quality of supply to end users through improved network voltage control via generators; and there will not be any reliable power to end users.

The country will lose out on the numerous benefits to be derived therefrom, such as promoting socioeconomic activities and wellbeing, increased business investment as a result of reliable power supply among others. Continuous power challenges can cripple the local economy in the affected areas, create unemployment as businesses will have to lay off workers because of inadequate energy to support and sustain economic and business activities. The employment opportunities that the project will bring to the area will not materialize. The extension of the GWCL mains to the project site which the local communities can benefit from will also not happen in the short to medium term.

There will be no additional emission of noxious gases into the atmosphere from a government owned thermal power plant. However, this will be negated with the use of various diesel generators as some businesses and organizations who can afford will go for diesel generator sets to support their business operations.

The no action option is not a preferred option at all as the power challenges will not only persist but become worse and affect the socioeconomic, wellbeing and livelihood activities in the affected area in general.

SELJEN CONSULT

CHAPTER FOUR

DESCRIPTION OF THE EXISTING ENVIRONMENT

FINAL

ENVIRONMENTAL IMPACT STATEMENT

VOLTA RIVER AUTHORITY

4.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

This chapter presents the existing environmental and social baseline information of the project area. The project area of influence include the project site and its immediate environs including the Anwomaso community and the larger area which covers the Oforikrom Municipality. The environmental and social baseline information is obtained through literature reviews/desktop studies and outcomes of field investigations both during this EIA studies and the project feasibility study. The chapter is subdivided into three major headings as follows:

- Physical Environment
- Biological Environment
- Social Environment

4.1 Physical Environment

4.1.1 Climatic Condition of the Project Area

The study area falls within the wet sub-equatorial climatic zone. The project area experiences a double maxima rainfall regime in June and in September/October. The major rainy season starts from March to July with a peak usually in June. The minor season starts from September to November with a peak either in September or October. August is usually cool and dry. The main dry season occurs in December to March during which the desiccating harmattan winds blow over the area.

Thirty (30) years meteorological data (from 1990-2020) about the project area was received from the Ghana Meteorological Service. The data included: temperatures, wind speed and direction, the humidity and rainfall. The wet and dry bulb temperatures of the area was plotted and the results have been presented in **Figures 4-1** and **4-2. Figure 4-1** contains the minimum, average and maximum wet bulb temperatures over the past 30 years. From **Figure 4-1,** the minimum wet bulb temperature usually occurs in the month of January while the maximum wet bulb temperature occurs in the March. The minimum and maximum wet bulb temperatures readings for the past 30 year are 20.40 ºC and 24.70 ºC.

Figure 4-2 contains the dry bulb temperature of the past 30 years; the maximum dry temperatures occurs in the month of February while the minimum occurs in the month of July. The maxim dry bulb temperature recorded in the area is 36.9 ºC, while the minimum dry bulb is 27.1ºC.

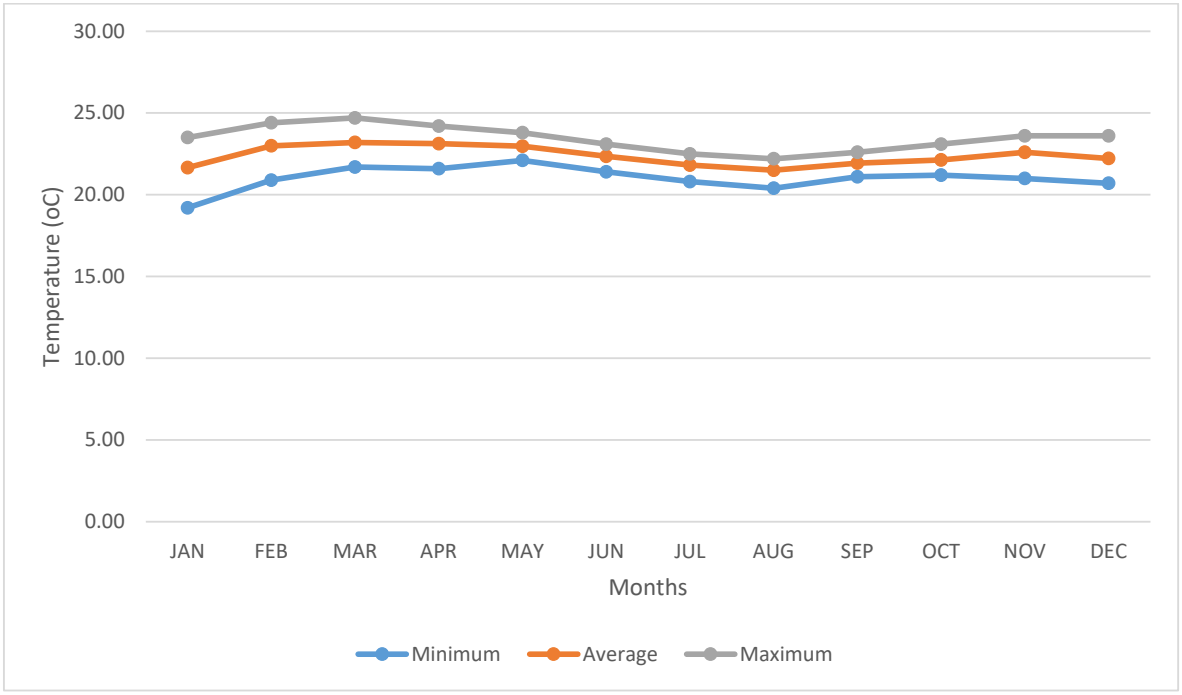


Figure 4-1: Historical (1990-2020) Wet Bulb Temperature of the Project Area

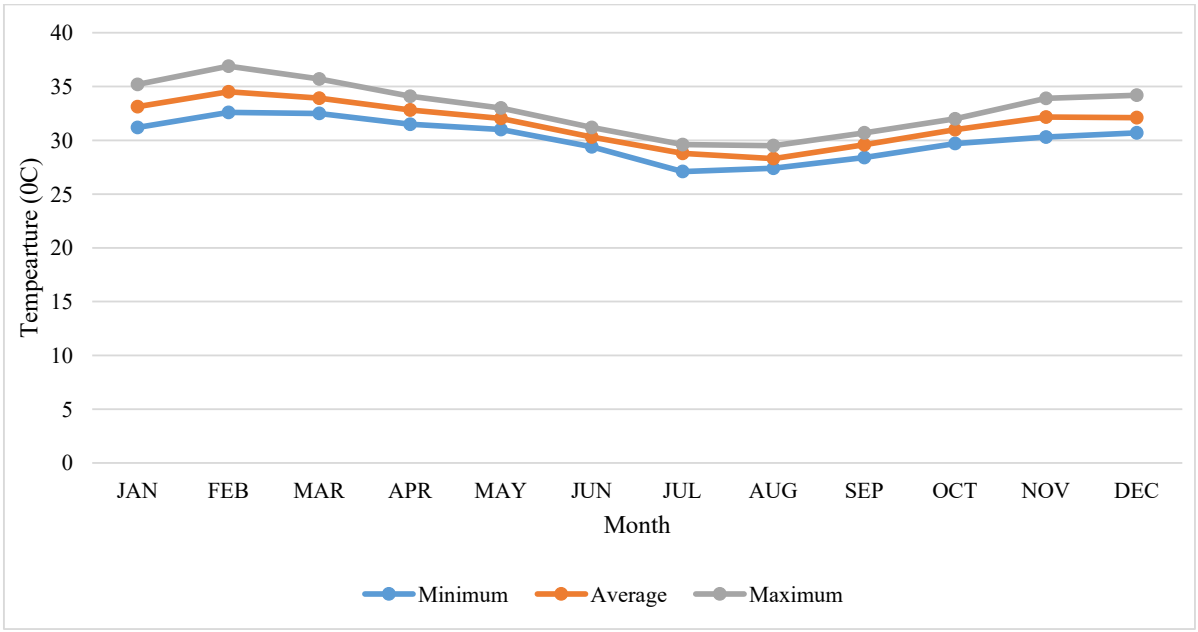


Figure 4-2: Historical (1990-2020) Dry Bulb Temperature of the Project Area

The relative humidity plot of the area has been presented in **Figure 4-3**. From the graph the driest month is January. The least relative humidity recorded is 24% and the maximum is 98%.

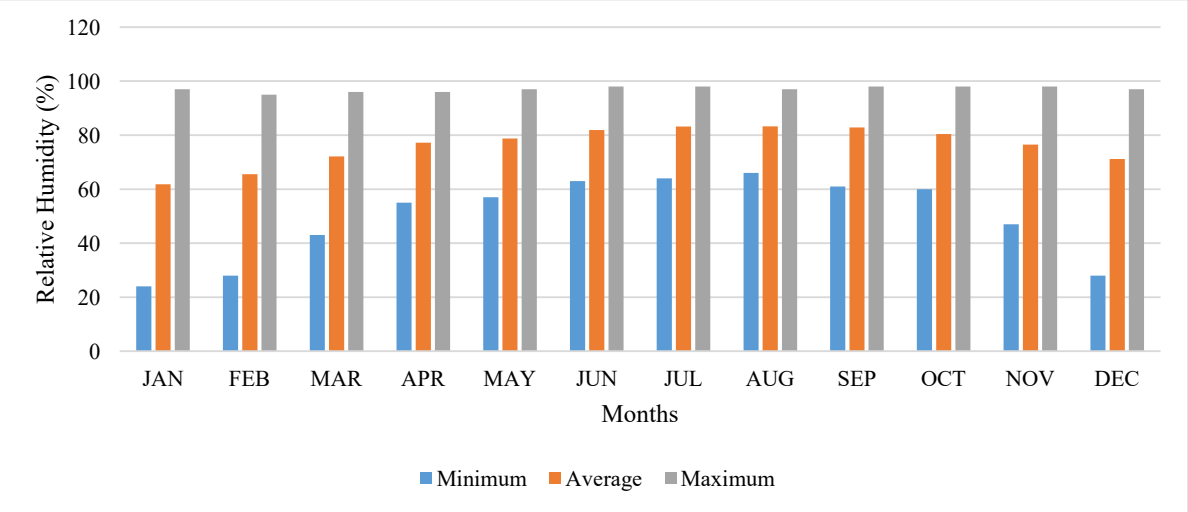


Figure 4-3: Historical (1990-2020) Relative Humidity of the Project Area

The rainfall pattern for 30 years in the project area was also obtained and plotted. The result is shown in **Figure 4-4**. From the graph, driest month is January and the rainiest is September. The month with highest rainfall recorded over the years is 534.50 mm.

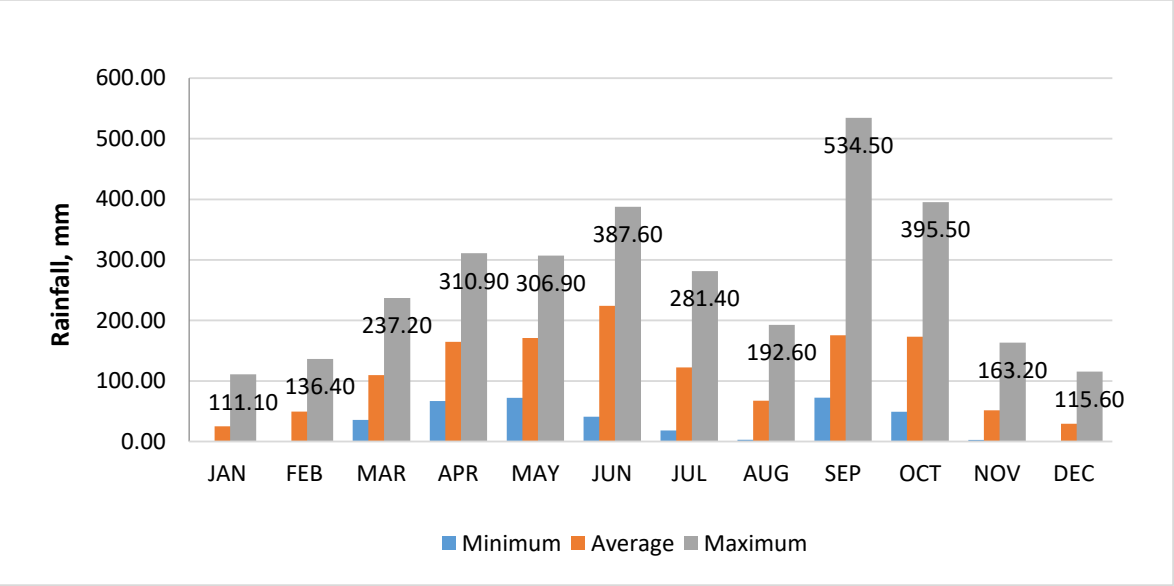


Figure 4-4: Historical Rainfall (1990-2020) Pattern of the Project Area

The prevailing wind directions are NNW, NW and WNW with the respective percentage dominance of 13.33%, 46.67% and 40.00% of the project area. The wind direction is indicated in **Figure 4-5**. The wind speeds are in the magnitudes from 0 m/s to 4.5 m/s on the wind rose diagram.

This wind rose helped to determine the predominant direction of pollutants emitted from the stack of the Kumasi 1 Thermal Power Plant. Hence the communities that will be most impacted are those areas lying from SSW to WSW.

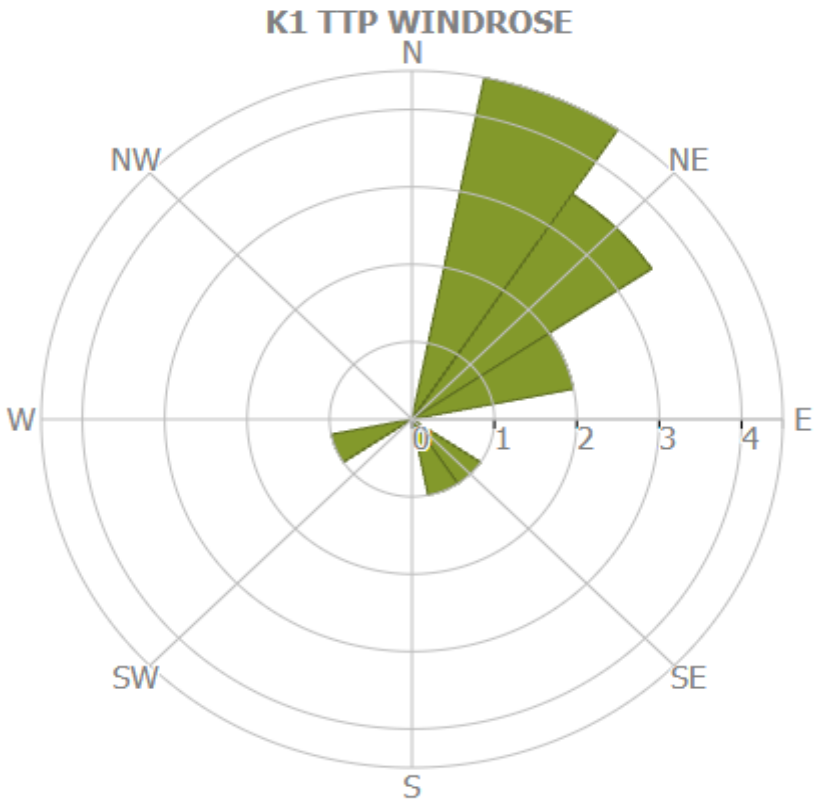


Figure 4-5: Historical (1990-2020) Windrose Diagram for the Project Area

A summary of the meteorological parameters is provided in **Table 4-1.**

Table 4-1: Summary of Meteorological Parameters

Parameter	Minimum	Average	Maximum
Wet bulb temperature, ºC	20.40	22.37	24.70
Dry temperatures, ºC	36.9	31.55	27.1
Relative humidity, %	24	76.20	98
Rainfall, mm	0	113.65	534.50
Wind speed, knot	0	3.5 (1.8m/s)	5 (2.57 m/s)

4.1.2 Topography/Relief

Oforikrom Municipality lies within the plateau of the South – West physical region which ranges from 230-300 meters above sea level. The topography is generally undulating for the municipality. The proposed project site is on a low ridge with the surrounding land sloping gently down to the south and south-west. The existing ground surface at the project site is approximately 268 to 285 m above mean sea level.

4.1.3 Drainage

The Municipality is traversed by water bodies such as Susan, Wiwi, Saman, Aboabo and Adote. The list of water bodies in the Municipality is provided in the table below. However, human activities such as construction of housing and improper waste disposal have impacted negatively on these water bodies and is increasingly leading to their extinction and inability to support living organisms in them.

*Table 4-2: **List of Water Bodies within the Municipality***

S/N	Water Bodies	Location
1	Susan	Susanso, Susaakye, Bomso, Anloga (Nkasem)
2	Wiwi	Ayigya, Kentikrono
3	Saman	Kokoben
4	Bobo	Tech

5	Oda	Kodiekrom, Deduako, Apemso
6	Tawiah	Anwomaso (Primary)
7	Subiri	Oduom, and Anwomaso
8	Adote	Nana Serwaa (Anwomaso High Tension)
9	Aboabo	Oforikrom

Source: OfMA NADMO Department 2021

Drainage at the proposed site occurs by natural sheet flow towards the south/south-west, with some local depressions at low elevations. The proposed site is within 200m from a stream called Adote (sometimes also spelt Adoti) Stream.

4.1.4 Surface Water Quality

The Adote River is the nearest water body to the project site and was sampled upstream and downstream on November 3, 2021 for water quality analysis. The samples were analyzed at KNUST Environmental Quality Laboratory of the Civil Engineering Department. The sampling/laboratory report showing the location map for the sampling sites is provided as **Annex 4-1** in the Volume II of this report. The water quality results are provided in the table below. The pH of Adote River downstream is slightly acidic, i.e. 5.70 units, and outside the Water Resources Commission (WRC) Surface Water Quality Guidelines (Ghana TWQR) for agriculture water use range of 6.5 -8.5 units. However, other physiochemical parameters (Total Dissolved Solids, Total Suspended Solids) and metals (Total Iron, Zinc and Lead) were within the acceptable limits of the Ghana TWQR for agriculture water use.

Table 4-3: Results of Adote River Water Quality Analysis

PARAMETERS	Ghana Standards (Effluent from Thermal Power Plant)	1st Point (Upstream) (GPS Coordinates - 06.59455N 001.52069W)	2nd Point (Downstream) (GPS Coordinates- 06.69210N 001.52274W)	Ghana TWQR for agriculture water use by WRC	WHO Guidelines for Drinking Water Quality
pH	6.0-9.0	6.60	5.70	6.5 – 8.5	6.5-8.5
Temperature (°C)	<3° above ambient	26.70	28.50	-	-
Total Dissolved Solids (mg/l)	-	78.00	185.0	<40	1000
True Colour (TCU)	-	109.0	144.0	-	25
E. Conductivity (µS/cm)	-	100.0	250.0	-	500-700
Total Suspended Solids (mg/l)	50	11.0	14.0	<50	5
Turbidity (NTU)	75	8.44	15.5	-	5

PARAMETERS	Ghana Standards (Effluent from Thermal Power Plant)	1st Point (Upstream) (GPS Coordinates - 06.59455N 001.52069W)	2nd Point (Downstream) (GPS Coordinates- 06.69210N 001.52274W)	Ghana TWQR for agriculture water use by WRC	WHO Guidelines for Drinking Water Quality
Nitrate as N (mg/l)	-	5.80	5.50	-	10-45
B.O.D (mg/l)	-	3.00	8.00	-	50
C.O.D (mg/l)	250	10.00	25.00	-	250
Oil and Grease (mg/l)	5.0	0.00	3.00	-	-
Total Phosphate (mg/l)	2	3.54	5.30	-	5
Total Iron (Fe) (mg/l)	2	0.0002	0.0003	<5	0.3
Copper (Cu) (mg/l)	0.5	0.0075	0.0066	-	1
Zinc (Zn) (mg/l)	2	0.0221	0.0299	<1	3
Arsenic (As) (mg/l)	0.01	0.0000	0.0000	-	0.01
Chromium (Cr) (mg/l)	0.05	0.0047	0.0066	-	0.05
Selenium (Se) (mg/l)	0.1	0.0263	0.0294	-	-
Nickel (Ni) (mg/l)	0.5	0.0024	0.0037	-	-
Lead (Pb) (mg/l)	0.1	0.0031	0.0035	<0.2	-
Mercury (Hg) (mg/l)	0.005	0.0903	0.1153	-	0.001
Total Coliforms (cfu/100ml)	-	$83x10^2$	$115x10^2$	-	400

4.1.5 Geology

Geologically, Kumasi (Greater Kumasi) falls within the Lower Birimian which consists of dark grey slatey phyllites, phyllites and "sandy" (probably ashy) phyllites and greywackes. All gradations between these exist and different rock types are often intimately interbedded. The greywackes vary from fine grained to medium grained and all have metamorphosed and recrystallized. Near the contacts with the granite batholith, metamorphism has produced biotite, staurolite, garnet and kyanite schists. The rocks are deeply weathered and fresh outcrops of phyllite are never seen (Murray, 1961). The geology of Oforikrom Municipality is dominated by Middle Precambrian Rocks.

4.1.6 Soil

The major type of soil constituting the top soil of the Municipality is the Forest Ochrosol. This soil type is comprised of Oforikrom - Offin Compound Association; Bomso – Offin Compound Association; Nhyanao - Tinkong Association; Bomso – Suko Simple Association; Bekwai – Oda Compound Association and Bekwai – Akumadan – Oda Compound Association. Forest Ochrosol is endowed with the nutrient mostly needed to sustain the cultivation of food crops such as

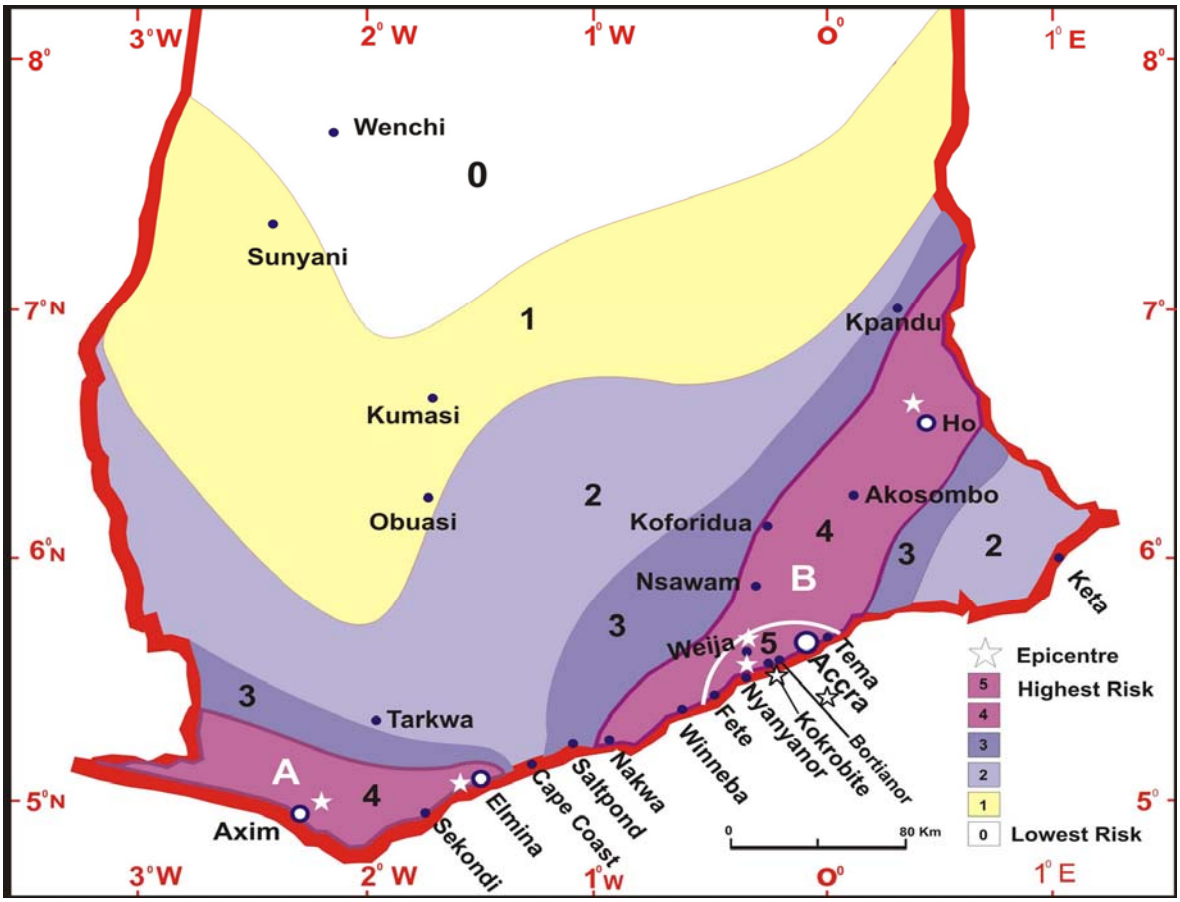
vegetables, plantain and cassava. The presence of this type of soils has sustained the cultivation of food crops notably at the periphery of the Municipality.

4.1.7 Seismicity and Earthquake Zoning

Ghana is not located close to any of the world's well-known seismic zones. Generally, Ghana is a stable land mass, and features very low seismic activity. However, significant earthquake activity has been reported in southern Ghana, especially the coastal region of the country, that is, along the Gulf of Guinea, where earthquakes up to magnitude 5.5 to 6.5 on the Richter-scale have been historically recorded (in 1906 and 1939) and occur on repetitive periods of between 50 and 140 years.

Seismic activity in southern Ghana is believed to be caused by movement along two active fault systems; the Akuapim Fault along the Akuapim mountain range which trends approximately NE-SW and is located about 20km west of Accra and the Coastal Boundary Fault which lies some 3km offshore and runs almost parallel to the coastline in the vicinity of Accra.

Figure 4-6 shows the seismic risk map of southern Ghana (Kutu, 2013). The earthquake zoning is related to the probability of occurrence. Zone 0 areas have the least occurrence of earthquakes and zone 5 areas have the most. This means that the higher the zone the more likely the areas under it will experience higher earthquake loads. According to the seismicity map of southern Ghana, the Kumasi area lies in Zone 1 of the seismic risk assessment map, which is located further away from the seismically active parts of Ghana, and is generally a lower seismic hazard zone. The Ghana Geological Survey Authority (GGSA) recommends peak ground acceleration values of 0.05 g to 0.10g for Zone 1.



Source: Kutu (2013)

Figure 4-6: Seismic Risk Map of Southern Part of Ghana

4.1.8 *Ambient Air Quality and Noise Level*

As part of this EIA, ambient air quality and noise assessment and pollutant dispersion modelling were undertaken for the proposed Kumasi 1 Thermal Power Plant Project. The ambient air quality and noise monitoring were carried out at seventeen monitoring sites (work environments and communities) within 5 km radius and modelled to 10 km radius from the project area. These monitoring stations were selected both to be in close to the project site (near field) and also far from the project site (far field). The air quality and noise monitoring programme was conducted from August 9 to September 12, 2021.The detailed report including scope of work, objectives, approach, results and the modelling outcomes is provided in **Annex 4-2** in the Volume II of this report. The description of the sampling stations is provided in **Table 4-4**. The sampling stations are shown in **Figure 4-7.**

Table 4-4: Description of Sampling Locations

No.	Location	Location Description	Types of Receptors	Coordinate		Field Observation	
				Latitudes	Longitudes	Particulates and Gas	Noise
NEAR FIELD MONITORING SITES							
1.	161 kV Substation	Substation with 3 transformers 15 m from Project Site, and are guarded by security personnel and workers that attend to the transformer	Workers and security personnel at the Substation	6°41.713 N	1°31.192 W	Emission from transformer, Burning from the farms nearby.	Transformer Fans, personnel and birds
2.	330 kV Substation	Substation with 1 transformer 20 m from Project Site, and are guarded by security personnel and workers that attend to the transformer	Workers and security personnel at the Substation	6°41.620 N,	1°31.125 W	Workers, Vehicular emission and transformer fuel	Noise from transformer, workers and birds
3.	Anwomaso Sand Winning Truck Station	600 m from project site Sand winning station that hosts drivers and customers. It 9.3 m from the main township road	Residents and commuters	6°41.503 N,	1°31.339 W	1. Occurrence of wind-blown dust. 2. Dust emissions from vehicles, motor cycles plying within the community 3. Fumes from exhaust of vehicles and motorcycles plying within the community.	1. Noise from commuters. 2. Noise from vehicles and motorcycles plying within the community. 3. Noise from wind action. 4. Noise from domestic activities.
4.	Anwomaso Presby JHS	1279 m from project site	Residents, commuters, vegetation	6°41.797 N	1°31.762 W	1. Dust from school pupils and teachers walking and playing. 2. Dust emissions from motor cycles plying within the community 3. Fumes from exhaust	1. Noise from commuters 2. Noise from motorbikes plying within the community 3. Noise from generator sets 4. Noise from wind action

No.	Location	Location Description	Types of Receptors	Coordinate		Field Observation	
				Latitudes	Longitudes	Particulates and Gas	Noise
						of vehicles and motor cycles plying within the community	5. Noise from domestic activities 6. Noise from school pupils and teachers
5.	Bebre	923 m from project site and community surrounded by forest reserve. The area is predominantly vegetated.	Residents, commuters, vegetation	6°42.063 N	1°31.480 W	1. Occurrence of wind-blown dust. 2. Dust emissions from dusty roads due to moving motorbikes and vehicles. 4. Fumes from exhaust pipes of vehicles/motor cycles plying within the community.	1. Noise from commuters. 2. Noise from moving vehicles and motorbikes within and from the community. 3. Noise from other anthropogenic activities within the community.
6.	Fumesua New Site	1489 m from project site	Residents, commuters, vegetation	6°42.516 N	1°30.791 W	1. Occurrence of wind-blown dust. 2. Dust emissions from dusty roads due to moving motorbikes and vehicles. 3. Fumes from exhaust pipes of vehicles/motor cycles plying within the community and construction.	1. Noise from commuter. 2. Noise from moving vehicles and motorbikes within and from the community. 3. Noise from other anthropogenic activities within the community.
7.	Domeabra 1	1476 m from project site	Residents, commuters	6°40.965 N	1°30.721 W	1. Occurrence of wind-blown dust 2. Dust emissions from dusty roads due to moving motorcycles and vehicles. 3. Fumes from exhaust of vehicles/motor cycles plying within the community	1. Noise from moving vehicles, motorbikes, and earth moving machines during first and second monitoring regimes 2. Noise from wind action
8.	Domeabra 2	2482 m from project site	Residents, commuters, vegetation	6°40.627 N	1°30.618W	1. Particulate from construction sites 2. Occurrence of wind-blown dust 2. Dust emissions from dusty roads	1. Noise from birds and insects 2. Noise from moving vehicles, motorcycles, and earth moving machines during

No.	Location	Location Description	Types of Receptors	Coordinate		Field Observation	
				Latitudes	Longitudes	Particulates and Gas	Noise
						due to moving motorbikes and vehicles. 4. Fumes from exhaust pipes of vehicles/motor cycles plying within the community	first and second monitoring regimes 3. Noise from wind action
9.	Asawase	3243 m from project site	Residents, commuters, vegetation	6°41.079 N,	1°29.440 W	1. Occurrence of wind-blown dust from the ground 2. Fugitive dust from moving motorbikes and vehicles on the route	1. Noise from chuckling of birds 2. Noise from wind action 3. Minimal noise from vehicles plying on the road
FAR FIELD MONITORING SITES							
10.	Apromase	3891 m from project site	Residents, commuters, vegetation	6°40.235 N	1°29.704W	1. Occurrence of wind-blown dust 2. Dust emissions from motorcycles plying within the community 3. Fumes from exhaust pipes of motor cycles plying within the community	1. Noise from commuters 2. Noise from vehicle and motorbikes plying within the community 3. Noise from generator sets 4. Noise from wind action 5.Noise from domestic activities
11.	Krapa	3616 m from project site	Residents, commuters, vegetation	6°42.215N	1°29.114W	1. Occurrence of wind-blown dust 2. Dust emissions from motorcycles plying within the community 3. Fumes from exhaust pipes of motorcycles plying within the community	1.Noise from commuters 2. Noise from motorbikes plying within the community 3. Noise from generator sets 4. Noise from wind action 5. Noise from domestic activities

No.	Location	Location Description	Types of Receptors	Coordinate		Field Observation	
				Latitudes	Longitudes	Particulates and Gas	Noise
12.	Aprade	3266 m from project site	Residents, commuters, vegetation	6°42'55.6" N	1°32'37.7"W	1. Occurrence of wind-blown dust 2. Dust emissions from motorcycles plying within the community 3. Fumes from exhaust of motor cycles plying within the community	1. Noise from commuters 2. Noise from motorbikes plying within the community 3. Noise from generator sets 4. Noise from wind action 5.Noise from domestic activities
13.	Fumesua	1351 m from project site	Residents, commuters, vegetation	6°42'29.7"N	1°31'24.5"W	1. Occurrence of wind-blown dust 2. Dust emissions from motor cycles plying within the community 3. Fumes from exhaust pipes of motor cycles plying within the community	1.Noise from commuters 2. Noise from motorbikes plying within the community 3. Noise from generator sets 4. Noise from wind action 5. Noise from domestic activities
14.	Oduom	3388 m from project site	Residents, commuters, vegetation	6°42'06.2"N	1°32'30.4"W	1. Occurrence of wind-blown dust 2. Dust emissions from motor cycles plying within the community 3. Fumes from exhaust pipes of motor cycles plying within the community	1. Noise from commuters 2. Noise from vehicles and motorcycles plying within the community 3. Noise from generator sets 4. Noise from wind action 5. Noise from domestic activities
15.	Kwamo	2030 m from project site	Residents, commuters, vegetation	6°42'46.5"N	1°30'23.4"W	1. Occurrence of wind-blown dust 2. Dust emissions from motorcycles plying within the community	1.Noise from commuters 2. Noise from motorbikes plying within the community

No.	Location	Location Description	Types of Receptors	Coordinate		Field Observation	
				Latitudes	Longitudes	Particulates and Gas	Noise
						3. Fumes from exhaust of vehicles and motorcycles plying within the community	3. Noise from generator sets 4. Noise from wind action 5. Noise from domestic activities
16.	Adako Jackie	2756 m from project site	Residents, commuters	6º43'12.4"N	1º30'16.6"W	1. Occurrence of wind-blown dust 2. Dust emissions from motor cycles plying within the community 3. Fumes from exhaust pipes of motor cycles plying within the community	1. Noise from commuters 2. Noise from vehicles motorcycles plying within the community 3. Noise from generator sets 4. Noise from wind action 5. Noise from domestic activities
17.	Krapa Newsite	4123 m from project site	Residents, commuters, vegetation	6º42'56.7"N	1º29'04.3"W	1. Occurrence of wind-blown dust 2. Dust emissions from motor cycles plying within the community 3. Fumes from exhaust of vehicles and motorcycles plying within the community	1. Noise from commuters 2. Noise from motorbikes plying within the community 3. Noise from generator sets 4. Noise from wind action 5. Noise from domestic activities

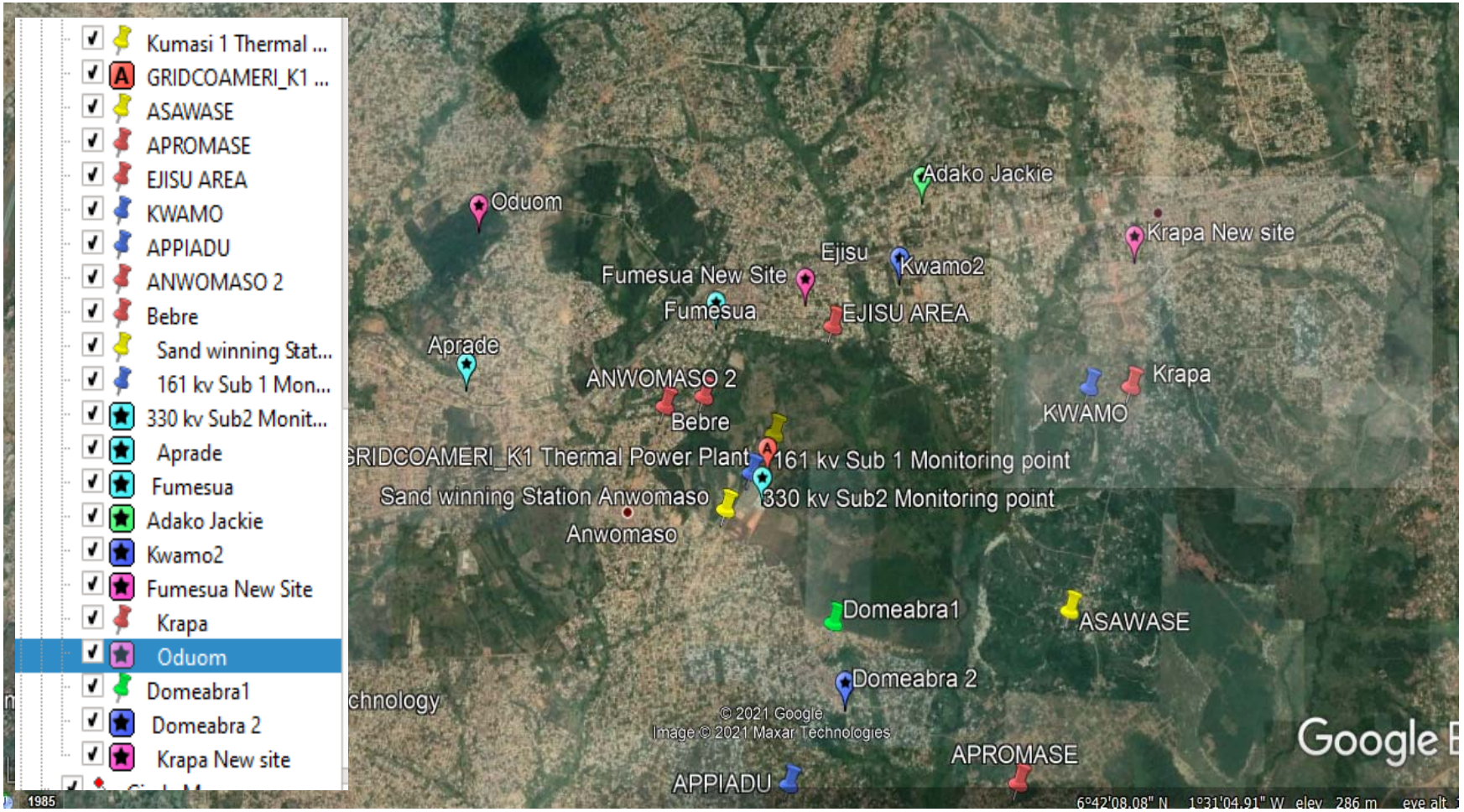


Figure 4-7: Sampling Stations

4.1.8.1 *Ambient Air Quality Results*

The air quality monitoring results are presented in **Tables 4-5 and 4-6**. **Table 4-5** provides the summary of the results for dust – TSP, PM_{10}, $PM_{2.5}$ and $PM_{1;}$ and **Table 4-6** provides the summary of the results for gases - Cl_2, NOx, CO, SO_2, and VOC, after sample analysis of data from the various monitoring stations.

Table 4-5: Results of Particulate Matter/Dust Monitoring

No.	Sampling Location	Averaging Time	Particulate Matter (µg/m³)			
			TSP	PM_{10}	$PM_{2.5}$	PM_1
1	161 kv Substation	24 hrs	208.40	136.6	74.06	37.62
2	330 kv Substation	24 hrs	134.70	87.10	30.01	10.8
3	Anwomaso Sand Winning Truck Station	24 hrs	284.90	154.00	36.35	13.14
4	Anwomaso Presby JHS	24 hrs	137.5	72.6	17.87	6.49
5	Bebre	24 hrs	67	40.2	19.8	10.28
6	Fumesua New Site	24 hrs	85.6	51.7	25.13	10.96
7	Domeabra 1	24 hrs	45.2	21.4	8.5	3.14
8	Domeabra 2	24 hrs	31.9	15.4	13.46	4.15
9	Asawase	24 hrs	23.9	18.6	4.28	1.34
10	Apromase	24 hrs	48.9	21.1	5.85	1.8
11	Krapa	24 hrs	53.3	38.6	20.88	11.11
12	Aprade	24 hrs	63.2	33.2	13.15	5.81
13	Fumesua	24 hrs	79.38	39.39	23.36	14.63
14	Oduom	24 hrs	53.51	35.49	26.44	13.45
15	Kwamo	24 hrs	68.38	32.49	28.37	9.45
16	Adako Jackie	24 hrs	39.27	20.49	13.44	5.34
17	Krapa Newsite	24 hrs	73.51	40.49	23.44	9.58
Ghana Standards (µg/m³)		**24 hrs**	**150**	**70**	**35**	**-**
WHO/IFC Guideline Values (µg/m³)		**24 hrs**		**50**	**25**	**-**

NB: hrs = hours; Values are maximum readings over the study period

Table 4-6: Sampling locations and recorded gases

No.	Location	Gases (ppm)				
		Cl_2	NOx	CO	SO_2	VOC
1.	161 kv Substation	0.11	0.10	0.00	0.00	
2.	330 kv Substation	0.11	0.10	0.00	0.00	0.30
3.	Anwomaso Sand Winning Truck Station	0.12	0.00	3.00	0.2	0.30
4.	Anwomaso Presby JHS	0.11	0.10	2.00	0.00	0.00
5.	Bebre	0.10	3.00	0.00	0.00	0.00
6.	Fumesua New Site	3.00	0.00	5.00	0.00	0.00
7.	Domeabra 1	0.01	0.10	0.00	0.00	0.10
8.	Domeabra 2	0.06	0.10	0.00	0.10	0.00
9.	Asawase	0.01	0.10	3.00	0.00	0.00
10.	Apromase	0.05	0.10	2.0	0.00	0.00
11.	Krapa	0.05	0.1	2.00	0.00	0.00
12.	Aprade	0.06	0.10	3.00	0.10	0.00
13.	Fumesua	0.04	0.10	0.00	0.00	0.00
14.	Oduom	0.05	0.00	3.00	0.00	0.00
15.	Kwamo	0.03	0.00	0.00	0.00	0.00
16.	Adako Jackie	0.01	0.00	0.00	0.00	0.00
17.	Krapa Newsite	0.04	0.00	3.00	0.00	0.00
Ghana Standards			150		50	-
WHO/IFC			200		20	-

NB: hrs = hours; Values are maximum readings over the study period

The Ghana Standards (GS 1236:2019), as shown in **Table 4-5**, set a limit of 150 µg/m^3 70 µg/m^3, 35 µg/m^3 for TSP, PM_{10} and $PM_{2.5}$ respectively. From **Table 4-5**, particular matter concentration levels for the Anwomaso Sand Winning Truck Station were above the GS threshold limit. This is due to the proximity of the truck station to the main road leading to the Substations. The effect is also observed at 161 kV Substation and 330 kV Substations. The rest of the records were generally below the GS threshold because they are away from roads. From **Table 4-6**, the concentration for Cl_2, NO_2, CO, SO_2, and VOC at all the monitoring stations were relatively and below the GS standard.

4.1.8.2 *Results of Ambient Noise Levels*

The noise levels were determined using CASTLE Sonus sound level meter. Noise measurements were only accepted to be valid if the calibration levels from before and after the measurement agree to within 1.0 dBA.

The noise measurements were conducted continuously throughout the measurement period between 06:00 and 22:00 hours day time and 22:00 hr - 6:00 hours during night time from 9 August 2021 to 12 September 2021. The Noise Meter was calibrated at a range of (30 -120) dBA prior to field work. The instrument was mounted on a stand 1.5 meters high at the sampling locations. The detailed report is provided in **Annex 4-2** (see Volume II of this report). The noise monitoring sites coincided with the air quality monitoring sites as a total of seventeen (17) sampling locations were chosen. The average (L_{eq}), maximum (L_{max}) and minimum (L_{min}) as well as statistical values for L_{10}, L_{50}, and L_{90}, noise levels were computed and recorded over the same period (day and night) at each sampling location. Table 4-4, earlier provided, contains a brief description of the sample locations and coordinates as well as observations in the area. The summary of the noise level results over the study period are provided in **Table 4-7**.

Table 4-7: ***Noise Levels at Monitoring Stations***

No.	Location	Time of Day	Noise Level dBA					
			L_{90}	L_{50}	L_{10}	Lmax	Lmin	Leq
1.	161 kv Substation	Day	77.99	81.99	85.99	90.40	49.30	68.60
		Night	76.98	80.97	85.99	90.40	49.40	68.60
2.	330 kv Substation	Day	49.64	52.24	61.82	81.20	40.10	46.70
		Night	49.49	51.49	55.92	73.10	46.00	49.30
3.	Anwomaso Sand Winning Station	Day	58.06	62.36	66.66	74.90	55.70	59.70
		Night	42.01	55.01	55.39	97.20	39.88	43.30
4.	Anwomaso Presby JHS	Day	56.99	61.99	80.56	80.80	47.20	62.40
		Night	48.30	57.80	76.34	85.60	45.90	55.70
5.	Bebre	Day	45.82	57.99	62.91	64.80	43.80	47.90
		Night	45.32	50.18	58.30	69.40	42.10	48.80
6.	Fumesua New Site	Day	42.60	48.20	55.82	67.60	42.00	54.70
		Night	48.30	50.18	58.30	78.40	41.00	48.60
7.	Domeabra 1	Day	47.41	52.96	60.92	83.30	42.70	50.20
		Night	39.80	45.70	50.20	72.60	33.40	46.70
8.	Domeabra 2	Day	47.79	58.29	63.14	76.60	40.30	59.90
		Night	45.30	50.70	58.10	70.80	39.50	46.70
9.	Asawase	Day	45.82	57.99	62.91	52.30	39.60	41.50
		Night	48.30	57.80	76.34	84.60	45.90	53.70
10	Apromase	Day	42.26	51.99	62.44	71.00	49.90	55.70
		Night	45.82	57.99	62.91	75.30	43.10	50.10
11	Krapa	Day	42.84	64.07	64.89	61.90	38.20	48.10

No.	Location	Time of Day	Noise Level dBA					
			L_{90}	L_{50}	L_{10}	Lmax	Lmin	Leq
		Night	41.80	55.70	68.70	88.10	40.20	45.60
12	Aprade	Day	43.80	53.13	62.44	90.00	40.70	48.00
		Night	43.20	54.38	64.69	84.70	39.56	45.42
13	Fumesua	Day	42.90	51.99	62.44	98.40	40.30	56.10
		Night	45.41	61.10	63.37	78.30	42.10	48.00
14	Oduom	Day	43.85	55.37	64.02	91.80	40.30	52.10
		Night	43.51	45.32	57.44	90.10	39.70	55.70
15	Kwamo	Day	37.38	51.99	62.44	91.20	35.80	62.20
		Night	38.51	46.23	63.66	79.70	37.40	50.30
16	Adako Jackie	Day	39.29	50.37	66.24	61.70	35.60	43.20
		Night	39.26	51.99	62.44	79.20	35.40	48.70
17	Krapa Newsite	Day	41.58	53.24	64.02	102.80	35.80	57.10
		Night	41.54	54.49	64.05	98.40	39.80	50.07

Legend

i L_{eq} is the equivalent continuous sound level – the sound pressure level of a steady sound having the same energy as a fluctuating sound over a specified measuring period. It can be considered similar to an average level.

ii Lmax (dBA) is the maximum instantaneous value recorded over the monitoring period including A-weighting. Lmax : A-weighted, maximum, sound level - maximum is not peak

iii Lmin:

iv L_{90}: the noise level exceeded 90% of the time (background noise)

v L_{50}: the noise level exceeded 50% of the time (medium level noise)

vi L_{10}: the noise level exceeded 10% of the time (intermittent/peak noise)

The results are compared with the Ghana Standard (GS 1222:2018) for Health Protection – Requirements for Ambient Noise Control for Areas with light industrial activity (Zone A and F). Zone A is the noise level for the residential area and Zone F noise level standard was chosen because of the presence of the VRA substations.

Generally, both day and night noise levels measured were within the Ghana Standards for maximum permissible noise levels for areas with light industrial activity except the 161 KV substation. For example, the L_{90}, L_{50} and L_{10} at Kwamo which is the residential area are 37.38 dBA, 51.99 dBA and 62.44 dBA respectively. The L_{90}, L_{50} and L_{10} at 161 kv Substation are 77.99 dBA, 81.99 dBA and 85.99 dBA respectively. The values were high because of the noisy fan of one of the transformers.

4.2 Biological Environment

4.2.1 Terrestrial Flora Survey

A terrestrial flora and fauna survey was undertaken at the project site as part of the EIA. The field survey was conducted on the 9th August, 2021, and 11th November, 2021. The field survey was carried out on five sample plots of 20m radius at the project site. The detailed terrestrial ecology report with methodology, analysis and results is provided in **Annex 4-3,** presented in Volume II of this report.

4.2.1.1 *General Vegetation of the Project Area*

The project area (Anwomaso, Oforikrom Municipality, Kumasi Metropolis) generally falls within the Moist Semideciduous South East subtype of the high forest zone of Ghana (Hall and Swaine, 1981). Taylor, 1960, had classified this forest type as Celtis-Triplochiton Association. The Moist Semideciduous forest type is the most extensive forest type in Ghana. According to Hall and Swaine (1981), some trees may reach 50 or 60 m in height and a three tree-layered structure is evident in undisturbed portions. The South East subtype (MSSE) is characterized by species such as *Turraeanthus africanus*, *Daniellia ogea*, *Khaya ivorensis*, *Cola nitida* and *Pteris togoensis* (Hall and Swaine, 1981). The Moist Semideciduous forest zone is the most productive of the forest zones. It has been heavily cultivated, most of Ghana's cocoa plantations occur in here, and heavily logged for timber.

4.2.1.2 *Vegetation of the Project Site*

The field survey revealed that the project site has gently sloping topography with well drained upper slope and swampy or wet valley bottom which is the flood plain of the Adote stream. The Flood plain/valley bottom is under vegetable cultivation. The upper slope has food crop farms and secondary thickets/farm re-growths interspersing the landscape, giving it a mosaic/fragmented appearance. The existing vegetation of the project site is thus an admixture or mosaic of farmlands and farm re-growth/secondary thickets (**Plates 4-1 to 4-3**).

Food crop farms dominate the project site. The dominant food crops cultivated are such as cassava and maize and vegetables such as pepper. Forbes and herbaceous species which constitute the undergrowth of the farms include *Spigelia anthelmia, Schranckia leptocarpa, Mimosa pudica, Stachytarpheta cayennensis* and *Vernonia cinerea*.

The farm re-growths/secondary thickets have species such as *Ficus exasperata, Chromolaena odorata, Pycnanthus angolensis, Anthocleista djalonensis, Solanum torvum, Albizia zygia, Sterculia tragacantha* and *Griffonia simplicifolia*. The swamp and wetland vegetation has species such as *Raphia hookeri, ludwigia leptocarpa, Mitragyna ledermannii, Bambusa vulgaris* and *Alchornea cordifolia*.

Plate 4-1: Cassava farm on the project site

Plate 4-2: Farm re-growth/secondary thicket

Plate 4-3: Wetland/flood plain of Adote River cultivated with onion

4.2.1.3 *Floristic Analysis*

The species lists, floristic composition and analyses of the project site and the frequency distribution of the species encountered at the project site are presented in the flora and fauna study report in **Annex 4-3,** presented in Volume II of this report. *Panicum maximum*, *Baphia nitida*, *Chromolaena odorata*, *Ficus exasperata*, *Morinda lucida*, *Albizia zygia*, *Alstonia boonei*, *Centrosema pubescens*, *Elaeis guineensis* and *Vernonia cinerea* were the most frequent species encountered at the project site.

4.2.1.4 *Species of National and Global Conservation Concerns*

Most of the species (about 91.5%) recorded are of no conservation concern. Four (8.5%) species of national conservation concern were recorded at the project site and these include *Mitragyna ledermanii* (Subaha, Red Star, swamp species), *Antiaris toxicaria* (Pink Star), *Pycnanthus angolensis* (Otie, Pink Star) and *Elaeis guineensis* (Oil Plam, Pink Star). The Red and Pink Star species are mostly species under commercial exploitation.

Only 1 species (2.1%) recorded at the project site is of global conservation concern, being classified as Near Threatened (IUCN Red List, 2021). The Near Threatened species, *Mitragyna ledermannii*, is a swamp species that occurs in the flood plain of the Adote stream.

4.2.1.5 *Invasive Alien Species*

Two of the species recorded were Invasive Alien Species viz., *Chromolaena odorata* (Siam weed) and *Lantana camara* (wild sage). These two species are listed among the top 100 invasive species of the world by the IUCN Invasive Species Specialist Group. The more widespread of the 2 alien

invasive species within the project site was *Chromolaena odorata* with a frequency of (80%). *Lantana camara* had a frequency of 20% at the project site. The construction and operation phases of the project should be carried out in such a manner as to prevent the proliferation of these species within the project's area of influence.

4.2.1.6 *Ecosystem Services*

The ecosystem services and use-values of plants encountered in the survey as verified with the communities and literature are provided in **Annex 4-3 (**see Volume II of this report). Some of the plant species recorded are used in herbal medicine preparations and as food additives. The secondary thickets/farm re-growths provide habitat for some wild animals, which are hunted for bush meat. Parts of plant species such as *Morinda lucida* are harvested by herbalists in the communities and used in medicinal preparations to cure several ailments.

4.2.2 *Terrestrial Fauna Survey*

The faunal list of the project area (common mammals, amphibian species, birds species, butterfly species and reptiles) based on the information gathered from the various methods (interviews, desk surveys and direct observations), is provided in Annex 4-3. From the field investigations, most of the large mammals which were common in the area have moved further away from the area due to deforestation and hunting pressure. There appears to be no species of international conservation concern in the project area (most of the species listed are categorized as Least Concern in the IUCN Redlist, 2019). A considerable number are listed on the Ghana Wildlife regulations Schedule II and so do enjoy some level of protection in Ghana.

4.2.3 *Aquatic Biology Study*

4.2.3.1 *Introduction*

Aquatic biology study of the Adote River was carried out as part of the EIA. The study involved both desktop and field assessment. The study used bio-assessment protocols by combining habitat description (e.g., physical structure, flow regime), and biological measures to establish a comprehensive report on the Adote river at Anwomaso. Sampling was done at the upstream and downstream sections of the river. Field data collection was undertaken in December 2021 on three different occasions (1st, 8th and 20th December, 2021). Sampling included stream flow and physical characteristics measurements and bio-assessments including fish capture and identification, insect identification, aquatic plant identification and sampling for zooplankton macroinvertebrates. The detailed Aquatic Biology Study Report with field sampling and methodology, results and analysis are provided in **Annex 4-4** in the Volume II of this report.

The Adote River traverses near the project site and through the Anwomaso Township. The river is about 150 meters from the GRIDCo/ECG sub-station at Anwomaso. It receives its sources from neighbouring drainage systems within the catchment area of Anwomaso but mostly filled by groundwater. The Adote river flow through Anwomaso and neighbouring communities before ending up in the Subin River. There low areas along sections of the river course which has made such areas to become wetlands, making access to the stream channel in such areas difficult during the rainy seasons.

4.2.3.2 *Description of Sampling Locations*

The section of the river sampled is within a human settlement. A portion of the channel at the upstream is flanked with agricultural activities (sugarcane, rice and vegetable farms) and a few houses. The downstream is largely surrounded by homes. Generally, a lot of plastic pollution and other domestic wastes litter the stretch of the river studied.

Plate 4-4: A section of River Adote

The upstream and downstream sampling areas of the Adote River had an average channel width of 3m and 4.44 m respectively and had an undulating depth profile up to a maximum depth of 1.8 m upstream and 2.5m downstream. The calculated cross-sectional area of the upstream sampling area was 0.146 m^2 and downstream was 1.04 m^2. The average water flow velocity was estimated to be 0.024 and 0.029 ms^{-1} upstream and downstream respectively. The discharge was calculated to be 0.04 and 0.302 m^3 s^{-1} upstream and downstream respectively. The water flow and channel

characteristic values downstream were relatively higher than the upstream sections due to an adjoining storm-drain.

4.2.3.3 *Results*

Fish Species

The fish sampling yielded only 3 species of fish belonging to 2 distinct families namely cichlidae and clariidae. The family cichlidae had more species namely *Hemichromis fasciatus* and *Oreochromis niloticus* and the other family was clariidae (*Clarias garipienus*). In all, 15 fishes were observed in the river; 14 (made up of all 3 species) upstream and a single *Clarias garipienus* observed downstream. The low fish composition can be attributed to relatively low levels of water at the time of sampling and as young children who harvested fish along the river reported higher abundance of fish during periods of increased water levels.

Plate 4-5: Nile Tilapia

Macroinvertebrate Assemblage of the Adote River

Seven (7) species of aquatic macroinvertebrates belonging to 3 orders were sampled along the Adote River. Species of dragonflies belonging to the order odonata (such as; the scarlet dragonfly, black-tailed skimmer and common darter) as well as hemipterans such as the water strider and water boatman were dominant at the upstream. However, dipterans largely composed of pollution-tolerant chironomids were dominant downstream. Odonates are a flagship group, and an important component of aquatic ecosystems, in which they can often be top predators. Their sensitivity to

environmental conditions makes odonates excellent biological indicators of environmental conditions. The list of the macroinvetebrates are provided in the table below.

Table 4-8: List of macroinvertebrates

No.	Common name	Order
1	Water strider	Hemiptera
2	Water boatman	Hemiptera
3	Scarlet dragonfly	Odonata
4	Black-tailed skimmer	Odonata
5	Common darter	Odonata
6	Slaty skimmer	Odonata
7	Chironomids	Diptera

Aquatic Plants in the Adote River

Two aquatic plants were identified within the stretch of the river and its banks. These were the *Cyperus javanicus* and *Eichhornia crassipes*. The presence of these plants in the river is an indication of the high nutrient levels in the water. This could be as result of the run-off from the agricultural activities from farms upstream and domestic wastes from adjoining drainage systems.

Zooplankton

In general, rotifers were the most abundant group for both sites, followed by copepods, and cladocerans. Rotifers are important at the fundamental stages of aquatic food webs because they provide enough nutrients to the fish and other higher aquatic carnivores to promote growth. The higher proportion of rotifers suggests that, environmental conditions that support their population growth such as high nutrient load were available; environmental factors such as food is a factor that influences zooplankton growth.

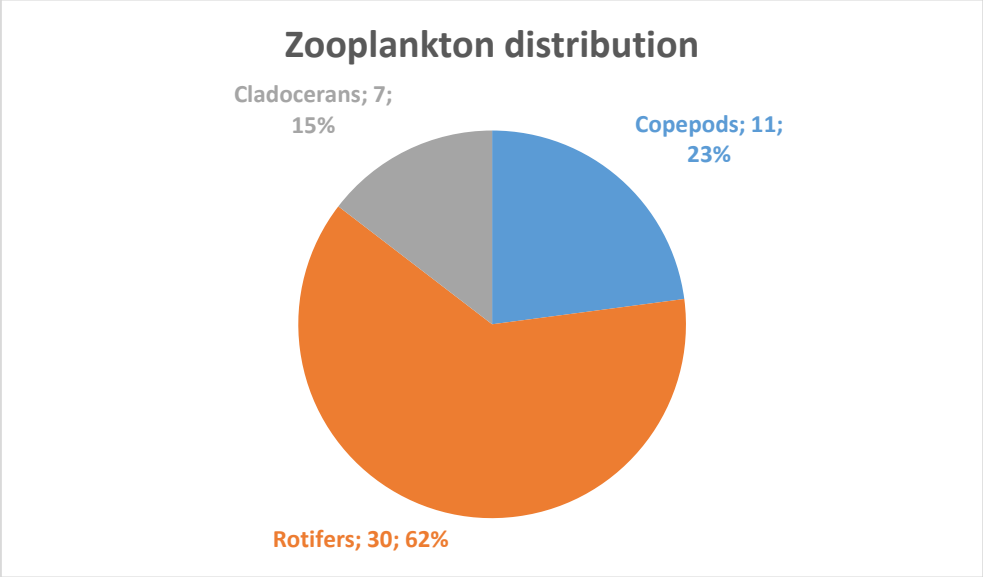


Figure 4-8: Zooplankton Distribution

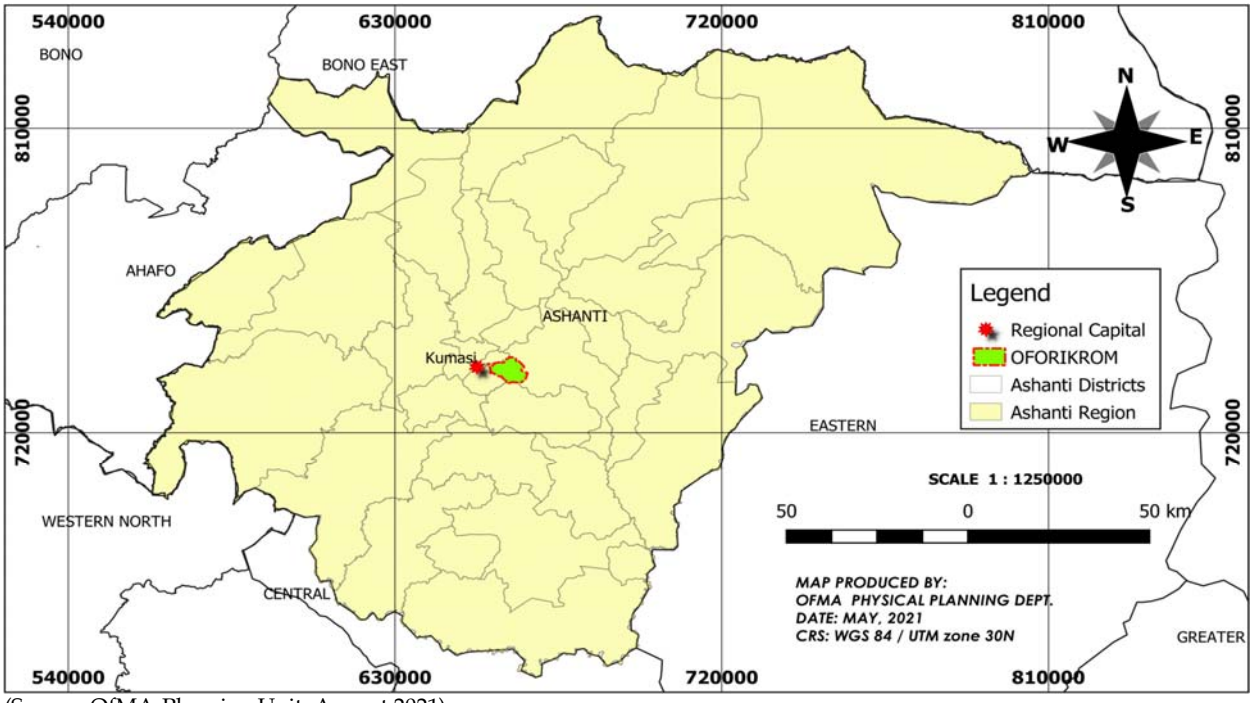
4.3 Social Environment

This section provides a general socioeconomic and cultural overview of the Oforikrom Municipality, the project district and the land-use of the project site and surrounding areas.

4.3.1 Location and Size

The Municipality is located between Latitude 6.42°986N and 6.38°582N and Longitude $1^0$29'58.33"W and $1^0$36'8.29°E and elevated 240 to 300 meters above sea level. The Municipality shares boundaries with Ejisu to the East, Bosomtwe DA to the South, Asokwa MA to the South West, Asokore Mampong to the North and KMA to the West.

Oforikrom Municipal Assembly is approximately 270km north of the national capital, Accra. It has a surface area of approximately 4,978.47 hectares (49.78 kilometres square) which is about 0.0192 percent of the total land area of Ashanti Region. The capital of the Municipality is Oforikrom. **Figure 4-9** is a map of the Municipality in the regional context, and **Figure 4-10** is the political/administrative map of the Municipality.



(Source: OfMA-Planning Unit, August 2021)

Figure 4-9: Location map of Oforikrom Municipality in the Regional Context

(Source: OfMA-Planning Unit, August 2021)

Figure 4-10: Map of Oforikrom Municipality

4.3.2 Population

According to the 2010 Population and Housing Census, the Municipality recorded a population of 303,016 made up of 149,827 (49.45%) males and 153,189 (50.55%) females. The 2019 projected population is 373,055; 184,165 males and 188,890 females. The most densely populated community is Ayigya with projected population 67,604, whilst the least densely populated is Bebre with projected population of 2,667.

4.3.3 Culture

The culture of the people of Oforikrom is manifested in their way of life. These include inherited ideas, beliefs, values, knowledge and skills. One of the dominant cultural practice in Oforikrom is the celebration of the Akwasidae festival, which is celebrated by the Asantes. Since culture is dynamic, some practices of the people have undergone major changes over the years such as "Bragoro" and as such has far reaching implications on development. The Asante's hold in high esteem their traditional values, attitudes and practices. This is profound in their celebration of Akwasidae, the organization of marriage ceremonies, funerals etc. The Akwasidae is held regularly at 40 days' interval on Sundays and nine times in a year. Every forth "Akwasidae" is celebrated as "Adaekese" which is celebrated twice in a year. This ceremony gives the Asantes the opportunity to celebrate their past leaders and heroes. It attracts people from all walks of life, especially those in the Diaspora. Thus, it also serves as a means of foreign exchange earnings through tourism.

There are various ethnic groups in the Municipality and this can be attributed to its strategic location and the University (KNUST), which provides teaching and learning to both Ghanaians and foreigners.

4.3.4 Gender Profile

In the Municipality, it can be realised that both males and females are engaged in economic activities. Activities such as carpentry work, barbering, farming, photography, transport services are male dominated while petty trading, hawking, dress making, catering, etc. are female dominated. Both sexes can be seen to have equal opportunity to own land and property in the Municipality however when it comes to leadership positions such as at the Assembly level, females are poorly represented. Out of the fifteen (15) electoral areas in the Municipality, there is only one (1) female Assembly member representing the electorates.

4.3.5 Security

The Oforikrom Municipal Assembly falls under the jurisdiction of three (3) Police Administrations or Districts: namely, Domebra (under Ejisu Municipality), KNUST and Oforikrom (which falls under Zongo "B" District- KMA). This situation affects the efficient and effective management as well as reporting on security issues in the Municipality. Efforts are being made through the Regional Police Commander and the Regional Security Council to bring the various commands within the Municipality under one command.

The KNUST District Police Command which serves as the Municipality's main command has staff strength of nine-one (91) personnel for its various operational demands. The personnel are however not evenly distributed. Many of the inspectorate rank are working in the areas of MTTD and CID. The District has a total of eighteen (18) Detectives who are responsible for crime detection in the MA. They are assisted by three (3) aides. The District also has a total of forty-four policewomen.

4.3.6 Economic Activities

Inhabitants of Oforikrom Municipality are engaged in various economic activities. These include; providers of transport services, scrap metal and e-waste dealers, private educational institutions, hostel/hotels/guest houses operations, lottery businesses, restaurants/bars, retail of products, hairdressing/barbers, dress makers, millers, washing bays, financial institutions, auto mechanics, furniture manufacturers, video/photographers, bridal houses, waste management, printing firms, food processors, ware housing, health service providers, chemical and pharmaceutical shops, construction work, food crop production and animal rearing, amongst others.

Unemployment is however an issue of concern. The predominant sex adversely affected are females between the ages of 13-40 years. Measures put in place by the MA are skill trainings which includes yoghurt preparation, soap making, sobolo making etc. by the Social Welfare and Community Development and the Department of Agriculture.

<u>Agriculture</u>

Subsistence agriculture is the main type of agricultural practiced in the municipality. It focuses on the cultivation of vegetables such as carrot, cabbage, lettuce, green pepper and spring onions; rice as well as rearing of birds and livestock such as chicken, goat, sheep, cattle, pigs, fish farming on a very small scale. These could be found in and around KNUST campus and in low lying areas

within the Municipality. Rice farming is undertaken specifically at Appiadu and other pockets in the municipality.

Agricultural activities have been reduced to subsistence basis due to the growing competition for land and importation of agricultural produce from adjoining districts and other parts of the country at relatively cheaper prices. Vegetable farmers have limited access to suitable lands thus, making them prone to floods because of the areas in which they cultivate.

Poultry production is also a very popular enterprise in the Municipality with about forty-five (45) poultry farms identified. Notable among these farms include Genesis farms, Osvic farms and Ben J farms located at Appiadu, Deduako and Kodiekrom respectively.

Markets and Agro-processing

There are about five daily markets in the Municipality. These include the Onion market, Ayigya market, Kentinkrono market, Anwomaso market and Anloga market. The list of agro-processing currently on-going in the Municipal includes; Gari processing - Anloga, Palm kernel oil – Anloga (Ghana bar), Palm kernel – Oforikrom, Soya bean meal/oil – Boadi, Soya bean meal/oil – Apemso and Palm kernel oil – Ayigya Zongo.

4.3.7 Education

The Municipality can boast of 85 pre-schools, which are all private; 109 KGs (22 public and 87 private); 114 primary schools (25 public and 89 private); 82 JHS (24 public and 58 private); 9 SHS/TVET (2 public and 7 private); and one public special school.

There are seven tertiary schools in the Municipality and these include: Kwame Nkrumah University of Science and Technology, University College of Management Studies at Ayeduase, Multimedia Institute of Ghana at Oforikrom, Valley View University at Oduom, Jackson College of Education at Ayeduase, Knutsford University College at Bomso, and Christ the Teacher College of Education at Appiadu.

4.3.8 Health Facilities

The Municipality has in existence twenty-two (22) health facilities. Four (4) of the health facilities are government owned; one (1) is quasi-government and seventeen (17) are privately owned health facilities. The list of these facilities per sub-municipality is presented in the table below. The

Anwomaso sub-municipality has eight health facilities, of which two are government owned and six privately owned.

Table 4-9: List of Health Facilities

NO.	Sub-Municipality	Name of Facility	Location	Type	Ownership
1	Anloga	Anloga CHPS Compound	Anloga	CHPS Compound	Government
2		Florence Mat. Home	Anloga	Mat. Home	Private
3		Queen Victoria Mat. Home	Anloga	Mat. Home	Private
4		New Life Mat. Home	Anloga	Mat. Home	Private
5	KNUST	Kumasi Church of Christ Clinic	Bomso	Clinic	CHAG
6		Yentumi Boaitey Hospital	Bomso	Hospital	Private
7		Victory (Kumasi) Mat. Home	Ayigya	Mat. Home	Private
8		KNUST Hospital	KNUST Campus	Hospital	Private
9		Bomso Clinic	Bomso	Hospital	Private
10	Ayeduase	Aninwaah Medical Centre	Emena	Hospital	Private
11		Graceland Hospital	Appiadu	Hospital	Private
12		Ahmadiyya Homeopatic and Herbal Clinic	Boadi	Clinic	Private
13		Ayeduase Health Centre	Ayeduase	Health Centre	Government
14		Tawheed Natropatic Clinic	Boadi Junction	Clinic	Private
15	Anwomaso	Anwomaso Health Center	Anwomaso	Health Centre	Government
16		Asbury Hospital	Anwomaso	Hospital	Private
17		Peace and Love Hospital	Oduom	Hospital	Private
18		Kumasi Comfort Mat. Home	Oduom	Mat. Home	Private
19		Vibro Mat. Home	Anwomaso	Mat. Home	Private
20		Mesoam Community Clinic	Mesoam	Clinic	Private
21		Kentinkrono CHPS Compound	Kentinkrono	CHPS Compound	Government
22		Nykon Clinic	Kentinkrono	Clinic	Private

(Source: OfMA Department of Health, 2021)

4.3.9 Diseases and Major Causes of Death

Top 10 Diseases

The top 10 diseases reported at OPDs from 2018 to 2020 in the Municipality is provided in the **Table 4-10**, whiles the top 10 OPD cases of diseases reported at the Anwomaso sub-municipality is provided in **Table 4-11**.

*Table 4-10: **Top 10 OPD Cases in the Municipality***

No.	2018			2019			2020		
	Disease Condition	**Number**	**%**	**Disease Condition**	**Number**	**%**	**Disease Condition**	**Number**	**%**
1	Malaria	31,175	25	Malaria	37,317	22	Rheumatism & Other Joint Pains	11,864	16
2	Hypertension	12,831	10	Upper Respiratory Tract Infections	19,158	11	Hypertension	7,813	11
3	Upper Respiratory Tract Infections	9,728	8	Rheumatism & Other Joint Pains	11,202	7	Upper Respiratory Tract Infections	7,344	10
4	Rheumatism & Other Joint Pains	7,013	6	Hypertension	10,641	6	Malaria	6,382	9
5	Acute Urinary Tract Infection	4,518	4	Acute Urinary Tract Infection	8,004	5	Intestinal Worms	5,552	8
6	Intestinal Worms	3,744	3	Skin Diseases	7,013	4	Skin Diseases	5,033	7
7	Skin Diseases	3,673	3	Intestinal Worms	5,477	3	Acute Urinary Tract Infection	4,761	6
8	Diabetes Mellitus	3,497	3	Diarrhea Diseases	3,882	2	Pregnancy Related Complications	2,288	3
9	Anaemia	2,375	2	Ulcer	2,547	1	Anaemia	2,054	3
10	Acute Eye Infection	2355	2	Preg. Related Complications	1,970	1	Gynecological conditions	1,969	3
11	All other conditions	44,187	35	All other Diseases	63,482	37	All other Diseases	18,361	25
	TOTAL	**125,096**	**100**	**TOTAL**	**170,693**	**100**	**TOTAL**	**73,385**	**100**

(Source: OfMA Department of Health, 2021)

Table 4-11: Top 10 OPD Cases in Anwomaso Sub-Municipality

No.	2020 (January - December)			2021 (January - October)		
	Disease	**Number**	**Percentage**	**Disease**	**Number**	**Percentage**
1	Malaria	920	43.9	Malaria	1046	42.7
2	Upper Respiratory Tract Infections	377	18.0	Upper Respiratory Tract Infections	524	21.4
3	Diarrhoea Diseases	348	16.6	Diarrhoea Diseases	416	17.0
4	Rheumatism / Other Joint Pains / Arthritis	232	11.1	Rheumatism / Other Joint Pains / Arthritis	394	16.1

No.	2020 (January - December)			2021 (January - October)		
	Disease	Number	Percentage	Disease	Number	Percentage
5	Home Injuries (Home Accidents and Injuries)	189	9.0	Skin Diseases	147	6.0
6	Skin Diseases	174	8.3	Acute Eye Infection	123	5.0
7	Acute Urinary Tract Infection	105	5.0	Ulcer	116	4.7
8	Hypertension	105	5.0	Hypertension	84	3.4
9	Anaemia	82	3.9	Anaemia	82	3.3
10	Occupational / Industrial Injuries	73	3.5	Home Injuries (Home Accidents and Injuries)	66	2.7
11	All other Diseases	2,095	100.0	All other Diseases	2,452	100.0

(Source: OfMA Department of Health, 2021)

Top 10 Causes of Death

The top 10 causes of death in the Municipality is shown in **Table 4-12.** Hypertension is the leading cause of death in the Municipality, and is followed by Diabetes.

Table 4-12: Top 10 Causes of Deaths in the Municipality

No.	CONDITIONS	PERCENTAGE
1	Hypertension	43.2
2	Diabetes Mellitus	12.6
3	Multiple Organ Failure	7.4
4	Anaemia	7.4
5	CVA	4.2
6	Diseases of the nervous system	4.2
7	Liver Disease	3.2
8	Kidney Disease	2.1
9	Pneumonia	2.1
10	Prostate Disease	2.1
	Others	11.6
	TOTAL	100.0

(Source: OfMA Department of Health, 2021)

4.3.10 HIV/AIDS Prevalence and COVID-19 Cases in the Municipality

HIV/AIDS Prevalence

Ghana's HIV status data for persons living with HIV from the Ghana AIDS Commission as at 2019 stands at 342,307 in total, and this is made of 122,321 males and 219,986 females living with HIV. The national prevalence rate in the country is pegged at 2.0%.

According to the 2019 data from the Ghana AIDS Commission, the top 10 districts/ municipalities with the highest HIV prevalence were Ayawaso Central 23,075; Kumasi 13,672; Okai Koi North 12,532; Kwadaso 9,495; La-Nkwantanang-Madina 5,982; Asokore Mampong 5,932; La-Dade-Kotopon 5,924; Accra Metro 5,710; Ga South 4,725; Berekum 4,450.

The Oforikrom Municipal is not within the top 10 districts/municipalities with high HIV infection in the country but Kumasi Metro is within the top 10 districts. The Oforikrom Municipality is however within the top 20 districts/municipalities, i.e. Oforikrom 3,519. With regard to the prevalence rate in the adult population, the Oforikrom Municipal has 1.75% prevalence rate and Kumasi Metropolis has 1.95% prevalence rate. The Ashanti Region has 1.94% prevalence rate with estimated 76,672 living with the virus.

Summary of COVID-19 Cases in the Municipality at week ending of 12th September 2021

Cumulative cases = 2,174

Recovered/Discharged = 2,124

Percentage (%) recovered/discharged = 97.7

Deaths Recorded = 21

Case fatality rate = 1.0

Active cases = 29

4.3.11 Information and Communication Technology

Telecommunications services play a major role in the daily activities of all citizens of Oforikrom in addition to its significant impact on businesses. Oforikrom has two types of telecommunication networks namely the mobile networks and the fixed line system. There is only one fixed line operator, which is Vodafone Ghana Ltd. There are four mobile telecommunications network companies operating in the Municipality and these are Vodafone, AirtelTigo, MTN and Glo, and these provide variety of services.

The available networks/connectivity is provided below.

1. MTN 4G/3G/2G/GSM
2. VODAFONE 4G/3G/2G/GSM
3. AIRTELTIGO- 3G/2G/GSM
4. GLO 2G/GSM

There are four radio/TV stations in the Municipality and these include: Nhyira Fm, Luv Fm, Focus Radio, and Tek TV. There are about 18 information centers scattered across the Municipality.

4.3.12 Solid Waste Management

Oforikrom has two main methods for collecting and disposing off solid waste. These are the house-to-house collection and the communal collection points. The main contractors for the collection of waste within the Municipality are Zoomlion Ghana Ltd. and Asadu Company which are located at Oforikrom and Nsenie respectively. The house-to-house collection is carried out by compactor trucks and tricycles that move from house to house. The frequency of emptying the household bins is usually once a week depending on the area. The charges for house-to-house collection ranges from GH¢20.00 to GH¢60.00 per household bin and based on the classification of the area. However, it is worth noting that the amount paid for the house-to-house collection is reviewed annually during the fee fixing resolution.

Communal collection on the other hand is whereby a skip container is placed at a vantage point within the community and community members commute there to dispose of their waste at a fee. The introduction of the 'Pay as you Dump' system has addressed the bottlenecks that hitherto were being faced by the community collection system. The table below shows the number of skip containers acquired by the Assembly and their locations.

Table 4-13: List of Skip Containers Sites

No.	Community	Number of Containers
1.	Anloga onion market	1
2.	Anloga/ Susankyi	1
3.	Bomso	1
4.	Ayigya Zongo	1
5.	Oduom- Asadu main office	1
6.	Nsenie	1
7.	Kentikrono	1
8.	Boadi	1

No.	Community	Number of Containers
9.	Bebre	1
10.	Appiadu	2
11.	Emena	1
12.	Deduako	2
13.	Kotei	1
14.	Ayeduase	2
15.	Kokoben	1
16.	Mesuem	1
17.	Ayigya Ahenbronum	1
18.	Anwomaso	1
19.	Oforikrom near the M/A school	2
20.	Aprade	2
21.	Anloga junction	2
Total		**27**

(Source: OfMA Environmental Health Unit, 2021)

Unapproved disposal methods prevailing in the Municipality include burning of waste in the open and disposal into drains and rivers during rainfall. About 10 percent of households dispose their waste improperly. This phenomenon partly explains the poor and filthy environmental condition that has engulfed certain communities in the Municipality. The Municipality currently has no final disposal site of its own. Refuse collected within the Municipality are sent to Oti landfill site under Asokwa Municipal Assembly.

4.3.13 Land-use of the Project Area

The project site is basically agricultural land, partly occupied by farms and farm re-growths with isolated trees. The major crops cultivated on the farms are cassava, maize, plantain and vegetables such as tomatoes. The surrounding land use is for farming, GRIDCo substation, and Vocational Training Institute buildings which are currently uncompleted. Specifically, the proposed site is bounded on the south by 161kV and 330kV substations of GRIDCo; north and west by farmlands and on to the east by farmland/National Vocational Training Institute (NVTI) Complex of the Ministry of Education (as previously shown in **Figure 3-1).**

4.3.14 Uses of the Adote River

The river serves as a source of water to vegetable farmers along the stretch of the river, Agricultural activities around the river area generally involves vegetable farming, cereals (rice and maize) farming and some level of fishery. The locals from the Anwomaso Township are the people who farm along the stretch of the river most especially at the upstream. Another evident

practice is sugarcane plantation that lies along the river stretch. These agriculture activities are practiced both at commercial and subsistence levels.

Some dugouts have been created around the river by farmers to store water for irrigation during the dry season. The constant use of weedicides and fertilizers by these farmers coupled with the clearing of the topsoil resulting in erosion are major causes of the deplorable state of the water body. The fishery aspect is mainly at the subsistence level where natives use hook and line and monofilament nets as traps to harvest fish but this activity is dwindling due to gradual population of the river by human activities and discharge of contaminants into the river by the adjoining drainage systems.

Almost all residents along the river stretch have their waste drainage system connected to the river course allowing the introduction of contaminants, non-degradable materials such as sanitary pads, used polyethene bags, used pampers etc. into the river. This is also one of the means of building up waste in the river hence, silting up of the river.

The river serves as a source of water to construction companies operating within and around the Anwomaso environs. Some commercial car operators sometimes wash their cars around the river bank close to the constructed bridge across the main Anwomaso-Domeabra road where the water containing detergents ends up in the river.

SELJEN CONSULT

CHAPTER FIVE

STAKEHOLDER CONSULTATIONS

FINAL

ENVIRONMENTAL IMPACT STATEMENT

VOLTA RIVER AUTHORITY

5.0 STAKEHOLDER CONSULTATIONS

Stakeholder participation during project planning and implementation is recognized as an integral part of environmental and social management for projects. It is a two-way flow of information and dialogue between project proponents and stakeholders and should start at an early stage that can help shape project design.

5.1 Key Objectives of the Stakeholder Consultations

The main objective of stakeholder consultations is to discuss the proposed project's environmental and social implications and to identify appropriate mitigation and monitoring measures for adverse impacts management. Specifically, the consultations carried out sought to achieve the following objectives:

- To provide relevant information about the proposed project to stakeholders;
- To provide opportunities for stakeholders to discuss their concerns and offer recommendations;
- To gain insight on the role of each stakeholder in the implementation of the environmental and social safeguards as well as structures in place for the management of the proposed facilities;
- To provide and discuss with stakeholders the design options considered to reduce anticipated impacts;
- To identify and verify significance of environmental, social and health impacts; and
- To inform the process of developing appropriate mitigation and management options.

5.2 Stakeholder Identification Criteria

Stakeholder identification process for the proposed project is based on an appreciation of the interest and influence of various organizations/institutions/ communities/ persons or groups in relation to the project. The main criteria used to identify stakeholders is that relevant stakeholders should fall under one or more of these groupings as follows:

- Funding agencies;
- Project proponents;
- Regulatory bodies/institutions;
- Utility agencies/companies;
- Relevant government institutions;
- Local government and administrative authorities;

- Traditional authorities;
- Local/ nearby communities within project area of influence;
- Project affected persons;
- Neighbouring organizations;
- NGOs/CBOs/CSOs;
- Technical Experts/Consultants/Contractors;
- The Media; and
- The General Public/Citizenry.

5.3 Stakeholder Groups and their Key Roles for the Proposed Project

The identified stakeholder groups and their roles as relevant to the proposed project are presented in the table below.

Table 5-1: Stakeholders and their Roles

No.	Stakeholder Group	Examples of Stakeholder(s) identified	Key Role of Stakeholder and Remarks
1	Funding agencies	Government of Ghana (GoG) / Ministry of Finance/ International Funding Agencies	• To provide funds for project implementation or implementation of a subproject activity or associated facility. • In case International funding agencies come up along the line, these agencies may have their own environmental/ social safeguard policies and requirements that will have to be complied with during project implementation.
2	Project Proponents	• Ministry of Energy • Volta River Authority (VRA)	• Accountable entities responsible for successful implementation of proposed relocation, construction and installation of the Kumasi 1 Thermal Power Plant, including planning, design, construction, operation and maintenance of the power plant. • Project proponents must take into consideration requirements of any international funding agencies that may be involved in due course.
3	Regulatory Agencies/ Bodies	Environmental Protection Agency (EPA)	• Responsible for regulating the environment. • The Agency will issue an environmental permit for construction and operation of the proposed project, and will monitor project to ensure compliance to the permit conditions and adherence to the Environmental Assessment Regulations, 1999.
		Energy Commission	• Regulator of the energy sector in general, which includes proposed project. • To issue various permits/ licences for project implementation including:

No.	Stakeholder Group	Examples of Stakeholder(s) identified	Key Role of Stakeholder and Remarks
			1. Project Registration Certificate 2. Siting Permit 3. Construction Permit 4. Commissioning Permit 5. Operations Approval or Permit
		Ghana National Fire Service (GNFS)	• National institution responsible for the prevention and management of undesired fires. • To provide fire permit /certificate for project facilities during construction and operation
		Water Resources Commission	• To provide water use permit in case of raw water abstraction from groundwater sources during project implementation.
		Department of Factories Inspectorate	• Regulator for health and safety of workers and workplaces in general. • To issue facility/project registration certificate or approval • Factories Inspectorate will monitor safety of workers at project sites.
4	Utility Agencies/ companies	GRIDCo,	• Off-take of the power produced by VRA. • Interested in the power infrastructure aspect of project. • GRIDCo responsible for power transmission. • Has a substation (K2 BSP) close to the proposed site.
		ECG	• ECG responsible for power distribution in the southern sector of Ghana. • Shares facility with GRIDCo at the K2 BSP at Anwomaso near the project site.
		Ghana Water Company Ltd (GWCL)	• Responsible for the extension of water supply to the project site to meet operational needs. • Responsible for provision of potable water for urban areas.
		Ghana National Gas Company Limited	• To be responsible for provision of natural gas to the project site.
5	Other Government Institutions	Lands Commission	• To be involved with approval of site plan for project site, and transfer of project land from KNUST to Ministry of Energy/VRA. • The Lands Valuation Division of the Commission may be involved with the valuation of affected properties or approval of valued properties for compensation purposes in project areas.
		Minerals Commission	• Responsible for ensuring the protection of the country's mineral resources and regulating the efficient exploitation of the resource.
		Ghana Police Service	• To be involved with the provision of security and maintenance of law and order in project areas during implementation.

No.	Stakeholder Group	Examples of Stakeholder(s) identified	Key Role of Stakeholder and Remarks
		Labour Department	• To enforce labour laws and regulations including the Workmen Compensation law that applies to project implementation issues associated with workers.
		Labour Commission	• The Commission exists to develop and sustain a peaceful and harmonious industrial relations environment through the use of effective dispute resolution practices within the context of the law, promotion of cooperation among the labour market players and mutual respect for their rights and responsibilities.
		Ghana Standards Authority	-Responsible for the management of the nation's quality infrastructure embracing the three (3) pillars of metrology, standardisation and conformity assessment (i.e. Testing, Inspection and certification). -Responsible for Calibration, Verification and Inspection of Weights, Measures and Weighing and Measuring Instruments -Promoting Quality Management Systems in Ghana. -Develops Environmental Standards for ambient air quality, noise control and effluent discharges, and makes available hardcopies of these Standards to the general public at a fee.
		National Museums and Monuments Board:	Responsible for ensuring the protection and proper storage of all archaeological finds.
6	Local Government and Administrative Authorities	• Ashanti Regional Coordinating Council • Oforikrom Municipal Assembly (OfMA)	• Responsible for the political administration and development of the project area and local communities within the Municipality. • To provide business registration/operating license for firms and companies working within their jurisdiction. • Land Use and Spatial Planning Department to provide development approvals and building permits for project facilities, structures and buildings.
7	Traditional Authorities	• Kumasi Traditional Council • Anwomaso Traditional Authority	• Traditional Authorities have traditional/ cultural oversight of local communities in the project area. • Traditional Authorities facilitate development and resolution of conflicts/ disputes among community members.
8	Local communities	Anwomaso	• Nearby community to the project site • Likely or possible recipient of project adverse impacts
9	Project affected Persons (PAPs)	Farmers/ Owners of crops grown at the project site	These are individuals or persons that will lose their crop (e.g. plants/crops) because these crops are located on the propose site or close to proposed site.

No.	Stakeholder Group	Examples of Stakeholder(s) identified	Key Role of Stakeholder and Remarks
10	Neighbouring organisation	NVTI	Have uncompleted and uninhabited properties near the project site, and are likely recipient of project adverse impacts.
11	Research Institutions/ University	KNUST	• Owners/lease holders of proposed project site. • Could share relevant information on project land ownership and land users with Consultant/VRA.
12	NGOs/ CBOs/ CSOs	(To be confirmed during engagement with Energy Commission/ VRA and Municipal Assembly)	• May have interest in the Project or in the environment or community where the project will be undertaken or other aspects of project production and operational activities. • May have interest in the proposed project and affected resource users/ persons in the project area.
13	Mass media –	Print and Electronic media in the Kumasi area, e.g. Graphic Corporation, New Times Corporation, Chronicle, Daily Guide etc	• Responsible for information dissemination, communication and education of the general public and local communities through electronic and print media
14	General Public/ Citizenry	Every Ghanaian in Kumasi area or in the country	• Public interest role

5.4 Outcome of Stakeholder Consultations Carried Out

5.4.1 Stakeholder Engagement Workshop for the EIA

A stakeholder engagement workshop was organized on November 11, 2021 as part of the stakeholder engagement for the EIA. The workshop report is provided as part of the Stakeholder Engagement Strategy and Consultation Report in **Annex 5-1** presented in the Volume II of this report. The list of stakeholders invited for the engagement workshop include:

- Farmers (on proposed land for project)
- Chiefs and Leaders of Anwonmaso
- Print & Electronic media
- State Agencies
    - ✓ Electricity Company of Ghana
    - ✓ Environmental Protection Agency (EPA), Kumasi Regional Office
    - ✓ Forestry commission, Kumasi
    - ✓ Ghana Grid Company (GRIDCO), Anwonmaso

- ✓ Ghana Health Service
- ✓ Ghana Museums and Monuments Board
- ✓ Ghana National Fire Service
- ✓ Ghana Police Service
- ✓ Ghana Water Company Limited
- ✓ Kwame Nkrumah University of Science and Technology
- ✓ Lands Commission, Kumasi
- ✓ Minerals Commission
- ✓ National Vocational Training Institute (NVTI)
- ✓ Oforikrom Municipal Assembly
- ✓ Road Agencies-Ghana Highway Authority
- ✓ Water Resources Commission
- ✓ Volta River Authority

A summary of the concerns, questions and suggestions/recommendations from the engagement workshop is provided in the table below.

Table 5-2: Summary of the outcome of the stakeholder engagement workshop for the EIA

Questions/Concerns	Feedback/response from the client
• The MCE wanted to know how fast the project will be executed since VRA claims it is a fast track project.	• Third quarter of 2022
• A representative from EPA wanted to know how the effluent from the project is going to be discharged into the environment. In addition, she wanted to know whether Cyanide will be produced as part of the project's waste.	• No effluent is expected to be generated during the operation of the plant. However, should there be any effluent generated the required treatment facility will be provided to ensure effluent are treated before being discharged into the environment. • Cyanide will not be produced as part of the project's waste
• A representative from EPA wanted to understand how the various processes of the project will pollute the environment.	• An environmentally based process flow diagram will be included in the EIS to the Agency
• Representative from the Land's Commissions enquired if the land has already been acquired by VRA and proper documentation were in place for the installation of the generators for the project.	• VRA is consulting with the KNUST, the land owners on this

Questions/Concerns	Feedback/response from the client
• Representative from the Minerals Commissions enquired if the project would have a visual impact (aesthetics) on the area.	• Visual impact will be assessed as part of the EIA
• Representative from the Water Resources Commission asked of the source of water for the project since there is no existing pipeline in that vicinity. He also asked of the effect of the project on ground water in case the project has to depend on ground water for cooling stages of the generators.	• GWCL will extend water from Oduom to the project site as part of the project agreement with GWCL • The cooling system for the Plant is the dry/air cooling condenser. Because availability of sufficient water is a constraint in the project area, no wet cooling system will be used. The plant will therefore not rely on groundwater source for its cooling system.
• A stakeholder also enquired of the effect of the project on aquatic life in the nearby stream.	• An aquatic life study of the Adote stream will be carried out as part of the EIA
• Farmers stated that farming is very difficult, and they will need some support from the project. They admitted that the land is not theirs. However, they will be thankful if the project will provide sufficient notice for them to harvest their crops. In addition, they want to be employed when work commences (to substitute their lost livelihoods). •	• VRA will provide adequate notice for farmers to harvest their crops and vacate the land for project implementation. Farmers are expected to start planning their exit as they are being informed and sensitized as part of the EIA process. • Farmers should take notice that VRA will not pay compensation to any farmer.
• Representative from Ghana Fire service raised concerns about frequent bush fires in the area. He appealed to all to minimize the occurrence of fire. He also stated that those who cause these fires will be dealt with when caught.	• Concerns well noted. VRA will prepare an Emergency Response Plan for the Plant and will factor prevention and responses to bush fires as well in the emergency plan.
• A stakeholder wanted to know how long the plant will be on the proposed project site. She was concerned that just like the plant is to be moved from Aboadze to Anwomaso, it is most likely the same plant will be relocated in the future.	• Usually, the life span of Thermal Power Plants is 25 years and above. At 25 years the thermal plant is due for a major retrofitting to extend its life span. As part of the decommissioning and relocation plan for the Ameri, an assessment of the condition of the plant will be undertaken to determine it current state and useful life span.
• Stakeholders raised concerns about security of equipment in the project area since expensive generators and associated ancillaries are to be relocated there.	• Just like any other national installation, the precincts of the project will be fenced and up-to-date 24-hour security features will be provided. The facility will also be manned by security personnel to be provided by VRA.

Questions/Concerns	Feedback/response from the client
	• VRA will inform and educate the public about the dangers of attempting to break in.
• Representation of the Ghana Health Service was concerned about the health implication of the project on the inhabitants of the area. She added that there is going to be pressure on the existing health facilities by the employees as the existing health facilities are not sufficient for the inhabitants.	• Concern noted. It must be emphasized that the project will be manned by VRA staff and adequate medical arrangements would be made to carter for the health needs of all staff, both permanent and temporary during the life span of the project
• EPA member mentioned that the various activities of the project should have been outlined so that they would suggest some of the mitigation measures.	• The Agency has the opportunity to review the scoping and draft EIA reports, and can provide their recommended mitigation measures as part of their review comments
Suggestions/Recommendations from Stakeholders	
• VRA will have to monitor and control their operations when project commences. • Visual impact (aesthetics) of the project should be address in the report. • The initial health status of the inhabitants of the area should be established so the long-term health implication of the project emissions can be determined. • Farmers should be supported despite the fact that land is not theirs. • Various impacts of the project should be thoroughly addressed in the EIA report.	

Plate 5-1: Scenes from the Stakeholder Workshop for the EIA

5.4.2 Consultations with Ghana Gas, GWCL and Energy Commission

The outcome of consultations with Ghana National Gas Company, Ghana Water Company and the Energy Commission is provided below. Details of the engagement and contacts of officials consulted are provided in **Annex 5-1** (presented in the Volume II of this report).

Outcome of engagement with Ghana National Gas Company on 06/09/2021 @10:30 am

- VRA has to acquire adjacent lands for use as buffer to prevent future developments getting closer to the project site.
- The access road to the project site is narrow, and need to be expanded so that in case of emergency, evacuation will not be a problem.
- VRA should consider extracting water from Lake Bosomtwe (if Water Resources Commission will permit that) to ensure consistent and reliable water supply, as GWCL may be unreliable. However, a cost benefit analysis should be done to select the best option.
- VRA should also consider other alternative project sites taking the population, road and water access into consideration.
- Laying of pipeline is underway from Asiama to Prestea and to Dawusaso, and then toward Kumasi. There is a separate EIA for the laying of the gas pipelines to the Project site.
- Compensation to farmers should be paid.
- Gas supply is not a problem as there is excess.
- Burning gas emits some carbon compounds. An appropriate stack height/stack with emission simulator can ensure proper dispersion of emissions.

Plate 5-2: Meeting with Ghana National Gas Company

Outcome of consultation with Ghana Water Company Limited on 15/09/2021 @2:13 pm via phone call

- According to the Regional Chief Manager in charge of Ashanti South, GWCL have been officially informed and engaged by VRA on the project. VRA and GWCL have both visited the project site.
- GWCL has been provided with information on the project water demands/requirements.
- Sometimes, GWCL does water rationing in Kumasi.
- The civil or ground work to extend water to the project site has not yet started.

Outcome of Consultation with Energy Commission

- Existing land use practices should be considered to prevent adverse impact on other land use practices during construction and operation.
- Site selection should take into account the closeness of habitation and other ecosystems.
- All relevant regulatory bodies should be consulted.
- The project affected community should be engaged on the project and the safety issues.
- Baseline information in the project location should be assessed comprehensively to know their existing conditions.
- Details of the solid and hazardous generation with their category and quantity, disposal system during both construction and operation should be indicated.
- All expected environmental impacts and mitigation measures during construction and operational phases should be clearly stated.
- Terms of Reference (ToR) for Emergency Response & Disaster Management Plan should be provided indicating how to deal with fires, explosion and oil spills.

5.4.3 Consultations during the Scoping Phase

A summary of the outcome of the consultations carried out during the scoping phase is provided in **Table 5-3. Plates 5-3 and 5-4** show some pictures of engagement with community leaders. Other pictures of the institutional engagements or meetings are provided in **Annex 5-1 (**presented in the Volume II of this report).

Table 5-3: Summary outcome of consultations during the Scoping Phase

Stakeholder	Contacted Person	Designation	Mobile Phone contact	Date	Issues/ Concerns and Suggestions
Project Affected Persons/ Farmers	Kwame Yamoah	Farmer	0243428555	9th August, 2021	• The farmers do not have any objection to the project. • The farmers want compensation for the crops they will lose. • Some farmers stated that they have gone for loans to cultivate the land. They will therefore need the compensation to settle their debt. • Some farmers want to be employed by the project, as some of them are artisans such as masons.
	Esther Ansong	Farmer	0241506177		
	Afia Sarpong	Farmer	0247084640		
	Mary Aliruba	Farmer	-		
	Adwoa Pinaman	Farmer	-		
	Comfort Mensah	Farmer	0551232912		
GRIDCo	Bernard Gyan	Network & Maintenance Manager	0204305007	9th August, 2021	• The technical staff engaged did not object to the project. • Their main concern was safety. They are very particular about neighboring activities and the safety distances away from their facility. • Though the technical staff did not see it necessary to compensate farmers, the Administrative officer for GRIDCo stated clearly that compensation of farmers will have to be done. He shared a previous experience were GRIDCo had to compensate farmers during the execution of GRIDCo project in Anwomaso.
	Laurence Doe	Planning & Business Support Manager	0243755694		
	Joseph Safo	Administrative Officer	0244463933		
KNUST	James Oberko	Senior Assistant Registrar, Public Affairs	0208139778	10th August, 2021	• The KNUST staff engaged were happy about the project as they expect the project to resolve their current poor electricity supply situation (e.g. frequent light out & low current during peak times). • The Head of Maintenance Unit anticipates that this project will be of great benefit to the University. She lamented that the growing population of the University is causing damages to their transformers and other electrical equipment causing the University to spend a lot on repair woks.
	Harriet Ashon	Head of Maintenance Engineering Unit	02444461700		

Stakeholder	Contacted Person	Designation	Mobile Phone contact	Date	Issues/ Concerns and Suggestions
	Isaac Daniels	Quantity Surveyor at the Development Office	0557275956		• The situation could worsen as the students' population continue to increase, and also KNUST expects to execute more power consuming projects in future. Hence, they are glad the power project is coming on. • The officers wants a dedicated transmission station and line when the project is completed. • When the Consultant asked how they plan to manage the farmers on the project land, they confirmed that the project land belongs to KNUST. • The officers indicated that the Project should officially inform KNUST to assist in getting the farmers off the land when ready to use the proposed site for the project.
	Baba Akurugu	Laborer at the Development Office	024626298441		
Oforikrom Municipal Assembly	Madam Irene Godi	Municipal Development Planning Officer	024 336 4458	10th August, 2021	• The Municipal Development Planning Officer made it known that they have not been officially informed about the proposed project. • She stated that she has no objection to the project. • However, she was concerned about the how the project was going to ensure the safety of the neighboring community.
	Mr. Asante Kweku Adjei	Municipal Physical Planning Officer	050 977 2929		• Mr. Asante Kweku Adjei made some references to their drawing records to confirm the original plan for the proposed land for the project. He confirmed that it has been earmarked as an educational zone for KNUST. Hence OfMA does not have plans for the land as a Municipality. • He concluded that if KNUST is providing the land then they have no objections.
NVTI	Mr. Benjamin Sekyi	Project Manager	055 278 8431	9th and 18th August	• According to the Project Manager, the school project is due for completion this year. However, this is not likely and hope to finish the school project next year. • His concern was the safety of students, teachers and other staff who will be using the facility when in operation.

Stakeholder	Contacted Person	Designation	Mobile Phone contact	Date	Issues/ Concerns and Suggestions
Anwomaso Community	Hon. Frank Frimpong	Assemblyman	024 44 87 991	10th August, 2021	• The **Assemblyman** recounted his bad experience with Gridco. According to him, the transport of heavy Gridco equipment caused damages to their bridges. Gridco did not repair the bridges. This damages almost claimed the life of an old woman. He stated that he does not want to experience a similar situation with VRA because of this project. • The **Assemblyman** lamented about Gridco's unconcern about supporting the community. He expects Gridco to provide basic support like street lights for the community. *He is however hoping that VRA will be different.*
Anwomaso Community	Okyeame Boakye	Linguist	024 64 58 187	10th August, 2021	• Okyeame Boakye, the **Linguist**, welcomed the project because he anticipates that it is will benefit Ghana. He said he is unemployed and has to stay home. He is however unhappy about the unemployment situation in the community. He expressed his desire to be gainfully employed by the project. He is hoping that this project will create jobs for people in the community.
Anwomaso Community	Nana Akosua Gyaamah	Queen Mother	024 00 20 363	10th August, 2021	• Nana Akosua Gyamaah, the **Queen Mother**, recounted their past engagement with VRA about ten (10) years ago. According to her, VRA together with KNUST officially came for about 41 acres of land. Together with KNUST, the community transferred ownership of the land to VRA. VRA also made several promises to the community. VRA promised to pay the chief monthly, exempt the Chief from paying electricity bills, and provide support to the community. They have since not heard from VRA. Instead GRIDCO had been using part of this land without fulfilling VRA's promises. She stated that she cannot hold GRIDCO responsible for the promises VRA made. • On behalf of the chiefs, the Queen said they will like to meet VRA to address these concerns. Failure to address their concerns will result in serious demonstrations against the Project to draw media attention. • She confessed that the project seems good and they are willing to welcome it. However, the needful will have to be done. • She asked if farmers who are currently using the land will be compensated. She said the project should ensure that the farmers will be compensated. • She finally expressed the fear of potential environmental impacts of the project on the community.

Stakeholder	Contacted Person	Designation	Mobile Phone contact	Date	Issues/ Concerns and Suggestions
Anwomaso Community	Nana Opoku	Gyase Hene	0243978101	14th August, 2021	• He is optimistic that the Plant will help improve power supply in the greater Kumasi area. • Lamented about the fact that KNUST has taken a greater part of their land. • He advocated for jobs for the youth in the community. • On CSR, he suggested that the Palace should be completed; need for street lights between Anwomaso and neighboring communities; provision of tarred roads, clinic and schools in the community. • He concluded by requesting for a community durbar.

Plate 5-3: ***Engagement with the Assemblyman of Anwomaso***

A. Meeting with the Linguist of Anwomaso B. Engagement with Nana Gyase Hene (left)

Plate 5-4: Meeting with Key Traditional Leaders of Anwomaso

SELJEN CONSULT

CHAPTER SIX

IMPACT IDENTIFICATION AND SIGNIFICANCE

FINAL

ENVIRONMENTAL IMPACT STATEMENT

VOLTA RIVER AUTHORITY

6.0 IMPACTS IDENTIFICATION AND SIGNIFICANCE

The identification of potential key issues, impacts and risks has been greatly facilitated by the project scope, literature/project documents review, field investigations and observations as well as the outcome of stakeholder consultations. The construction and operation of the proposed project will result in a number of potential impacts on the physical, biological and social environments, which may either be significant or minor.

6.1 Project Area of Influence

According to the IFC Performance Standard 1, the area of influence encompasses, as appropriate:

- The area likely to be affected by: (i) the project (e.g. project sites, immediate airshed and water shed or transport corridors) and the client's activities and facilities that are directly owned, operated or managed (including by contractors) and that are a component of the project; (ii) impacts from unplanned but predictable developments caused by the project that may occur later or at a different location; or (iii) indirect project impacts on biodiversity or on ecosystem services upon which Affected Communities' livelihoods are dependent.
- Associated facilities, which are facilities that are not funded as part of the project and that would not have been constructed or expanded if the project did not exist and without which the project would not be viable (e.g. railways, roads, transmission lines, pipelines, warehouses, logistics terminals).
- Cumulative impacts that result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted (e.g. incremental contribution of gaseous emissions to an airshed, reduction of water flows in a watershed due to multiple withdrawals, increases in sediment loads to a water shed, interference with migratory routes or wildlife movement, or more traffic congestion and accidents due to increase in vehicular traffic on community roadways).

This EIA refer to the project Area of Influence (AOI) as the area where air/water resource or land is required for construction of any component of the Project and the actual project footprint; and the surrounding vicinity and environment/ institutions where the Project can affect receptors even if there is no direct project activity taking place. However, the natural gas supply and water supply extension pipelines to the project site will undergo a separate EIA study and permitting.

The geographical, biophysical environment, socio-economic/cultural and institutional influences of the project are foremost identified and described hereunder.

6.1.1 Geographical Area of Influence

The immediate geographical area of concern covers the 15 acre project site and its immediate environs, where the nearby local communities are located. The larger geographical area of influence is the Oforikrom Municipality of the Ashanti Region of Ghana as well as all communities likely to be impact by the noise/air dispersion from the plant operations.

6.1.2 Environmental Media Influence

The main environmental media to be influenced are:

- The land/landscape of the Project site;
- The flora/fauna of the Project site;
- The soil resources at the Project site;
- The Adote Stream which traverses near the project site;
- The groundwater resources at and around the Project site;
- The ambient air environment around the project site and also as far as the emissions/noise pollution can reach;
- Communities near the project area of influence (i.e. Anwomaso, Bebre); and
- Farmers in the project area of influence.

6.1.3 Socio-economic Influence

The proposed project has a bearing on the economic and socio-cultural conditions of the Greater Kumasi Metropolitan Area (GKMA), and the northern part of the country as a whole. The immediate community and people to be affected by the proposed project is Anwomaso community and the very few farmers on the project land.

6.1.4 Institutional Influence

The major institutions to be influenced or involved in the proposed project include:

- Ministry of Energy;
- Ministry of Local Government and Rural Development;
- Environmental Protection Agency;
- KNUST;
- Energy Commission;
- VRA;

- GRIDCo and ECG;
- Lands Commission;
- GWCL;
- NVTI;
- Ghana National Gas Company Ltd;
- Department of Factories Inspectorate;
- Ghana National Fire Service;
- Water Resources Commission;
- Oforikrom Municipal Assembly; and
- Anwomaso Traditional Authority.

6.2 Project Activities of Environmental/Social Concern

6.2.1 Preparatory/Pre-construction Phase Activities

Preparatory phase activities include among others:

- Procurement of labour, equipment/materials;
- Feasibility studies and survey works;
- Land acquisition;
- Stakeholder consultations;
- Statutory permitting activities for approvals from-EPA, Energy Commission, GNFS, Factories Inspectorate Division and the Municipal Assembly.

6.2.2 Constructional Phase Activities

Constructional phase activities include among others:

- Procurement of labour, equipment/ materials;
- Setting up work camp/site office and storage areas;
- Site clearing;
- Transportation of materials and equipment;
- Construction and/or repair of access roads;
- Earthworks and excavations
- Civil and installation works;
- Mechanical and electrical works;
- Disposal of construction spoil and waste in general;
- Testing and commissioning of the proposed thermal power plant.

6.2.3 Operational and Maintenance Phase Activities

Operational phase activities include:

- Procurement of labour, equipment/spare parts and materials;
- Plant operations and maintenance;
- Maintenance of water and gas supply pipelines;
- Equipment maintenance and management;
- Maintenance of powerhouse/switchyard station, offices and warehouse;
- Materials handling and storage, including hazardous chemicals and fuels;
- Site protection and security services;
- Storm water and runoff management; and
- Waste management including solid and liquid waste.

6.2.4 Decommissioning Phase Activities

The major activities will include:

Post-construction phase activities

- Demobilization of equipment after construction;
- Termination of construction workforce/labour employment contracts;
- Decommissioning of work camp/storage sites;
- Disposal of wastes.

Post-operational phase activities

- Relocation or removal of plant components/site facilities;
- Decommissioning of other associated facilities;
- Laying off or termination of workforce employment contracts;
- Disposal of wastes.

6.3 Impact Assessment/ Evaluation Approach

6.3.1 Impact Identification and Characterization

Impacts are described in terms of their characteristics, including the impact's type and the impact's spatial and temporal features (namely extent, duration, scale and frequency). The definitions of the terms used are described in **Table 6-1.**

Table 6-1: Impact Characteristics

Characteristic	Definition	Terms
Type	A descriptor indicating the relationship of the impact to the Project (in terms of cause and effect).	**Direct** - Impacts that result from a direct interaction between the Project and a resource/receptor (e.g., between occupation of a plot of land and the habitats which are affected). **Indirect** - Impacts that follow on from the direct interactions between the Project and its environment as a result of subsequent interactions within the environment (e.g., viability of a species population resulting from loss of part of a habitat as a result of the Project occupying a plot of land). **Induced** - Impacts that result from other activities (which are not part of the Project) that happen because of the Project. **Cumulative** - Impacts that arise because of an impact and effect from the Project interacting with those from another activity to create an additional impact and effect.
Duration	The time period over which a resource / receptor is affected.	**Temporary** - (period within 1 year -negligible/associated with the notion of reversibility) **Short term** - (period of up to 2 years i.e. construction period or production ramp up period) **Medium term** -(period of more than 2 years to 5 years) **Long term** - (period of more than 5 years and less than 25 years i.e. life of facility/plant) **Permanent** - (a period that exceeds the life of facility – i.e. irreversible. Or may last for a very long time)
Extent	The reach of the impact (i.e. physical distance an impact will extend to)	**On-site** - impacts that are limited to the Project site. **Local** - impacts that are limited to the Project site and adjacent properties. **Regional** - impacts that are experienced at a regional scale, i.e. beyond adjacent properties, covering the Metropolis/Municipalities/ Districts and beyond **National** - impacts that are experienced at a national scale. **Trans-boundary/International** - impacts that are experienced outside of Ghana
Scale	Quantitative measure of the impact (e.g. the size of the area damaged or impacted, the fraction of a resource that is lost or affected, etc.). or the professional viewpoint of the measure of impact	Quantitative measures as applicable for the feature or resources affected/ professional viewpoint of expert as applicable for the feature or resource in terms of severity of impact measure (i.e. minor, moderate, severe).
Frequency	Measure of the constancy or periodicity of the impact.	No fixed designations; intended to be a numerical value or a qualitative description, e.g. intermittent, once, annually, daily, continuous etc

Characteristic	Definition	Terms
Likelihood	Characteristic that pertains to unplanned events determined either qualitatively or quantitatively estimated on the basis of experience and/or evidence that such an outcome has previously occurred.	**Unlikely** – The event is unlikely but may occur at some time during normal operating conditions. **Possible** – The event is likely to occur at some time during normal operating conditions. **Likely** - The event will occur during normal operating conditions (i.e., it is essentially inevitable).

6.3.2 Determining Impact Magnitude

Once an impact's characteristics are defined, the next step in the impact assessment phase is to assign each impact a 'magnitude'. Magnitude is typically a function of some combination (depending on the resource/receptor in question) of the following impact characteristics:

- extent;
- duration;
- scale; and
- frequency.

Magnitude (from small to large) is in practice a continuum, and evaluation along the spectrum requires the exercise of professional judgement and experience. Each impact is evaluated on a case-by-case basis, and the rationale for each determination is noted. The universal magnitude designations, for negative effects, are: negligible, small, medium and large. The magnitude designations themselves are universally consistent, but the definition for the designations varies by issue. In the case of a positive impact, no magnitude designation has been assigned as it is considered sufficient for the purpose of the impact assessment to indicate that the Project is expected to result in a positive impact.

6.3.3 Determining Receptor Sensitivity

The other principal step necessary to assign significance for a given impact is to define the sensitivity of the receptor. There are a range of factors to be taken into account when defining the sensitivity of the receptor, which may be physical, biological, cultural or human. As in the case of magnitude, the sensitivity designations themselves are universally consistent, but the definitions for these designations will vary on a resource/receptor basis. The sensitivity of receptor used is low, medium and high as shown in the table below.

Table 6-2: Sensitivity Criteria

Value / Sensitivity	Low	Medium	High
Biological and Species Value / Sensitivity Criteria			
Criteria	Not protected or listed as common / abundant; or not critical to other ecosystem functions (e.g. key prey species to other species).	Not protected or listed but may be a species common globally but rare in Ghana with little resilience to ecosystem changes, important to ecosystem functions, or one under threat or population decline.	Specifically protected under Ghana legislation and/or international conventions e.g. species listed as rare, threatened or endangered e.g. IUCN
Socio-Economic Sensitivity Criteria			
Criteria	Those affected are able to adapt with relative ease and maintain pre-impact status.	Able to adapt with some difficulty and maintain pre-impact status but only with a degree of support.	Those affected will not be able to adapt to changes and continue to maintain-pre impact status.
Physical Sensitivity Criteria			
Criteria	The resource remains unaffected and maintains pre-impact status.	Pre-impact status is temporarily altered. May be restored over time naturally or through specific interventions.	Pre impact status is permanently altered by the development. Receptor or resource is held in high-esteem by stakeholders

6.3.4 Assessing Significance

Once magnitude of impact and sensitivity of a receptor have been characterised, the significance can be determined for each impact. The impact significance or severity rating is determined using the matrix provided in **Table 6-3.** The definitions or explanations of the impact significance assessment rating is provided in **Table 6-4.**

Table 6-3: Impact Significance Rating Matrix

		Sensitivity / Vulnerablity of Resource / Receptor		
		Low	**Medium**	**High**
Magnitude of Impact	**Negligible**	**Negligible**	**Negligible**	**Negligible**
	Small	**Negligible**	**Minor**	**Moderate**
	Medium	**Minor**	**Moderate**	**Major**
	Large	**Moderate**	**Major**	**Major**

Table 6-4: Definition of the Impact Significance/Severity Assessment Rating

Rating	Impacts
Negligible	• Impacts that are hardly distinguishable from background conditions and expected development in a no-project situation • Impacts very unlikely to happen
Minor	• Impacts of low intensity, limited in scale (site-specific) and low/medium duration (temporary) • Impacts unlikely to happen and/or the sensitivity of receiving environment is very low and/ or project designs have installed sufficient control mechanisms • impacts can be mitigated and minimized to a negligible level through adoption of best practice, continuous improvement and optimization measures
Moderate	• adverse impacts on people and/or environment of medium intensity, which may have a regional spatial scale of influence or a long term duration • impacts that are measurable and able to change some characteristics of the receptor/ resource, but not to generate irreversible, unprecedented or multiple adverse effects or damage • impacts can be avoided, managed and/or mitigated with relatively uncomplicated accepted measures
Major	• significant adverse impacts on human populations and/or environment, high in intensity and/or spatial extent (e.g. large geographic area, large number of people, transboundary impacts, cumulative impacts) • permanent and/or irreversible impact • areas impacted include areas of high value and sensitivity (e.g. valuable ecosystems, critical habitats) • impacts may give rise to significant social conflict • impact may not always be reduced by implementing mitigation measures. In this case, further options have to be considered in order to avoid any critical significance driven by project (analysis of alternative strategy). Therefore, significant resources or fundamental changes in the activities and systems are required where necessary.

6.4 Potential Positive Impacts Evaluation

The potential positive or beneficial impacts are presented below.

6.4.1 Preparatory and Construction Phase Positive Impacts

- Employment and job creation opportunities;
    - Engagement of skilled and unskilled labour during construction phase.
- Creation of business opportunities for locals/Ghanaians and improvement of local economy;
    - Ghanaians may take up the business of supplying some needed construction materials, equipment/machinery, mechanical and electrical fittings etc.
    - The contractor will procure some construction materials such as sand, water, chippings, cement, food etc locally.
- Improvement in the local/national revenue
    - Taxes of workers and construction firm will accrue to the State.
    - Indirect tax/VAT on goods and services will also accrue to the State.

6.4.1.1 *Preparatory Phase Positive Impacts*

The positive impacts from the preparatory phase activities include the employment of consultancy services for the preparation of the feasibility /design study and EIA reports among others during the preparatory phase. Local consultancy companies as well as individual Ghanaian specialist will be contracted to carry out various studies/surveys (e.g. topographic survey, traffic surveys, geotechnical investigations, EIA studies etc) and these will create jobs for local firms or individual Ghanaians. The hospitality industry will also benefit from these technical staff as they will have to patronise their services (i.e. hotels/guest houses and restaurants) during the study period.

The regulatory bodies will charge processing and permit fees (e.g. EPA, Energy Commission, GNFS, Factories Inspectorate Department, and Oforikrom Municipal Assembly) in providing approvals or permits for project facilities and implementation. These fees will improve the revenue base of these institutions.

Summary Evaluation of Preparatory Phase Positive Impacts

The impact types are both direct and indirect, duration is short term, extent is national, and likely to occur. The impact frequency is intermittent. The receptors are generally state institutions, local consultancy firms/businesses/ organisations and individual specialists. The magnitude is medium, the sensitivity is medium, and the impact significance is moderate.

6.4.1.2 *Construction Phase Positive Impacts*

Employment Opportunities

The proposed project is expected to engage some local people around the project corridor as part of the expected work force or various aspects of construction and installation activities. This will provide employment for both skilled and unskilled youth in the area for the duration of the project. The provision of employment will keep some of the youth occupied and help focus their attention away from societal vices. About 30 to 50 persons will be engaged during the construction phase and the types of labour required will include unskilled labour, drivers, masons, carpenters, plumbers, electricians, mechanics, equipment operators, engineers, and administrators. These will create job opportunities for local people.

Local resource use and improvement in local economy

The contractor will be required to purchase some construction materials from the local and Ghanaian markets to shorten the supply time and reduce the cost, such as sand, aggregates, stones,

rocks, and parts of equipment. The major materials to be procured from the local companies may include crushed stone rock, sand, cement, fuel, water etc.

Local workshops will be engaged to help repair machines/equipment and components if necessary. The hospitality industry will also benefit from the presence of Ghanaians who do not have personal residence or accommodation and or expatriates/foreign workers.

Local individuals/traders will also bring their goods and food items near construction sites to sell and this will generate income for the local people. Mechanical workshops in the Kumasi area will also benefit or be engaged to help repair breakdown vehicles, machines/equipment if necessary. The hospitality industry will also benefit from workers who do not have their own accommodation facilities in the project area.

Increase in District/ National Revenue

Revenue will accrue to the State in the form of tax deductions from wages of workers and Contractor fees.

Summary Evaluation of Construction Phase Positive Impacts

The impact types are both direct and indirect, duration is short term, extent is both local and regional, and likely to occur. The impact frequency is intermittent. The receptors are generally local communities, state institutions, local businesses/ organisations and individual experts. The magnitude is medium, the sensitivity is high and the impact significance is positive and major.

6.4.2 Operational and Maintenance Phase Positive Impacts

The operational and maintenance phase positive impacts include:

- Employment generation and improvement in local economy
    - Engagement of skilled and unskilled labour during the operation phase. Over 33 professionals will be engaged to operate and maintain the Plant.
    - Local security firms will be engaged to provide security at the Plant site.
    - Local mechanical workshops will be engaged to help repair machines/equipment and components if necessary.
    - The hospitality industry will benefit from the presence of Ghanaians who do not have personal residence or accommodation in the project area and or expatriates to be engaged in any maintenance and repair works.

- Improvement in Institutional and State revenue
    - Regulatory bodies to charge for operational permits
    - Workers taxes to accrue to the State.
- Provision of 250MW of electric power for the Greater Kumasi area and the northern part of the country.
- Improvement in the voltage stability of the NITS.
- Significant reduction in transmission system losses.
- Improvement in the quality of supply to end users through improved network voltage control via generators.
- Continuous supply of reliable power to end users, thus reducing impact on power rationing in the Kumasi area and beyond.
- Natural gas as fuel represents a cleaner form of fossil fuel powered thermal power generation. Particulate matter (PM) and SO_2 emissions from natural gas firing thermal plants are negligible (USEPA, 1995). PM emissions from turbines primarily result from carryover of non-combustible trace constituents in the fuel.
- Reliable power supply to support socioeconomic activities and businesses in the Kumasi area.
- Improvement in the local community development and infrastructure/facilities from corporate social responsibility interventions by VRA.
    - Support for community educational and health related projects
    - Support for livelihood interventions in the communities
    - Support for cultural related projects including festivals, community centers, chief palaces

Summary Evaluation of Operational Phase Positive Impacts

The impact type is both direct and indirect, duration is long term, the extent is regional, the impacts are likely to occur; the frequency is annually; the magnitude is large and the sensitivity is high because the receptors are individuals, traders/businesses, both state and traditional institutions and the general populace particularly in the Kumasi area and parts of the northern regions of the country. The impact significance is positive and major.

6.5 Potential Negative/Adverse Impact Evaluation

The potential negative/adverse impact evaluation for the preparatory/pre-construction, construction, operational/maintenance and decommissioning phases of project implementation are presented and assessed below.

6.5.1 Preparatory/Pre-construction Phase Potential Adverse Impacts

The likely impact/risk issues to arise during the preparatory phase are discussed in the table below and include:

- Land-take and displacement of farmers;
- Anxiety/agitation on the part of affected farmers, local people and Anwomaso leaders;
- Risk of not acquiring all relevant statutory permits;
- Worker health/safety concerns; and
- Public/community health and safety concerns.

Table 6-5: Preparatory or Pre-construction Phase Potential Adverse Impact Evaluation

No.	Potential Impact	Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
Preparatory/ Pre-Construction Phase							
1.	Land-take and displacement of farmers	Land acquisition	KNUST as current land owner/ /farmers on the land	• About 15 acres of land will be acquired for project implementation and this forms about 1.1% of the about 1,395 acres of KNUST land at Anwomaso. • The land belongs to KNUST and it currently uses part of the land for its plant research programs. • About 6 farmers have been identified working on portions of the project land and will have to relocate. • There are various vegetables and annual crops such as cassava grown on the affected land. • There are isolated cases of oil palm trees identified during the terrestrial flora survey. • There are no structures or buildings nor cultural heritage resources such as shrine/cemeteries nor religious buildings like church or mosque on the land. The impact type is direct, duration is long term; the extent is local; the impact is likely, and the scale is low.	Small	High	Moderate
2.	Anxiety on the part of local community leaders/ people and affected farmers and nearby organisations	Survey works and feasibility studies, stakeholder consultations	Affected farmers/ local communities/ Anwomaso chief and elders, NVTI	• Dissemination of information with regards to land-take, scope, schedule and impact of the proposed project could bring about anxieties or concerns or negative reactions from local chiefs, community members and affected farmers. This could be expressed in terms of lack of cooperation from local communities/chiefs and affected farmers, PAPs/community members going to local FM stations to make allegations or complaints about the project. • Affected farmers on the project land are in expectation of receiving	Medium	Medium	Moderate

No.	Potential Impact	Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				some compensation for farms/crops, and lack of compensation payment may bring anxiety and tension. Regular sensitization and agreement with farmers required if no compensation will be paid to farmers but given adequate time to harvest their crops. • Stakeholder consultations showed key concerns from the Anwomaso Queen Mother with regard to VRA. Key among the concerns were the allegations made by the Queen Mother that Anwomaso community transferred land to KNUST and VRA over ten years ago and VRA made several promises to the community including exempting the chief from paying electricity bills and providing support to the community among others. The Queen Mother alleged also that GRIDCo uses part of the transferred land for its substation and that VRA failed to honour its promises. Failure to address these concerns from the Queen Mother could bring unnecessary tension between the community/ chiefs and VRA. • Stakeholder consultations showed high expectations for jobs and employment. Where project implementation especially construction phase does not meet the employment expectation of the local people, the locals especially the youth will be disappointed, and this could bring about tension and mistrust. The impact is indirect, the duration is short-term or long term. The extent is local and the impact likelihood is possible.			

No.	Potential Impact	Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
3.	Risk of not acquiring appropriate permits for project implementation	Acquisition of statutory permits and licenses prior to commencement of construction	VRA, Ministry of Energy, Contractor	The Project has to acquire all necessary environmental permits/licenses for project implementation from relevant regulatory bodies. The identified regulatory bodies and permits required include: • EPA (for environmental permit); • Energy Commission (Siting permit, construction permit and operational permit) • Water Resources Commission (for abstraction of groundwater as one or two boreholes will be drilled); • Ghana National Fire Service (for fire permit for the work camp, and storage areas/warehouse and project buildings); • Department of Factories Inspectorate (certificate of registration and permit for work camp and plant facilities); and • Oforikrom Municipal Assembly (for building and development permits). • There is pressure on the Government to fix the unstable power situation in the Kumasi area, and therefore there is the tendency or risk of not acquiring all the relevant permits/approvals prior to project construction. • Failure to acquire these approvals/ permits will deny the regulators the relevant processing and permit fees. • Stakeholders and the general public may have issues with VRA/MoE if VRA does not follow due process and does not acquire all relevant permits or approvals. This will create bad publicity for VRA and can affect their corporate image. The risk or likelihood of occurrence is possible. The impact could be both direct and indirect. The extent is both national and international as	Medium	High	Major

No.	Potential Impact	Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				VRA is known to follow best industry practices including the IFC Performance Standards and Guidelines.			
4.	Occupational Health & Safety	Survey works and feasibility and ESIA studies	Technical/ Consulting teams	• There is the likely exposure of technical experts and teams carrying out topographical survey works, geotechnical survey, and environmental assessment studies to COVID-19 and injury and bites from insects and dangerous reptiles such as snakes, scorpions, bees, ants, etc. These can be prevented or minimised through the use of appropriate personal protective equipment such as safety boots gloves, wearing of coveralls/overalls, wearing of nose masks, and observing COVID-19 protocols during meetings. The impact is both direct and indirect, the duration could be temporary or long term depending upon the impact/injury. However, it is unlikely that fatalities will occur except for some minor injuries.	Small	High	Moderate
5.	Public/ community health and safety concerns	Meetings or engagement with community members, survey and field work	Local community members	• Local community members could be exposed to COVID-19 during interactions or meetings with project consultants or field teams. • Community members assisting field teams or consultants during survey workers are also likely to be exposed to injury and bites from insects and dangerous reptiles among others. • Traffic incidents could occur on the Anwomaso road as consultants/technical teams travel to and from project sites during the period of their studies and surveys. The impact is both direct and indirect, the duration could be temporary or long term depending upon the impact/injury. However, it is unlikely that fatalities will occur except for some minor injuries.	Small	High	Moderate

6.5.2 Construction Phase Adverse Impacts

The likely impact/risk issues to arise during the construction phase are discussed in the table below and include:

- Air pollution;
- Noise and vibration nuisance;
- Impact on soil resources/soil contamination;
- Water pollution/siltation of water body;
- Waste generation and disposal;
- Destruction and loss of vegetation/habitat;
- Impact on aquatic life;
- Labour influx;
- Visual intrusion/ attraction;
- Non-compliance with socio-cultural norms of local communities;
- Worker health/safety concerns and labour issues; and
- Public/community health and safety, and security concerns.

Table 6-6: Construction Phase Potential Adverse Impact Evaluation

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
	Construction Phase						
1.	Air Pollution	Construction of work camp and storage facilities; Repair of access routes; Site clearance; Transportation of materials and equipment to and from project site; Movement and operation of equipment/ machines; Earthworks and excavation, loading and dumping activities; Cement and concrete works; and construction of project facilities; and waste disposal.	Nearby local community especially Anowmaso, GRIDCo office/substation and NVTI near project site; construction workers; trespassers/nearby farmers	• The background dust (TSP, PM_{10}, $PM_{2.5}$) concentration levels in the project area (i.e. recorded for the seventeen (17) sampling stations) were within the Ghana Standards except the VRA Substations and Anwomaso Sand Winning Truck Station which is close to the main road leading to the area. This means the airshed is not generally polluted with dust except for some specific areas as mentioned. • The background gas (Cl_2, SO_2, CO, NO_2, VOC) concentration levels recorded for the project area were within Ghana Standards. • Dust generation will arise from site clearance, excavations, general construction works and topsoil handling and other key activities as listed in the key activities column. • Vehicular/truck movements and transport of materials/ equipment to and from site will generate exhaust emissions and dust from unpaved surfaces. • Loading, haulage and dumping of sand/stone aggregates as well as cement handling will also generate dust that can increase the air borne particulate in the vicinity of these activities. • Wind-blown dust may be generated from unpaved work sites, roads, exposed soils, cement handling and material stockpiles.	Medium	High	Major

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				• These dust/fumes generation activities will result in a temporary increase in the concentrations of airborne particulates and noxious gases in the ambient air. • Dust is the major air quality problem from construction sites, and is a problem for a variety of reasons, including: o Inconvenience to local people and nearby offices/work places. For example, people may have to re-wash laundry that has been put outdoors to dry, and wash windows, curtains and vehicles. o Dust may affect health by irritating eyes and worsening the health of people with asthma. o Dust can be blown to far places or long distances by the wind. o Within the construction site, dust can cause mechanical or electrical problems in sensitive equipment such as computers. • Use of construction vehicles, trucks and generators will generate fumes/gaseous emissions from combustion of diesel engines of such equipment. Inhalation of fumes and gaseous emissions such as carbon monoxide, sulphur oxides and nitrous oxides can affect the health of persons exposed to these gases for prolonged periods. • Air dispersion modelling for emissions/fumes from the construction equipment suggest that even at a distance of 400m, the concentrations will be below the WHO and Ghana Standards (**Annex 4-2** in the Volume II of this			

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				report). • Considering that the wind blows primarily from the northeast, the communities in the project's south western part would be particularly impacted by dust/gaseous emissions. The impact is direct, indirect, and could be cumulative as well due to the activities of Anwomaso sand winning station nearby; the impact could be short term and likely, lasting during the construction phase; the impact from a construction site is local in extent i.e. limited to the project site and adjacent properties/ areas.			

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
2.	Noise and Vibration Nuisance	Movement/ operation of equipment/ machines; construction and installation works in general and transportation activities; piling, blowing of horns from vehicles/ equipment etc	Anowmaso, GRIDCo office/substation and NVTI; construction workers; trespassers/ nearby farmers	• Typical noise level from construction activities range from 80dB(A) to 112dB(A) (BS 5228-1:2009) within the operational areas and is expected to significantly reduce to 30dB(A) to 62dB(A) at a distance of about 80m from the site. • Generally, both day and night noise levels measured at the project area were within the Ghana Standard for maximum permissible noise levels for areas with light industrial activity (Day= 70 and Night= 60 dBA) except the 161 KV substation area. The 161kV substation values were high because of the noisy fan of one of the transformers. • According to construction equipment noise levels determined even at distances of 500 meters from the project site as provided in **Annex 4-2** in the Volume II of this report, construction equipment with a worse case noise level of 120 dBA will have sound levels of about 58 dBA at a distance of 500m, which is below the GSA standard of 60 dBA in light industrial areas at night. • During the construction phase of the project, the noise level of the project would not significantly impact the nearest community, Anwomaso community, about 600m from the site even during the night time. • Nearby sensitive receptors such as the NVTI might be affected due to its proximity, about 200m to the construction sites. • The major recipient will be the GRIDCo substation	Medium	Medium	Moderate

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				workers and nearby farmers. The impact is direct, temporary or short term and likely, moderate in scale; frequency is intermitted; local in extent i.e. limited to the project site and adjacent areas at any given time.			

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
3.	Impact on soil resources – loss of topsoil/ soil erosion/soil contamination	Project site clearance and access road repairs; topsoil stripping; excavation and earthworks; waste disposal	Soil resources, flora and fauna, Adote stream	• Loss of topsoil will occur during site clearance and access road repairs. Topsoil is removed by stripping, bulk excavations and earthworks will impact on topsoil; compaction of topsoil will occur; loss of topsoil by wind and water erosion and covering of topsoil by project works/ facilities including placement of embankments, imported laterite materials and granite aggregates. • About 140,080 cubic meters of materials will be excavated, removed and disposed of during site preparations according to the project feasibility study report. • Erosion:-Without adequate protection measures soil erosion will occur at cleared and excavated sites, during earthworks and on heaped topsoil/excavated materials. • Contamination due to oil spills: - Potential soil contamination is a possibility resulting from poorly managed fuels/oils used during the project works. Leakage of oil from poorly serviced /conditioned trucks leading to contamination of soil. The impact is direct, likely, local in extent, moderate in scale and could be short-term or long-term in duration.	Large	Medium	Major
4.	Water pollution/ Siltation of Adote River	Site clearance/ land preparation, Excavation and construction works, waste disposal.	Adote River, and aquatic life; groundwater resources	• Site/land preparation, comprising clearance of vegetation in the site, as well as excavation works for the power plant construction would result in loosening and exposure of top soil. This could facilitate erosion/ sediment transport via runoffs into the nearby Adote	Large	Medium	Major

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				river leading to siltation of stream channel and increased turbidity. • Discharge of contaminated or polluted wastewater (e.g. oily wastewater) into the streams environment could adversely affect water quality. • Other constructional phase impacts include the improper disposal of wastes generated from the construction works. The impact is direct, short term and likely. The impact may be local and or regional in extent as the stream traverses beyond the Oforikrom municipality. Cumulative impact could occur due to pollution from other pollution sources or discharges as stream is used for irrigation purposes and can be pollute from pesticides and general surface runoffs.			
5.	Waste Generation/ Disposal and Sanitation Concerns	All construction activities including construction of site office, work camp and storage facilities; installation works; servicing and maintenance of equipment/ machinery	Soil/disposal sites, nearby stream, local communities, construction workers	• Bulk waste to be generated include vegetation/biomass from site clearing activities and excavated materials from the project site. • About 140,080 cubic meters of materials will be excavated, removed and disposed of during site preparations according to the project feasibility study report. • Other wastes to be generated include metal scraps, worn-out tyres and spent lubricating oil, rubber seals, concrete debris, pieces of wood/plastics, used polythene bags, office waste, food wastes/containers etc which must be disposed of properly to avoid adverse impact on the	Large	High	Major

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				general environment. ***Sanitation issues*** • Poor housekeeping at the project site and improper disposal of waste (construction waste, food waste, polythene bags, drinking water sachets, etc.) will create sanitation problems. • Open defecation may occur if adequate toilet facilities are not provided for the construction workers. • Open or improperly covered trenches or excavations may also result in stagnant water and breeding of mosquitoes, leading to malaria infestation. The impact is direct, short term and likely, lasting during the construction phase; the impact is also local in extent i.e. limited to the project site and adjacent properties and disposal site, and moderate in scale.			
6.	Loss of vegetation/ habitat/ displacement of fauna/ risk of spread of invasive plant species	Project site clearance; land preparation, topsoil removal.	Flora and fauna at project site	• The clearing of the 15 acre land will lead to removal of vegetation mostly trees, shrubs and herbs. • From the baseline ecological study carried out, about 91.5% of the species encountered are of no conservation Concern in Ghana, and 97.9% are of no global conservation concern from the IUCN threatened species assessment carried out. • Four species of national conservation concern recorded at the project site were *Mitragyna ledermanii, Antiaris toxicaria, Pycnanthus angolensis,* and *Elaeis guineensis*. • One species recorded at the project site is of global conservation concern, *Mitragyna ledermannii*, is a swamp species that occurs in the flood plain of the Adote	Large	Medium	Major

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				stream. • The removal of vegetation and land preparation activities will destroy and or displace limited habitats of fauna such as small mammals, rodents, reptiles, insects and nesting birds. No large mammals will be affected. • Construction workers may attack and kill fleeing wildlife like small mammals, grasscutters, etc if not properly sensitized. • The project site recorded two invasive plant species, viz., *Chromolaena odorata* (Siam weed) and *Lantana camara* (wild sage). Construction material transfers and movement of construction equipment from one place to the other poses risk of spread of invasive plant species. The impact is direct, likely, and long term; local in extent and moderate in scale; the impact will occur on-site and adjacent areas.			
7.	Impact on aquatic organisms and biodiversity	Site clearing, Excavation and construction activities	Adote River, aquatic life in the river	• The presence of life from zooplankton and plants to macroinvertebrates and fish, indicate that the Adote River maintains some minimum ecological integrity. • There is expected to be some disturbance to aquatic life, especially fish resources that are in the Adote River due to sediment transport into the stream resulting in increased turbidity. The impact is both direct and indirect; is likely; extent is regional; scale is moderate; impact could also be cumulative	Medium	Medium	Moderate

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				as river also receives polluted municipal wastewater discharges or surface runoffs from farmlands.			
8.	Visual intrusion/ aesthetics	Site clearing, excavation works, Presence and movement of equipment/ material/ and construction workers; plant/turbine and generator installation	Anwomaso community/Local communities/ Trespassers /nearby farmers	• The visual impact of construction projects is based on two principal aspects: (a) the alteration of the landscape character of an area including impacts on recognised features of landscape importance; and (b) the impact on public views of the site either from residential properties or areas of public access, e.g. footpaths, and from public roads. • The project site is not located close to any major or busy access road and cannot be viewed from such roads (i.e. Accra-Ejisu-Kumasi highway or Anwomaso-Odoum road). It is also located about 600 from the nearest community. • However, the location of the proposed project is not totally secured from public view. It can be viewed by users of the access road that passes in front of the NVTI and farmers/people working on farmlands near the project site. • Even though it is near the existing GRIDCo substation and within the high tension transmission line corridors, project activities would alter the current view of the area. • Poor housekeeping practices at the site may also reduce the aesthetic value of the proposed site. • Site preparation/ vegetation clearance, and construction activities, movement of workers, materials and equipment/machines to and from Project site along the	Medium	Medium	Moderate

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				access route to the project will attract the attention of local residents and trespassers. The impact is direct, likely, temporary/short term and local in extent. The scale is moderate.			
9.	Labour influx	Procurement of labour; construction phase activities	Local communities/ work camp/ site office	• Job seekers, mainly unskilled youth and some skilled persons will throng the project area to look for jobs and may end up engaging in illicit behaviours/irresponsible sexual behaviours in nearby local communities as the character of these people may not be known. • Non-locals, mainly unskilled youth, who will be engaged are likely to reside in nearby local communities due to proximity to project site, and this could put pressure on existing social amenities and environmental resources in the communities and such workers may not conform to societal norms and cultural practices, and may be involved in anti-social behaviours. Irresponsible sexual behaviours could lead to HIV/AIDS infections, other sexually transmitted diseases and teenage/unwanted pregnancies. • Some construction workers will bring their wives or relations to settle in local communities to be closer to them, and this will put pressure on local community resources. • Indirect labour influx will result from traders, especially women who will bring food/water and goods to sell to construction workers could generate wastes and	Medium	Medium	Moderate

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				sanitation issues. The impact is both direct and indirect, temporary, regional in extent and moderate in scale.			
10.	Occupational health, safety and labour right issues	All construction and installation activities- haulage of materials/ equipment, earthworks, civil works; mechanical and electrical works.	Construction workers/ staff	• Workers will be exposed to risks during construction works. The risks include hazards from operation of construction machinery/ equipment, transportation of construction materials, inhalation of dust and fumes, exposure to noise and falling objects and other hazards as identified in detail in the provisional health/safety management plan in **Annex 8-1** presented in the Volume II of this report**.** • Risk of trips and falls at site, including falling from working at height. • Risk of accidents and injury from use of construction equipment/ machinery. • Unhygienic working conditions, discriminatory practices, engagement of child labour could bring about social and labour conflicts and may trigger labour rights concerns. • Electrocution and fire risks from welding works may also occur. • Poor management of waste could also affect safety in the workplace. • Risk of accidents from the materials management at the work camps, including accidents from poorly managed workspace and fire from fuel storage facilities.	Medium	High	Major

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				• Site preparatory activities such as vegetation clearance exposes expose workers to dangerous reptiles such as snakes, insects and other animals. The impact is direct, temporary or long-term and likely, lasting during the constructional phase or beyond; the impact is national. In terms of number of people to be engaged, the scale is moderate.			
11.	Public/ community health & safety and security	Hoarding of site; Construction of site office, work camp and storage facilities; Site preparation; Repair of access routes; Equipment/ material/ transport; and Plant installation	Local communities	*Anxiety and agitation* • Portions of the project site and some adjacent areas are currently used by farmers and hoarding of the project site during construction may lead to denial of access to some areas for use as thoroughfare to farm sites and could result in agitation/ protests. *Dust and exhaust fumes and noise nuisance* • Nearby communities/residents may be exposed to dust and exhaust fumes from vehicular/equipment movement and excavation works in the dry season and noise nuisance from construction equipment and machinery. *Road Safety Impacts* • The transportation of out-of-gauge turbines and generators on the access road to Anwomaso community may pose congestion, traffic nuisance and risk of traffic related incidents. • The transportation of construction materials such as chippings/sand, cement, fill materials etc and movement of heavy equipment to and from project site could cause	Medium	High	Major

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				traffic congestion and traffic related incidents along the access route through the community. • Any unattended mechanical breakdown of trucks on the access route to Anwomaso community could create traffic congestion and incidents/accidents. *Spread of HIV/AIDS and other Sexually Transmitted Diseases (STDs)* • Construction activities may result in the movement of workers to the project area and people from other communities in search of job opportunities. • Influx of people during the construction period may promote irresponsible sexual behaviour which could lead to teenage pregnancies, HIV/AIDS and other STD infections. The impact may be permanent or irreversible in nature. *Public health issues and COVID 19* • Poor sanitation conditions at project sites and open defecation by construction workers in the bush or at obscure places will pollute the environment and ultimately nearby Adote stream if adequate toilet facilities are not provided for construction workers. • Improperly covered excavations may result in stagnant water and breeding of mosquitoes. • High risk of spread of COVID-19 is likely at construction sites due to crowding and non-observance of the protocols.			

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				Security concerns • The influx of labour into the project area is a security concern for local communities. Thieves and robbers may take advantage as job seekers to also come into local communities to steal or rob residents and workers respectively. • Poor security measures at construction sites could lead to theft of materials, tools and equipment. The impact is possible, direct and indirect, temporary and or long term/permanent depending upon injury/hazard, lasting during or beyond the constructional phase; the impact is regional and the impact scale from moderate to severe.			
12.	Impact on cultural heritage and sociocultural norms	Land preparation and clearing, excavation and construction and installation activities	Anwomaso community	• Field investigations indicate that no shrine, cemeteries or sacred groves will be affected. • The project site is under the Anwomaso Traditional Authority and construction activities with high noise/vibration are likely to infringe on sociocultural norms during festive celebrations when noise making is restricted. • Construction workers may not conform to community norms and cultural practices and this could result in some tension between workers and locals. The impact is possible, direct and local, and low in scale.	Small	Medium	Minor

6.5.3 Operational Phase Potential Adverse Impacts

The likely impact/risk issues to arise during the operational and maintenance phase are discussed in the table below and include:

- Noise and vibration nuisance;
- Air pollution;
- Greenhouse gas emissions and climate change impact;
- Water pollution concerns and impact on aquatic life;
- Waste generation and disposal;
- Water consumption;
- Worker health and safety concerns;
- Labour right issues and concerns;
- Public/community health and safety and security concerns;
- Emergency situations; and
- Sustainability risk.

Table 6-7: Operational/Maintenance Phase Potential Adverse Impact Evaluation

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
Operation and Maintenance Phase							
1.	Noise and Vibration Nuisance	Plant/turbine and generator operations; Vehicular movement; horn blowing; accidental explosions	Nearby local communities, GRIDCo substation, NVTI	• Principal sources of noise in the thermal power plant include the engines and turbine generators and auxiliaries; reciprocating engines; fans and ductwork; pumps; compressors; condensers; precipitators, including flappers and plate vibrators; piping and valves; motors; transformers; and circuit breakers etc. • The generators can create low level of ground vibration within the surrounding areas. • The closest community (Anwomaso) to the project is 600 m and the predicted noise level by the model is 34.02 dBA in the community. This noise level is below the background noise level in the community (Anwomaso) as presented in **Annex 4-2** in the Volume II of this report. Dealing with multiple noise level in the community, the composite would be 58.06 dBA, which will be the background noise level in the Anowmaso community during the day, and this is within the Ghana Standards. • The background noise level at night would be 42.88 dBA, which indicates a rise in 3 dBA. This is still below the GS of 48 dBA for residential areas at night and below 60 dBA for light industrial areas at night. • Sound levels beyond 500 m is less 70 dBA as required by GSA. However, this is the where all the turbines have no silencers. If silencers are used, the project's noise will have no effect on communities beyond 500 m from its location. However, without silencers noise would affect receptors within 5 km away from the project area ((**Annex 4-2** in the Volume II of this report).	Medium	High	Major

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				• The NVTI is located about 200m from the Plant site. At 300 m away from the turbines (**Annex 4-2** in the Volume II of this report), the sound level drops to 73.46 dBA. The Plant noise (without silencers) will have effect on the NVTI and this can affect learning or academic work. • The maximum noise level predicted within 20 m from the turbines without silencers is 123 dBA (1 m away from the source). • Where there are silencers installed, the noise levels at 20 m away from the source is 38.46 dBA, this noise levels are within Ghana Standards. This means that silencers should be installed on the turbines to reduce noise impact on NVTI. The impact is likely, direct and indirect, long-term and local in extent, and moderate in scale.			
2.	Air Pollution	Turbine and generator operations and stack emissions	Public/ local communities	• The background dust (TSP, PM10, PM2.5) concentration levels recorded for the project area, i.e. seventeen (17) sampling stations were within Ghana Standards except the GRIDCo Substations and Anwomaso Sand Winning Truck Station (**Annex 4-2** in the Volume II of this report). • The background gas (Cl_2, SO_2, CO, NO_2, VOC/HC) concentration levels recorded for the seventeen (17) sampling stations around the project area were within Ghana Standards (**Annex 4-2** in the Volume II of this report). • Turbine operations from combustion of natural gas/use of fuel will result in the emission of noxious gases and heat into the atmosphere via stacks. The main pollutants are: Carbon	Large	High	Major

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				Monoxide (CO); Nitrogen Oxides (NO_x); Carbon Dioxide (CO_2); and Hydrocarbon (HC). Fugitive emissions will also occur from generator operations. These pollutants can damage health and/or the environment. • Particulate Matter (PM) and SO_2 emissions from natural gas firing thermal plants are negligible or very minimal. PM emissions from turbines primarily result from carryover of non-combustible trace constituents in the fuel. • Natural gas is an inherently clean fuel, the combustion of which will not result in the emission of significant levels of Sulphur dioxide (SO_2). The use of natural gas in gas turbines is generally not associated with the emission of particulate matter (PM_{10}). • Emissions and dispersion modelling carried out (See **Annex 4-2** in the Volume II of this report) predicts that concentration of key pollutants (SO_2, NOx, PM_{10}, CO) will not exceed the Ghana Standards and WHO guidelines. • Considering that the wind blows primarily from the northeast, the communities in the project's south western part could be impacted, however the concentration are well below the WHO and GSA thresholds (**Annex 4-2** in the Volume II of this report**).** • The modeling takes into consideration the stack height design. Without an appropriate stack height, the heat to the environment will seriously cause damage and harm to the surrounding areas and people. The impact is likely, direct and indirect, long-term, and local in extent; and low in scale. Air emissions will be monitored to ensure			

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				compliance within the allowable limits			
3.	Greenhouse Gas Emissions and impact on climate change	Stack emissions	Ozone layer, general climate	• The emission of Carbon dioxide, one of the major greenhouse gases (GHGs) from the combustion of fuels during the operation of the thermal plant could contribute to climate change. • Fugitive emissions of methane, the primary constituent of natural gas and a potent greenhouse gas, can result from incomplete combustion of fuel, leaks in tubing, valves, connections, gas conveyance systems, pressure relief valves etc. Methane is 25 times a more potent greenhouse gas than carbon dioxide over a 100-year period. Adherence to standard maintenance and monitoring measures will assist in early detection and remediation. • Nitrous oxide is also emitted in small quantities from incomplete combustions. • The IPCC (AR4) reports that fossil fuels account for the majority of global anthropogenic GHG emissions. However, natural gas exceptionally produces the lowest amount of GHG per unit energy consumed. Emissions from the proposed Thermal Power Plant, with natural gas as the fuel, is therefore expected to be the minimum expected from thermal plant. • The proposed power plant is not a new power plant project for the country but relocation of an existing Plant. Therefore, greenhouse gas emissions from the Plant will not be a new addition to the nation's contribution. The impact is likely, direct with regard to GHG emissions and indirect	Small	High	Moderate

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				with regard to impact on climate change, cumulative, long-term, and international in extent; and low in scale. The sensitivity of the ozone layer is however high.			
4.	Water Pollution/ impact on aquatic flora and fauna	Storm water management; general maintenance of plant facilities; wastewater disposal,	Surface water quality, aquatic flora and fauna	• Garbage made up of litter, dust, plastic bags, metal cans etc. may be introduced into the aquatic environment via wind action/storm-water runoffs by inappropriate disposal of waste at the plant site. • Accidental spills of oils, and other oily liquids or hazardous substances at the project area could seep into the ground and pollute groundwater and also be carried by storm water runoffs to contaminate nearby Adote River. • The building/structure roofs and paved yards will lead to increased storm-runoffs that can carry wastes or pollutants into the stream. • Any Stream water pollution will adversely affect aquatic life in the stream. • The Adote Stream will receive treated wastewater from the demineralized process as and when the neutralization sump is released of its content. The Adote Stream is a perennial stream. The effluent from the demineralized process which will either be acidic or alkaline will be treated in a neutralization sump to ensure that the pH is within 6-9 units prior to discharge through a covered drain or PVC pipes, which will eventually empty into the Adote Stream. The compressor wash water which is used demineralized water is neutral will be discharged into the storm drain. VRA will avoid discharging its treated wastewater from the demineralization process and compressor wash water directly	Medium	Medium	Moderate

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				to the wetlands but via storm drain linking the stream. About 10,000 litres (10m3) of demineralized water will be used and discharged as compressor wash water per year, which is less than 1m3 (i.e. 0.83m3) per month on average. The quality of the stream and the adjoining wetlands will not be adversely impacted by the treated wastewater from the neutralization process and release of compressor wash water. • Desilting of site drains when if choked will result in transport of soft sediments to nearby stream and will temporary increase suspended solids and turbidity. • Pollution from Plant maintenance works is possible in case of careless handling of maintenance materials and wastewater and failure to adhere to good maintenance practices. The impact is possible, direct, long term and local in extent. The scale could be moderate to major due to level of contamination.			
5.	Water consumption	Plant operations, Domestic uses	Power Plant, workers/ local community	• The operation of the proposed thermal plant will require about 7.5 m3/day of demineralized water for its operations. VRA will drill boreholes and also GWCL will provide the water through extension of its lines from Oduom to the project site. • The supply from GWCL could put a stress on the constrained potable water supply system in the project area as currently GWCL supply does not cover Anwomaso community and beyond to Ejisu. • There is a high risk of illegal connections to the GWCL pipeline that will be extended from Oduom to the project site at Anwomaso by nearby local communities that do not currently	Medium	High	Major

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				receive potable water supplies from GWCL, and more especially if they do not benefit from the water extension to the project site. • VRA will drill one or two boreholes on-site and also put in measures for the efficient use of water including recycling/reuse. The impact is both direct and indirect; is likely and long-term, is local in extent and moderate in scale. The sensitivity of water availability is high for both industrial and domestic uses. An impact on the availability of potable water has far reaching consequences on the prevailing socioeconomic and health conditions of local communities.			
6.	Waste generation/ disposal and sanitation concerns	Plant operation and maintenance and repair works; office and workshop activities/ operations; workers activities	General environment near project area/land; nearby stream / local communities	<u>Solid Waste</u> • Solid waste to be generated during the operational phase include garbage from the offices, food waste, packaging materials, scrap metals etc. Proper handling and management of solid waste is required to minimize or avoid environmental pollution and community health and safety concerns. • Maintenance and repair works and office duties also generate wastes that must be disposed of. <u>Liquid Waste</u> • No effluent expected from the Power Plant. The Plant will not discharge effluent into the environment. • Wastewater to be generated include o wastewater from the production of demineralized water; o turbine wash water, o onsite storm-water runoffs;	Medium	Medium	Moderate

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				○ wash water discharges during cleaning and maintenance of the yards/plant site; ○ wastewater/sewage from the washrooms/offices and workers ablutions in general. • Waste oil from generator/vehicle operations/maintenance • The solid and liquid wastes pose disposal challenges. Inappropriate disposal of the wastes will contaminate the nearby stream and also create sanitation problems within the project area and nearby local communities The impact is likely, direct and indirect, long-term, of local in extent, scale is moderate.			
7.	Disruption in land use/ landscape visual intrusion and aesthetics	Thermal power production and operations	Farmers, KNUST Plant Research, Anwomaso community and NVTI	• Current land use for the 15 acre site is largely for farming (subsistence and limited commercial by individuals) and Agricultural plant research activities by KNUST. • The implementation of the project will change the land use from farming/plant research site to a thermal power plant installation and thermal energy production site. • The change in land use will impact on the zoning status of the project area from an agricultural use to an industrial area. • The Power Plant and associated facilities including stacks will change or modify the landscape. The plant might present unwanted visual impacts both by its physical presence and profile against the surrounding areas, and by visual impacts of the stacks and plume/stack emissions (particularly during periods of poor	Medium	Medium	Moderate

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				atmospheric dispersion). • The main recipients of impact are local communities and adjacent property users such as NVTI. • GRIDCo/ECG workers are generally used to power generation plants. • It is expected that local community members/public and NVTI will get used to the presence of the power plant facilities with time. The impact is likely and unavoidable, direct, long-term, local in extent and moderate in scale. However, the impact is reversible after future decommissioning.			
8.	Occupational health and safety concerns	Plant operation and maintenance activities; working on power transmission and distribution lines and along active roads	Operational and maintenance workers and subcontractors / consultants	• The operational and maintenance activities pose a serious risk of injury and death to workers due to exposure to heat, fugitive hot gases, live power lines, electric/magnetic fields, electrical hazards from use of machinery and tools if correct preventive measures are not in place and enforced by the management. • Potential risks include electrocution, burns, falling from heights when working on transmission/distribution lines, and/or swinging objects; workers handling hazardous materials such as the gas turbine compressor cleaners/paints and lubricants. • Risk of working along active roads/traffic incidents and electrocution during maintenance works on power transmission and distribution lines. • Risk of accidents and injury from use of equipment/machinery. • Risk of fires and explosions could occur and cause fatalities and injuries.	Large	High	Major

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				• The HIV/AIDS prevalence rate in the Oforikrom Municipality has 1.75% and Kumasi Metropolis is 1.95%. There is however a lower risk of infection as staff at the power plant are expected to be permanent workers and more likely to comprise married individuals with families at their places of accommodation. More responsible behaviour is therefore expected of them. • Risk of COVID-19 spread among workers is likely if protocols are ignored and not followed. • The operation of the Plant will be guided by VRA's occupational health and safety policy and good international industry practices. This impact has very strong repercussions on the operational workforce, which can only be mitigated by strict adherence to the safety regulation stipulated in the VRA occupational health and safety policy. The impact is direct, possible, on-site, and could be severe in scale due to level of injuries or fatalities. The duration of impact could be long-term or permanent and may be irreversible.			
9.	Labour right concerns	Plant operations and maintenance activities	Workers, power beneficiaries	• Poor working condition of service, and labour intimidations/discriminations could lead to labour unrest and strike, and could affect the smooth operation of the plant. The impact is direct, possible, extent of impact could be onsite or regional in extent, impact is moderate in scale, frequency of impact	Medium	Medium	Moderate

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				could be intermittent. Duration could be temporary or short-term.			
10.	Public/ community health & safety and security concerns	Power Plant facilities operation and maintenance activities and repair works	Local communities, public	• Due to the expected high voltages and fire risk from the operation of a thermal power plant, a lapse in the security of these facilities, will result in unauthorized persons accessing high risk areas, making it a public safety concern. • The presence, storage and use of natural gas, and oils on the premises give rise to the very likely hazards of fire and explosion, which when occur poses a community safety threat. • The falling of a live electrical conductor could cause severe burns of any object on which it falls. An electrical conductor could fall from the towers or poles as a result of either a mechanical failure of an insulator string on the tower or snapping of the conductor itself. The mechanical failure of an insulator string could be the result of a lightning strike, rusting of insulator pins or a heavy object falling on the transmission line. The failure of a conductor joint could also cause snapping of the conductor. Strict adherence to the non-encroachment requirement of the right-of-way (RoW) will reduce the potential risks to public safety. This impact cannot be easily reduced unless the RoW for high tension lines and the switchyard are protected from the public and also farmers not allowed to farm under the high tension. Currently, there are farmers working under the high tension lines. • Road traffic incidents could occur among VRA vehicles and public/ private vehicles on the roads (e.g. due to over speeding, careless driving poor state of vehicles and bad drivers etc) and result in injuries and fatalities.	Large	High	Major

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				• Inhalation of fugitive noxious gases from generators by nearby farmers will affect their health. • Poor security measures leading to theft of materials, tools and equipment. This impact on public health and safety is long term, direct, possible, national in extent, and could be moderate to severe in scale due to level of injuries or fatalities. The duration of impact could be temporary, short-term, long-term or permanent.			
11.	Emergency events and impacts on environment, properties and terrestrial/ aquatic ecology	Handling of natural gas and fire generation at facility operation and maintenance and repair works, earthquakes, oil spillages, traffic accidents	Ecology, Power Plant and associated facilities, adjacent properties, workers, local communities, general public	• Fire/explosion risk due to handling of natural gas, oils/lubricants and heat generating equipment such as turbines, generator • Other emergency situations such as release or spillage of hazardous materials such as waste oils could be carried into nearby stream or be carried by storm-runoffs into stream. • The occurrence of natural disasters such as earthquakes, severe thunderstorms may pose serious threat to plant operations and the environment in general. The impact is direct, possible, local in extent, and could be severe in scale. The duration of impact could be temporary, short-term, long-term or permanent.	Large	High	Major
12.	Impact due to lack of sustainability measures	Poor and bad maintenance culture, theft or removal of	Electricity beneficiaries in Ashanti and beyond,	• Poor and bad maintenance culture will affected the integrity and proper functioning and lifespan of the Plant and its associated facilities. • Lack of funds for operation and maintenance activities will	Large	High	Major

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
		plant parts	workers, local communities	seriously affect maintenance and life span of the plant facilities. • Impacts resulting from emergency situations and equipment failure could compromise the sustainability of the proposed project. • Natural occurrences such as earth quakes and lightning could result in damage to equipment and facilities. • Operational challenges are anticipated from reliability of natural gas delivery, system management and other downstream activities like tariff setting, revenue collection, and illegal connections among others, and these can impede the sustainability of the system. • The losses in the system could be higher if appropriate measures are not put in place to manage the system efficiently. The impact is possible; both direct and indirect impacts will occur from this; the scale could be severe, extent is regional/national and effect could be long-term. The sensitivity is high as the receptors are general populace within Ashanti Region and beyond.			

6.5.4 Decommissioning Phase Potential Adverse Impacts

The likely impact/risk issues to arise during the decommissioning phase are discussed in the table below and include:

Post-construction activities

- Occupational/ public safety, accidents, traffic incidents and labour issues
- Soil contamination/ sediment transport
- Water contamination/ impact on aquatic organisms
- Air pollution/ Noise nuisance
- Hazardous materials/Waste management
- Loss of construction employment

Post-operational phase

- Loss of employment and labour/community agitations
- All other impacts
    - Decommissioning plan to be prepared outlining how all other impacts will be managed and EPA to issue permit for the decommissioning activities.

Table 6-8: Decommissioning Phase Potential Adverse Impact Evaluation

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
	Post construction phase						
1.	Occupational/ public safety and traffic and labour issues	Post – construction activities (dismantling of construction work camp, relocation of construction equipment/ machinery/ un-used materials; and disposal of wastes)	Workers, public/ local communities	• The relocation of all construction facilities/equipment and remaining materials including concrete mixer, vehicles/truck, water tanks to contractor office for future works could result in accident and injury to workers. • The transportation of such equipment and materials could also pose traffic risk and public safety concerns within the vicinity. The duration of the impact is temporary and or permanent. The impact is possible, direct, local in extent, and the scale could be minor to severe depending on injuries and fatalities.	Small	High	Moderate
2.	Soil contamination / sediment transport	Post – construction activities (dismantling of construction work camp, construction equipment/facilit	Soil resources/ fauna	• The removal and relocation of all construction equipment and remaining materials may result in soft soil/sediments being remobilised at the work camp and could enhance sediment transport during downpours. • Leakage and spills from improper removal and handling of fuel containers and waste oil drums could contaminate the soil. • The disposal of site waste from demobilisation activities	Medium	Medium	Moderate

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
		ies and disposal of site wastes)		at unapproved sites can also pollute the land/soil. The impact is direct, temporary and likely, lasting during the decommission phase. The impact is also local in extent i.e. limited to the project site/adjacent areas and disposal sites; and the scale is moderate.			
3.	Water contamination/ impact on aquatic organisms and biodiversity	Post – construction activities (dismantling of construction work camp facilities, demobilisation of construction equipment/ machinery and disposal of site wastes)	Aquatic environment	• The removal and relocation of all construction equipment and remaining materials may result in soft sediments being remobilised at the work camp and could enhance sediment transport during downpours. These loose sediments could be channelled via runoffs into nearby stream. • Leakage and spills from improper removal and handling of fuel containers and waste oil drums could contaminate the soil and be transported by storm-runoffs into nearby stream. • The improper disposal of site wastes from decommissioning activities can also pollute water resources and affect aquatic life in the stream in the project area. The impact is direct, temporary and likely, lasting during the post-construction decommissioning phase. The impact is also	Small	Medium	Minor

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
				local in extent i.e. limited to the project site, adjacent areas and disposal sites and low in scale.			
4.	Waste generation and disposal/ Hazardous materials	Post – construction activities (dismantling of construction work camps project sites and disposal of wastes)	Soil, aquatic environment and local communities	• The dismantling and removal of work camp facilities, equipment and materials at the site could generate different waste types such as scrap metal, wood, concrete debris, oily waste and garbage (pieces of plastic bags, food wrappers, etc.). The impact is direct, temporary and likely, lasting during the demobilization phase; the impact is also local in extent i.e. limited to the project site and adjacent properties and disposal site, and moderate in scale.	Medium	Medium	Moderate
5.	Air pollution	Dismantling of construction work camp facilities, demobilization of construction equipment/ machinery and disposal of wastes)	Ambient air, Workers, Anwomaso community, NVTI	• The dismantling and removal of work camp facilities, equipment and materials at the site could generate dust and movement of vehicles will generate fumes. The duration of the impact is temporary, direct, and likely, lasting during the demobilization/post-constructional phase. The impact is also local in extent i.e. limited to the project site and adjacent properties.	Small	Medium	Minor

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
6.	Loss of employment	All preparatory and construction activities	Consultants and Construction workers	• Local consultants and individual who worked on the project during the preparatory phase will have to look for new jobs. • The estimated 50 people to be involved during the construction period will lose their jobs as such engagements are temporary. All labourers will be affected. The impact is likely, direct, duration is short-term or long-term depending on when a new job is secured. The extent is national.	Medium	Medium	Moderate
Post operation/maintenance phase							
1	Loss of job/ employment	Laying-off workers and ending contracts	Plant operation workers and consultants	• The over 33 staff to be engaged because of the Power Plant operations and maintenance activities will be laid off after operation and decommissioning activities are over, and will include all maintenance contractors and consultants. The impact is direct and indirect, national in extent and short term or long term depending on when a new job is secured. The impact is possible and the scale is moderate.	Medium	Medium	Moderate
2	All other impacts	Decommissioning of Power Plant and associated	Bio-physical/ social environment,	(Any such decommissioning may will occur in the distant future when baseline conditions and project facilities would have changed or modified. A detailed Decommissioning Plan will be prepared for approval and permitting by the operator before final decommissioning of both Plant and associated facilities to confirm how			

No.	Potential Impact	Key Activities	Key Receptor(s)	Evaluation of Impact	Magnitude	Sensitivity	Rating
		facilities such as water/gas pipelines, buildings etc, disposal of wastes	road users and the general public	decommissioning activities will be carried out and how any identified significant impacts and risks will be managed).			

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CHAPTER SEVEN

ENHANCEMENT AND MITIGATION MEASURES

FINAL

ENVIRONMENTAL IMPACT STATEMENT

VOLTA RIVER AUTHORITY

7.0 ENHANCEMENT AND MITIGATION MEASURES

The anticipated positive and adverse impacts from the proposed project have been evaluated in the previous chapter in line with the objectives of the environmental impact assessment. Mitigation and enhancement measures have been proposed as part of the EIA to ensure that the project adverse impacts are managed within reasonable and acceptable limits and positive impacts enhanced to ensure full benefits are realized and maximized.

7.1 Enhancement Measures

7.1.1 Enhancement of Employment Impacts

A labour recruitment policy will be put in place by the Contractor to manage local hire in order to bring some project benefits to the nearby local communities, in line with international best practice and IFC standards.

The Contractor's labour recruitment policy will aimed at increasing the use of unskilled local workforce (i.e. workforce coming from the nearby local communities). The recruitment policy will include specific measures such as:

- Advertising jobs locally
- Encouraging and attracting local workforce to apply for jobs
- Prioritizing the hire of local workforce where reasonable and practical
- Training programs
- Monitor local workforce recruited

7.1.2 Improvement in local/district economies

The positive impacts of the proposed Project on the local economy will be sustained through sourcing of local or Ghanaian suppliers and subcontractors. Efforts will be made to identify and maintain a database of local firms that qualify as service providers (e.g. electrical suppliers, catering service providers, equipment suppliers, equipment/machine repairs, waste collection companies, security service firms etc). Relevant firms will be informed of any tender process and invited to bid for services or supplies.

Where local or Ghanaian firms do not have the capacity, foreign firms to be engaged as subcontractors or service providers will be encouraged or made to associate with Ghanaian firms in order to improve their capacity and experience as well as implement a local content policy.

VRA will continue with the stakeholder engagement and involvement programs during the construction phase to enhance better relationships between the project, contractor and nearby local communities.

7.2 Mitigation Measures

7.2.1 Rules for Designing Mitigation Measures

The general rules followed in designing the mitigation measures are:

a. Avoidance of major impacts: major impacts are generally considered unacceptable, impacts that would endure into the long-term or extend over a large area;
b. Reduction of major and moderate impacts to as low as reasonably practicable (ALARP) by planning, designing and controlling mitigation measures. This implies that mitigation measures will be applied until the limitations of cost effectiveness and practical applications are reached. The limitations are established by best international practice; and
c. Implementation of good contractor practices for impacts rated as minor, in order to ensure that impacts are managed within good reason.

7.2.2 Types of Mitigation Measures

The mitigation measures adopted may be classified as preventive, control and compensatory measures.

7.2.2.1 *Preventive Measures*

These are measures adopted during the design and pre-construction phase. The measures are aimed at avoiding or minimising potential major impacts at source. Avoiding or reducing an impact at source is essentially 'designing' the project so that a feature causing an impact is designed out or altered or avoided.

7.2.2.2 *Control Measures*

These are measures adopted to abate or remedy the impacts occurring during construction and operation/ maintenance phases. Impacts can be abated on site or at receptor end. Repair or remedy of impacts involves unavoidable damage to a resource, e.g. sediment transport from earthworks. In this case, the control essentially involves engineering controls and implementation of best practices to reduce sediment transport.

7.2.2.3 *Compensatory Measures*

Where other mitigation measures are not possible or fully effective, then compensation in some measure for loss, damage or general intrusion might be appropriate. This will mainly be 'in cash'.

Monetary compensations may be paid to individuals whose legal properties or legal occupancy of a place or standing crops will be affected by the project.

7.3 Proposed Mitigation Measures for Significant Adverse Impacts

Mitigation measures are proposed based on the analysis of the anticipated impacts. All significant (i.e. moderate and major) adverse impacts identified from the analysis and evaluation of the potential impacts from the proposed project in the preceding Chapter are considered for mitigation and control. In addition, good construction/industry practices and some mitigation measures have also been proposed for some minor impacts to ensure that these impacts remain minor or negligible throughout project implementation. **Tables 7-1, 7-2, 7-3, and 7-4** present summaries of the mitigation/management measures proposed for the preparatory, construction, operation/maintenance, and decommissioning phases respectively to ensure that the adverse impacts are managed within reasonable and acceptable limits.

Table 7-1: Proposed Mitigation Measures for the Preparatory Phase Adverse Impacts

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures	Residual Impact Significance
Preparatory/ Pre-Construction Phase					
1.	Land-take and displacement of farmers	KNUST as current land owner/ /farmers on the land	Moderate	• VRA will follow due process and engage KNUST on project land acquisition and documentation. • VRA will regularly engage affected farmers on project work plan for project implementation through an established communication channel. • All necessary documentation needed for acquiring land will be approved as mentioned during the stakeholder workshop for the EIA. • Ensure affected farmers are well informed and given adequate and agreed time to harvest vegetable and annual crops prior to the start of construction. • Any isolated perennial crops at the project site such as oil palm should be compensated. • Engage the Lands Commission to carry out valuation of affected standing crops if VRA fails to provide adequate time for crops to mature and be harvested. • VRA must liaise with the Lands Commission to ensure that all grievances/concerns related to affected standing crops are resolved. • VRA will disclose public information of the project.	Minor
2.	Anxiety on the part of local community leaders/ people and affected farmers and nearby organisations	Affected farmers/ local communities/ Anwomaso chief and elders, NVTI	Moderate	• VRA will maintain an open communication with stakeholders including KNUST, affected farmers, Anwomaso traditional leaders, Anwomaso Transport Associations, NVTI, GRIDCo/ ECG in the project area on the proposed project to avoid conflicts. • VRA will develop a program for periodic stakeholder interactions and education on proposed project activities, impacts and proposed mitigation measures. • VRA will implement grievance redress mechanism to enable institution and community concerns to be documented and resolved in a timely fashion. • VRA to ensure liaison with all stakeholders and affected persons/institutions, and local communities are maintained throughout project life.	Minor

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures	Residual Impact Significance
3.	Risk of not acquiring appropriate permits for project implementation	VRA, Ministry of Energy, Contractor	Major	VRA will ensure that it acquires relevant regulatory approvals prior to construction activities, including: • Approval from the EPA for the implementation of the Project. • Energy Commission siting, construction and operational permits/licenses. • Permit from the Water Resources Commission for drilling of borehole(s) at the site. • Fire permits from GNFS; Factories Inspectorate Department registration certificate; building/development permits from Oforikrom Municipal Assembly.	Minor
4.	Occupational Health & Safety	Technical staff/ Consulting teams	Moderate	• The Technical staff/Consultants will use appropriate personal protective equipment such as safety boots, reflectors, overalls, nose masks, hand gloves, and earplugs as appropriate when carrying out their field studies. • The Technical staff/Consultants involved with specialist studies will use first aid kit to treat minor ailments. However, major cases will be referred to selected public/ private Hospitals/ clinics in Kumasi for treatment. • VRA and subcontractors will ensure that survey teams are well-trained and experienced for the various pre-construction and survey activities. • Survey teams will be briefed by their employers on the presence of dangerous reptiles and animals such as snakes, insects etc at the site and need for safe work methods. • COVID-19 protocols especially wearing of nose masks and use of sanitizers will be followed during meetings with stakeholders. • Survey and technical teams will carry drinking water to the field, and will avoid working in the rain.	Negligible
5.	Public/ community health and safety concerns	Local community members	Moderate	• Good conditioned as well as well-maintained vehicles will be used to avoid frequent breakdowns along the roads and to reduce noise nuisance and smoke emissions, which could otherwise affect community health and safety. • COVID-19 protocols especially wearing of nose masks and use of sanitizers will be followed during meetings with stakeholders.	Negligible

Table 7-2: Proposed Mitigation Measures for the Construction Phase Adverse Impacts

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures	Residual Impact Significance
Construction Phase Mitigation Measures					
1.	Air Pollution	Nearby local community especially Anowmaso, Gridco office/substation and NVTI near project site; construction workers; trespassers/nearby farmers	Major	• The construction works will be done using mitigation and control techniques, such as standard dust suppression measures with water, e.g. All exposed surfaces, unpaved surfaces and aggregate stockpiles will be frequently dampened with water. • Vehicular/truck speed limits of between 30km/h and 50km/h will be the rule on any unpaved landscape to minimize dust generation. • The Contractor will implement the manufacturer recommended engine maintenance programs for all construction equipment and vehicles to minimize the emission of fumes into the environment. • The Contractor will monitor dust at NVTI whenever dust generating activities take place and remedial action will be taken whenever dust concentration levels exceed acceptable limits. • Dust-related grievances will be investigated and managed as part of the Grievance Redress Mechanism. • Earthworks and other construction activities will not be done during very windy conditions to minimize wind-blown dust from the site. • The Contractor will not burn cleared vegetation	Minor

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures	Residual Impact Significance
2.	Noise and Vibration Nuisance	Anowmaso, Gridco office/substation and NVTI; construction workers; trespassers/ nearby farmers	Moderate	• The Contractor will employ standard noise abatement measures and engineering good practices to ensure that the impact of noise are minimized and reduced to acceptable limits. • All equipment/ machinery shall be operated and maintained in accordance with appropriate industry and equipment standards including specifications for noise levels and manufacturer's specifications (including regular checks and maintenance). • Machines in intermittent use shall be shut down in the intervening periods between works or throttled down to a minimum. • All construction and earthworks will be done during daytime to avoid disturbing the serene nights of local communities. Heavy equipment such as excavators, graders and compact rollers will be operated in the daytime to minimize the impact of high noise levels on the surrounding communities. • The Contractor will implement a policy of minimal or no tooting of horns unless in an emergency cases only. • Earplugs and Earmuffs will be provided for workers where necessary.	Minor
3.	Impact on soil resources – loss of topsoil/ soil erosion/soil contamination	Soil resources, flora and fauna, Adote River	Major	• Topsoil will be stripped and stored for reclamation and landscaping activities after the construction works. • The topsoil stockpiles will be protected from erosion by constructing diversion channels and silt fences around stockpiles. • Clearance of vegetation will be limited to authorized or designated areas only. • Lubricant /oil and waste oil will be stored in drums that are not leaking and kept in contained areas. • The Contractor will use equipment that are in good condition and which do not leak oil. • On-site vehicles and equipment shall be inspected regularly for leaks and all leaks shall be immediately repaired. Incoming vehicles and equipment shall be checked for leaks. Leaking vehicles/equipment shall be repaired before allowed on-site. • Visual assessment of onsite erosion features after every significant rainy event will be carried out to provide evidence of where immediate control measures	Minor

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures	Residual Impact Significance
				are needed or required to check erosion. • The Contractor will adopt erosion control practices such as re-grading, compaction, diversion of runoff. • Early re-vegetation of disturbed areas will be undertaken.	
4.	Water pollution/ Siltation of Adote River	Adote River, and aquatic life; groundwater resources	Major	• Clearance of vegetation will be limited to authorized or designated areas only to avoid exposing unauthorized areas to soil erosion and transport of sediments to nearby stream. • Washroom wastewater/sewage from work camp will be discharged into septic tank. • Sediment barriers or traps will be constructed down gradient of construction sites to prevent sediment transport into Adote River or its wetland areas. • Lubricant /oil and waste oil will be stored in drums that are not leaking and kept in contained areas. • Construction equipment/ machines and vehicles will not be refueled at workplaces but on purpose-built designated area or commercial fuel stations in town. • The Contractor will avoid washing equipment/vehicles on site or near water bodies/wetlands or drains but at designated commercial washing bays. • The Contractor will use equipment that are in good condition, which do not leak oil. • The Contractor will provide temporary drainage channels to divert storm water away from excavated materials and stockpiles. • The Contractor will not store solid wastes near water bodies nor dispose wastes into the stream/wetland areas.	Minor
5.	Waste Generation/ Disposal and Sanitation	Soil, flora and fauna, nearby stream/ wetland areas, local	Major	<u>General Waste/ Garbage</u> • The Contractor will liaise with the Oforikrom Municipal Assembly to confirm approved waste disposal sites for use. • The Contractor will engage the services of a waste collection firm to assist	Minor

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures	Residual Impact Significance
	Concerns	communities, construction workers		with onsite waste collection and disposal. • The Contractor shall appoint a waste management coordinator, who will be responsible for tracking of loads, and protocols for the maintenance of records of the quantities of wastes generated, reused/recycled and disposed. • General domestic waste and refuse will be disposed of at the Municipal Assembly approved disposal sites. • The Contractor will provide adequate waste bins at the work camp and construction sites/workplaces to minimize littering of the environment. <u>Construction Waste</u> • There will be segregation of construction waste at the project sites. • All metal scraps will be collected and given to recognized scrap dealers to send to steel manufacturing companies in the Kumasi enclave for recycling. • Stripped topsoil will be stockpiled and used for reclamation and landscaping activities. • Excavated sub-soils will be reused to the extent practical for backfilling during construction to reduce waste. • Other construction wastes will be disposed of at the approved Municipal Assembly disposal sites. <u>Hazardous Waste</u> • The Contractor will liaise with the Regional EPA in Kumasi to obtain a list of at least two reputable hazardous waste collectors to work with. • The Contractor will engage one EPA approved hazardous waste collector for collection and disposal of all hazardous wastes during the construction period. • All hazardous waste (e.g. oily waste/waste contaminated with oil, batteries etc) generated during construction will be temporarily stored as per manufacturer's instructions for collection and disposal by the EPA approved hazardous waste disposal firm. • Contaminated soil will be considered as hazardous waste and will be disposed of at the appropriate disposal site.	

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures	Residual Impact Significance
				• Hazardous waste tracking system will be put in place and this will be mandatory. <u>Human waste</u> • Toilet and washroom facilities will be provided for workers at the work camp and project site to discourage "free-range" defecation and its attendant public health concerns. • Workers will be educated to use the toilet/washroom facilities to be provided. • An approved cesspit emptier service provider from either the Municipal Assembly or privately operated ones will be engaged to empty septic tank as and when full or before decommissioned at the close of the project.	
6.	Loss of vegetation/ habitat/ displacement of fauna/ risk of spread of invasive plant species	Terrestrial flora and fauna at project site and adjacent areas	Major	• Limit construction activities to only designated places and clearly mark out or delineated affected vegetation to be cleared especially around project site boundaries, so that they are clearly visible to construction staff/equipment operators so that they do not clear 'no go areas'. • The Contractor will remove vegetation only on areas needed for the proposed Project. • The Contractor will implement a wildlife animal protection policy on no hunting and killing of wildlife at the project sites and adjacent areas. • Stray wildlife will be given the right of passage at the project site and work camp and not killed. • Scheduled inspection and monitoring of trucks and their contents during transfer of construction materials from offsite to the project site to be carried out at the source and delivery ends to identify any fugitive invasive plant species. • Dismantle and remove all equipment and machinery after construction from site.	Minor
7.	Impact on aquatic organisms and biodiversity	Adote River and nearby wetlands, aquatic life in the stream	Moderate	• Construction workers and other staff will be instructed not to dispose or dump any kind of waste into the wetland areas of the Adote River or into the stream itself, but place them in waste storage bins or at designated temporary waste storage sites.	Minor

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures	Residual Impact Significance
				• Water pollution measures as earlier presented above will be implemented to minimize adverse impact on aquatic life in the stream.	
8.	Visual intrusion/ aesthetics	Anwomaso community/ Local communities/ Trespassers /nearby farmers, KNUST Plant researchers	Moderate	• The project site is not located close to any major or busy access roads and cannot be viewed from such roads. It is also located about 600m from the nearest community. • The work camp will be fenced. • The Project site will be hoarded off from public view during construction. • VRA will make announcements, give notices and warning signs for the construction and installation activities and changes in landscape and would communicate clearly to Anwomaso community/ farmers. • Planting of landscape vegetation will be done as appropriate after construction in collaboration with the Parks and Gardens Department. • The design, colour and finish of the power plant will be carefully considered to enhance the beauty of the project area. • Heaping of remaining excavated material at project areas mostly damages landscape. In this respect, any remaining excavated material will be used in landscaping works and excavated materials left after landscaping works will be sent to offsite disposal areas.	Minor
9.	Labour influx	Local communities/ work camp/ site office	Moderate	• The Contractor will implement a recruitment policy that will encourage the engagement of most unskilled labour from the local communities. • The Contractor will implement a stakeholder engagement program that will include a feedback and grievance mechanism with the Anwomaso community. • The Contractor and VRA will put in measures to collect feedback or complaints related to project labour influx from the Anwomaso community and will resolve these labour influx related complaints with the community opinion leaders.	Minor
10.	Occupational health and safety concerns	Construction workers/ staff	Major	<u>Implementation of a Health and Safety Policy/Plan</u> • The Contractor will prepare and implement an occupational health and safety management plan, which shall conform to the health/safety standards of VRA	Minor

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures	Residual Impact Significance
	and labour right issues			for contractors and the provisions in this EIS. The provisional health and safety management plan provided in **Annex 8-1** to serve as guide for the preparation of the construction health/safety management plan. • The Contractor will educate its workers/ staff on the health/safety plan. • An Environmental and Safety Officer will be appointed to ensure compliance with the Health and Safety Plan. • Contractor will organise weekly toolbox meetings for workers and brief them on EHS issues and what to do to safeguard the environment and avoid accidents or injuries. <u>First Aid Centre/Hospital</u> • The Contractor will have an on-site first aid centre with a site nurse to treat minor ailments. • Major cases will be referred to identified public/private hospitals/ clinics in the Kumasi area. • There will be at least one vehicle designated for emergency transfers, but not necessarily an ambulance. <u>Use of Qualified and Experienced Personnel</u> • The Contractor will ensure that experienced and well-qualified workers are engaged to operate any heavy machine or equipment. • Only drivers and equipment operators with the requisite licenses will be allowed to handle vehicles and earth-moving equipment. • Initial training and testing in machine/equipment handling and safe working procedures will be given to all new drivers, operators and other field workers. <u>Provision of Personal Protective Equipment (PPE)</u> • The Contractor will ensure that workers are provided with the appropriate PPEs such as safety boots, helmets, reflectors, overalls, rain-coats, hand gloves, earplugs and nose masks. • Supervisors will be mandated to ensure the use of the protective equipment	

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures	Residual Impact Significance
				and to impose agreed sanctions when necessary. <u>Use of Road Worthy Vehicles/Equipment</u> • Good conditioned vehicles will be used to avoid any breakdown along the roads. • The Contractor will ensure that well maintained vehicles/equipment are used in order to reduce noise nuisance and smoke emissions, which could affect equipment operators and other workers. • Tools and equipment will be inspected to ensure they are in good working order, and are well maintained with maintenance records. <u>Use of warning signs and restricted access to dangerous sites</u> • Open trenches/excavations will be protected using indicator linings or illustrative warning notices or wire mesh (whichever best suits the situation) to prevent fall hazards. • Caution/warning signs will be placed and maintained at vantage points around the project site. • There will be restricted access to dangerous working areas and will be limited to authorized construction/electrical staff only. <u>Worker Rights and Wellbeing</u> • The Contractor will implement a Human Resource Policy that adheres to the requirements of IFC PS2 and the national labour laws, including requirements for all workers to have contracts/appointment letters; access to drinking water at workplaces; access to places of convenience/toilets at work sites etc. • The conditions for the engagement will be communicated and made clear to all workers. • Workers Grievance Redress Mechanism will be implemented to help minimize labour disputes during the construction period.	
11.	Public/ community	Local communities,	Major	<u>Transport and public safety management measures</u> • Transport of the turbines and generators and other associated equipment	Minor

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures	Residual Impact Significance
	health & safety and security	public, trespassers, farmers		from Aboadze to Anwomaso will be done under escort to avoid traffic incidents. • All the vehicles to be used for the project and especially for transporting equipment and materials will be serviced regularly and all the drivers to be engaged/ assigned would be required to hold the requisite driver's license as prescribed by the Drivers and Vehicles Licensing Authority (DVLA) and with at least three years' experience, • All drivers/operators will be educated on public safety issues and measures. • All project vehicles and trucks will observe existing traffic speed limits (e.g. within 50km/hr) when passing through communities as required. • Reckless tooting of horns will be prohibited. • Trucks transporting quarry products and other friable materials to the sites will have these materials covered. • All trucks conveying materials to the project site will carry appropriate warning signals such as red flag and rotating amber lights. • Only roadworthy vehicles/trucks will be used. • A code of conduct for drivers on the road would be implemented. • Community complaints handling arrangements would be instituted. • Any accidents on the roads involving contractor vehicle/trucks would be investigated immediately and corrective actions taken to avert re-occurrence. • The transport of heavy equipment and loads of materials to site will avoid the usual working days rush hours of 6am to 8am and 4.30pm to 6.30pm. <u>Theft/security</u> • The Contractor will ensure that security personnel are recruited to protect lives and properties against theft and worker safety at the work camp and project site. • Due diligence will be carried out prior to recruiting any security person and a code of conduct will be developed to guide the conduct of all security personnel to ensure that these personnel do not become a threat to residents/ local community members, and do not manhandle prospective job seekers.	

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures	Residual Impact Significance
				• Security personnel to be engaged will be trained in human right issues to ensure that they do not abuse the human rights of the locals or job seekers. • Dangerous work sites and warehouse/storage facilities will have restricted access to authorized construction team members only <u>Provision of alternative foot or farm paths</u> • The contractor will be required to provide alternative farm paths or footpaths when any existing farm or foot paths are affected due to construction activities to enable farmers/pedestrians or residents to easily access their farms. <u>Public Health /Toilet facilities</u> • The Contractor will provide toilet facilities for workers during the construction phase. <u>Use of warning signs and restricted access to dangerous sites</u> • Open trenches/excavations will be protected using indicator linings or illustrative warning notices or wire mesh (whichever best suits the situation) to ensure public safety and prevent fall hazards. • Caution/warning signs will be placed and maintained at vantage points around the project site. • There will be restricted access to dangerous working areas and will be limited to authorized construction staff only.	
12.	Impact on cultural heritage and sociocultural norms	Anwomaso community	Minor	• There are no shrines, cemeteries nor sacred groves at the project site. However, the Contractor will establish and implement a chance find procedure and reporting system to ensure that any cultural heritage resources or antiquity chanced upon are handled properly. • Any antiquity found during the construction phase will be made known to the Ghana Museums and Monuments Board (GMMB) as required. • Where the observance of any traditional and cultural festivities/norms will affect project implementation timelines, the Contractor, and VRA/MoE will engage the traditional authorities for exemptions if possible.	Negligible

Table 7-3: Proposed Mitigation Measures for Operational &Maintenance Phase Adverse Impacts

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures	Residual Impact Significance
Operation and Maintenance Phase Mitigation Measures					
1.	Noise and Vibration Nuisance	Nearby local communities, GRIDCo substation, NVTI	Major	• Exhaust stacks will be provided with silencers behind the exhaust gas diffusers to reduce noise levels at the plant fence line. • The gas turbines, which can generate as high as 120 dBA will be placed in acoustical enclosures to reduce noise levels to the allowable 85dBA at 1m distances from the enclosures. • The distance between the gas turbines and the NVTI facility will be at least 500m. • VRA will use sound absorbing or insulation materials in walls and ceilings. • Adequate noise reduction fixtures will be provided on heavy vehicles and hauling equipment, which will transport materials and other items to the site. • Caution signs will be placed at all high noise zones, reminding workers of the mandatory use of ear protective equipment such as Earmuffs in those areas. • Adequate earplugs and training on their proper usage will be provided to all VRA and GRIDCo staff working in highly noisy areas on site. • A noise monitoring program will be instituted and data obtained will be analyzed and periodically reported on as required by the Regulators and VRA Management.	Minor
2.	Air Pollution	Public/ local communities and workers	Major	• The combustion system will have a suitable inlet air filters for the compressor to ensure efficient combustion system for the gas turbines. • VRA will use natural gas for the power generation, which is known to have minor air pollution impact due to its low sulphur content. Emissions of SO2 and Particulate Matter will be minimized by the use of natural gas. • For NOx, emissions will be minimized by the application of dry low NOx combustion system technology of the GE gas turbine. There will also be negligible ambient air quality via atmospheric dispersion from a stack height	Minor

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures	Residual Impact Significance
				of 56m. • The stack height will be 56m. This will enable high plume dispersal preventing fumes and heat from affecting the surrounding areas. • Stack emissions and ambient air quality will be monitored regularly as part of good environmental practice. • The Plant and its associated facilities especially turbines/generators will be operated efficiently and regular maintenance regime put in place to ensure that their combustion systems function properly. • VRA will procure and use modern equipment/ machinery and vehicles that meet applicable emission performance standards to minimize pollution. • All equipment/machines, trucks and vehicles will be maintained in good working order and turned off when not in use, to minimize emissions. • The exhaust emissions of heavy machinery will regularly be monitored by site staff. • There will be no burning of waste by VRA in the project area. • VRA will work closely with EPA to ensure compliance with emission limits through regular/continuous monitoring during operation. • VRA will provide nose masks for use by workers in areas where fugitive dust/emissions pose a challenge.	
3.	Greenhouse Gas Emissions and impact on climate change	Ozone layer, general climate	Moderate	• VRA will implement energy conservation and efficiency measures to check excessive combustion of fuels. • VRA will maintain and sustain the use of natural gas for the power plant to ensure that low emissions of GHGs are sustained throughout plant life. • VRA will put in place and carry out a scheduled and regimented maintenance program for its natural gas pipeline, and turbines to minimize fugitive gas emissions.	Minor
4.	Water Pollution/ impact on aquatic flora	Surface/ ground water, aquatic flora and fauna	Moderate	• Wastewater from washrooms/sanitary areas will be channeled into septic tanks and not into nearby water body. • Waste oils will be stored in separate drums and treated as hazardous wastes and not discharged directly or released into the environment.	Minor

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures	Residual Impact Significance
	and fauna			• Wastewater from the demineralization process will be treated in a neutralization sump prior to discharge into the storm drain from the Plant site that will connect the Adote Stream. • Awareness creation on water pollution minimization will be organized for all categories of workers.	
5.	Water consumption	Power Plant, workers/ local community	Major	• VRA will implement water conservation and efficiency measures to ensure effective optimization of water use and reduction of wastage. • VRA will drill one or two boreholes to supplement GWCL supplies so that available water for municipal and other community needs/usage is not compromised. • Water would be properly stored using the proposed facilities for use on the power plant site. • Water meters will be installed on GWCL pipelines leading to the office and plant and borehole line to monitor water usage. • Monitoring of water consumed and analysis of water consumption data with the assistance of GWCL would help to determine the need for an increased or decreased supply to the power plant station. • Awareness creation on water conservation practices will be organized for workers.	Minor
6.	Waste generation/ disposal and sanitation concerns	General environment near project area/land; nearby stream / local communities	Moderate	<u>Solid Waste Management</u> • Reusing/Recycling/Recovering techniques will be employed where possible to minimize disposal requirements/cost (e.g. by waste segregation according to type, separation of recyclable materials such as metal, paper reuse of wood from site, plastics). • Waste materials will be collected and disposed of frequently to prevent odour nuisance, wind-blown materials causing litter on site and vermin infestation. • Adequate waste bins will be provided at the power plant site to avoid littering of the sites.	Minor

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures	Residual Impact Significance
				• Solid wastes will be disposed of at approved Municipal Assembly dumpsites or landfill sites within the Kumasi Metropolis. • VRA will engage a solid waste management firm approved by the Municipal Assembly to collect and dispose of solid wastes regularly. • Scrap metals collection will be given to licensed dealers to send to steel recycling and manufacturing firms. <u>Liquid Waste Management</u> • Wastewater from washrooms/sanitary practices will be channeled into septic tanks, and dislodged by registered cesspit tank emptier. • Waste oil will be stored in drums kept in bunds. Waste oils will be collected and disposed of by EPA licensed waste oil companies. • Wastewater from the water treatment facility will be stored in a sump and neutralized prior to discharge into the storm drains that will empty into the stream. <u>Awareness creation</u> Awareness creation on waste minimization strategies will be organized for all workers.	
7.	Disruption in landscape aesthetics	Farmers, KNUST Plant Research, Anwomaso community, NVTI	Moderate	• VRA will fence of the plant site appropriately to minimise visual intrusion. • VRA will engage the Parks and Gardens Department to enhance or improve upon the landscape of the area by planting appropriate trees along the fence lines. • The local communities and nearby institutions will get use to the power plant installations overtime.	Minor
8.	Occupational health and safety concerns	Operational and maintenance workers and subcontractors/	Major	<u>Adoption of Health and Safety Policy and Plans</u> • VRA will educate all workers on the health and safety policy of VRA. • VRA will ensure that workers comply with the health and safety policy of the Company, and the EMP/ Health and Safety Plan for the power plant.	Minor

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures	Residual Impact Significance
		consultants		• A health and safety officer will be appointed to ensure compliance with the Health and Safety requirements of the power plant. <u>Training in equipment and chemical handling</u> • VRA will ensure that workers involved in the operation and maintenance of equipment at the power house, switchyard station and the transmission lines are given adequate safety training. • Handlers of all anti-corrosion chemicals will also be trained and would have access to the materials safety data sheets (MSDS) on the dangers and ways of handling these chemicals safely. <u>Use of Qualified and Experienced Personnel</u> • VRA will ensure that experienced and well-qualified workers are engaged to operate any heavy machine or equipment. • Only drivers/operators with the requisite licenses will be allowed to handle vehicles and earth-moving equipment. • Training and testing in machine/equipment handling and safe working procedures will be given to all new drivers, and operators to help minimise the occurrence of accidents on site. • VRA will institute regular defensive driving training sessions for its drivers to ensure their safety and the safety of the general public. <u>Provision of appropriate PPE</u> • VRA will provide and enforce the use of all required personal protective equipment including overalls safety boots, rain-coats, hand gloves, earplugs, nose masks, anticorrosive gloves, full body harness and non-conductive hand tools rated for the voltage at which live electrical work is being performed. • The Company will ensure that all visitors at site wear appropriate safety materials at all times. • Supervisors will be mandated to ensure the use of these protective devices and	

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures	Residual Impact Significance
				to implement agreed sanctions when necessary. <u>Emergency Provisions and Safety Precautions</u> Emergency Response plan will be developed for the operation and maintenance of the power plant, switchyard/substation, and high tension lines. The following safety precautions will be implemented: • As much as possible avoid working on live electrical parts except when de-energizing the equipment creates additional hazards or when the equipment must be energized to allow for testing that can only be performed live. • Ensure only qualified persons are allowed to work on live electrical parts. • Avoid ladders made from conductive materials such as aluminum or steel when working around overhead power lines. • Ensure that all staff working on live equipment or lines will be without conductive apparel (watches, bracelets, rings, key chains, necklaces, zippers, cloth with conductive thread, etc.). • Provide barricades and signage for all live electrical equipment. <u>Infirmary/Hospital</u> • VRA will have an on-site infirmary with a site nurse to treat minor ailments. • Major cases will be referred to selected public/private hospitals in the Kumasi area. • There will be an ambulance or a designated vehicle for emergency transfers.	
9.	Labour right concerns	Workers, power beneficiaries	Moderate	• VRA will comply with the labour laws of the country. • Every worker will be given a letter of appointment and condition of service for the engagement. • Workers will be allowed to join the appropriate labour unions of the TUC. • Management and general workers will agree on welfare conditions. • VRA will implement Workers Grievance Mechanism to help minimize labour disputes at the power station.	Minor

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures	Residual Impact Significance
10.	Public/ community health & safety and security concerns	Local communities, public	Major	• VRA will ensure correct operation and maintenance of the installed equipment, including regular inspections and maintenance regime. These measures will be defined in the operation and maintenance manual of the equipment/plant. • VRA will minimise emergency response time through the provision of adequate emergency equipment, development of emergency response procedures and training of staff to respond to emergency situations such as falling of a live electrical conductor, fire outbreak, explosions etc. • VRA will ensure timely repair and replacement works on fuel pipelines and transfer facilities, equipment at the power plant and switchyard station. • VRA will secure and fence the power plant and switchyard to prevent direct public access. • Security Officers will be provided for the facilities at all times to ensure intruders are kept away and for them to report all incidents that might be out of the ordinary for prompt attention. • VRA will monitor the integrity of the stacks, high tension poles, conductors and transformers. • The switchyard will be clearly marked with a red inscription on white background - "DANGER – High Voltage" to ward off trespassers, etc	Minor
11.	Emergency events and impacts on environment, properties and terrestrial/ aquatic ecology	Ecology, Power Plant and associated facilities, adjacent properties, workers, local communities	Major	• VRA will prepare and implement an emergency preparedness and response plan for the power plant. • The power plant will have a fire-fighting equipment installed at strategic areas of the power house.	Moderate
12.	Impact due to lack of sustainability	Electricity beneficiaries in Ashanti and	Major	• VRA, GRIDCo and ECG will regularly engage the PURC to ensure that bulk power is sold and procured at realistic charges to ensure sustainability of the system.	Moderate

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures	Residual Impact Significance
	measures	beyond, workers, local communities		• VRA/GRIDCo will set up a task force in the project area to sanction people who illegally vandalise any equipment. • Procedures for handling emergency situations such as equipment failure or falling of a live conductor will be put in place. • A comprehensive maintenance program will be put in place to avert any serious breakdowns or failures. The required maintenance for the systems will include among others: o Environmental incident/accident investigation; o Routine maintenance/inspection schedule; o Annual equipment inspection and maintenance record; o Procedure for pre-arranged repair service; o Procedure for preventive maintenance; o Procedures for handling materials; o Regular calibration; and o Emergency response plans and procedure.	

Table 7-4: Proposed Mitigation Measures for Decommissioning Phase Adverse Impacts

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures	Residual Impact Significance
Post construction Decommissioning Phase					

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures	Residual Impact Significance
1.	Occupational/ public safety and traffic and labour issues	Workers, public/ local communities	Moderate	(apply mitigation measures for construction phase)	Minor
2.	Soil contamination / sediment transport	Soil resources/ fauna	Moderate	(apply mitigation measures for construction phase)	Minor
3.	Water contamination/ impact on aquatic organisms and biodiversity	Aquatic environment	Minor	(apply mitigation measures for construction phase)	Negligible
4.	Waste generation/ disposal	Soil, aquatic environment and local communities	Moderate	(apply mitigation measures for construction phase)	Minor
5.	Air pollution	Ambient air, Workers, Anwomaso community, NVTI	Minor	(apply mitigation measures for construction phase)	Negligible
6.	Loss of employment	Consultants and Construction workers	Moderate	• The contracts for all consultants to be involved during the preparatory and construction phase will clearly indicate the duration of their assignment. • All workers to be engaged by the contractor will be informed that their engagement is temporary and ends after construction, and that their engagement is not a guarantee for reemployment during the operational phase.	Minor
Post operation/maintenance Decommissioning Phase					
1	Loss of job/ employment	Plant operation workers and subcontractors/ consultants	Moderate	• VRA will develop and include a retrenchment policy as part of the condition of service/service agreement for workers for them to know what they will be entitled to during retrenchment. • The contracts for all consultants/subcontractors to be involved	Minor

No.	Potential Impact	Key Receptor(s)	Evaluated Impact Rating	Proposed Mitigation and Management Measures	Residual Impact Significance
				during the operational/maintenance phase will clearly indicate the duration of their assignment.	
2	All other impacts	Bio-physical/ social environment, road users and the general public	(Not determined)	(To be determined and proposed in the future Decommissioning Plan of both Plant and associated facilities)	

SELJEN CONSULT

CHAPTER EIGHT

PROVISIONAL ENVIRONMENTAL MANAGEMENT PLAN

FINAL

ENVIRONMENTAL IMPACT STATEMENT

VOLTA RIVER AUTHORITY

8.0 PROVISIONAL ENVIRONMENTAL MANAGEMENT PLAN

A Provisional Environmental Management Plan (PEMP) for the proposed project is included in this EIS in accordance with the Environmental Assessment Regulations 1999, LI 1652. The aim of the PEMP is to act as a guiding manual by outlining management commitment towards implementation of the mitigation and monitoring of the adverse impacts during construction and operation/maintenance of the proposed project. An estimated cost for the PEMP implementation is also included in this report.

The VRA has a Safety Health and Environment (SHE) Standards for Contractors in place and these will be adopted for the construction of the project alongside the provisions of this EIS. The Contractor will be mainly responsible for the implementation of the construction phase mitigation and monitoring measures, whiles the VRA will be responsible for the implementation of all operational phase mitigation and monitoring measures. However, the VRA will collaborate with the Contractor during the construction phase to ensure the successful implementation of the provisions of this EIS and all permit conditions related to the project.

8.1 Objectives

The implementation of the Provisional Environmental Management Plan is expected to meet the following objectives:

- Manage actual impacts during project implementation phase;
- Ensure proper implementation of project permitting conditions;
- Ensure satisfactory environmental performance;
- To provide an early indication or warning should any of the environmental/social control measures or actions fail to achieve the acceptable standards;
- To monitor the effectiveness of the mitigation measures; and
- To take remedial actions if unacceptable impacts arise.

8.2 Environmental Policy

The VRA has an environmental policy in place. The Contractor shall be guided by the VRA Environmental Policy. The VRA project management team shall ensure a satisfactory level of environmental protection through planning, development, and management of the project according to relevant national legal requirements and international good industry practices. The

objective is to ensure environmental stewardship and compliance. The Contractor and VRA shall integrate environmental, health/safety matters into the construction phase decisions.

8.3 Health & Safety Policy

The VRA has a health and safety policy as well as SHE Standards for Contractors in place to guide the construction phase activities. Both VRA and the Contractor will be committed to a high level of worker/ public health and safety as well as a safe and secure project site and facilities in order to achieve a zero or minimal accidents.

The project management team shall give matters of health and safety equal importance to actual civil works and will manage accidents or emergencies in accordance with legislation and international good practices. A contingency plan or an emergency preparedness response plan to manage accidents/ emergencies and other natural disasters during the construction as well as operational phases will be put in place.

8.4 Measures to meet Requirements

The measures required to meet the objectives of the environmental management plan include commitment to the following:

- Acquisition of Environmental/Safety Permits or Approvals and compliance with statutory obligations/reporting;
- Management Structuring;
- Preparation of Method Statements and Standard Operational Procedures (SOP);
- Preparation of Construction EMP & HSMP;
- Capacity Building, Training and Awareness Creation;
- Public Involvement;
- Public Complaints and Grievance Redress;
- Corporate Social Responsibility;
- Environmental Mitigation Action Plan;
- Environmental Monitoring Plan;
- Document Control and Tracking;
- Management of Project Facilities;
- Resource Utilization and Management;
- Framework for Emergency Response Planning;

- Environmental Audit and Reviews; and
- Summary of Environmental Management Budget.

8.4.1 Acquisition of relevant environmental/safety permits and compliance with statutory obligations

The VRA and the Contractor will ensure that all relevant environmental and safety permits or approvals are obtained for the implementation of the project for both construction and operational phases and also ensure that the conditions or schedules attached to these permits are complied with. The key environmental/safety and energy permits required are provided in the table below.

Table 8-1: Key Environmental/Safety and Energy Approvals or Permits

Regulatory body	Permits/licenses and certificates	Project Phase	Remarks
Environmental Protection Agency	Environmental Permit	Prior to Construction Phase	After acceptance of final EIS by the EPA.
	Environmental Certificate	Within 24 months of commencement of Operations	After preparation of first EMP. Renewable every three years.
Energy Commission	Acquisition of provisional licence	During the planning and design stage	-
	Acquisition of siting clearance (siting permit)	Prior to commencement of construction works	Requires Environmental Permit
	Acquisition of construction work permit (authorization to construct)	Prior to commencement of construction works	After obtaining Environmental Permit
	Acquisition of operational licence	Prior to commencement of operation	After obtaining Environmental Permit
Ghana National Fire Service	Fire Permit/ Certificate	For both construction and operational phases. Construction of office buildings/ facilities and for contractor work camp/ storage facilities	Renewable on annual basis
Factories Inspectorate Department	Certificate of Registration	Construction and Operation phases. For contractor work camp/storage facilities and plant office/buildings and facilities	Renewable on annual basis
Oforikrom Municipal Assembly	Development and building approvals (for office buildings/ facilities	Prior to construction of facilities/buildings	-

Regulatory body	Permits/licenses and certificates	Project Phase	Remarks
Water Resources Commission	Borehole drilling license Water abstraction permit	Construction or Operational Phase	Drilling license for borehole contractor. Groundwater abstraction permit for VRA for boreholes

Environmental Reporting Obligations

The VRA will also ensure that statutory environmental reporting obligations such as submission of the necessary monthly/quarterly monitoring as well as annual environmental reports to the EPA in accordance with LI 1652 and the EPA permit schedules will be carried out.

8.4.2 Management Structuring including EHS

Construction Phase

(a) Appointment of a Project Manager by the Contractor

The Contractor shall appoint a Project Manager (PM) to oversee the day-to-day construction operations and shall be responsible for all aspect of the Environment, Health and Safety (EHS) Management for the Project. He or She shall among other things

- Ensure that all EHS logistics including PPEs are provided and available for the works.
- Ensure all machinery and equipment are in good condition and well serviced and the operators adhere to standard equipment operating procedures as well as environment, health and safety procedures.
- Monitor all construction/installation procedures, quality assurance and EHS documents, and other technical documents and records.
- Have an oversight supervision of all other site managers/supervisors for effective implementation of all actions required for project implementation success.

(b) Appointment of an Environment, Health and Safety (EHS) Officer by the Contractor

The Contractor will appoint an Environment, Health and Safety (EHS) Officer for the Project and he/she will report directly to the Project Manager. The responsibilities of the EHS Officer include among other things:

- Implement the environmental, health and safety policies agreed upon

- Enforce the environmental permit conditions and mitigation, monitoring and management measures
- Liaise with the PM to ensure all required PPEs, waste bins and other logistics are provided for the construction operations
- Identify appropriate training/sensitization programs for construction workers
- Ensure all machinery and equipment are in good working condition and well serviced
- Ensure all equipment operators adhere to environment, health and safety procedures
- Liaise with regulatory institutions such as EPA and GNFS and the local government authorities
- Keep records and reports of all incidents/accidents and illnesses
- Report all complains from the community and other stakeholders/workers concerning environmental, health and safety to the PM
- Report all non-compliances of environmental, health and safety procedures to the PM for appropriate action
- Enforce disciplinary actions against workers who don't comply with health and safety procedures.

(c) Formation of an Environment, Health and Safety (EHS) Committee

During the construction phase, VRA will constitute an environmental, occupational health and safety committee in consultation with the contractor's management team to design strategies to address possible impacts and risks. To ensure commitment from both sides, the respective Project Managers will provide environmental guidance to support the work of the EHS Committee.

Responsibility of EHS Committee

The functions of this committee will include among others:

- Carry out routine construction inspections and audits
- Ensure the implementation of the environmental permit conditions as well as the provisions of this EIS as well as the VRA environmental/safety policies for the construction phase;
- Work closely with the various project managers, contractor EHS officer and field workers to co-ordinate all activities with bearing on the environment and occupational health and safety;
- Reviewing monthly data collated on environmental management, workers' health and safety and security issues;

- Ensure that environment, health, safety and security complains and concerns of workers and communities are addressed; and
- Undertaking disciplinary actions against workers who do not comply with health and safety procedures.
- Process and manage environmental data to be generated with time to be presented in a friendly way to ensure easy consumption and appreciation by both management, other stakeholders and the general public; and
- Consult with Management to decide the role of Consultants/Experts and other third parties required to assist in the implementation of the environmental/safety management programs.

The Committee shall have monthly meetings or as agreed by the committee to discuss and deliberate on environment, health, safety and security issues and review the performance of the contractor. It is proposed that the EHS committee for the construction phase of the project to be made up of a six (6) membered committee. The Environmental Manager of VRA will serve as the chairman of the committee. The committee will include:

- VRA Environmental Manager – Chairman of committee
- VRA Health/Safety Representative
- A representative from the Supervising Consultant if any
- Three (3) representatives from the Contractor including
    - the Project Manager,
    - Contractor EHS Officer, and
    - A Construction Supervisor.

Operational Phase

During the operational phase however, VRA's existing Environment and Health/Safety Departments will take full responsibility over the environmental/safety management actions and programs.

8.4.3 Method Statements and Standard Operating Procedures

The Contractor shall develop Method Statements and Standard Operating Procedures (SOP) respectively for all key construction works/activities and equipment/machinery operations/ handling for the execution of the project. The standard operating procedures will serve to guide the workers in the proper use of equipment/machinery and the method statement will help the

engineers/technicians in the execution of major construction works/activities aimed at avoiding or minimising adverse impacts to the environment and ensuring worker/community health and safety and security.

8.4.4 Development of Construction EMP and HSMP

Prior to the commencement of construction activities, a Construction Environmental Management Plan (CEMP) and Construction Health/Safety Management Plan (CHSMP) will be prepared by the Contractor to govern construction activities as required by the IFC. The reports shall take into consideration the provisions in the VRA SHE Standards for Contractors, the construction phase mitigation and monitoring measures in this EIS, the provisional Health/Safety Management Plan to this EIS in **Annex 8-1** in the Volume II of this report, and other management requirements captured in this EIS. The Construction EMP and HSMP shall among other things confirm construction phase activities, confirm impacts and risks, describe resource allocation and assign roles and responsibilities for the execution of the tasks including monitoring and reporting.

8.4.5 Capacity Building/Training and Awareness Creation

Contractor and its Workers

The Contractor in consultation with VRA shall develop appropriate training and awareness materials for information, education and communication (IEC). The Contractor will disseminate the environmental, health and safety policies on the project to all construction workers including casual or sub-contract workers. Supervisors will be tasked to ensure that all workers comply with all the environmental and safety measures.

The operational manuals of construction equipment/ machinery as well as installation manuals of plant components will be made readily available to equipment operators, engineers and technicians as first source of information and for quick references for their operations.

Management and supervisors will also use induction briefing, early morning/ tool box meetings for task assignments as well as monthly project meetings as a means of communicating all environmental and social issues and tasks to construction workers in general including casuals and sub-contract workers. Workers and staff will be educated at these meetings and via circulars on the benefits of the mitigation measures put in place to address issues of noise, air/water pollution, biodiversity issues, waste management strategies put in place, need for efficient use of resources

as well as health and safety of workers/community, HIV/ AIDS, STDs and COVID 19 prevention protocols.

VRA and its Workers

The VRA will disseminate its environmental, health and safety policy documents to all workers on the Kumasi 1 Thermal Power Plant during the operational phase. The policy document will be made available or accessible to all employees including casual or sub-contract workers. The various plant and equipment supervisors will be tasked to ensure that all workers adhere to the environmental, health and safety policies of VRA.

Circulars and early morning meetings for task assignments will form the main means of communicating all environmental/safety issues and assignments to supervisors and workers in general. Periodic practical training programs on EHS including fire safety will be organised for workers to prevent or minimise the occurrence of accidents on the job.

Management will make available all operational manuals to relevant staff and organise short courses for staff where necessary to ensure the proper use of all materials and equipment. Environmental, occupational health and safety issues will form part of all agenda for management meetings. VRA will produce hand-outs on environmental and safety issues for all supervisory level staff relating to their respective areas of work.

The Plant Manager and Supervisors will be encouraged and sponsored to attend relevant EPA, Factories Inspectorate or Energy Commission sponsored seminars and workshops.

8.4.6 Public Involvement

The Contractor will welcome any complaints, constructive suggestions and advice on environmental, social, safety and security issues of concern during the implementation of the proposed project from nearby communities and the general public. Such complaints or suggestions will be received directly by the EHS Officer and or by the Security Officer at the project site. The office of the Project Manager for VRA will also welcome any such complaints or constructive suggestions and advice during project implementation.

Aggrieved individuals or communities can make or submit all complaints or concerns to their respective elected Assemblymen or Traditional Authorities for onward submission to VRA

Complaint Office for redress. Periodic announcement on local FM stations will be made as to where aggrieved individuals or communities can make complaints. It is envisaged that public involvement will help reduce conflict through early identification of contentious issues.

8.4.7 Provisional Grievance Redress Mechanism Framework

It is important that all stakeholders have a way of communicating their ideas and issues regarding the proposed project. Assemblymen and Assemblywomen must not be saddled with the task of handling such communication. For this reason, a Grievance Redress Mechanism (GRM) will be put in place to ensure that grievances are received, resolved and reported on.

8.4.7.1 *GRM Framework for the Construction Phase*

The Contractor in consultation with the VRA will use this GRM framework to establish a more detailed GRM for project implementation during the construction phases. The objective of the Grievance Redress Mechanism (GRM) is to provide an effective, transparent and timely system that would give aggrieved persons redress, minimize bad publicity, avoid/minimizes delays and avoid litigation in execution of the proposed project. This ensures public health and safety, and sustainability of the project. The GRM will provide affected stakeholders, avenues through which they can express their concerns and receive the needed corrective actions in an appropriate and timely manner.

The Contractor Project Manager and VRA will inform or notify the local communities and stakeholders of the establishment of a GRM. This will be done in collaboration with the Oforikrom Municipal Assembly. The sensitization on the GRM will be done in Asante Twi and English to enable stakeholders/local communities understand the content.

The GRM for the construction phase will consist of a four-tier resolution arrangement as follows:

- Local (project site) level;
- Complaint referred to or lodged with VRA;
- Municipal Assembly level grievance resolution; and
- Ministry-level grievance resolution.

The general process is that a project affected person and/or other stakeholders should first raise a grievance at the contractor project site office. If unresolved, it is referred to VRA Local or Corporate office. Beyond this level, the issue will be referred to the Municipal Assembly to

address and further to the Ministry of Energy if unresolved at the Assembly Level. If these prove unsuccessful in resolving the grievance, the complainant may seek legal redress at the law court to resolve the issue. The levels of the GRM are briefly discussed below and summarized in **Figure 8-1**.

Local (Project site) level

A complaint made to the contractor project site office shall be received by an assigned officer from the Supervising engineer/. The procedure shall be as follows:

- A complaint form shall be filled, dated and signed, a copy of the same shall be deposited in the Supervising Engineer's office and a copy sent to the Contractor.
- An acknowledgement of complaint form shall also be filled, signed and given to the complainant.

The Supervising Engineer will ensure that contractor provides adequate information to affected communities in respect of names, telephone numbers, and office locations where questions and complaints can be directed. The Supervising engineer will also ensure that the contractor makes this information available by appropriate means including signboards, leaflets, community meetings, etc.

For construction issues, the Project Manager of the Contractor shall investigate the issue with the Supervising Engineer and ensure that the proffered solution is communicated to the contractor through a site instruction. The Contractor shall resolve the grievance or rectify the anomaly within two (2) weeks of receipt of complaint. The Contractor's monthly project report will include grievance/complaints data and resolutions. The periodic monthly site meetings shall also discuss complaint issues.

Depending on the nature of the complaint, the Supervising Engineer can identify and involve a respectable community opinion leader or the local Assemblyman to assist with the resolution of the grievance at the local level if necessary.

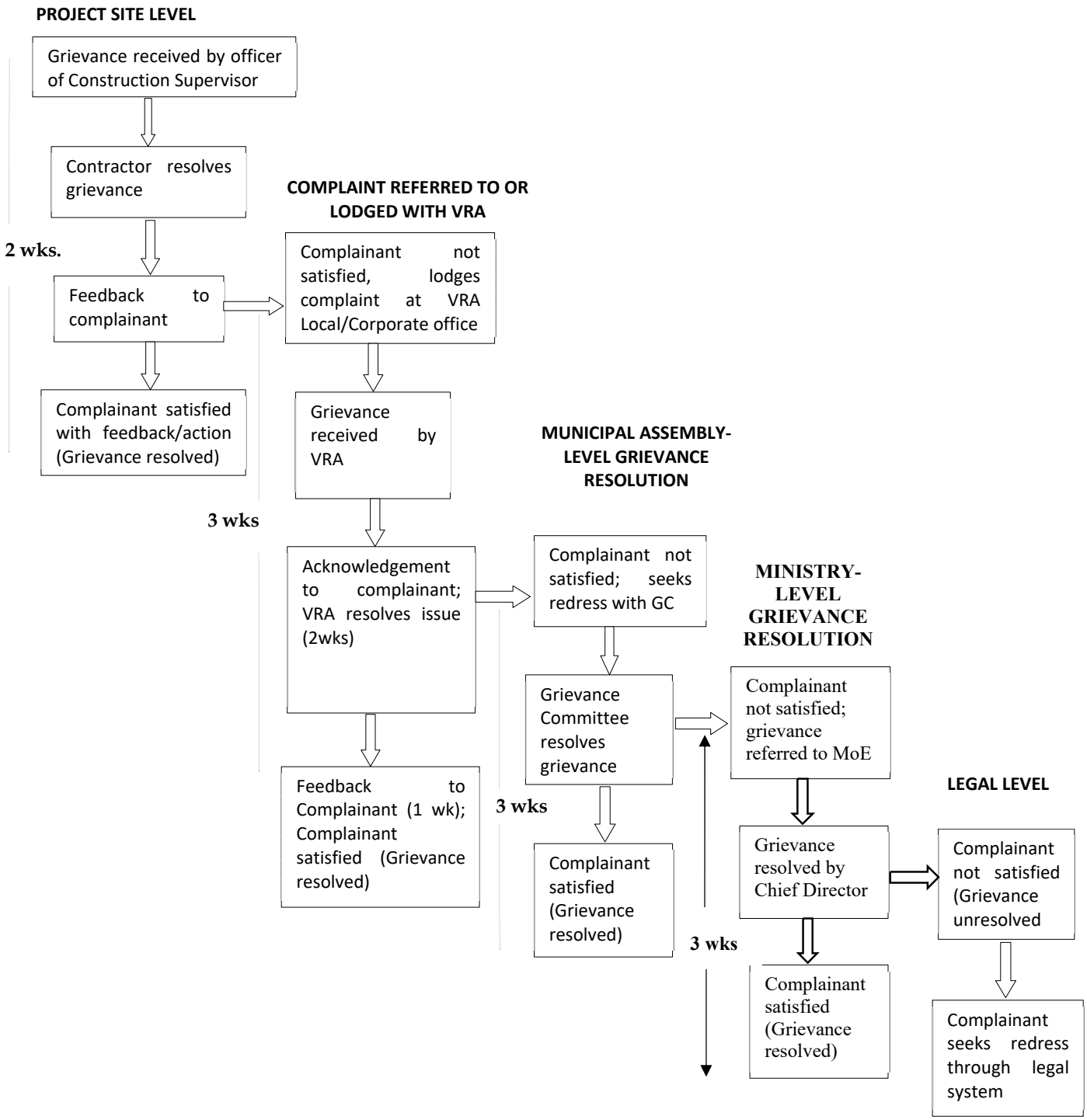

Figure 8-1: Proposed Grievance redress Mechanism Levels for Construction Phase Project Implementation

Complaints lodged or referred to VRA local/ Corporate Office

A written, email, or verbal complaint can be delivered at VRA local/corporate office. The supervising engineer can also refer unresolved complaints at the project site level to VRA. VRA shall record and sign such complaints to acknowledge receipt. An acknowledgement of complaint form should be sent or communicated to the complainant within two (2) weeks. Within this time, VRA shall liaise with the Supervising Engineer and the Contractor Project Manager to have the issue(s) resolved. When a solution is reached, the complainant shall be informed verbally and/or in writing within one (1) week thereafter. A written record of the proposed resolution shall be made. The solution proffered shall be recorded and executed. The VRA will follow up to find out whether the complainant is satisfied, and the results of the follow-up will be recorded.

Municipal Assembly-level Grievance Resolution

For issues that could not be resolved either directly with the Contractor on-site or through lodging of complaint with the VRA local/Corporate office, a project level Grievance Committee (GC) will be set up at the Municipal Assembly to handle such cases. The GC will include the following:

- A representative of Oforikrom Municipal Assembly (i.e. the Coordinating Director), as chairperson;
- Local Assemblyman for the affected community;
- Representative of VRA;
- Representative of the Contractor; and
- Representative of the Complainant.

The representative of the Assembly will chair the GC. The project GC at the Assembly will be made known to stakeholders as part of the sensitization on the GRM, but will sit to resolve grievances or complaints on as and when basis. The GC shall provide a response within three (3) weeks of receiving formal notification of a grievance. In cases where further site visits, investigations or discussions with the aggrieved stakeholder are deemed necessary in order to arrive at an amicable resolution, a date shall be planned with the complainant for the follow-up visit which will fall within the mandated three (3) weeks. Where it is not possible to address the issue within the proposed three weeks' timeframe, plausible reasons shall be communicated to the complainant or through his/her representative at the GC.

Ministry-level Grievance Resolution

Any unresolved grievances from the Municipal Assembly-level will be referred to the Ministry of Energy (MoE) for resolution. An acknowledgement of the complaint shall be sent to the complainant within two (2) weeks. The Chief Director at MoE shall further investigate the issue with VRA and will be responsible for mediating and resolving the complaint. The entire process shall be within three (3) weeks of receipt of complaint and the solution reached shall be communicated to the complainant.

Recourse or Alternative or legal level

If the aggrieved stakeholder or complainant is not satisfied with the outcome of the GC's intervention in resolving the grievance, the affected stakeholder has the option to pursue appropriate recourse through the legal system/law court as allowed by the Constitution of Ghana.

8.4.7.2 *Grievance Redress Mechanism for the Operational Phase*

The existing VRA grievance redress arrangement will apply during the operational phase. VRA will sensitize the local communities and stakeholders on the VRA grievance redress arrangement in place. The grievance procedure form and grievance closeout form used in the registration, resolution and closure of grievances are provided in **Annex 8-2** in the Volume II of this report**.**

8.4.8 Corporate Social Responsibility

VRA will extend its Corporate Social Responsibility (CSR) policy to the project during the operation phase by instituting a Community Development Program (CDP). The company will engage key stakeholders such as traditional authorities, local NGOs/CSOs, KNUST, Oforikrom Municipal Assembly, EPA, and the Energy Commission in the implementation of the CSR policy at all times.

Some of the issues considered in the CSR policy include:

- financial or other forms of contributory support for community infrastructural/social development such as education scholarships, health etc;
- special programs which benefit women, and support for youth and sports;
- malaria and HIV/AIDs and COVID-19 prevention and interventions;
- role of local government and traditional authorities; and
- role of non-governmental organizations.

VRA will also liaise with other power/energy supply companies within the project area such as GRIDCo, and ECG, to develop a holistic CSR programs or actions for implementation to the benefit of all the local communities in the project area to avoid duplication of actions and ensure effective use of resources.

8.4.9 Environmental Mitigation Action Plans

The Environmental Mitigation Action Plan (EMAP) is prepared to ensure that the mitigation measures proposed (***Chapter 7***) for potential impacts identified (***Chapter 6***) from the preparatory/pre-construction, construction and operational phases of the proposed K1 Thermal Power Plant Project are implemented in a timely and appropriate manner, and monitored to ensure compliance with the national and international environmental and health/safety requirements.

The Environmental Mitigation Action Plans are presented in **Tables 8-2** (pre-construction), **8-3** (construction phase) and **8-4** (operational phase) and organized under the following headings:

- Impact Issue;
- Mitigation actions;
- Objective;
- Timeframe;
- Frequency of monitoring or reporting;
- Responsibility;
- Indicator or means of verification; and
- Estimated annual cost.

Estimated cost or budget has been provided for the proposed actions where appropriate. Some of the mitigation actions form part of the Contractor's Bill of Quantities (BoQ) for the construction phase. Some of the cost for the proposed actions also form part of the usual annual recurring expenditure during the operational phase. The implementation of the pre-construction, and construction phases mitigation actions will respectively cost **GH₵144,000 per annum** and **GH₵187,000 per annum** (excluding cost that form part of Contractor BoQ). The implementation of the operational phase mitigation actions is estimated to cost **GH₵524,500 per annum**, and this also excludes some annual operational cost as provided in the tables below.

Table 8-2: ***Environmental Mitigation Action Plan-Pre-construction Phase***

Impact issue	Mitigation Actions	Objective	Timeframe	Frequency of monitoring or reporting	Responsibility	Indicator or means of verification	Estimated Cost/ Annum (GH₵)
Preparatory/ Pre-Construction Phase							
Land-take and displacement of farmers	• Engage KNUST on project land acquisition and documentation. • Seek approval for all necessary documentation needed for acquiring land.	To ensure that VRA follows due process to acquire the project land.	Pre-construction phase	Monthly	VRA	-Records of engagement meetings with KNUST. -Records on project land documents.	Part of project cost
	• Engage affected farmers on project work plan through an established communication channel.	To ensure that concerns of affected farmers are addressed	From start of land acquisition process to start of construction activities	Monthly	VRA Community Relations Team	-Records of meetings with affected farmers. -Records of concerns raised and extent of resolution.	3,000.00
	• Inform affected farmers and agree on adequate timeframe for harvesting vegetable and annual crops on land.	To ensure that affected farmers are able to salvage crops on the land	6 months before start of construction activities	Monthly	VRA Community Relations Team	-Records of meetings with affected farmers -Records of agreed timeframe between VRA and affected farmers.	2,000.00
	• Compensate any isolated perennial crops at the project site, e.g. oil palm	To ensure that affected farmers are fairly treated.	Prior to start of construction	Once	VRA Community Relations Team	-Records of identified isolated perennial crops. -Records of valuation and compensation.	2,000.00
	• Liaise with the Lands Commission to resolve all grievances/concerns related to affected standing crops	To ensure that affected farmers are fairly treated	3 months to start of construction	Monthly	VRA and Lands Commission	-Records of agreed timeframe between VRA and affected farmers	3,000.00

Impact issue	Mitigation Actions	Objective	Timeframe	Frequency of monitoring or reporting	Responsibility	Indicator or means of verification	Estimated Cost/ Annum (GH₵)
	• Disclose public information of the project.	To ensure public or social accountability	Throughout project implementation	Quarterly	VRA	Records of public disclosure or notifications on the project via FM announcements	8,000.00
Anxiety on the part of local community leaders/ people and affected farmers and nearby organisations	• Maintain an open communication with stakeholders including KNUST, affected farmers, Anwomaso traditional leaders, Anwomaso Transport Associations, NVTI, GRIDCo/ ECG in the project area. • Sustain liaison with all stakeholders and affected persons/institutions, and local communities	• To avoid or minimise tension and conflict. • To ensure trust and maintain good relationship among stakeholders and the Project	Throughout pre-construction phase	Monthly	VRA	Records of communication and engagement with stakeholders	6,000.00
	• Have periodic stakeholder interactions and education on proposed project activities, impacts and proposed mitigation measures.	To create awareness on the project, impacts and measures put in place to manage adverse impacts	Throughout project implementation	Quarterly	VRA	-Records of engagement/ interactions	-
	• Implement grievance redress mechanism	To enable stakeholder and community concerns to be documented and resolved in a timely manner	Throughout project implementation	Daily	VRA and Contractor	-GRM document prepared -Records of grievances and resolution	-

Impact issue	Mitigation Actions	Objective	Timeframe	Frequency of monitoring or reporting	Responsibility	Indicator or means of verification	Estimated Cost/ Annum (GH₵)
Risk of not acquiring appropriate permits for project implementation	• Obtain approval from the EPA for the implementation of the Project.	To comply with EPA Act 1994 and LI 1652	Prior to start of construction and during operation	Monthly	VRA	Record of EPA permit	70,000.00
	• Obtain Energy Commission siting, construction and operational permits/licenses.	To comply with Energy Commission Act 1997, Act 538	Prior to start of construction and start of operation	Monthly	VRA	Record of Energy Commission licenses and permits	30,000.00
	• Obtain permit from Water Resources Commission for drilling of borehole(s) at the site.	To comply with WRC Act 1996 and LI 1692	Prior to start of construction of borehole	Monthly	VRA	Record WRC permit for borehole drilling	10,000.00
	• Obtain fire permits from GNFS	To comply with the Fire Precaution (Premises) Regulations 2003, LI 1724	Prior to start of construction and during operation	Monthly	VRA and Contractor	Record of fire permit	10,000.00
	• Obtain registration certificate from the Factories Inspectorate Department	To comply with Factories, Offices and Shops Act 1970, Act 328	Prior to start of construction and during operation	Monthly	VRA and Contractor	Record of registration certificate from Factories Inspectorate	5,000.00
	• Obtain building/ development permits from Oforikrom Municipal Assembly.	To comply with Local Governance Act 2016, Act 936	Prior to start of construction and during operation	Monthly	VRA and Contractor	Record of development/ building permit	10,000.00

Impact issue	Mitigation Actions	Objective	Timeframe	Frequency of monitoring or reporting	Responsibility	Indicator or means of verification	Estimated Cost/ Annum (GH₵)
Occupational Health & Safety	• Use appropriate personal protective equipment such as safety boots, reflectors, overalls, nose masks, hand gloves, and earplugs as appropriate	To protect field teams from injury during field work	During field studies for preparatory activities	Daily in the field	VRA technical staff, Consultant	-Inspections -PPEs procured by consultants, technical staff	-
	• Use first aid kits to treat minor ailments. • Refer major cases to public/ private hospitals/ clinics in Kumasi for treatment.	To ensure appropriate treatment of minor and major injuries	During field work for preparatory activities	Daily	VRA technical staff, Consultants, Contractor	-Observation -Record of first aid kits available for field teams and selected hospitals/ clinics identified for major injury treatment	-
	• Use well trained and experienced survey teams	To ensure that survey teams knows what they are about in order to minimise field injury	Prior to start of survey work	As and when required	VRA, Contractor	Qualification of survey teams	-
	• Notify survey and field teams on the presence of dangerous reptiles and animals such as snakes, insects etc at the site.	• To notify field and survey teams of the likely presence of dangerous animals in the bush • To ensure that field teams adopt safe work methods	Mainly during pre-construction and during site clearing works	Prior to filed work	Employers	-Record of notification or awareness creation	-

Impact issue	Mitigation Actions	Objective	Timeframe	Frequency of monitoring or reporting	Responsibility	Indicator or means of verification	Estimated Cost/ Annum (GH₵)
	• Follow national COVID-19 protocols especially wearing of nose masks and use of sanitizers.	To prevent contraction and transmission of COVID-19	Throughout the pre-construction period	Daily during field work	VRA field team, consultant	-Observations -Record of sanitizer, nose masks usage	5,000.00
	• Carry drinking water to the field, and avoid working in the rain.	To avoid dehydration of workers	During pre-construction survey and field studies	Daily	Field/ survey teams	-Observations -Record of drinking water purchase and usage	-
Public/ community health and safety concerns	• Use good conditioned and well-maintained vehicles	To avoid frequent breakdowns on the roads and to reduce noise nuisance and smoke emissions	Throughout the preparatory period	Daily	Field/survey teams and consultants/ subcontractors	Records on vehicle servicing and maintenance regime	-
	• Follow national COVID-19 protocols during meetings with stakeholders.	To avoid contracting and spreading of COVID-19	Throughout preparatory phase	During meetings with stakeholders	Field/survey teams and consultants/ subcontractors	-Observations -Record of use of nose masks and sanitizers at meetings.	10,000.00
TOTAL-Pre-construction Phase							**144,000.00**

Table 8-3: Environmental Mitigation Action Plan for the Construction Phase

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility/ Supervision	Indicator or means of verification	Estimated Cost/Annum (GH₵)
Construction Phase Mitigation Measures							
Air Pollution	• Dampen exposed dusty surfaces, unpaved surfaces and aggregate stockpiles during construction with water	To suppress dust raising	Throughout construction period	Once daily during the dry periods	Contractor/ Supervising Engineer	Records of periodic watering	5,000.00
	• Limit vehicular/truck speed to between 30km/h and 50km/h on unpaved landscape/ routes	To minimize dust generation from vehicular movement	Throughout construction period	When unpaved landscape or routes are dry	Drivers and equipment operators	-Records of over-speeding complaints	-
	• Implement the manufacturer recommended engine maintenance program for all construction equipment and vehicles.	To ensure efficient engine performance of construction equipment/ vehicles. To minimise emissions of fumes and exhausts	Throughout construction period	As recommended in the vehicle/ equipment manual	Contractor	Equipment/ vehicle maintenance records	Part of Contractor equipment maintenance cost in BoQ
	• Monitor dust at NVTI whenever dust generating activities take place	To ensure dust levels do not exceed acceptable limits	Throughout construction period	As and when dust generating activities are observed	Contractor/ Supervising Engineer	Monitoring program in place	Part of environmental monitoring cost
	• Investigate dust-related grievances	To confirm cause of the dust complaints	Throughout construction period	As and when dust related complaints are registered and resolved	Contractor/ Supervising Engineer	Records of investigations and extent of resolutions	5,000.00

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility/ Supervision	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	• Do not undertake earthworks and other construction activities during very windy conditions	To minimize wind-blown dust from the site	Throughout construction period	As and when windy situations occur	Contractor/ Supervising Engineer	Inspection/ observation	-
	• Do not burn cleared vegetation	To prevent the generation of smoke polluting the ambient air	Throughout construction period	Daily	Contractor/ Supervising Engineer	Daily inspection	-
Noise and Vibration Nuisance	• Employ standard noise abatement measures and engineering good practices	To ensure that the impact of noise are minimized and reduced to acceptable limits	Throughout construction period	Quarterly	Contractor/ Supervising Engineer	-Noise control program -Record of engineering good practices	10,000.00
	• Operate and maintain all equipment/machinery in accordance with appropriate industry and manufacturers standards including regular checks and maintenance.	To ensure equipment/ machinery operate efficiently and effectively to minimise noise generation.	Throughout construction period	Weekly	Contractor	Equipment/ machinery maintenance records	Part of equipment maintenance cost in Contractor BoQ
	• Shut down or throttle down to a minimum machines in intermitted use during the intervening periods between works	To minimise noise and vibration generation	Throughout construction period	Daily	Contractor/ Supervising Engineer	Inspection/ observation	-

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility/ Supervision	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	• Undertake all construction and earthworks during daytime	To avoid noise nuisance during the night-time for local communities	Throughout construction period	Daily	Contractor/ Supervising Engineer	-Inspection -Records on time of close of work for construction activities	-
	• Implement a policy of minimal or no tooting of horns unless in emergency cases only.	To minimise noise generation from unnecessary tooting of horns by drivers and equipment operators	Throughout construction period	Daily	Contractor/ Supervising Engineer	-Policy on tooting of horns -Records of complaints	-
	• Provide earplugs or earmuffs for use by workers where necessary.	To minimise the effect of noise on workers	Throughout construction period	Daily	Contractor/ Supervising Engineer	Procurement records on earplugs. -Records on issuance of earplugs to workers	Part of general cost for PPEs
Impact on soil resources – loss of topsoil/ soil erosion/soil contamination	• Strip and store topsoil for reclamation and landscaping activities after construction works.	To ensure topsoil conservation and reuse	Throughout site preparation and construction period	As and when	Contractor/ Supervising Engineer	Inspections	Part of Contractor BoQ
	• Construct diversion channels and or silt fences around topsoil stockpiles	To protect topsoil stockpiles from erosion	Throughout construction period	As and when	Contractor/ Supervising Engineer	Inspections	Part of Contractor BoQ
	• Remove vegetation only at authorized or designated areas.	To avoid clearing undesignated areas	Throughout construction period	A and when	Contractor/ Supervising Engineer	Inspections	Part of Contractor BoQ

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility/ Supervision	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	• Store lubricant /oil and waste oil in drums that are not leaking and keep them in contained areas.	To minimise oil leakage and spread of leakage oil	Throughout project implementation	Daily	Contractor/ Supervising Engineer	-Inspections -Waste oil drums procured	Part of Contractor BoQ
	• Use equipment that are in good condition and which do not leak oil.	To avoid leakage of oil	Throughout project implementation	Daily	Contractor/ Supervising Engineer	-Inspections -Equipment maintenance records	Part of Contractor BoQ
	• Inspect on-site vehicles and equipment for leaks and repair all leakages immediately. • Check incoming vehicles and equipment to site for leaks, and repair leaking vehicles/equipment before allowed on-site.	To minimise onsite soil contamination	Throughout construction period	Daily	Contractor/ Supervising Engineer	-Inspections -Records of daily inspection report	Part of Contractor BoQ
	• Carry out visual inspection of project site for erosion features after every significant rainy event.	To identify eroded or areas prone to erosion requiring immediate control measures	Throughout construction period	After every major rainfall	Contractor/ Supervising Engineer	-Inspections	Part of Contractor BoQ
	• Adopt erosion control practices such as re-grading, compaction, diversion of runoff.	To control erosion on site	During site preparation, earthworks and civil works	As and when	Contractor/ Supervising Engineer	-Inspections	Part of Contractor BoQ
	• Carry out early re-vegetation of disturbed areas	To check erosion	Throughout construction period	As and when works on portions of the site is	Contractor/ Supervising Engineer	-Inspection -Revegetation program	Part of Contractor BoQ

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility/ Supervision	Indicator or means of verification	Estimated Cost/Annum (GH₵)
				completed			
Water pollution/ Siltation of Adote River	• Remove or clear vegetation at authorized or designated areas onsite only	To avoid exposing unauthorized areas to soil erosion and transport of sediments to nearby stream.	Throughout construction period	As and when	Contractor/ Supervising Engineer	-Inspection -Designated areas well demarcated for equipment operator	Part of Contractor BoQ
	• Discharge washroom wastewater/sewage from work camp into septic tank.	To avoid pollution of water bodies	Throughout construction period	Daily	Contractor/ Supervising Engineer	-Inspection -Septic tank in place at work camp	Part of Contractor BoQ
	• Construct sediment barriers or traps down gradient of construction sites	To prevent sediment transport into Adote River or its wetland areas.	Throughout construction period	As and when	Contractor/ Supervising Engineer	-Inspections -Sediment barriers in place	Part of Contractor BoQ
	• Store lubricant /oil and waste oil in drums that are not leaking and keep in contained areas.	To prevent leaked oil from being carried into water body	Throughout construction period	Daily	Contractor/ Supervising Engineer	-Inspections -Waste oil drums procured	Part of Contractor BoQ
	• Do not refuel construction equipment/ machines and vehicles at workplaces but use purpose-built designated area or commercial fuel stations in town.	To avoid oil spills from workplaces polluting water body	Throughout construction period	As and when	Contractor/ Supervising Engineer	-Inspections -Records of equipment refuelling	-

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility/ Supervision	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	• Do not wash equipment/vehicles onsite or near water bodies/wetlands or drains but at designated commercial washing bays.	To avoid contaminated wastewater from polluting water body	Throughout construction period	Daily	Contractor/ Supervising Engineer	-Inspections -Records or receipt of equipment/ vehicle washing	-
	• Use equipment that are in good condition, which do not leak oil.	To avoid oil leakages from equipment being transported into water bodies	Throughout construction period	Daily	Contractor/ Supervising Engineer	-Inspections -Equipment maintenance records	Part of Contractor BoQ
	• Provide temporary drainage channels to divert storm water away from excavated materials and stockpiles.	To minimise transport of sediment from excavated materials and stockpiles into the stream	Throughout construction period	As and when	Contractor/ Supervising Engineer	Inspections	Part of Contractor BoQ
	• Do not store solid wastes near water bodies nor dispose wastes into the stream/wetland areas.	To avoid pollution of water body with solid wastes	Throughout construction period	Daily	Contractor/ Supervising Engineer	-Inspections -Records of waste storage and disposal sites	-
Waste Generation/ Disposal and Sanitation Concerns	<u>General Waste/ Garbage</u> • Liaise with the Oforikrom Municipal Assembly to confirm approved waste disposal sites for use. • Engage the services of a waste collection firm to assist with onsite waste collection and disposal.	To ensure proper management of general waste/ garbage to minimise environmental pollution and safety concerns	Throughout construction period	Weekly	Contractor / Supervising Engineer	-Records of approved waste disposal sites -Records of waste bins procurement -Contract agreement with Waste collection firm	40,000.00

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility/ Supervision	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	• Appoint a waste management coordinator, who will be responsible for tracking of loads, and protocols for the maintenance of records of the quantities of wastes generated, reused/recycled and disposed. • Dispose domestic waste and refuse at the Municipal Assembly approved disposal sites. • Provide adequate waste bins at the work camp and construction sites/workplaces to minimize littering of the environment.					-Designated worker in charge of waste management -Inspections	
	<u>Construction Waste</u> • Segregate construction waste at the project sites. • Collect all metal scraps and give to recognized scrap dealers to send to steel manufacturing companies in the Kumasi enclave for recycling. • Stockpile topsoil for reclamation and landscaping activities. • Reuse excavated sub-soils to the extent practical for backfilling to reduce waste. • Dispose of other construction waste at the approved Municipal Assembly disposal sites.	To properly manage construction waste or spoil to minimise environmental pollution and safety concerns	Throughout construction period	Weekly	Contractor / Supervising Engineer	-Records of scrap dealers -Records of disposal sites for construction waste	Part of Contractor BoQ

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility/ Supervision	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	Hazardous Waste • Liaise with the Regional EPA in Kumasi to obtain a reputable hazardous waste collector to work with. • Engage an EPA approved hazardous waste collector for collection and disposal of all hazardous wastes. • Temporarily store all hazardous waste (e.g. oily waste/waste contaminated with oil, batteries etc) generated during construction as per manufacturer's instructions for collection and disposal by the EPA approved hazardous waste disposal firm. • Consider contaminated soil as hazardous waste and dispose of at the appropriate disposal site. • Put in place a hazardous waste tracking system.	To properly manage construction waste or spoil to minimise environmental pollution and health/safety concerns	Throughout construction period	Weekly	Contractor / Supervising Engineer	-Contract agreement with Hazardous waste collection firm -Records of hazardous waste tracking system -Records of hazardous waste containers	20,000.00

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility/ Supervision	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	Human waste • Provide toilet/washroom facilities for workers at the work camp and the project site. • Educate workers to use the toilet/washroom facilities provided. • Engage an approved cesspit emptier service provider from either the Municipal Assembly or privately operated ones to empty septic tank	To discourage free-range defecation and its effect on public health	Throughout construction period	Daily	Contractor /Supervising Engineer	Evidence of toilet facilities provided	Part of Contractor BoQ
Loss of vegetation/ habitat/ displacement of fauna/ risk of spread of invasive plant species	• Limit construction activities to only designated places and clearly mark out or delineated affected vegetation to be cleared, so that they are clearly visible to construction staff/equipment operators	To minimise clearance of unauthorised areas	Throughout construction phase	Weekly	Contractor /Supervising Engineer	-Record of area of land cleared -Inspections	Part of Contractor BoQ
	• Implement a wildlife /animal protection policy on no hunting and killing of wildlife at the project site and adjacent areas.	To prevent workers from hunting or killing wildlife or animals during project implementation	Throughout construction phase	Weekly	Contractor /Supervising Engineer	-Wildlife/ animal protection policy -Record of wildlife/ animals killed -Field observations	-
	• Give stray wildlife the right of passage at the project site and work camp.	To prevent workers from killing stray wildlife	Throughout construction period	Daily	Contractor / Supervising Engineers	Records of stray animals not killed	-

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility/ Supervision	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	• Inspect and monitor trucks and their contents during transfer of construction materials from offsite to the project site to be carried out at the source and delivery ends.	To identify any fugitive invasive plant species	Throughout construction phase	Daily	Contractor / Supervising Engineer	Inspections Records of fugitive plant species	Part of Contractor BoQ
	• Dismantle and remove all equipment and machinery after construction from site.	To prevent equipment and machinery from suppressing vegetation growth	After construction works	As and when	Contractor / Supervising Engineer	Construction equipment and machinery removed from site	Part of Contractor BoQ
Impact on aquatic organisms and biodiversity	• Do not dispose or dump any kind of waste near or into the Adote River, but place them in waste storage bins or at designated temporary waste storage sites.	To minimise pollution of surface water affecting aquatic life	Throughout construction period	Daily	Contractor / Supervising Engineer	-Records of waste disposal -Inspections	-
	• Implement water pollution measures as earlier presented above	To minimise adverse impact on aquatic life	Throughout construction period	-	Contractor / Supervising Engineer	Records of water pollution measures implemented	-
Visual intrusion/ landscape aesthetics	• Inform or notify the local communities/farmers about the nature of the construction and installation activities of the power plant and changes in landscape.	To make the local communities aware about the nature of the project facilities	During pre-construction and construction phases	Monthly	VRA	Records of notification	3,000.00
	• Fence the work camp facility.	To minimise direct view of work camp by local residents and farmers	Throughout construction phase	One off	Contractor / Supervising Engineer	Inspections	Part of Contractor BoQ

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility/ Supervision	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	• Hoard of the Project site from public view.	To prevent public view of construction site	Throughout construction period	One off	Contractor/ Supervising Engineer	Inspections	Part of Contractor BoQ
	• Do not heap remaining excavated material at project areas after construction. • Use remaining excavated material for landscaping works as appropriate. • Send remaining excavated materials after landscaping works to offsite disposal areas.	To avoid heaping excavated materials on site which will damage the landscape	Throughout construction period	Weekly	Contractor/ Supervising Engineer	Inspections	Part of Contractor BoQ
	• Plant landscape vegetation	To enhance the landscape aesthetics of the project area	During and after construction works	As and when	Contractor and VRA	Inspections	Part of Contractor BoQ
	• Ensure the design, colour and finish of the power plant takes into consideration the landscape of the area	To enhance the beauty of the project area	Preparatory and construction phase	-	VRA and Contractor	Inspection	-

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility/ Supervision	Indicator or means of verification	Estimated Cost/Annum (GH₵)
Labour influx	• Engage unskilled labour from the local communities. • Implement a stakeholder engagement plan that includes a feedback and grievance mechanism with the Anwomaso community. • Put in measures to collect feedback or complaints related to project labour influx from the Anwomaso community. • Resolve all labour influx related complaints with community opinion leaders	To minimise labour influx and its associated impacts	Throughout construction period	Weekly	Contractor and VRA	• Stakeholder engagement plan in place • Feedback and grievance mechanism in place • Records of labour influx grievance resolutions	5,000.00
Occupational health and safety concerns and labour right issues	Implementation of a Health and Safety Policy/Plan • Prepare and implement an occupational health and safety management plan, which shall conform to the health/safety standards of VRA for contractors and the provisions in this EIS during the construction phase. • Educate construction workers/ staff on the plan. • Appointed an Environmental and Safety Officer to ensure compliance with the Health and Safety Plan. • Contractor will organise weekly	To ensure the holistic management of occupational health and safety issues and to prevent/minimise the possibility of accidents/incidents and reduce health associated risks.	Throughout construction period	Daily	Contractor and VRA	• Record of Health and safety policy • Health and safety plan in place	Part of Contractor BoQ

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility/ Supervision	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	toolbox meetings for workers and brief them on EHS issues and what to do to safeguard the environment and avoid accidents or injuries.						
	First Aid Centre/Hospital • Put in place an on-site first aid centre with a site nurse to treat minor ailments. • Refer major cases to identified public/private hospitals/ clinics in the Kumasi area. • Designate at least one vehicle for emergency transfers, but not necessarily an ambulance.	To ensure that injured workers are properly treated.	Throughout construction period		Contractor	-Record of first aid center -Record of designated vehicle for emergency transfers	24,000
	Use of Qualified and Experienced Personnel • Engage experienced and well-qualified workers to operate any heavy machine or equipment. • Allow only drivers and equipment operators with the requisite licenses to handle vehicles and earth-moving equipment. • Provide initial training and testing in machine/equipment handling and safe working procedures to all new drivers,	To ensure that equipment/vehicle handling does not cause accidents	Throughout construction phase	Daily	Contractor/ Supervising Engineer	-Records of licenses and qualifications of drivers/ operators -Training and testing program for equipment handling and safe working procedures in place	-

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility/ Supervision	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	operators and other field workers.						
	Provision of Personal Protective Equipment (PPE) • Provide appropriate PPEs such as safety boots, helmets, reflectors, overalls, rain-coats, hand gloves, earplugs and nose masks to workers. • Empower Supervisors to ensure the use of the protective equipment and to impose agreed sanctions when necessary.	To ensure that workers are protected and not injured whiles working	Throughout construction period	Daily	Contractor / Supervising Engineer	Records of PPE procurement and issuance to workers	50,000.00
	Use of Road Worthy Vehicles/Equipment • Use good conditioned vehicles to avoid any breakdown along the roads. • Use well maintained vehicles/equipment in order to reduce noise nuisance and smoke emissions. • Inspect tools and equipment to ensure they are in good working order, and are well maintained with maintenance records.	To ensure vehicles and equipment do not breakdown often, generate noise nuisance/smoke nor cause accidents	Throughout construction period	Daily	Contractor / Supervising Engineer	Records of road worthiness of vehicles/ equipment	Part of Contractor BoQ
	Use of warning signs and restricted access to dangerous sites	To inform or notify workers about	Throughout construction	Daily	Contractor / Supervising	-Inspections -Records of	Part of Contractor

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility/ Supervision	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	• Protect open trenches or excavations using indicator linings or illustrative warning notices or wire mesh (whichever best suits the situation) to prevent fall hazards. • Place and maintain caution/warning signs at vantage points around the project site. • Restrict access to dangerous working areas and allow authorized construction/electrical staff only.	dangerous sites and to prevent unauthorised access.	period		Engineer	warning signs usage.	BoQ
	<u>Worker Rights and Wellbeing</u> • Implement a Human Resource Policy that adheres to the requirements of IFC PS2 and the national labour laws, including requirements for all workers to have contracts/appointment letters and clearly communicate to workers the conditions for their engagement. • Provide drinking water, places of convenience/toilets at work sites etc. • Implement Workers Grievance Redress Mechanism during the construction period.	To help minimize labour disputes during the construction period.	Throughout construction period	Daily	Contractor	-Record of human resource policy in line with IFC PS2 and national labour laws -Records of workers grievances and resolutions -Inspection of drinking water provision and places of convenience	Part of Contractor BoQ
Public/	<u>Transport and public safety</u>	To avoid traffic	Throughout	Weekly	Contractor /	-Records of traffic	Part of

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility/ Supervision	Indicator or means of verification	Estimated Cost/Annum (GH₵)
community health & safety and security	<u>management measures</u> • Provide escort for the transport of the turbines and generators and other associated equipment from Aboadze to Anwomaso. • Regularly service all construction vehicles and trucks especially in transporting equipment and materials. • Engage drivers who hold the requisite driver's license as prescribed by the Drivers and Vehicles Licensing Authority (DVLA) and with at least three years' experience. • Educate all drivers/operators on public safety issues and measures. • Ensure project vehicles and trucks observe traffic speed limits (e.g. within 50km/hr) when passing through communities as required. • Prohibit reckless tooting of horns. • Cover buckets of trucks when transporting quarry products and other friable materials to the sites. • Put appropriate warning signals	incidents, traffic congestion and ensure public safety. To minimise noise, dust and exhaust fumes nuisance.	construction phase		VRA	incidents -Records of public complaints and resolutions	Contractor BoQ

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility/ Supervision	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	such as red flag and rotating amber lights on trucks conveying materials to site. • Use only roadworthy vehicles /trucks. • Implement a code of conduct for drivers. • Put in place a community complaints handling arrangements. • Immediately investigate any accidents on the roads involving contractor vehicle/trucks and take corrective actions to avert re-occurrence. • Avoid the usual working days rush hours of 6am to 8am and 4.30pm to 6.30pm when transporting heavy equipment and loads of materials to site.						
	<u>Theft/security</u> • Recruit security personnel to protect lives and properties against theft and worker safety at the work camp and project site. • Carry out due diligence on security personnel prior to their engagement. • Develop a code of conduct to	To avoid or minimise theft and protect workers and properties at the project site/work camp. To confirm integrity of security persons engaged	Throughout construction period	Daily	Contractor	-Records of theft at project site -Records of security breaches at project site	Part of Contractor BoQ

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility/ Supervision	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	guide the conduct of all security personnel to ensure that these persons do not become a threat to residents/ local community members, and do not manhandle prospective job seekers. • Provide training for Security personnel in human right issues. • Do not allow unauthorized persons to dangerous work sites and warehouse/storage facilities	and to ensure security persons do not abuse the human rights of local people and job seekers.					
	<u>Provision of alternative foot or farm paths</u> • Provide alternative farm paths or footpaths when existing foot or farm paths are affected or obstructed by construction activities	To enable farmers/pedestrians or residents to access their farms.	During construction period	As and when required	Contractor/ Supervising Engineer	Inspections	5,000.00
	<u>Public Health /Toilet facilities</u> • Provide toilet facilities for workers.	To avoid open defecation	Throughout construction period	Two weeks to start of construction	Contractor /Supervising Engineer	Inspections Record of Toilet facilities in place	Part of Contractor BoQ
	<u>Use of warning signs and restricted access to dangerous sites</u> • Protect open trenches or excavations using indicator linings or illustrative warning notices or wire mesh (whichever best suits the situation) to ensure	To inform or notify the public and trespassers about dangerous sites and to prevent unauthorised access.	Throughout construction period	Daily	Contractor /Supervising Engineer	Inspections Record of warning signs usage	Part of Contractor BoQ

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility/ Supervision	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	public safety. • Place and maintain caution/warning signs at vantage points around the project site. • Do not allow unauthorized persons or locals access to dangerous working areas	To minimise or avoid public safety threats					
Impact on cultural heritage and sociocultural norms	• Establish and implement a chance find procedure and reporting system. • Inform the Ghana Museums and Monuments Board (GMMB) and VRA when any antiquity is found during the construction period	To ensure that any cultural heritage resources or antiquity chanced upon are handled properly.	During site preparation, excavation and earthworks	As and when	Contractor and VRA	Record of chance find procedures Records of notification to GMMB	10,000.00
	• Engage and negotiate with traditional authorities for exemptions when the observance of traditional and cultural festivities/norms will affect project implementation timelines.	To ensure that project timelines are met	Throughout construction period	As and when	Contractor and VRA/MoE	Records of engagement with traditional authorities	10,000.00
TOTAL-Construction Phase							**187,000.00**

BoQ = Bill of Quantities

Table 8-4: Proposed Mitigation Measures for Operational &Maintenance Phase Adverse Impacts

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility	Indicator or means of verification	Estimated Cost/Annum (GH₵)
Operation and Maintenance Phase Mitigation Measures							
Noise and Vibration Nuisance	• Provide exhaust stacks with silencers behind the exhaust gas diffusers	To reduce noise levels from stacks and plant fence line.	Throughout operational phase	Prior to installation of stacks	VRA	-Inspection -Audit report	Part of project cost
	• Place gas turbines in acoustical enclosures.	To reduce noise levels from 120 dBA to 85 dBA at 1m distance from the enclosures.	Throughout operational phase	Prior to installation of gas turbines	VRA	-Inspection -Audit report	Part of project cost
	• Position or site the gas turbines/plant at a distance of about 500m from the NVTI facility	To ensure that noise from the Plant is not a nuisance to NVTI	Construction period	Once	VRA and Contractor	-Field measurement	Part of project cost
	• Use sound absorbing or insulation materials in walls and ceilings.	To reduce noise levels from plant fence line	During construction of buildings and structures	-	VRA	-Inspection -Audit report	Part of project cost
	• Procure and use heavy vehicles and hauling equipment with adequate noise reduction fixtures to transport materials and other items to the power station.	To reduce noise levels from heavy vehicles and hauling equipment	Throughout operational phase	As and when procurement of vehicles/ equipment is to be made	VRA	Record of vehicle/ equipment procurement specifications	Part of recurrent operational budget

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	• Place caution signs at all high noise zones	To remind workers of the mandatory use of ear protective equipment such as ear muffs	Throughout operational period	Monthly	Plant Manager/ HSSE Officer	Audit report Annual report	Part of recurrent operational budget
	• Provide adequate earplugs and train VRA and GRIDCo staff working in highly noisy areas on site on their proper usage.	To ensure the effective use of ear plugs provided	Throughout operational phase	Daily	Plant Manager /HSSE Officer	Record of earplug procurement and issuance to workers -Audit report	Part of general PPE purchase cost
	• Institute a noise monitoring program, analyse data obtained and periodically report on monitoring outcomes as required by Regulators and VRA Management.	To ensure that noise levels are within acceptable standards	Throughout operational phase	Monthly	HSSE Officer	-Monitoring program -Audit report	Part of noise monitoring cost
Air Pollution	• Sustain the use of natural gas for the power generation, which is known to have minor air pollution impact due to its low sulphur content.	To minimise gaseous pollutant generation	Throughout operational phase	Continuous	VRA	Record of natural gas supplies	Part of recurrent operational budget
	• Install stacks of not less than 56m high.	To enable high plume dispersal preventing flue gases and heat from affecting the surrounding areas	Prior to start of operations	Once	VRA	Field measurement	Part of project cost

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	• Monitor stack emissions and ambient air quality regularly as part of good environmental practice.	To ensure that concentrations of emissions and ambient air quality are within acceptable standards	Throughout operational period	Continuous for stack emissions and Monthly for ambient air quality	VRA	Monitoring returns	Part of environmental monitoring cost
	• Operate Plant and its associated facilities especially turbines/ generators efficiently.	To ensure their combustion systems function properly.	Throughout operational phase	Daily	VRA	Record of plant efficiency	Part of operational cost
	• Procure and use modern equipment/ machinery and vehicles that meet applicable emission performance standards.	To minimise fumes generation and pollution	Throughout operational phase	As and when required	Plant Manager	Records of equipment procurement specifications on emission standards	Part of recurrent operational budget
	• Maintain all equipment/machines, trucks and vehicles in good working order and turn off engines when not in use.	To minimise emissions	Throughout operational phase	Daily	Plant Manager	Equipment/ machine maintenance records	Part of recurrent operational budget
	• Monitor exhaust emissions of heavy machinery regularly.	To ensure quality of emissions is within acceptable standards	Throughout operational phase	Biannually	VRA	Monitoring returns	10,000.00
	• Do not burn waste in the project area.	To avoid smoke generation and air pollution	Throughout operational phase	Daily	VRA staff	Inspection Record on waste burning	-

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	• Work closely with EPA during operation of the plant through regular/ continuous monitoring	To ensure compliance with emission limits	Throughout operational phase	Continuous monitoring	VRA management	Monthly monitoring report	Part of monitoring cost
	• Provide nose masks for use by workers in areas where fugitive dust/emissions pose a challenge.	To prevent the inhalation of fugitive dust/emissions by workers	Throughout operational phase	Daily	Plant Manager/ HSSE Officer	Record of procurement of nose masks and issuance to workers	Part of general PPE cost under health/safety
Greenhouse Gas Emissions and impact on climate change	• Implement energy conservation and efficiency measures to check excessive combustion of fuels.	To check excessive combustion of fuels	Throughout operational phase	Quarterly	VRA	Energy conservation and audit reports	Part of recurrent operational budget
	• Maintain and sustain the use of natural gas for the power plant	To ensure that the low emissions of GHGs from natural gas are sustained throughout plant life.	Throughout operational phase	Annually	VRA	Record of natural gas supplies	Part of recurrent operational budget
	• Put in place and carry out a scheduled and regimented maintenance program for its natural gas pipeline and turbines.	To minimise fugitive gas emissions	Throughout operational phase	Monthly or quarterly	VRA	Record of scheduled maintenance program Audit report	Part of recurrent operational budget
Water Pollution/ impact on aquatic flora and fauna	• Channel wastewater from washrooms/sanitary areas into septic tanks. • Store effluent from the demineralization plant in a sump	To prevent untreated and poor quality wastewater discharge into Adote River	Throughout operational phase	-	VRA	Design of washroom/ sanitary areas. Design of neutralisation	Part of project cost

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	and treat before discharge into the storm drain from the plant site.					sump	
	• Store waste oils in separate drums and treat as hazardous wastes. • Do not discharge or release waste oils directly into the environment.	To prevent discharge of hazardous waste into the environment	Throughout operational phase	Monthly	VRA	- Records for waste oil storage and disposal. -Inspections -Audit reports	Part of recurrent operational budget
	• Organize awareness creation on water pollution prevention and minimization for all categories of workers.	To educate workers on water pollution concerns	Throughout operational phase	Annually	VRA and EPA	Awareness creation program -Awareness creation report	Part of general awareness creation budget
Water consumption	• Implement water conservation and efficiency measures	To ensure effective optimization of water use and reduction of wastage	Throughout operational phase	Daily	Plant Manager	Water conservation and audit report	Part of recurrent operational budget
	• Drill one or two boreholes to supplement GWCL supplies	To ensure that potable water from GWCL available for municipal and other community needs/usage is not compromised	After construction and before start of operations	Once	VRA	-Inspection -Record of borehole drilled	20,000.00
	• Use the proposed facilities to properly store water for use on the power plant site.	To ensure adequate storage and control of water for plant usage	Throughout operational phase	-	VRA	-Inspection -Facility audit report	-

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	• Installed water meters on GWCL pipelines leading to the office and plant and borehole line.	To effectively monitor water usage at various sections of the facility	Throughout operational phase	After installation of pipeline	VRA and GWCL	-Inspection -Records on installation of water meters	Part of recurrent operational budget
	• Monitor water consumption and analyze water consumption data with the assistance of GWCL.	To help to determine the need for an increased or decreased supply to the power plant station.	Throughout operational phase	Monthly	VRA and GWCL	Water consumption monitoring report	Part of recurrent operational budget
	• Create awareness on water conservation practices for workers.	To ensure that workers are educated on water conservation practices	Throughout operational phase	Annually	VRA and GWCL	-Awareness creation program -Training report	Part of general awareness creation cost
Solid waste generation/ disposal	• Employ reuse/recycle/recovery techniques (e.g. by waste segregation according to type, separation of recyclable materials such as metal, paper reuse of wood from site, plastics).	To minimize disposal requirements and cost	Throughout operational phase	Weekly	HSSE Manager	-Records of waste segregation	Part of recurrent operational budget
	• Collect and dispose of waste materials frequently.	To prevent odour nuisance, wind-blown materials causing litter on site and vermin infestations.	Throughout operational phase	Weekly	HSSE Manager and waste disposal firm	Records of waste collection and disposal	Part of recurrent operational budget

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	• Provide adequate waste bins at the power plant station.	To avoid littering of the station.	Throughout operational phase	Weekly	Plant Manager	Inspection Records on waste bins provision	4,500.00
	• Dispose of solid wastes at approved Municipal Assembly dumpsites or landfill sites within the Kumasi Metropolis.	To ensure proper disposal of solid wastes and to minimise environmental pollution	Throughout operational phase	Weekly	HSSE Manager and waste disposal firm	Records on disposal sites	Part of cost for engagement of waste collection firm below
	• Engage a solid waste management firm approved by the Municipal Assembly to collect and dispose of solid wastes regularly.	To ensure proper collection and regular disposal of solid wastes	Throughout operational phase	Annually	Plant Manager	Contract of engagement	20,000.00
	• Give scrap metals to licensed dealers to send to steel recycling and manufacturing firms in the Kumasi enclave.	To ensure proper collection and disposal of scrap metals	Throughout operational phase	Quarterly	HSSE Manager	Records of scrap metal disposal	Part of recurrent operational budget
	• Create and organize awareness on solid waste minimization strategies for all workers.	To educate workers on solid waste minimisation strategies	Throughout operational phase	Annually	HSSE Manager/Plant Manager	Awareness creation program Training report	Part of general awareness creation budget

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility	Indicator or means of verification	Estimated Cost/Annum (GH₵)
Liquid Waste	• Channel wastewater from washrooms/sanitary areas into septic tanks, and use registered cesspit tank emptier to dislodge when full	To ensure proper storage of wastewater from washrooms and sanitary areas	Throughout operational phase	Continuous	Plant Manager	Septic tanks constructed.	Part of recurrent operational budget
	• Store waste oil in drums kept in bunds. • Engage EPA licensed waste oil companies to collect for final disposal.	To ensure proper management of waste oils	Throughout operational phase	As and when required	HSSE Manager/ Plant Manager	-Inspection of waste oil drums -Engagement contract for licensed waste oil firm	80,000.00
	• Store wastewater from the water treatment facility in a sump and neutralize prior to discharge into the storm drains.	To ensure quality of wastewater from the water treatment facility meets acceptable standards	Throughout operational phase	Weekly	HSSE Manager/ Plant Manager	-Inspection -Sump constructed. Records on neutralisation activities	Part of project and recurrent operational budget
	• Create and organize awareness on liquid waste minimization strategies for all workers.	To educate workers on liquid waste minimisation strategies	Throughout operational phase	Annually	HSSE Manager	-Awareness creation program -Training report	Part of general awareness creation budget
Disruption in landscape aesthetics	• Fence of the plant site appropriately	To minimise visual intrusion.	Throughout operational phase	Prior to start of operational activities	VRA	-Inspection -Site fence in place	Part of project cost
	• Engage the Parks and Gardens Department to enhance or improve upon the landscape of the area by planting appropriate trees along the	To improve or enhance the landscape beauty of the project area	After construction works	-	VRA	Records on engagement	20,000.00

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	fence lines.						
Occupational health and safety concerns	<u>Adoption of Health and Safety Policy and Plans</u> • Educated all workers on the health and safety policy of VRA. • Ensure workers adhere to the health and safety policy of VRA, and the EMP/ Health and Safety Plan for the power plant. • Appoint a health and safety officer to ensure compliance with the Health and Safety Policy.	To ensure the holistic management of occupational health and safety issues and to prevent/minimise the possibility of accidents/ incidents and reduce health associated risks.	Throughout operational phase	Monthly	VRA	Record of VRA health and safety policy Audit reports Annual reports	Part of recurrent operational budget
	<u>Training in equipment and chemical handling</u> • Provide adequate safety training of workers involved in the operation and maintenance of equipment at the power house, switchyard station and the transmission lines. • Provide training to handlers of all anti-corrosion chemicals and access to the materials safety data sheets (MSDS) on the dangers and ways of handling these chemicals safely.	To ensure that workers involved in the operation and maintenance of equipment and handling of chemicals are trained.	Throughout operational phase	Annually	VRA	Training program Training report	Part of recurrent operational budget

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	<u>Use of Qualified and Experienced Personnel</u> • Engage experienced and qualified workers to operate any heavy machine or equipment. • Allow only drivers with the requisite licenses to handle vehicles and earth-moving equipment. • Given all new drivers, operators and other field workers initial training and testing in machine/equipment handling and safe working procedures. • Institute regular defensive driving training sessions for drivers to ensure their safety and the safety of the general public.	To help minimise the occurrence of accidents on site and ensure the safety of the general public	Throughout operational phase	Daily	VRA	Records of licenses and CVs of drivers/ operators Training reports	Part of recurrent operational budget
	<u>Provision of appropriate PPEs</u> • Provide and enforce the use of all personal protective equipment including overalls, safety boots, reflectors, raincoats, hand gloves, ear plugs, nose masks, anticorrosive gloves, full body harness and non-conductive hand tools rated for the voltage at which live electrical work is being performed.	To protect workers and onsite visitors from injury	Throughout operational phase	Working days	VRA Management	Records on PPE procurement and issuance to workers	150,000.00

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	• Ensure that all visitors at site also wear appropriate safety materials at all times. • Supervisors will be mandated to ensure the use of these protective devices and to implement sanctions when necessary.						
	<u>Emergency Provisions and Safety Precautions</u> • Develop an Emergency Response plan for the operation and maintenance of the power plant, switchyard/substations, and high tension lines. • Implement the following safety precautions: o As much as possible avoid working on live electrical parts except when de-energizing the equipment creates additional hazards or when the equipment must be energized to allow for testing that can only be performed live. o Ensure only qualified persons are allowed to work on live electrical parts. o Avoid ladders made from conductive materials such as	To minimise emergency cases and effectively manage emergency cases when they occur.	Throughout operational phase	As and when required	VRA Management	Records on emergency response plan preparation and implementation	Part of emergency response plan cost provided below

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	aluminum or steel when working around overhead power lines. o Ensure that all staff working on live equipment or lines will be without conductive apparel (watches, bracelets, rings, key chains, necklaces, zippers, cloth with conductive thread, etc.). o Provide barricades and signage for all live electrical equipment.						
	Infirmary/Hospital • Have an on-site infirmary with a site nurse to treat minor ailments. • Refer major cases to selected public/private hospitals in the Kumasi area. • Have an ambulance or a designated vehicle for emergency transfers.	To properly treat injuries and ailments	Throughout operational phase	Monthly	VRA Management	-Inspection -Records on selected hospitals for referrals -Records on dedicated vehicle or ambulance procurement	Part of recurrent operational budget
Labour right concerns	• Comply with the labour laws of the country.	To ensure that workers labour rights are respected	Throughout project life	Monthly	VRA Management	Record of labour disputes	Part of recurrent operational budget

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	• Give every worker a letter of appointment and condition of service document	To ensure that workers labour rights are respected	Throughout project life	As and when required	VRA Management	Records on letters of appointment	Part of recurrent operational budget
	• Allowed workers to join the appropriate labour unions of the TUC.	To ensure that workers labour rights are respected	Throughout project life	As and when required	VRA Management	Records on Labour unions at plant site	Part of recurrent operational budget
	• Agree on welfare conditions for workers.	To ensure a satisfactory welfare conditions for workers	Throughout project life	Annually	VRA Management and workers	Records ob welfare conditions	Part of recurrent operational budget
	• Implement workers grievance redress mechanism	To help minimise labour disputes at the power station	Throughout project life	Monthly	VRA Management	Records on workers grievances and resolutions	Part of recurrent operational budget
Public/ community health & safety and security concerns	• Implement measures provided in the operation and maintenance manual of the equipment/ plant and carry out regular inspections and maintenance program.	To ensure correct operation and maintenance of the installed equipment	Throughout operational phase	Monthly	VRA Engineering and Maintenance Department	Equipment and machinery maintenance records	Part of recurrent operational budget
	• Provide adequate emergency equipment, develop emergency response procedures and train staff in emergency situations such as responding to falling live electrical conductor, fire, explosions etc	To minimise emergency response time	Throughout operational phase	Biannually	VRA	-Records on emergency equipment procurement -Training report	Part of recurrent operational budget

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	• Carry out timely repair and replacement works on fuel pipelines and transfer facilities, equipment at the power plant and switchyard station.	To prevent escalation of damages leadings to an emergency occurrence	Throughout operational phase	Annually	VRA	Repair and maintenance records for pipelines, switch yard and plant	Part of recurrent operational budget
	• Secure and fence the power plant and switchyard facilities	To prevent direct public access	Prior to start of operations	Once	VRA	-Inspection -Records on fencing work	Part of project cost
	• Provide security officers for the facilities at all times	To ensure intruders are kept away and enable the officers to report all incidents that might be out of the ordinary for prompt attention.	Throughout operational phase	Daily	VRA	Records on security personnel engagement	Part of recurrent operational budget
	• Monitor the integrity of the stacks, high tension poles, conductors and transformers	To guarantee the integrity and stability of these facilities	Throughout operational phase	Annually	VRA Engineering Department	Facility integrity monitoring records or report	Part of recurrent operational budget
	• Clearly marked with a red inscription on white background - "DANGER – High Voltage" to ward off trespassers, etc at the switchyard	To inform the general public of the danger of the switchyard	Throughout plant life	As and when required	VRA	-Inspection -Records on safety signage	Part of recurrent operational budget

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility	Indicator or means of verification	Estimated Cost/Annum (GH₵)
Emergency events and impacts on environment, properties and terrestrial/ aquatic ecology	• Prepare and implement an emergency preparedness and response plan for the power plant.	To make the Plant and staff ready for any emergency	Throughout operational phase	Daily	VRA Management	Record of emergency response plan documentation	200,000.00
	• Install fire-fighting equipment on the power plant and at strategic areas of the power house.	To control and fight any fire outbreak and minimise damage	Throughout operational phase	-	VRA	-	Part of project cost
Impact due to lack of sustainability measures	• Regularly engage the PURC to ensure that bulk power is sold and procured at realistic charges to ensure sustainability of the system.	To enable power utility agencies charge realistic rates	Throughout operational phase	Annually	VRA, GRIDCo and ECG	Records on meetings	10,000.00
	• Set up task force in the project area to sanction people who illegally vandalize any equipment.	To determine appropriate punishment or sanction for people who damage equipment	Throughout operational phase	Annually	VRA and GRIDCo	Records on Task force formation and activities	10,000.00
	• Instituted procedures for handling emergency situations such as equipment failure or falling of a live conductor.	To enable workers able to deal with such emergency situations	Throughout operational phase	Annually	VRA	Records on documentation of procedures for handling emergency situations	-

Impact Issue	Mitigation Actions	Objective	Timeframe	Frequency of reporting or monitoring	Responsibility	Indicator or means of verification	Estimated Cost/Annum (GH₵)
	• Put in place a comprehensive maintenance program. Include among others the following in the maintenance program: o Environmental incident/accident investigation; o Routine maintenance/inspection schedule; o Annual equipment inspection and maintenance record; o Procedure for pre-arranged repair service; o Procedure for preventive maintenance; o Procedures for handling materials; o Regular calibration; and o Emergency response plans and procedure.	To avert any serious breakdowns or failures	Throughout operational phase	Annually	VRA	Records on a comprehensive maintenance program	Part of recurrent operational budget
TOTAL –Operational Phase							**524,500.00**

8.4.10 Environmental Monitoring Plan

Environmental monitoring is an essential component of a post project review phase following Environmental Assessment. The monitoring of various environmental parameters will help to confirm any predicted impact or otherwise and assess the effectiveness of the implementation of the mitigation measures outlined. By way of monitoring, a change in a predicted impact can be reviewed. Where observed impact levels exceed the expected levels, additional appropriate mitigation measures will then be instituted. Monitoring will also identify and confirm any residual impacts, which are normal with the development of such a project and ensure that these do not escalate to significant adverse levels.

8.4.10.1 *Monitoring Objectives*

The objectives of the monitoring programme are to:

i. Confirm any predicted impact or otherwise made from the environmental/social assessment during project implementation;
ii. Ensure that all mitigation and control measures are working efficiently and with designed effect;
iii. Provide information to develop improved practices and procedures for environmental protection, community health/safety and worker safety;
iv. Detect changes in the receiving environment and enable analysis of their causes; and
v. Enable effective liaison with stakeholders/communities including addressing complaints and concerns.

8.4.10.2 *Environmental Monitoring Programme*

Monitoring programmes will be instituted and carried out and relevant records would be kept to ensure compliance with sound environmental practices. The major environmental issues for which monitoring will be focused on include:

- Ambient noise levels;
- Ambient air quality;
- Air emissions;
- Surface water quality;
- Wastewater quality;
- Loss of vegetation/habitat and impact on fauna;
- Waste generation and disposal;

- Resource utilisation (energy, water, fuel, raw materials, chemicals);
- Occupational health and safety;
- Labour issues;
- Community/ public safety/health and traffic;
- Socioeconomic issues and corporate social responsibility;
- Stakeholder engagement and public/community complaints; and
- Emergency response issues.

Some of the above issues will be monitored during the construction phase. The environmental monitoring program for the construction and operational phases are set out in **Tables 8-5** and **8-6** respectively.

8.4.10.3 *Key Responsibilities for Environmental Monitoring*

Construction Phase

The primary responsibility for implementation of the environmental monitoring program during the Construction Phase is the Contractor. VRA in collaboration with its Supervising Engineer will ensure that the monitoring activities are carried out to acceptable standards. The Contractor will be required to assign an HSE Officer responsible for implementation of the Health, Safety and Environmental actions, including the EPA permit schedule for the construction phase (i.e. when the EPA approves the project), and other lending covenants. The Contractor shall also ensure that instrument calibration and quality assurance/quality control procedures are in place during the performance of all monitoring activities.

Operational Phase

The VRA has the primary responsibility for environmental monitoring during the project operational & maintenance phase. The key departments to be responsible for the environmental/safety monitoring programs are the Environment and Sustainability Department, and the Health/Safety Department.

8.4.10.4 *Estimated Monitoring Cost*

About **GH₵308,000.00** is estimated to be spent on monitoring activities annually during the construction phase and includes the ambient air quality monitoring by VRA for air dispersion modelling for dry season scenario and **GH₵651,000.00** annually during the operational phase as shown in **Tables 8-5** and **8-6**. However, the Contractor will update the construction phase

monitoring cost when preparing its Construction EMP and HSMP. The VRA will also revise the operational & maintenance phase figures accordingly during the operational phase.

Table 8-5: Environmental Monitoring Programme for the Construction Phase

Environmental component	Parameters to be monitored	Monitoring Sites/ locations	Methodology/ (Standards)	Monitoring Frequency/ Reporting	Responsibility/ (Supervision or Verification)	Estimated Cost/Annum **(GH₵)**
CONSTRUCTION PHASE						
Ambient Noise Levels	Sound levels in dBA	GRIDCo substation; and NVTI	Noise Level Data Logger /(Ghana Standards (GS 1222:2018) / IFC EHS Guidelines)	Monthly or as per EPA permit/ Quarterly	Contractor/ Supervising Engineer, (VRA and EPA)	20,000
Ambient Air Quality	NOx, CO, SO_2, $PM_{2.5}$, PM_{10} and TSP	GRIDCo substation; and NVTI	Air quality monitoring equipment/ (GS 1236:2019/ IFC EHS Guidelines)	Monthly or as per EPA permit/ Quarterly	Contractor/ Supervising Engineer, (VRA and EPA)	65,000
Ambient Air Quality (specifically for air dispersion modelling for dry season scenario)	Same parameters done for the baseline study (TSP, PM_{10}, $PM_{2.5}$ and $PM_{1;}$ Cl_2, NOx, CO, SO_2, and VOC)	Same 17no. monitoring sites done for the baseline study for this EIS	Particulate Matter monitoring using air quality monitor (SIRA Certified OSIRIS TURNKEY INSTRUMENT. Gas levels monitoring using CROWCON gas level meter. / (GS 1236:2019/ IFC EHS Guidelines)	Daily for one month / per one month duration only	Consultant and VRA	100,000
Surface Water Quality	General physicochemical parameters, oil/grease, trace metals, and bacteriological parameters including Faecal and Total Coliforms	Upstream and downstream sampling sites for Adote River	In-situ sampling and laboratory analysis/ (GS 1212:2019/ Ghana WRC Raw Water Quality Guidelines for surface water and Baseline Water Quality of Adote River captured in this EIS)	Monthly or as per EPA permit/ Quarterly	Contractor/ Supervising Engineer, (VRA and EPA)	18,000
Loss of vegetation and impact on fauna	-Area of land cleared and or disturbed outside authorization (m^2)	Project site and work camp area	Field observations and measurements/ Animal incident records	Weekly/ Monthly	Contractor/ Supervising Engineer, VRA	9,000

Environmental component	Parameters to be monitored	Monitoring Sites/ locations	Methodology/ (Standards)	Monitoring Frequency/ Reporting	Responsibility/ (Supervision or Verification)	Estimated Cost/Annum **(GH₵)**
CONSTRUCTION PHASE						
	-Major wildlife and domestic animals killed or injured					
Waste generation and disposal	-Garbage -Waste oil/ hazardous wastes -Construction spoil	Project Site/ Work Camp	-Record quantity and type of waste generated. -Inspect quantity and condition of waste bins. -Keep records of time and place of final disposal.	Weekly/ Monthly	Contractor/ Supervising Engineer, VRA	24,000
Occupational health and safety	-Use of PPEs (Safety boots, gloves, earplug, nose mask, reflectors, Helmet etc) -Accidents, injuries -Worker training/ sensitisation records on Safety, HIV/AIDS prevention and awareness, COVID 19 protocols -New cases of COVID-19 among workers.	Project area (project site, work camp, access routes etc)	Inspections, Observations Audits and medical test; Complaint & incident records/ (Health/Safety policy of Contractor and VRA, Act 328, IFC PS 2)	Daily/ Monthly	Contractor/ Supervising Engineer, VRA, and Factories Inspectorate Department)	36,000
Labour Issues	-Records of worker contracts and payments.	Project area	Observation, audits, complaint/ incident and claim records/	Weekly/ Monthly	Contractor/ Labour Department	-

Environmental component	Parameters to be monitored	Monitoring Sites/ locations	Methodology/ (Standards)	Monitoring Frequency/ Reporting	Responsibility/ (Supervision or Verification)	Estimated Cost/Annum **(GH₵)**
CONSTRUCTION PHASE						
	-Worker grievance mechanism records -Worker compensation claims due to accidents/ injuries		(Recruitment policy of Contractor; Condition of Service for construction workers / National Labour Laws and Workmen compensation law, IFC PS 2)			
Emergency response	-Oil/ fuel spills -Fire /explosions -Natural disasters	Project area (sites/ work camp)	-Training/ awareness creation programs and records -Field inspections /(Contractor Emergency Response Plan, National Fire Safety laws)	Weekly/ Monthly	Contractor/ Supervising Engineer, VRA, EPA, OfMA, GNFS, NADMO	-
Public/community health and safety and security	-Road traffic accidents an incidents -Fatalities on the road involving contractor vehicles. -HIV/AIDS and COVID-19 prevention and awareness creation. -Number of cases of noise nuisance, air pollution and improper waste disposal complaints -Sensitization of food vendors on or near project site on	Project area, local communities and access roads	Field observations/ inspections, and incident/ accident records; HIV/AIDS and COVID-19 sensitization programs and records; -Sensitization program and records for food vendors at or near project sites /(Contractor and VRA Health and Safety Policies/ National policies on HIV/AIDS and COVID-19 Protocols)	Weekly/ Monthly	Contractor/ Supervising Engineer, VRA, Ghana Police MTTD, EPA	18,000

Environmental component	Parameters to be monitored	Monitoring Sites/ locations	Methodology/ (Standards)	Monitoring Frequency/ Reporting	Responsibility/ (Supervision or Verification)	Estimated Cost/Annum **(GH₵)**
CONSTRUCTION PHASE						
	public health requirements, HIV/AIDS and COVID-19 Protocols.					
*Stakeholder engagement and community/ public complaints/ Grievances	-Number of sensitization programmes and or meetings organized -Type and nature of complaints/concerns received and resolved	Affected farmers; Anwomaso and other local communities; stakeholders in general	Stakeholder meetings and feedback, complaint records, / (Project GRM and Stakeholder Engagement Plan)	Weekly/ Monthly	VRA and Contractor	18,000
Total – Construction Phase						**308,000.**

* to be commenced during the pre-construction phase by VRA

NA = Not Applicable; OfMA= Oforikrom Municipal Assemblies

MTTD = Motor Traffic and Transport Department

Table 8-6: Environmental monitoring programme for the Operational & Maintenance Phase

Environmental component	Parameters to be monitored/ Actual activities	Monitoring Sites/ locations	Methodology/ Standards	Frequency/ Reporting	Responsibility/ Supervision or Verification	Estimated Cost/Annum **(GH₵)**
OPERATIONAL & MAINTENANCE PHASE						
Ambient Noise Levels	Sound levels in dBA	Plant fence line – North, South, East and West; and NVTI	Noise Level Data Logger /Ghana Standards (GS 1222:2018)	Monthly/ Quarterly	VRA/ EPA	45,000
Ambient Air Quality	NOx, CO, SO_2, $PM_{2.5}$, PM_{10} and TSP	NVTI, GRIDCo substation, key local communities such as Anwomaso and Domeabra	Air quality monitoring equipment/ GS 1236:2019	Monthly/ Quarterly	VRA/ EPA	75,000
Air Emissions	NOx, CO, SO_2, $PM_{2.5}$, PM_{10} and TSP	Stack sites	Continuous Emission Monitoring Systems (CEMs)/ GS 1236:2019	Monthly/ Quarterly	VRA/ EPA	150,000
Surface Water Quality	General physicochemical parameters, oil/grease, Trace metals, and bacteriological parameters including Faecal and Total Coliforms	Upstream and Downstream Sampling Sites of Adote River	In-situ sampling and laboratory analysis/ GS 1212:2019 for wastewater and Ghana WRC Raw Water Quality Guidelines for surface water	Quarterly/Bi-annually or as per EPA permit	VRA/ EPA	48,000
Wastewater quality	pH of wastewater from water treatment plant	Neutralisation sump at plant premises	pH meter/ GS 1212:2019	Weekly/Quarterly	VRA	3,000
Waste generation and disposal	-Garbage/refuse -Waste oil -Hazardous wastes including turbine wash water -Scrap metal/disused tyres	Plant premises	-Record quantity and type of waste generated; Inspect quantity and condition of waste bins; Keep records of time and place of final disposal /(VRA	Monthly/Annually	VRA	50,000

Environmental component	Parameters to be monitored/ Actual activities	Monitoring Sites/ locations	Methodology/ Standards	Frequency/ Reporting	Responsibility/ Supervision or Verification	Estimated Cost/Annum **(GH₵)**
OPERATIONAL & MAINTENANCE PHASE						
			Environmental Policy and National Environmental Sanitation Policy)			
Occupational health and safety	-Use of Personal protective equipment (e.g. Safety boots, gloves, earplug, nose mask, reflectors, Helmet etc) -Accidents, injuries (i.e. Type and frequency of injuries /accidents) -Worker training/ sensitisation records on Safety, HIV/AIDS prevention and awareness, COVID 19 protocols -New cases of STDs/ COVID-19	Workplaces and plant site	Inspections, Observation, audits, complaint & incident records/ Health/Safety policy of VRA, Act 328	Daily /Monthly	VRA/ Energy Commission and Factories Inspectorate Department	60,000
Labour Issues	-Records of worker contracts and payments. -Worker grievance mechanism records -Worker compensation claims due to accidents/ injuries	Workplaces	Observation, audits, complaint, incident and claim records/ Recruitment policy of VRA; Employment Condition of Service for workers/ National Labour Laws and Workmen compensation	Monthly/ Quarterly	VRA/Labour Department and Labour Commission	50,000

Environmental component	Parameters to be monitored/ Actual activities	Monitoring Sites/ locations	Methodology/ Standards	Frequency/ Reporting	Responsibility/ Supervision or Verification	Estimated Cost/Annum **(GH₵)**
OPERATIONAL & MAINTENANCE PHASE						
			law			
Public/ community safety /health and security	-Road traffic accidents -Traffic incidents -Fatalities on the road -HIV/AIDS and COVID-19 cases and awareness creation programs -Number of cases of noise nuisance, air pollution and improper waste disposal complaints -Sensitization of food vendors on site on public health requirements	Public/local communities; access routes	Field observations/ inspections, and incident/ accident records HIV/AIDS and COVID-19 sensitization program and records -Sensitization program and records for food vendors/ kitchen/canteen operators	Monthly/ Quarterly	VRA/ OfMA / Ghana Police MTTD	60,000
Emergency response	Oil/ fuel spills -Fire safety & explosions -Natural disasters	Plant premises	-Training and simulations -Field inspections /VRA Emergency Response Plan for the Plant, National Fire Safety laws	Monthly/ Annually	VRA/ EPA/ OfMA/ GNFS/ NADMO	60,000
Resource utilisation	Energy - process and non-process energy use	Plant premises	Energy consumption records	Monthly/ Quarterly	VRA HSSE Manager / Plant Manager	-
	Water - process and non-process water use	Plant premises	Water consumption records			-
	Fuel- fuel use	Plant premises	Fuel consumption records			-

Environmental component	Parameters to be monitored/ Actual activities	Monitoring Sites/ locations	Methodology/ Standards	Frequency/ Reporting	Responsibility/ Supervision or Verification	Estimated Cost/Annum **(GH₵)**
OPERATIONAL & MAINTENANCE PHASE						
	Raw materials- raw material usage	Plant premises	Raw material usage records			-
	Chemicals- chemical usage	Plant premises	Chemical usage records			-
Socioeconomic and corporate social responsibility	-Donations in support of community development initiatives -Corporate social responsibility programs	Local communities	-Records of donations and community development supports/ VRA Corporate Social Responsibility Policy	Quarterly/ Annually	VRA	-
Community/ public complaints/ grievances	-Number of sensitization programs organized -Type and nature of complaints/concerns received and resolved	Public, local communities	Complaint records, Stakeholder meetings; /GRM and Stakeholder Engagement Plan	Monthly/ Quarterly	VRA, OfMA and Anwomaso Traditional Council	50,000
Total – Operational & Maintenance Phase						**651,000**

NB: NA = Not Applicable

8.4.11 Management of Project Facilities

8.4.11.1 *Power Plant Management*

The Power Plant Management will seek to maintain security by allowing only authorised personnel and ensure the proper functioning of all equipment in place. The scope of the monitoring will include the following:

- Concrete structure failures;
- Corrosion and equipment damage;
- Leakage of transformer oil;
- Level of restriction of access from unauthorized personnel; and
- Visibility and eligibility of signage within the premises.

Measures adopted to manage these concerns include:

- Weekly inspections and damage control;
- Quality assurance and security; and
- Annual monitoring of pressure vessels and lifting equipment.

Weekly Inspections and Damage Control

The Maintenance and Safety units for the natural gas turbine plant will be adequately resourced to carry out weekly inspections and damage control activities, at the power house and switchyard station under their area of jurisdiction. The aim is to identify possible cracks or visible signs of structural failure, as well as housekeeping issues that could compromise safety and smooth operation, as early as possible for rectification.

Quality Assurance and Security

VRA will consistently monitor to ensure the accuracy of the input and output voltages from its power house and switchyard station. The presence and operation of the assigned security persons will be monitored by management. The security personnel will be equipped with a reliable communication equipment to notify the responsible station manager in event of emergency or a breach of security.

Annual monitoring of pressure vessels and lifting equipment.

The maintenance and Safety Unit of the VRA will ensure that pressure vessels and lifting equipment are tested by certified engineer surveyors at least once every year. The certificate of

testing will be submitted to the Factories Inspectorate Department. This will help identify possible cracks or visible signs of structural failure that could compromise safety and smooth operation, as early as possible for rectification.

8.4.11.2 *Pipelines Management*

Both natural gas pipeline and water pipeline subproject activities will be permitted under separate EPA permits. The Ghana National Gas Company will be responsible for the management of the natural gas pipeline and GWCL will be responsible for the water pipeline management. VRA will ensure that a pipeline integrity mmanagement system is developed to ensure the safe operations of the natural gas pipeline. The integrity management plan will include weekly routine inspection and regular Right-of-Way (RoW) surveys with hand held gas detection, cathodic protection surveys (close interval protection surveys and direct current voltage gradient surveys) as well as in-line inspection with intelligent pigs. The integrity management activities will be planned and scheduled in accordance with good international industry practice.

8.4.11.3 *Good Housekeeping*

Management will ensure that good housekeeping is maintained at all times at the plant premises of the switchyard station and the power house. All weeds springing up through the stone carpet of the switchyard station and the power house shall be physically removed. The buffer zone of the switchyard station and the power house shall also be monitored on a daily basis to ensure that there is always a fire break at the perimeter. The premises will be monitored to ensure that potential nesting places of birds are kept free of bird nests that are likely to cause electrical faults.

Oil and lubricants will be stored away from equipment and potential fire sources e.g., welding and handled carefully to prevent spills. All equipment will be kept clean and leakages sealed. Management will ensure that all equipment and materials are in their assigned place and that no loose or unnecessary tools are left lying about in the workplaces, and caution notices will be provided such as “Do Not Litter”.

8.4.11.4 *Storm Water Drains*

Storm water drains at the switchyard station and the power house shall be managed and monitored on a regular basis to ensure that there are no blockages and that the water drains out quickly to avoid backflow and flooding of the facilities.

8.4.12 Resource Utilization and Management

Sustainable use principle aims as ensuring that the consumption of resources and their impacts do not exceed the capacity of the environment. Resource use efficiency encompasses both the reduction of resources utilized within a process and the reduction of waste produced by a process. It is basically a practice in which the primary consideration of material use begins with the concept of "Reduce-Reuse-Recycle-Repair" stated in descending order of priority. Indeed, cost effectiveness could be improved through resource use efficiency enhancement and also facilitate meeting environmental quality guidelines.

VRA strives to apply the principles of resource use efficiency to all projects undertaken. VRA's resource use efficiency principles are applied to all technology processes by assessing technology selection, re-use efficiency, process optimization and waste reduction. VRA aims to ensure that the outcome of each project is economically and environmentally sustainable. Resources that require sustainable management for operations at the Power Station include process water and energy (electric power, and fuel/natural gas) and process chemicals.

8.4.12.1 *Water Use Management*

VRA knows that good management of water usage allows for a reduction in its consumption with its concomitant monetary savings. Depending on a minimum amount of water also allows the organisation to be competitive at moments of shortage with respect to other industries in the sector, in both costs and in production capacity. Systems will be put in place to ensure efficient and prudent water supply and management at the power station and these include the following:

Organizational measures

- Periodically control the physical state of all the elements that operate within the inner distribution of the water, i.e., valves of all types and other devices that control the exit of the water of the pipes;
- Close stop cocks of all the consuming water apparatuses as this measure when systematically applied, can reduce wastefulness;
- To maintain in good state the isolation of all the components of the drivers of hot water and steam, and to solve any unforeseen circumstance immediately;
- To maintain and clean heat-transfer surfaces in all the interchangers, heaters and other elements of transfer, to diminish the losses; and
- Periodically clean the pipes that control non-treated water.

Measures with short periods of amortization

- Limit the provision of water strictly to necessary amounts required for each operation;
- Use automatic locking valves that allow the better regulation of the consumption of water especially for activities that water flows such as the case of the showers, sinks and toilets; and
- Install meters to measure water consumption.

Measures with long periods of amortization

- If not absolutely necessary and essential, avoid using demineralized water for various operations;
- Take advantage to the maximum, the use of groundwater water of relevant operations; and
- Use of thermostatic valves to guarantee that the temperature of hot water stays in the pre-established minimum values.

8.4.12.2 *Energy Management*

Energy management is of key priority in all VRA operations. VRA seeing the financial returns from superior energy management continuously strive to improve its energy performance. This is based on regularly assessing energy performance and implementing steps to increase energy efficiency. VRA's energy management strategies are aimed at creating an energy efficiency culture that would ensure a reliable, sustainable and diverse supply of competitively priced power for the nation. It is also to ensure that it generates enough energy to meet demand. This is because the VRA is committed to protecting the interests of Ghanaians and assisting consumers to use energy more efficiently.

The primary benefits for VRA in implementing an energy-use management system include: (1) lowering energy costs and consumption, (2) providing more control over environmental impacts, leading to lower impacts and costs, and (3) sustaining improvements that result in higher productivity and lower capital improvement needs.

Currently, VRA periodically assesses the energy performance of its various power plants so as to:

- Categorize energy use by fuel type, operating division, facility, product line, etc.;
- Identify high performing facilities for recognition and replicable practices;
- Prioritize poor performing facilities for immediate improvement;

- Understand the contribution of energy expenditures to operating costs;
- Develop a historical perspective and context for future actions and decisions; and
- Establish reference points for measuring and rewarding good performance.

VRA has also put in place the under-listed energy management measures as part of its energy management process for its thermal power stations:

- Metering its energy consumption and collecting the data;
- Finding and quantifying opportunities to save energy;
- Targeting the opportunities to save energy; and
- Tracking progress at saving energy

VRA has also identified energy conservation information tips as a beneficial strategy for its workers and consumers and has developed various information, education and communication materials on energy management. This is to help increase awareness of energy and environmental impacts within the organization. The energy conservation tips developed by VRA are aimed at the identifying the facilities, equipment, processes and personnel with significant impact on energy usage and/or environmental results. It deals with the use of energy in all VRA offices, including existing thermal power plants, with respect to office appliances, lighting, use of refrigerators, air conditioners, electrical appliances.

8.4.12.3 *Chemicals Use Management*

VRA endeavours to acquire relevant chemicals in batches and on as-required basis to ensure that only the amount of chemical required for use is available at its existing power plants and will do same for the proposed K1TPPP in order to avoid excess that could expire. However, chemical wastes can arise as a result of the processes and operations at K1TPPP. These can range from simple cleaning products to complex intermediates used in the generation process (e.g. Conntect 6000 used for the gas turbine compressor cleaning. The MSDS of this chemical is provided in **Annex 8-3** in the Volume II of this report). Whether these arise because they are no longer needed, they are contaminated or in some other way do not meet the necessary specifications, or simply have a surplus, VRA is well positioned to manage them safely with maximum value in mind.

In the event that any chemical expire and become obsolete, VRA is required to submit Material Safety Data Sheet (MSDS) to the Chemical Control Management Centre of EPA Head Office, Accra for advice on disposal methods for the particular chemical. Currently, these chemicals are

classified, re-packaged (if needed) and disposed of. However, disposing of these substances is never the first priority, instead, VRA always seek to establish alternative secondary markets for them. When re-use is not possible, the existing practice for its thermal power plant in Takoradi is that VRA with approval of the EPA disposes of the chemicals in excavated pits lined with impermeable lining material.

8.4.13 Framework for the Emergency Response Planning

The Emergency Response Plan is aimed at addressing potential accidental occurrences during the development and operational phases with the general objective of minimizing hazards to workers, local communities, the public and the general environment. The specific objectives of the emergency response plan are to:

- Identify all stakeholders, their official contacts and their roles.
- Identify the key persons to be involved and clearly define their roles and the procedures that must be followed during an emergency;
- Identify all the likely emergency scenarios associated with the operations and provide effective response procedures for each identified emergency scenario;
- Save human life and minimize damage to equipment, property and the general environment;
- Identify training needs of personnel and resources required to ensure emergency preparedness at the site;
- Establish notification procedures and communication arrangements;
- Establish evacuation procedures;
- Provide clean-up and remediation arrangements;
- Put in place emergency response plan review arrangements; and
- Develop budget for the implementation of the ERP.

The emergency response plan will be based upon all the different operational facilities in place. The ERP shall be linked with the existing VRA emergency response plans to ensure effective and efficient responses to emergencies. The ERP will be disclosed to all potentially impacted people including the neighbouring local communities and organisations (Anwomaso and Domeabra communities, NVTI and GRIDCo substation workers).

The ERP will cover the following risk situations:

- Fire outbreak

- Explosion
- Damage to gas pipeline and leakage from the pipeline
- Damage to water pipelines and leakage from the pipelines
- Oil spillage
- Flooding
- Terrorist Attack
- Natural disasters – earthquake/seismic activity, Thunderstorms etc.; and
- Medical emergencies

VRA will designate an area within the project site as an emergency assembly point and will label it appropriately. VRA will also put in place an evacuation procedure for all emergencies anticipated.

VRA Management will report, as appropriate, emergencies/accidents to relevant stakeholders/regulatory bodies such as the Energy Commission, EPA, Ghana National Fire Service (GNFS), the Municipal Assembly, NADMO and Ghana Police Service.

The Plant Manager would be required to ensure that procedures are revised to reflect changes in personnel, facilities or desired action. It is expected that details of particular actions required in the emergency plan would be reproduced in easy-to-read type and posted at visible and strategic areas where they are required.

It is also expected that drills and practices of the various procedures would be carried out, at least, twice a year. After the drills, there should be discussions of what transpired, and any shortcomings pointed out. Suggestions for any improvements to the procedures are welcomed and encouraged.

All authorized hard copies of the ERP document must have the signatures of the review and approval Directors/Managers. Authorized electronic copies of the document will have the approval date as a footer or header on every page.

8.4.14 Document Control and Tracking

Documentation

The Plant HSSE Manager will keep records on all environmental and public health/safety data including, environmental emergencies. Environmental data will be kept in both electronic and

hard copy formats. A format for documentation of information in electronic form will be developed to capture daily/weekly information on environmental sampling/monitoring, environmental quality results, waste generation and disposal, environmental resource use (water, fuel/oil, electricity, raw materials, chemicals), environmental incidences and emergencies, training and awareness creation programs such as staff durbars/fora, workshops, seminars and meetings.

Document Tracking and Control

VRA will maintain procedures to control all documents and permits that are required to ensure compliance and to make sure that:

- All documents and permits are easily traceable;
- All statutory documents are periodically reviewed, revised as necessary and approved as adequate by the relevant regulatory agency;
- All permits and approvals are renewed as and when necessary; and
- Current versions of relevant documents are available on site.

8.4.15 Annual Environmental/ Safety Audit and Reviews

The VRA will internally undertake an annual environmental and safety audit of the Power Plant and associated facilities or outsourced to an environmental/safety experts to undertake such audits. Issues or gaps identified will be addressed. Management of the Plant will carry out annual reviews of the plant's environmental performance. The monitoring program will also provide relevant information for effective auditing and reviews.

8.5 Summary of Environmental Management Budget

The environmental management cost earmarked for implementation require detailed cost analysis to determine the actual budget needed. Initial cost estimates provided in **Table 8-7** indicate that about **GH₵739,450** and about **GH₵1,528,275** will be needed per annum during the preconstruction/construction and operational phases respectively for the implementation of the environmental management programmes. These costs exclude Contractor BoQ costs and VRA annual recurrent operational costs.

Table 8-7: Provisional Environmental and Social Management Budget

Program	**Activity/ Issues**	**Estimated Cost (GH₵)/year**	
		Pre-construction & Construction Phases	**Operational Phase**
Environmental mitigation action plans	(see Tables8-2, 8-3, and 8-4)	301,000.00	524,500.00
Environmental Monitoring	(see Tables 8-5 and 8-6)	308,000.00	651,000.00
Environmental and Safety Audits and Reviews	Performance of activities and facilities during construction/ operations	20,000.00	50,000.00
Capacity building, training and awareness creation	Training workshops, sensitization, refresher courses, meetings, seminars etc	30,000.00	100,000.00
Grievance redress mechanism	Complaints registration and resolution	20,000.00	50,000.00
Compliance with IFC requirement during construction phase	Preparation of Construction Environmental Management Plan/ Health & Safety Management Plan	30,000.00	-
Statutory compliance/ Documentation and Reporting	Preparation of Environmental Management Plan. (To EPA, In line with LI 1652, within 24 months of start of operation)	-	70,000.00
	Annual Environmental Report. To EPA, In line with LI 1652	-	10,000.00
Subtotal	-	***709,000.00***	***1,455,500.00***
Contingencies	Uncertainties, etc. (5% of subtotal)	30,450.00	72,775.00
Total		**839,450.00**	**1,528,275.00**

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CHAPTER NINE
DECOMMISSIONING

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9.0 DECOMMISSIONING

9.1 Post Construction Phase

9.1.1 Work Camp and other Site Facilities

The Contractor will dismantle and relocate all work camp/ temporal camp facilities upon completion of the construction and installation activities. Waste generated will be disposed of at OfMA approved waste disposal sites.

Decommissioning of work camp with sanitation facilities will be in compliance with both Ghanaian environmental health policies and OfMA sanitation byelaws governing decommissioning of such facilities.

If the work camp is sited outside the project site boundary, VRA in collaboration with the Contractor will carry out a pre-mobilisation survey with the contractor, to record the status of the proposed sites for the work camp (e.g. photo log). VRA will carry out demobilisation check with the Contractor to compare status of site after demobilisation to that of the pre-mobilisation survey condition recorded. VRA will ensure that the Contractor rectifies any significant gaps or concerns.

9.1.2 Project Equipment/Machinery

Project equipment such as concrete mixers, bulldozers, hydraulic excavators, pumps, generators, vehicles and other machinery will be relocated to new or other project sites in the country or auctioned to the public.

9.2 Post Operational Phase Decommissioning

9.2.1 Introduction and Objectives

The VRA will carry out periodic maintenance and repairs on the thermal power plant to ensure that the power plant last for the 25 years design period. In the long-term, rehabilitation and upgrade works based on cost benefit analysis and new technologies will be carried out as appropriate due to depreciation, worn-out or damage to ensure its integrity.

The purpose of this provisional decommissioning plan is to describe the general objectives for the post project land use, and the planning processes leading to development of a decommissioning plan. The specific objectives in managing the decommissioning process will be:

- To ensure that decommissioning and rehabilitation are carried out in a planned sequential manner, consistent with best practice;
- To ensure that the decommissioned site is safe and does not endanger human and animal life;
- To ensure that agreed post-project land-use outcomes are achieved; and
- To avoid future liability issues.

However, should it become necessary for the power plant to be decommissioned in the long term, any such decommissioning activity will be undertaken in line with the environmental assessment procedures of the country. The decommissioning activity will be registered with the EPA, and a decommissioning plan prepared for the Agency's approval and permitting in accordance with the Environmental Assessment Regulations 1999, LI 1652.

Other stakeholders and relevant institutions will be informed and consulted prior to the decommissioning work, and these include:

- Ashanti Regional Coordinating Council, Kumasi
- Asanteman Council
- OfMA - Local government authority in charge of the project area
- Anwomaso community and nearby communities – local communities/towns near the project site
- Utility Companies – GRIDCo, ECG, GWCL, Ghana Gas and the Telecommunication companies who provide utility services to VRA and the thermal power plant at its Anwomaso base.

9.2.2 Decommissioning Activities

Plant equipment to be removed will include the ten GE TM 2500+ Aero Derivative Gas Turbines with their stacks, mobile station service transformers, office structure and control room, underground cable conduits and other associated infrastructure such as gas and water pipelines as described under Chapter 3 (Description of the Proposed Project) of this report. These will be dismantled at its Anwomaso base and relocated to another place as may be determined in the future or sent to VRA storage areas or sold off or disposed of as appropriate.

Activities to be undertaken during the decommissioning exercise are as depicted in **Figure 9-1** and described in the subsequent sections below. The exercise will ensure public health and safety, environmental protection, and compliance with applicable regulations.

9.2.2.1 *Closure of all Power Generation and Related Activities*

This will entail the cessation of all electricity generation activities and the complete de-energization of all electrically powered equipment to ensure a safe working environment at the site before dismantling activities commences. In this regard, an isolation and de-energization protocols will be enforced. These protocols would be vetted and agreed as a safety guarantee prior to the removal of any equipment onsite.

9.2.2.2 *Site Inventory and Preparatory Works*

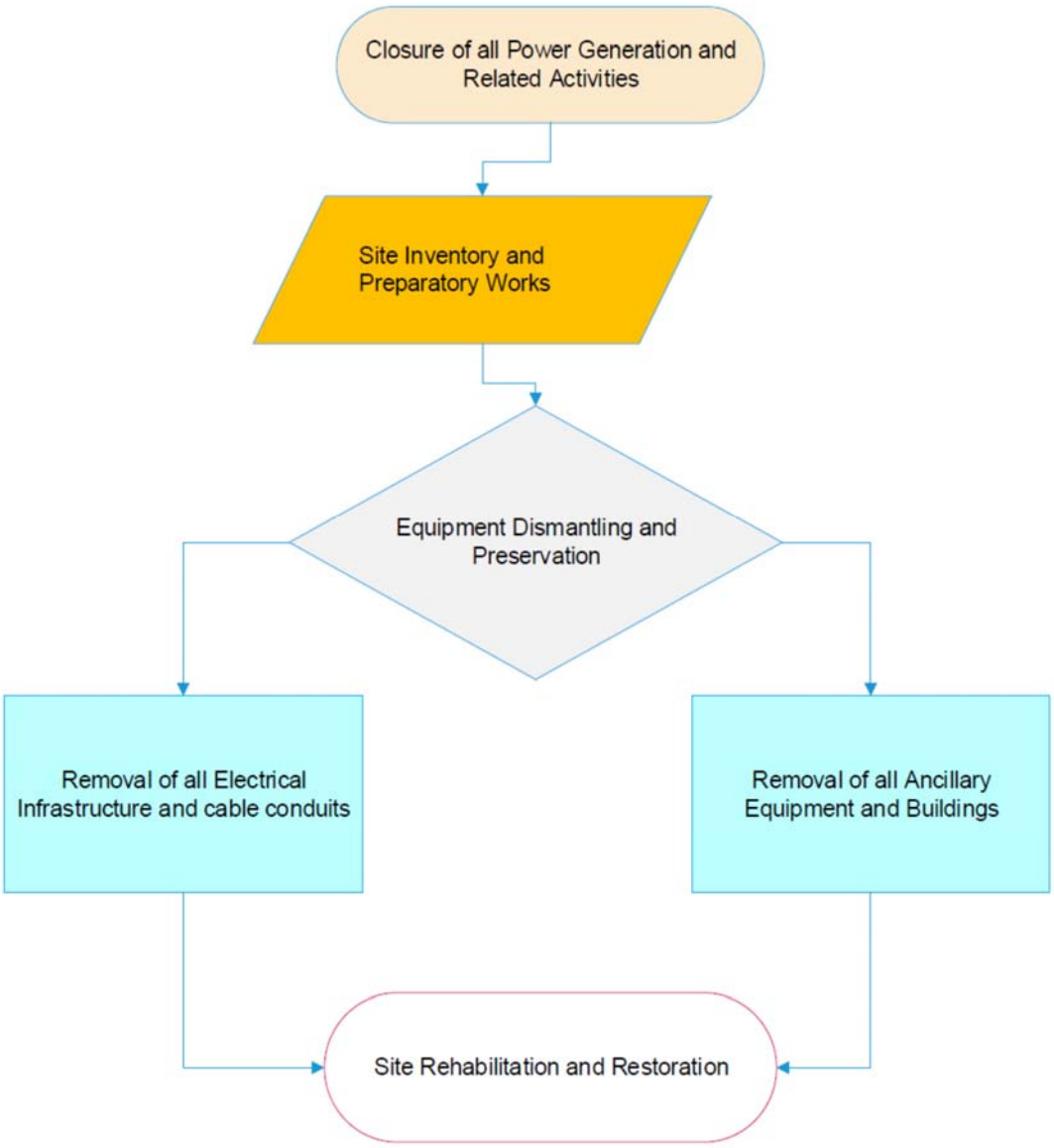
Prior to the commencement of dismantling activities, an inventory of all equipment used at the site will be undertaken to assess equipment type and condition. The inventory will determine which items can be readily relocated, preserved prior to transit, refurbished, scrapped, or replaced. Peculiar equipment such as Forklift, Man lift, Pressure washers, etc. will have to be in good working condition prior to relocation or auctioning. Lubricants and other consumables with shelf-life will be well evaluated to understand the cost implications before deciding to transport to receiving site or otherwise. Moreover, an Asset database and identification will be developed and made common across the donor and receiving sites to prevent the mixing up of identical equipment, the transportation of obsolete items, inaccuracy in inventory quantities and loss of equipment history.

9.2.2.3 *Equipment Dismantling and Preservation*

This stage will entail the dismantling of gas turbines and associated facilities, the removal of all electrical infrastructure and cable conduits and the removal of all ancillary equipment and buildings. After dismantling, approved and agreed preservation protocols will be implemented for the various equipment that will either be relocated or stored or auctioned as appropriate. Where dismantled equipment/materials can be recycled, metal equipment will be sent to steel manufacturing companies for recycling and all others that cannot be recycled or reused will be disposed of at approved waste disposal/landfill sites in the Greater Kumasi Metropolis.

9.2.2.4 *Removal of Concrete Foundations*

All concrete foundations will be demolished and removed from the site to facilitate site reclamation and restoration activities. Demolished concrete foundations will be disposed of in consultation with the Municipal Assembly.



(Source: Decommissioning and Site Closure Plan for Ameri Power Plant, July 2021)

Figure 9-1: Flow Diagram of Decommissioning and Dismantling Activities

9.2.2.5 *Liquid Waste Management-Clean Up of Oil Spills*

Prior to the dismantling of plant, equipment and machinery, oil containing equipment such as generators, transformers, circuit breakers, and fuel tanks, will be drained of their oil content. The oil waste will be stored in drums and disposed of through the VRA approved methods of recycling to licensed operators. Any spills, which might occur during the decommissioning process, will be cleaned up as per VRA Emergency Response Plan/Procedure, using e.g. bio-degradable oil absorbent pads and materials. Domestic liquid waste from the plant's sanitary facilities will be disposed of through a contract with the Oforikrom Municipal Assembly's Waste Management Department or Zoomlion or any reputable private waste management firm.

9.2.2.6 *Solid Waste Management*

All solid waste resulting from the decommissioning process will be disposed of as follows:

- Paper from cartons, office waste, wood waste and waste plastics would be sent to recyclers; and
- Other solid wastes would be evacuated by selected firms approved by the Municipal Assembly's Waste Management Department.

9.2.2.7 *Site Rehabilitation/Restoration*

Following completion of the demolition activities, the surface areas disturbed during decommissioning will be restored to match the existing topography. The proposed Kumasi I Thermal Power Plant site belongs to KNUST and is currently used for Agricultural research activities, including crop farming.

The final Decommissioning and Reclamation Plan to be prepared will include the land use for the site as agreed by stakeholders after decommissioning. Areas of the land that have been excavated and back filled will be re-graded. Disturbed areas will be seeded with appropriate vegetation to improve the productivity of the soil.

Where necessary, the receptiveness of the soil for re-vegetation will be enhanced by ripping, topsoil application or the use of fertilizers and compost. Quick growing, indigenous plant species that provide stability will be established. Any site restoration activities will be undertaken in consultation with stakeholders including the EPA, KNUST, OfMA, Anwomaso community, GRIDCo/ECG, and other relevant stakeholders in compliance with prevailing regulations.

9.2.3 Post-Decommissioning Assessment

At the end of the decommissioning exercise, the EPA will be invited to carry out a post-decommissioning assessment to establish compliance with all regulatory requirements and issue a clearance certificate to that effect.

Best practice requires that planning of thermal power plant closure be undertaken progressively throughout the lifetime of the operational phase. As such the provisional Plan will be reviewed and updated as and when necessary. The Decommissioning Plan will be finalized and submitted to the relevant authorities for approval at least three months prior to start of decommissioning and closure of the site.

9.2.4 Decommissioning Schedule/Duration

The duration for the removal of machinery, equipment, turbines and all other materials related to the project will be indicated in the decommissioning plan. However, it is envisaged that the preparation of the decommissioning plan and acquisition of the decommissioning permit could take three (3) months; decommissioning of the thermal power plant components and associated facilities could be undertaken in four (4) months; site rehabilitation and restoration activities will take three (3) months; and post-decommissioning monitoring activities carried out within one (1) month; and post-decommissioning assessment and clearance by the EPA undertaken in one (1) month. In all, VRA may take about one year (12 months) for the decommissioning and closure of the plant site as shown in the provisional decommissioning schedule provided in **Table 9-1**.

Table 9-1: Provisional Decommissioning Schedule

No	Activity/ Task	Duration/ Days	Months											
			1	2	3	4	5	6	7	8	9	10	11	12
1.0	**Preparation of Decommissioning Plan and acquisition of Decommissioning Permit**	**60**												
2.0	**Decommissioning Activities**	**80**												
2.1	Closure of power generation and related activities	20												
2.2	Site Inventory and Preparatory Works	20												
2.3	Equipment Dismantling and Preservation and Concrete Foundation Removal	40												
2.3.1	Removal of electrical infrastructure	15												
2.3.2	Removal of ancillary infrastructure and structures	15												
2.3.3	Demolition and removal of concrete foundations	15												
3.0	**Site Rehabilitation and Restoration Activities**	**100**												
3.1	Scarification, leveling and reshaping of disturbed lands	20												
3.2	Establishing erosion control measures	10												
3.3	Seeding and Re-vegetation	40												
4.0	**Post-decommissioning Monitoring**	**20**												
5.0	**Post-decommissioning Assessment and Clearance by EPA**	**20**												

9.2.5 Responsibility & Budgeting

Budgetary provision shall be made as part of VRA corporate budget for decommission and reclamation activities at the end of project life. In order to provide such financial assurance before the end of the useful life of the equipment, VRA agrees to deliver to relevant agencies prior to the decommission and closure phase, a financial instrument with an aggregate initial face amount equal to the decommissioning cost estimate in accordance with national laws.

Costs of dismantling of the thermal power plant and associated facilities will be determined with consultants/contractors. It is expected that external resources (i.e. hiring of cranes, trucks, wheel loaders) and Consultants/contractors will be required to implement the Decommissioning Plan in full. A provisional cost estimates is provided in the table below. About GH₵359,000 is required to decommission and reclaim the site accordingly.

Table 9-2: Provisional Decommissioning Cost Estimate

No	Activity/ Task	Estimated Cost (GH₵)
1.0	**Acquisition of Decommissioning Permit**	**50,000.00**
1.1	Preparation or production of Decommissioning Plan	20,000.00
1.2	EPA Processing Fees	10,000.00
1.3	EPA Permit Fees	20,000.00
2.0	**Decommissioning Activities**	**155,000.00**
2.1	Closure of power generation and related activities	25,000.00
2.2	Site Inventory and Preparatory Works	20,000.00
2.3	Equipment Dismantling and Preservation and Concrete Foundation Removal	-
2.3.1	Removal of electrical infrastructure	20,000.00
2.3.2	Removal of ancillary infrastructure and structures	30,000.00
2.3.3	Demolition and removal of concrete foundations and disposal of wastes	60,000.00
3.0	**Site Rehabilitation and Restoration Activities**	**144,000.00**
3.1	Scarify, level, reshape and establish erosion control measures (15 acres)	90,000.00
3.3	Re-vegetation of site (15 acres)	54,000.00
4.0	**Post-decommissioning Monitoring**	**5,000.00**
5.0	**Post-decommissioning Assessment and Clearance by EPA**	**5,000.00**
6.0	***TOTAL***	***359,000.00***

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CHAPTER TEN
CONCLUSION

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10.0 CONCLUSION

VRA is fully aware of its corporate responsibility to sound environmental practices. It will undertake the project in compliance with Ghanaian environmental/safety laws especially with regard to the provisions in the Environmental Protection Agency Act 1994, Act 1994; Environmental Assessment Regulations 1999, LI 1652; and the Factories, Offices and Shop Act 1970, Act 328; and in accordance with good international industry practice.

The Kumasi 1 Thermal Power Plant Project will operate in a simple cycle mode. In this operation, natural gas will be received from the Ghana National Gas Company Ltd (GNGCL). The gas is then conditioned to the right temperature and pressure at the gas conditioning module attached to each gas turbine and sent to the combustion chamber. The compressor draws atmospheric air through the air inlet filters into the compressor. The hot air is introduced into the combustion chamber of the combustor at the same time as the pre-heated fuel from the fuel selection skid. The air-fuel mixture is ignited and the resultant combustion produces heat and exhaust gas. The efficiency of combustion is dependent upon the type of burners and the air-fuel ratio.

The resultant mass flow of the exhaust gas, which is appropriately directed unto the gas turbine blades, provides the necessary force to turn the gas turbine, which is in turn coupled to a generator through a shaft for power generation. The exhaust gas is then discharged into the atmosphere through the stack alongside the heat. Power generated will be transmitted to the grid through the existing GRIDCo 161 KV substation at Anwomaso.

Reliable fresh water supply for the operation of the thermal power plant will be made available by the extension of GWCL mains from Oduom to the project site, and GWCL has confirmed that its capacity will be sufficient to accommodate the water requirements. VRA will exploit groundwater sources at the project site to further augment the GWCL supplies with the aim to minimize impacts on domestic water supplies. The VRA has indicated that the natural gas supply and availability from the GNGCL gas extension project from Prestea-Dawusaso to the project site are sufficient and reliable to accommodate the operations of the Kumasi 1 Thermal Power Plant Project.

The major potential environmental/social and health/safety issues and impacts associated with the proposed thermal power project, have been identified and duly assessed in this EIS. The

identified potential environmental, safety risks and impacts associated with the implementation of the Project include land-take and displacement of farmers; anxiety/agitation on the part of affected farmers, local people and Anwomaso leaders; risk of not acquiring all relevant statutory permits; destruction and loss of vegetation/habitat; air pollution; noise and vibration nuisance; impact on soil resources/soil contamination; water pollution/siltation of water body and impact on aquatic life; waste generation and disposal; labour influx; Visual intrusion/ attraction; worker health/safety concerns and labour issues; public/community health and safety, and security concerns; greenhouse gas emissions and climate change impact; water consumption; emergency situations; and sustainability risk.

The air dispersion model presented in this EIS predicts that ambient level concentrations from the operations of the thermal power plant will meet Ghana EPA and IFC air quality standards and guidelines in all cases. VRA will carry out ambient air quality monitoring in the dry season (i.e. November-December) for air dispersion modelling for the dry season scenario as well. Good engineering practice suggest that the stack height for plants surrounded by settlements be higher than the tallest building within 800 m radius from the closest stack. It is predicted that the operation of the thermal power plant will achieve acceptable levels considering that the contribution of emissions from the power plant to ground level concentrations is negligible at a minimum stack height of 56m.

The noise emission model also show that communities beyond 500 m from the project site would not be impacted by the noise from the project provided silencers are used on the generators. The closest community (i.e. Anwomaso) to the project site is 600 m and the predicted noise level by the model is 34.02 dBA in the community. This noise level is below the background noise level in the Anwomaso community.

The power plant itself will not generate any effluent besides wastewater resulting from the water treatment facility and the periodic turbine wash water.

Ghanaian legislation does not permit the use of child or forced labour and VRA will ensure that the Contractor's Agreement enforces this requirement. No such practices will occur under the Kumasi 1 Thermal Power Plant Project (i.e. for both construction and operations).

Mitigation and management measures for the identified adverse impacts and risks have been proposed at the design/planning and implementation stages in order to minimise significant adverse effects and enhance the positive impacts. An environmental monitoring programme to help detect changes arising from the predicted adverse impacts is also included in the report together with a provisional EMP. The implementation of appropriate management policies and procedures including health/safety plans during project implementation, environmental quality monitoring and pollution prevention and response procedures will ensure that any residual environmental effects will be kept to a minimum, under normal operating conditions. In addition, the implementation of an emergency response plan will ensure that a high level of environmental protection is maintained.

A stakeholder engagement program and grievance redress mechanism will be implemented to ensure that stakeholder concerns and grievances are managed effectively to minimise potential conflicts during project implementation. The implementation of the proposed project will significantly improve the generation and supply of electricity to the Ashanti and northern regions to help minimize electricity supply challenges faced currently by these consumers.

Generally, stakeholders are willing to participate in project implementation where necessary to help ensure that the project is implemented in an environmentally friendly and socially acceptable manner to the benefit of the country. The local communities however, expect that appropriate corporate social responsibility measures will be put in place to bring development to the communities and affected farmers currently on the land expect that their concerns will be addressed.

The VRA and the Ministry of Energy will ensure that the Project is implemented in line with all relevant national policies, laws and standards to enhance the intended benefits of the Project and reduce potential negative impacts to acceptable levels.

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CHAPTER ELEVEN

BIBLIOGRAPHY

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11.0 BIBLIOGRAPHY

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ANNEXES

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ANNEXES

Annex 1-1 EPA Response to Project Registration

Annex 1-2 EPA Response to the Scoping Report

Annex 1-3 Administrative Flow Chart of the EIA Procedures

Annex 1-4 EPA Review Comments on the draft EIS

Annex 1-5 Responses to the EPA Review Comments on the draft EIS

Annex 3-1 Copy of Site Plan

Annex 4-1 Report on the water quality analysis

Annex 4-2 Air quality and noise monitoring and dispersion/emission modelling report

Annex 4-3 Terrestrial flora and fauna study report

Annex 4-4 Aquatic biology study report

Annex 5-1 Stakeholder Engagement Plan and Consultation Report

Annex 8-1 Provisional Health and Safety Management Plan- Construction Phase

Annex 8-2 Grievance registration and closeout forms

Annex 8-3 MSDS of Conntect 6000 used for the gas turbine compressor cleaning

NOTE: These Annexes are presented in the Volume II of this Report