GHANA NATIONAL GAS COMPANY LIMITED

REVISED ENVIRONMENTAL IMPACT STATEMENT

PROPOSED LPG BOTTLING PLANT AT AXIM IN THE NZEMA EAST MUNICIPALITY OF THE WESTERN REGION OF GHANA

JANUARY 2022

Document reference Number: GNGC/ABP/REIS/01-1

COMPANY PROFILE

Registered Name of Company:	Ghana National Gas Company Limited
Type of Undertaking:	LPG Bottling Plant
Type of Report:	Environmental Impact Statement
Head of Organization:	Dr. Ben Asante
Telephone Number:	+233 (0) 302 744200
Address of Correspondence:	P. O. Box CT 3686
Contact Person:	Mr. Emmanuel Moses
Position:	Senior Manager, Construction Mgt.
Contact Number:	+233 (0) 209 978 948 / +233 (0) 594 300142
Email of Contact Person:	emmanuel.moses@ghanagas.com.gh

Location of Undertaking

a) Plot/House No: N/A

b) Zoning Status: N/A

c) Town(s): Axim

d) Area Name: Axim

e) Region: Western Region

f) District(s)/Metropolis: Nzema East Municipality

Approved By:

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Designation

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Signature, Stamp and Date

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EIA TEAM

NAME OF PERSONNEL	QUALIFICATIONS/ TRAININGS	ROLE	Contact details
Charles Awuku Asare	MSc. DIC. Environmental Technology (Environmental Analysis and Assessment Option), M.Sc. Environmental Science and Technology (Pollution Option) B.Sc. (Hons) Biological Sciences	Team Leader	casare80@yahoo.com (0)243463122
Okoh Agyemeng	MSc. Water Supply and Environmental Sanitation BSc. Hons. Chemical Engineering	Deputy Team Lead/ ESIA Project Chemical Engineer	doc.okohmet@yahoo.com (0)244838560
Clement Abaidoo	PhD Candidate (DevelopmentStudies) Masters in Intellectual Property Master of Philosophy (Development Studies) degree in Environment and Development B.Ed degree in Economics and Management Education	Stakeholder & Socio-economic Baseline Specialist	kwesi.eduaful@yahoo.com (0)243001234
Steven Tsike	M S c E n v i r o n m e n t a l Technology BSc. Renewable Natural Resources	Ecologist	stevetsike@gmail.com (0)242633950
Nathaniel Sakey	MSc. Petroleum Geoscience MPhil. Geophysics BSc. Geology	Hydrogeologist	sackeynat@icloud.com (0)541221647
Delali Gamor	PhD Candidate, Integrated Coastal Zone Management MPhil Integrated Coastal Zone Management BSc (Hons) Fisheries and Aquatic Sciences	Coastal Studies Specialist	delgamora@gmail.com (0)242866762
Nana Yaw Wiafe	MSc Water Quality, Sanitation and Environment BSc Laboratory Technology	Climate Studies & Modeling Specialist, Lab Technician	wiafe@rocketmail.com (0)500006621
Edward Kojo Anagbo	MSc Environmental Engineering BSc Environmental Science	EIA Project Manager, Environmental Legislation Analyst	akojo.edward@gmail.com (0)247197014

EIA Team Declaration:

This Study was undertaken by:

GreenDev Associates International Limited

Zees Plaza, 6th Street, Methodist Church Road, Community 25 - Dawhenya Stretch

Tel: +233 (0) 266984364

Email: greendev.associates@gmail.com

Emmanuel Okoh Agyemang
Deputy Team Lead

Edward Kojo Anagbo
EIA Project Manager

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LIST OF ABBREVIATIONS

CRM	Cylinder Recirculation Model
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
FID	Factories Inspectorate Department
GG	Ghana Gas
GNGC	Ghana National Gas Company
GNGCBP	Ghana National Gas Company Bottling Plant
GPP	Gas Processing Plant
GNFS	Ghana National Fire Service
GSA	Ghana Standards Authority
GSS	Ghana Statistical Service
HSE	Health, Safety & Environment
HSSE	Health Safety Security & Environment
LI	Legal Instrument
LPG	Liquefied Petroleum Gas
MT	Metric Tons
MMSCFD	Million Standard Cubic Feet per Day
NED	Nzema East District
NEMA	Nzema East Municipal Assembly
NPA	National Petroleum Authority
OIML	International Organisation of Legal Metrology

Executive Summary

Background of the Company

Ghana National Gas Company (GNGC) is a limited liability company duly registered and incorporated in July 2011 at the Registrar General's Department in accordance with the Companies Code of 1963, Act 179.

GNGC is the nation's premiere mid-stream gas business company that owns and operates infrastructure required for the gathering, processing, transporting and marketing of natural gas resources in Ghana and internationally. GNGC is responsible for producing and prospecting of lean gas, condensate, LPG and isopentanes and further, plays a key role in accelerating the nation's industrial sector. GNGC operates on a business model and thus, obtains revenue through the processing, transportation and sale of natural gas and natural gas liquids.

Project Information

GNGC proposes to set up an LPG Bottling Plant at Axim in the Nzema East Municipality of the Western Region. The Plant will serve the residents in the Western Region and beyond. The project will be constructed and operated under strict national and international guidelines to ensure utmost safety and preventive standards.

The proposed plant is designed to have an initial installed capacity of 600 MT and will be fashioned to meet European and Indian standards with fully automatic and semi-automatic electronic filing carrousel. It will be designed to fill various sizes of cylinders for the domestic market (3 Kg, 6 Kg, 12 Kg and 14.5 Kg) and the commercial market based on demand and may include 35 Kg, 50 Kg or more. The main component of the plant include a 600MT Horton Sphere LPG bottling plant,

Off/Loading points for mobile trucks, LPG Filling Hall- Automatic and semi-automatic cylinder filling carousel, Maintenance building for testing of cylinders and valves and carrying out maintenance works, Cylinder storage (empty and filled) and the associated works, facilities and utilities. The LPG Bottling plant will be connected to a 600MT Horton LPG storage tank which will supply LPG for distribution by the plant into the cylinders. The storage tank will be filled by the LPG Bullet Trucks which will convey LPG from the GNGC Loading Gantry at Anokye. The plant will be scalable for expansion to double the capacity.

The bottling plant will be fashioned to meet American, European and Indian standards with fully automatic and semi-automatic electronic filing carrousel.

Some of the American, European and Indian Standards that the LPG Bottling plant will conform to include:

- ANSI: American National Standards Institute
- API: American Petroleum Institute
- ASME American Society of Mechanical Engineers
- ATEX 95: Equipment & Protective Systems for explosive atmospheres
- IEC: International Electro-technical Committee
- IEEE: Institute of Electrical & Electronic Engineers
- ISA: Instrument Society of America
- NFPA: National Fire Protection Association
- NEC: National Electrical Code
- NEMA: National Electrical Manufacturers Association
- PD 5500: United Kingdom's National Pressure Vessels Code

Purpose of the Report

In accordance with the Environmental Protection Agency Act 1994, Act 490 (parts 1&II) and Environmental Assessment Regulations 1999, LI 1652, the National Environmental Policy institutes and implements an environmental quality control program requiring prior Environmental Impact Assessment of all new investments that would be deemed to affect the quality of the environment. Environmental Impact Assessment aims to achieve:

a) Compilation of all relevant information on the proposed LPG Bottling plant project to inform the permitting authority (Environmental Protection Agency) to aid the environmental approval process.

b) Identifying all important receptors and disclosing identified potential environmental impacts of project prior to project being started.

c) Determining the significance of impacts and identifying mitigation measures to alleviate any significant adverse impacts.

d) Ensuring modern, precautionary control alternatives are well considered in the project design.

e) Developing sustainable environmental practices.

Legal Framework of the Project

National Environmental Policy and Related Requirements		
Policy/Legal Framework	**Summary of requirement**	**Compliance/ Applicability**
Ghana's Environmental Policy, 2012	The policy is fashioned for a holistic management of the environment, where people have access to clean air and water, decent housing and other necessities of life. The policy supports a new paradigm of sustainable development, based on coordinated environmental management to ensure quality of life of citizens and their living and working environments, as well as participation in decision making.	The implementation of the project should disrupt the quality of life in the community and not cause pollution to the air, water and soil
National Environmental Action Plan, 2014	The policy aims at sound management of resources and environment, and the reconciliation between economic planning and environmental resource utilization for sustainable national development.	Sound environmental management principles must be applied to the project.
Environmental Protection Agency Act 1994, Act 490	The EPA was established under the Environmental Protection Agency Act (Act 490 of 1994) as the leading public body responsible for the protection and improvement of the environment in Ghana. It is responsible for enforcing environmental policy and legislation, prescribing standards and guidelines, inspecting and regulating businesses and responding to emergency incidents. It is responsible for issuing environmental permits and pollution abatement notices for controlling waste discharges, emissions, deposits or other sources of pollutants and issuing directives, procedures or warnings for the purposes of controlling noise. The EPA has the authority to require an Environmental Impact Assessment (EIA), Preliminary Environmental Assessment (PEA), Waste Management Planning, etc. and is responsible for ensuring compliance with EIA procedures.	In that line an EIA has been requested for consideration of an environmental permit.The preparation and submission of this EIS therefore fulfills this policy.
Environmental Assessment Regulations 1999, LI 1652	The Environmental Assessment Regulations 1999 (LI 1652) enjoins any proponent or person to register an undertaking with the Agency and obtain an Environmental Permit prior to commencement of the project.	The company is currently seeking to obtain a valid permit.
Fees and Charges (Miscellaneous) Instrument 2019, L.I. 2386	This Act stipulates the fees and charges to be paid by proponents with respect to Environmental Permits and Certificates.	The company is committed to paying the various fees and charges that will be issued by the EPA
Environmental Sanitation Policy, 2010	In September, 2010, a revised Environmental Sanitation Policy of Ghana was produced. The overall goal of this new policy is to develop a clear and nationally accepted vision of environmental sanitation as an essential social service and a major determinant for improving health and quality of life in Ghana. The policy is a necessary tool required to help shape all efforts in dealing with the overwhelming challenges of poor sanitation in Ghana.	The company is expected to follow the guidelines of the policy ensure good housekeeping and avoid contamination of the environment.

National Environmental Policy and Related Requirements		
Policy/Legal Framework	**Summary of requirement**	**Compliance/ Applicability**
Hazardous and Electronic Waste Control and Management Act 2016, Act 917	This Act provides for the control, management and disposal of hazardous waste and electronic waste and for related purposes.	This act shall be used as guidance for disposal of hazardous waste from the facility.
Hazardous, Electronic and other Wastes (Classification) Control and Management Regulations 2016, LI 2250	This legal framework set the background for a new and innovative strategy towards a sustainable management of hazardous, e-waste and other wastes etc. in Ghana	The company must follow procedures stated in this legal framework for management of classification of e-waste and hazardous waste to enhance better control and management
Ghana National Climate Change Policy, 2013	The National Climate Change Policy is Ghana's integrated response to climate change. The policy aims to ensure a climate resilient and climate-compatible economy, while achieving sustainable development through equitable low-carbon economic growth for Ghana.	The promotion and use of LPG are a significant contributor to low carbon economic development as a substitute for fuelwood.
Riparian Buffer Zone Policy for Managing River Basins in Ghana, 2011.	It is a policy designed to provide comprehensive measures and actions that would guide the coordinated creation of vegetative buffers for the preservation and functioning of water bodies and vital ecosystems in Ghana.	The company will ensure it will abide with the respective buffer requirements

Ghana Standards for Environmental Quality		
Ghana Standard	**Summary of requirement**	**Compliance/ Applicability**
Ghana Standards for Environment: Requirements for Effluent Discharge (GS 1212, 2019)	This provides standards for specific quality of effluent discharge for various undertakings including industries and commercial facilities.	Since there isn't currently a specific set of standards for LPG Bottling Plants, the general industry standards will be used as the requirement.
Ghana Standards for Environment and Health Protection - Requirement for Ambient Air Quality and Point Source/Stack Emissions (GS 1236, 2019)	This provides standards acceptable level for ambient air quality and point source emissions.	GNGC is expected to comply with these air emission standards.
Ghana Standards for Health Protection - Requirement for Ambient Noise Control (GS 1222, 2018)	This standard gives the noise level of ambient noise generation for various classified zones including heavy industries, light industries, commercial zones, and residential areas.	GNGC will comply with the standards required for heavy industries

Framework for national planning and development		
Policy/Legal Framework	**Summary of requirement**	**Compliance/ Applicability**
National Land Policy, 1999	The main objectives of this policy are: • Ensure that socio-economic activities conform with the principles of sustainable land use. • Protect the rights of landowners and their descendants from becoming landless and • Provide mechanism for minimization and resolution of land dispute.	Management of GNGC will ensure that the project conforms with the land use and also the appropriate procedures are followed during the land purchasing from the owners.
Land Use and Spatial Planning Act, 2016 (Act 925)	An Act to revise and consolidate the laws on land use and spatial planning, provide for sustainable development of land and human settlements through a decentralised planning system, ensure judicious use of land in order to improve quality of life, promote health and safety in respect of human settlements and to regulate national, regional, district and local spatial planning and generally to provide for spatial aspects of socio economic development and for related matters	GNGC has ensured the site chosen for the project is suitable for industrial activity.
National Building Regulations, 1996 (LI 1630)	The core principle of the National Building Regulation is to provide guidelines for safety, health and governance. GNGC will ensure its plans and designs conform to the standards of the Nzema East Municipal Assembly.	GNGC will obtain the necessary building permit from the Nzema East District for its project.
Local Governance Act, 2016 (Act 936)	The Local Governance Act 2016 (Act 936) seeks to give a fresh expression to government's commitment to the concept of decentralization. It is a practical demonstration of a bold attempt to bring the process of governance to the doorstep of the populace at the Regional and more importantly, the District level. The Act establishes metropolitan, municipal and district assemblies as the highest decision making authority at the local level with powers to enforce zoning and building regulation as well as responsibility of waste management.	GNGC will ensure it abides with the rules and bye-laws enacted for the of the project area and shall work in accordance with provisions of the Nzema East Municipal Assembly
Ghana Building Code, GS 1207 of 2018	This code sets out requirements and recommendations for efficiency standards for residential and non-residential buildings and covers planning, management and practices	GNGC will ensure its contractors selected for the construction complies with the code.
Persons with Disability Act 2006, Act 715	An Act to provide for persons with disability, to establish a National Council on Persons with Disability and to provide for related matters.	GNGC shall ensure its facility is built to be disability-friendly.

Downstream petroleum sector policy and requirements		
Policy/Legal Framework	**Summary of requirement**	**Compliance/ Applicability**
National Energy Policy (2010)	The goal of the National Energy Policy within the downstream of the petroleum sub-sector is to facilitate the universal access to adequate, reliable and cost-effective petroleum products such as LPG. The policy also includes directions on increasing access to petroleum products, petroleum sector reforms and petroleum pricing.	GNGC shall abide with the policy and follow directives for pricing and reforms within the sector to enhance accessibility to LPG
National Policy on LPG Promotion, 2016	The policy seeks to ensure safety, increase access and adoption of LPG and its goal to ensure at least 50% of Ghanaians have access to safe and environmentally friendly LPG for cooking (domestic and commercial) and increased industrial usage by 2020. The policy objectives include: • Developing a standard market-based structure safety, increased access and adoption of LPG • Ensuring the existence of robust and standard Health, Safety and Environmental practices in the production, marketing and consumption of LPG; and • Ensure the sustainability of supply under the new market structure.	The implementation of this project will increase the accessibility to LPG to enhance industrial usage
Cylinder Recirculation Model (CRM)	Under this model, consumers will not own their cylinders, but simply pay a deposit for the cylinders and exchange their empty cylinders for a cylinder filled with LPG on payment for the LPG.	The implementation of this project is a step to realizing the policy objective
Strategic National Energy Plan	The strategic plan provides fuel substitution strategies within the informal industries, commercial/service entities and residential sector to shift from firewood to charcoal and then to other cooking fuels such as LPG, kerosene and electricity.	The chosen project location is key to increasing accessibility of LPG to rural users and includes a plan for an efficient distribution network and back-up support to combat potential gas accidents.
Sustainable Energy for All Action Plan	The Sustainable Energy for All Action Plan (2012) outlines specific solutions and prioritized actions to accelerate the achievement of universal access to modern energy services, among others, , for cooking and productive use of energy by the year 2020. The plan also advocated for the use of the LPG cylinder recirculation model for the distribution of LPG to accelerate the uptake of LPG for cooking.	The facility will provide accessibility for cylinder bottling which is a key component for ensuring sustainable energy for all.

Downstream petroleum sector policy and requirements		
Policy/Legal Framework	**Summary of requirement**	**Compliance/ Applicability**
Ministry of Energy HSSE Manual for Energy Sector Organisation	The objective of the manual is to ensure that companies in the energy sector have laid down minimum requirements to guide their respective operational procedure and processes in managing health, safety, security and environmental issues. The manual is divided into four sections: • HSSE Management System; • Standard Operating Procedures; • Incident Notification and Investigation; and • Record Retention Standard	The facility will be managed in accordance with the provisions in the HSSE Manual for the Energy Sector.
Energy Commission Act, 1997 (Act 541)	The Energy Commission Act, 1997 (Act 541) established the Energy Commission and provided for its functions relating to the regulation, management, development and utilization of energy resources in Ghana. The Act also provides for the granting of licenses for the distribution and sale of electricity and natural gas, marketing and sale of petroleum products, among others.	The management shall obtain the requisite license for the marketing and sale of LPG from the proposed facility
National Petroleum Authority Act, 2005 (Act 691)	The National Petroleum Authority Act, 2005 (Act 691) established the National Petroleum Authority and provided for its functions on regulation and monitoring in the petroleum downstream industry, including: • Granting Licenses to applicants • Maintaining a register and that on licenses, petroleum products and service providers; • Protecting the interests of consumers and petroleum service providers; and • Investigating the operation of service providers to ensure conformity with best practice.	GNGC shall register the facility with the NPA

National labour, safety and health requirements		
Policy/Legal Framework	**Summary of requirement**	**Compliance/ Applicability**
Factories, Offices and Shops Act 1970, Act 328	The Factories, Offices and Shops Act of 1970 (Act 328) requires all operators of industrial facilities to register their facilities with the Chief Inspector of Factories Inspectorate Division.	GNGC will duly register the facility with the Factories Inspectorate Division.
The New Labour Act 2003, Act 651	Section 118(1) of the New 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	The company is expected to provide the appropriate safe working conditions for all workers. These will include good equipment, PPE, training and emergency response measures.
Occupational Safety and Health (OSH) Policy of Ghana, Draft 2004	The OSH Policy statement (Draft, 2004) is to prevent accidents and injuries arising out of or linked with or occurring in the course of work, by minimizing as far as reasonably practicable, the cause of the hazards in the working environment and therefore the risk to which employees and the public may be exposed. The engagement of skilled and unskilled workforce at various stages of project implementation reiterates the relevance of the OSH Policy to the proposed project.	Management of GNGC has its own safety policy and programs which are in line with this policy.
National Workplace HIV/AIDS Policy, 2012	The general objectives of the Policy among others are to provide protection from discrimination in the workplace to people living with HIV and AIDS; prevent HIV and AIDS spread amongst workers and provide care, support and counseling for those infected and affected.	Involvement of persons from different backgrounds in performing various project related activities as a workforce indicate the relevance of this Policy to the intended project.
Public Health Act (2012) Act 851	This act states that "A person who manufactures, labels, packages, sells or advertises a consumable product in a manner that is false, misleading, deceptive or misbranded as regards its character, nature, value additives, substance, quality, quantity, composition, merit or safety commits an offence"	Management will ensure it produces LPG of the highest quality to meet the standard.
The Fire Precaution (Premises) Regulations 2003, LI 1724	The Fire Precaution (Premises) Regulation 2003 (LI 1724) requires all premises intended for use as workplaces to have Fire Certificates.	The management of GNGC will follow appropriate procedures and obtain a fire permit for the facility as well as install the appropriate fire fighting equipment for the facility

National labour, safety and health requirements		
Policy/Legal Framework	**Summary of requirement**	**Compliance/ Applicability**
Control and Prevention of Bushfire Law, PNDCL 229	Section 2 defines "starting of a bushfire". A person starts a bushfire if an action of that person results in the uncontrolled burning of a farm, forest or grassland. The Chief Conservator of Forests or the Chief Game and Wildlife Officer may authorize staring of fires by authorized officers in Conservation Areas under section 4.	Management will ensure it will not undertake bush burning during land preparation activities.
Ghana Standard Authority Decree, 1973 (NRCD 173)	This is an ACT to provide for promulgation of standards, for ensuring high quality of goods and other related matters.	The company is expected to use raw materials and manufacture products that comply with the local standards prescribed by the Ghana Standard Authority.
Boilers and Pressure Vessels Safety Regulations (LI 1663), 1970	These regulations shall apply to every steam boiler and every unfired pressure vessel to which an authorized safe working pressure has not been assigned by the Chief Inspector at the date of the coming into force of these regulations. Provided that where the Chief Inspector is of the opinion that the application of these regulations or part thereof to any steam boiler or unfired pressure vessel to which an authorized safe working pressure had been assigned at the date of the coming into force of these regulations is necessary to ensure the safety of any person or property he may in writing order that these regulations or part thereof shall apply thereto.	Management will ensure it works with the Factories inpectorate division to ensure that its pressure vessels are all safe for use.
Imposition of Restrictions Act, 2020 (Act 1012).	The Act provides for powers to impose restrictions on persons, to give effect to paragraphs (c), (d) and (e) of clause (4) of article 21 of the Constitution in the event or imminence of an emergency, disaster or similar circumstance to ensure public safety, public health and protection (section 1). Restrictions can be imposed if is reasonably required in the interest of defence, public safety, public health or the running of essential services; on the movement or residence within Ghana; to restrict the freedom of entry in to Ghana, or movement in Ghana, of a person who is not a citizen of Ghana; or for the purpose of safeguarding the people of Ghana against the teaching or propagation of a doctrine which exhibits or encourages disrespect for the nationhood of Ghana, the national symbols and emblems, or incites hatred against other members of the community. This includes social distancing for incidences such as COVID-19.	Management will ensure it follows all protocols under this act such as social distancing and hand sanitization to prevent the spread of COVID-19

Environmental Baseline Information

- The proposed site for the bottling plant project is a 63.31 acre land located about 2 km North-West of the Axim Township, in the Nzema East District of Ghana. The site is centred on longitude 2°14'52.30"W and latitude 4°53'24.10"N. It is largely undeveloped and about 100 m away from the Agona-Elubo road (N1) on its northern boundary and 400 m away from the Gulf of Guinea to the south.
- Axim experiences rainfall throughout the year. The coolest time of the year is between April and July when the main rainfall occurs. The mean peak period of rainfall is in the months of April to June and in October, with the highest peak value of 90mm in June. The lowest rainfall is in January of 7mm which is characteristic of harmattan (dry season). The 5year average minimum and maximum temperature is 24.9^0C and 30.5^0C respectively. Variations in temperature both annually and daily are quite small.
- The relative humidity in Axim ranges from 77% to 91%. The mean annual relative humidity in value is 85.0%. During the dry season, the average relative humidity is at 82% which rises to 85.0% during the rainy season. The wind speed in Axim experience little or no seasonal variations throughout the year. The average windspeed is 2.61 knots. The windiest month is in September with a windspeed of 3.4 knots. The prevailing wind direction in the project area is from the south to the northeast.
- The terrain of the Nzema East District (NED) is generally undulating with elevations ranging from 2m above sea level and the highest point at about 190m above sea level. The District is mainly drained by the Ankobra river and its major tributaries like the Ahama and Nwini rivers. The landscape has therefore been

generally modified by the Ankobra River and winds from the south through geomorphological processes.

- On a broad scale, the regional vegetation pattern of the area inland of Axim across the project site and extending west towards Takoradi is dry semi-deciduous forest. Mangrove communities could be found within the coastal lagoons and along the banks of the Ankobra River. On the Axim-Ankobra stretch of the coast, human activities have greatly influenced the vegetation cover, causing a low diversity in plant species occurring along the beach.
- Common flora in the area include various species of trees, shrubs, mangroves and grassland species. Dominant vegetation within 2km radius of the project site is characterized by flora of the Imperata cylindrical (Spear grass) association, Cocos nucifera, Cyperus articulatus, Ipomoea pes-caprae, Opuntia vulgaris, Paspalum vaginatum, Phoenix reclinata, Sporobolus virginicus, Thespesia populnea, and Triumfetta rhomboidea.
- The area has a wide variety of molluscs, and crustaceans including littorinid snails and crabs. The sandy beach fauna is dominated by the ghost crab, Ocypoda cursor, and the rocky beaches by bivalves, whelks, limpets and crabs e.g. Grapsus grapsus. Other commonly encountered fauna include isopods, amphipods, mysids and polychaetes.

Socio-Economic Baseline Information

- The Nzema East Municipality is one of the Seventeen (17) administrative authorities in the Western Region of Ghana. It is located on the Southern end of the region between longitude $2^{0}05$" and $2^{0}35$" West and latitude $4^{0}40$ and $5^{0}20$ North. The municipality is bounded on the West by Ellembelle District, North by Wassa Amenfi West District, East by Tarkwa-Nsuaem Municipality Prestea Huni Valley and Ahanta West and on the South by the Gulf of Guinea with about 9km stretch of sandy beaches.
- The Nzema East Municipality covers a total land area of 2,194 sq km. Its population as at 2010 stood at 60,828 and is currently (2021) estimated to be approximately 90,000; about 80,933 as at September 2020. The population of the Municipality constitutes less than five percent of the Western Region's population and has a slightly female dominant population of 50.8 percent (GSS, 2014).
- It is estimated that over 65% of the economically active population are engaged in agriculture (including fishing) and agro-processing. Cassava is the major food crop produced by the farmers in the area. Though there are quite a number of farmers associations in the communities as well as vast arable lands for cassava production. It is gathered that the Cassava value chain has not been fully exploited in the area. Cocoa is a major cash crop produced in the area, with over 35,000 hectors of land currently used.
- Shared cropping is the common land tenure system. The municipality boasts of a number of natural resources, commonest amongst them being Basalt, Gold, Gravel, Clay, and Rainforest Bamboo. NEMA is also a major fishing area with lots of activities and potential for fish farming and aquaculture development. Currently,

there are over 650 canoes and 13 landing sites in the municipality and this makes it one of the busiest fishing areas in the entire country.

- The Municipality has a total of 244 educational facilities ranging from pre-school to SHS/TVET with a total student population of 23,740. The student population in the area is largely dominated by females (61.2%). There is no tertiary institution in the entire municipality, apart from a distance learning study center of the University of Cape Coast at the Nsein Senior High School.
- Nzema East Municipal Assembly (NEMA) has a Municipal Hospital, three functioning polyclinics and 16 CHPS compounds with a Medical staff strength of 99. Most of the CHIP compounds are located in the rural communities. There is also a functional National Health Insurance Office with an active membership of 35,585 and 18 credential facilities.
- The municipality has a total of 335km feeder roads and 34km urban roads. Other water resources such as the Ankobra river and the sea (Gulf of Guinea) also serve as a means of transportation for some communities through the use of automated boats.
- Tourism is one of the major activities in the district. The municipal is the host to a number of tourist sites which attracts tourists from diverse parts of the country and the world. Notable among the tourist sites are the tomb and house of one of the historical fathers of Ghana, Alfred Paa Grant and the over five century old Castle Santo Antonio. There is also a Boboayisi Island. The beautiful Ankobra estuary and a 13 km sandy, coastline which has been identified as a potential for good leisure is also found in the Municipality.

Public Participations/Stakeholder Consultations

As part of the Environmental Impact Assessment, consultations were initiated held with key public institutions and immediate neighbours to provide them information of the project as it allows them the opportunity to voice their candid opinions about the project. This was achieved via all stakeholder-inclusive approach. The principal objective of public participation in the Environmental Impact Assessment (EIA) process is to inform and enrich decision-making. This approach sought to promote consensus building and general acceptance of the project by the stakeholders.

To date, various stakeholder groups, namely institutional regulators, traditional leaders and community members have been contacted and provided with information on the proposed Axim LPG Bottling Plant project and briefed about the EIA process.

The table below provides the list of stakeholders consulted so far.

Date	Stakeholder Group	Venue	Nº. of Participants
12/09/2020	Traditional Priests and Priestesses of Axim	Axim Traditional Palace	5
	Chiefs and Elders of Axim	Chief Palace	11
09/03/2020	Traditional leaders from Lower Axim Traditional Councils	Chief Palace	6
9/03/2020	Traditional leaders from Upper Axim Traditional Councils	Chief Palace	5
9/03/2020	Jomoro Traditional Council	Councils' Palace	10

Date	Stakeholder Group	Venue	Nº. of Participants
9/03/2020	Nzema East Municipal Assembly	Municipal Coordinating Council Hall	5
9/03/2020	Nsein Traditional Council	Chiefs Palace	7
10/03/2020	Ayisakro Community	Community center	About 100
10/03/2020	Adukrom Community	Community Shed	About 100
10/03/2020	Apataim Community	Community Shed	About 100
11/03/2020	Ankobra Community	Community Shed	About 100
11/03/2020	Akyinim Community	Community Shed	About 100
11/03/2020	Brawire Community	Community Center	About 100
12/03/2020	MPH Construction Firm	Work Camp	4
12/03/2020	China harbourr	Work Camp	4
7/10/2020	Member of Parliament of Gwira Evalue	MP's Office	2
02/02/2021	Forestry Commission-NEMA	FC Municipal Office, NEMA	1
02/02/2021	Management of Ankobra Beach Resort	Resort reception	2
02/02/2021	Management of Ghana National Fire Service, NEMA-Axim	Municipal Office, GNFS- NEMA	1
02/02/2021	Ghana Private Road Transport Union (GPRTU)-Drivers Association	GPRTU station (Under Shed), Esiama	8
03/02/2021	Leadership of Poultry farmers Association	Ishmael Poultry Farm-Esiama	1
03/02/2021	Electricity Company of Ghana-Esiama	ECG-Esiama office	1

Date	Stakeholder Group	Venue	Nº. of Participants
03/02/2021	NEMA Municipal Chief Executive and Coordinating Council	Office of the Municipal Coordinating Director, NEMA	3

The initial stakeholders consulted were very happy about the project. They however insisted that the project must be operated under strict safety rules approved by the EPA.

Impacts, Mitigation and Monitoring Measures

PHASE	IMPACTS TO BE MITIGATED	PROPOSED MITIGATION
Pre-Development	• Occupational Health and Safety Issues • Land Litigation and Compensation Issues	• Provision of PPEs, First Aid Kits and training of personnel • Using legal and institutional means to identify land owners and following due procedures to acquire and register the land. • Limiting movement on the site to only required areas for the feasibility survey
Construction	• Impact on Air Quality • Generation of Noise • Wastewater generation • Solid waste generation • Resource Consumption • Impact on ecosystem • Traffic Impact • Work camp impacts • Occupational Health and Safety Risks • Public Health and Safety Issues • Visual Impact • Erosion Impacts • Waste Oil Generation	• Use of water for dowsing bare surfaces, use of efficient fuels for vehicles and servicing of vehicles. • Servicing of construction machinery and limiting work to daytime hours. • Avoiding excess and reuse of slurry material for construction works • Providing bins and educating workers on the need to avoid littering. • Education of workers to help them adopt efficient resource utilization methods • Limiting vegetation removal to only required areas and preserving excavated topsoil for backfilling and growth of lawns • Contracting highly experienced drivers and using good routes to reduce traffic jams • Provide active on education on issues such as hygiene, communicable diseases, equal rights, etc. • Provision & enforcement of PPE usage, training staff to adhere to safe work practices • Avoiding unauthorized access to the site and using signage to notify the public • Creating a fence wall to screen off unsavory construction scenes. • Compacting soil surfaces to avoid erosion by wind or water. Limiting vegetation removal to only areas required and engineering drains for stormwater runoff. • Preventing waste oil spills and initiating clean up procedures in the event of a spill. Providing drip pans for waste oil.
Operation & Maintenance	• Increased Pressure on Utility Supply • Dust and Gaseous emissions • Noise Generation • Solid Waste generation • Wastewater Generation • Waste Oil Generation • Sanitation and hygiene impacts • Occupational Health and Safety Hazards • Fire & Explosion Hazards • Public Health and Safety Issues • Generation of heat • Hazardous Chemical spills • Traffic Impact	• Switching off machineries when they are not in use. • Paving the facility premises, ensuring couplings on nozzles are properly fitted to avoid gas leakage during discharge. • Regular servicing of machineries and operation of machines at required capacities • Provision of skips for collection of wastes and contracting waste management companies to dispose wastes safely. • Channeling greywater via effluent handling system into external drains. Black water will be channeled into septic tanks. Install grease traps in drains. • Building of a bund wall around the oil tanks, provision of spill kits for cleaning up spills and special containers for waste oil. • Provision of PPE, Well stocked first aid kit, emergency response equipment, health surveillance and health insurance packages for workers • Registering with GNFS, Providing Fire-Fighting Equipment and Training for employees. • Providing signage to alert the public and limiting their exposure to gaseous emissions through proper internal controls. • Creation of vents and installation of heat extractors to minimize temperatures on the production floor. • Drainage systems are connected to effluent handling systems and using MSDS to handle hazardous spills to avoid pollution. • Providing spacious parking space for BRVs and all forms of vehicles to avoid parking of vehicles on the roadsides. Providing separate entrance and exits for the facility. Ensuring there is driveways and walkways to avoid traffic incidents.

Proposed Environmental Monitoring Plan for Construction Phase

What to Monitor	When to Monitor	How to Monitor	Who Monitors	Budget (GHS)
Ambient Air Quality (TSP, PM_{10}, SO_X, NO_x, CO, VOCs)	Monthly	Test Methods and machinery in line the Ghana Standards	Site Safety Officer of Contractor	1500 per month
Raw Material Consumption	Weekly	Comparing Procurement sheets with project deliverables	Procurement Manager of Contractor	300 per month
Solid Waste Management	Daily	Visual inspection of site and waste trail documents	Site Safety Officer of Contractor	350 per month
Liquid Waste Management (Greywater exiting the facility)	Daily	Visual inspection of site and temporary washrooms and containers for carrying construction slurry	Site Safety Officer of Contractor	350 per month
Noise	Monthly	Noise Meters such as Casella	Site Safety Officer of Contractor	400 per month
Utilities	Monthly	Review of utility bills	Project Manager of Contractor	200 per month
Occupational and Public Health & Safety Issues including Traffic Impacts	Daily	• Observations • Review of incident records and complaint records	Site Safety Officer of Contractor	1000 per month
TOTAL				**4,100.00**

Provisional Environmental Monitoring Plan for Operational Phase

What to Monitor	When to Monitor	How to Monitor	Who Monitors	Budget (GHS)/Month
Ambient Air Quality (TSP, PM_{10}, SO_X, NO_x, CO, VOCs)	Monthly	Outdoor Ambient Air Quality Monitors such as Minivol Sampler, Aeroqual, etc.	HSE Officer	11,500.00
Raw Material Consumption	Weekly	Comparing procurement sheets against production output	Plant Manager	300.00
Solid Waste Management	Daily	Visual inspection of site and waste trail documents	HSE Officer	400.00
Liquid Waste Management	Monthly	Sampling and laboratory analysis	HSE Officer	1,500.00
Noise	Monthly	Noise Meters such as Casella	HSE Offer	650.00
Utilities	Monthly	Review of utility bills	Plant Manager	200.00
Maintenance of Pollution control systems	Monthly	The systems will be checked regularly to ensure they are in optimal working conditon	HSE Officer	1,000.00
Occupational and Public Health & Safety Issues including Traffic Impacts	Daily	• Observations • Review of incident records and complaint records • Conducting assessment for workers to ascertain their comprehension of safety trainings and systems	HSE Officer	4,000.00
Management of hazardous spills and responsible transportation of chemicals	Daily	Ensuring special purpose vehicles and on-site storage/ reception facilities are in good condition at all times	HSE Officer	1,000.00
TOTAL				**20,050.00**

Conclusion

GNGC proposes to set up an LPG Bottling Plant at Axim in the Nzema East Municipality of the Western Region. The Plant will serve the residents in the Western Region and beyond. The project will be constructed and operated under strict national and international guidelines to ensure utmost safety and preventive standards.

In line with the requirements of the Environmental Protection Agency, this Environmental Impact Statement has been prepared and the report is deemed to have adequately identified potential impacts of the project on the physical, biological and socio-economic/cultural environments, occupational safety, health and welfare of the employees. The report has also proposed mitigation measures to minimize/eliminate the negative impacts, taking into consideration: cost, feasibility and practicability. A review of the identified impacts shows there will be some regular significant impacts on the environment (e.g. traffic, air quality, noise, generation of solid waste and liquid waste etc. during the development and operational) whilst others will be minimal, intermittent and local in nature.

The project cannot be carried out without any impacts on the environment since some impacts are unavoidable. However, the mitigation measures proposed are expected to be able to minimize the impacts so as to make them pose no threats to the continued sustainability of the environment.

The report has also identified the benefits of the proposed project and categorically that the project will help to increase the socio-economic activity in the area thus it will be beneficial on a national scale as the project will have a positive impact on meeting the nation's industrialization objective.

1.0 INTRODUCTION

1.1 Company Profile

Ghana National Gas Company (GNGC) is a limited liability company duly registered and incorporated in July 2011 at the Registrar General's Department in accordance with the Companies Code of 1963, Act 179. (See the company registration certificates in Appendix 1).

GNGC is the nation's premiere mid-stream gas business company that owns and operates infrastructure required for the gathering, processing, transporting and marketing of natural gas resources in Ghana and internationally. GNGC is responsible for producing and prospecting of lean gas, condensate, LPG and isopentanes and further, plays a key role in accelerating the nation's industrial sector. GNGC operates on a business model and thus, obtains revenue through the processing, transportation and sale of natural gas and natural gas liquids.

GNGC currently has its headquarters at 225 Osibisa Close, Airport West Accra.

The current gas infrastructure comprises the following main elements:

- Offshore gas export pipeline, which consists of a 12 inch diameter 58 km long subsea pipeline, transporting dense-phase gas from the Jubilee FPSO to the Gas Plant (GPP).
- Gas Processing Plant (GPP) at Atuabo in the Western Region and has a design capacity of 150 MMScfd and normal design capacity of 120 MMScfd.
- Onshore gas pipeline, which consists of a 20 inch diameter 110 km pipeline, transporting sales gas from the GPP to an existing Thermal Power Plant at Aboadze.
- LPG truck-loading gantry located approximately 2.5 km from the GPP near Anokye.

GNGC is a trusted and reliable gas company and contributes to Ghana's economic development. GNGC has a workforce of professionals and specialists in the field of Engineering. The company encourages teamwork, loyalty, respect, integrity, accountability, excellence and professionalism and cares greatly about the environment. GNGC has well defined training programmes for its officers that enhance their skills and capabilities, encouraging staff to remain committed to the values and vision of GNGC.

GNGC provides room for new ideas to boost its activities and subsequently, increase economic gains from the gas business. The officers of GNGC are therefore motivated to give their utmost best to achieve the set target for each commercial year.

1.2 The Purpose and Objectives of the Undertaking

The Government of Ghana through the National Petroleum Authority (NPA) rolled out the LPG Cylinder Recirculation Model (CRM) in 2017. This is aimed at consolidating activities in the LPG value chain whilst reducing health, safety, security and environmental risk exposure. The objective of the policy is to ensure that 50% of Ghanaians have access to safe, clean and environmentally friendly LPG for increased domestic, commercial and industrial usage by 2030.

The CRM requires an LPG Bottling Facility, Cylinder Transporter and Cylinder Re-Distributor roles in the LPG value chain. This replaces the need for re-filling stations and reduces transportation of LPG (in bulk road vehicles) over long distances.

In line with the future prospects envisaged; and to ensure fulfillment of demand, GNGC proposes to set up an LPG Bottling Plant at Axim in the Nzema East Municipality of the Western Region. The Plant will serve the residents in the Western Region and beyond. The project will be

constructed and operated under strict national and international guidelines to ensure utmost safety and preventive standards. GNGC has obtained a Provisional license from NPA for the project (See Appendix 2 for the NPA Provisional License)

The proposed plant is designed to have an initial installed capacity of 1200 cylinders/hr. It will be designed to fill various sizes of cylinders for the domestic market (3 kg, 6 kg, 12 kg and 14.5 kg) and the commercial market based on demand and may include 35 Kg, 50 Kg or more. The LPG Bottling plant will be connected to a 600MT Horton LPG storage tank which will supply LPG for distribution by the plant into the cylinders. The storage tank will be filled by the LPG Bullet Trucks which will convey LPG from the GNGC Loading Gantry at Anokye. The plant will be scalable for expansion to double the capacity.

The bottling plant will be fashioned to meet American, European and Indian standards with fully automatic and semi-automatic electronic filing carrousel. Some of the American, European and Indian Standards that the LPG Bottling plant will conform to include:

- ANSI: American National Standards Institute
- API: American Petroleum Institute
- ASME American Society of Mechanical Engineers
- ATEX 95: Equipment & Protective Systems for explosive atmospheres
- IEC: International Electro-technical Committee
- IEEE: Institute of Electrical & Electronic Engineers
- ISA: Instrument Society of America
- NFPA: National Fire Protection Association
- NEC: National Electrical Code
- NEMA: National Electrical Manufacturers Association
- PD 5500: United Kingdom’s National Pressure Vessels Code

The summary objectives of the project are:

- Provide safe LPG bottles for domestic and commercial purposes.
- Reduce LPG related accidents, domestically and at the filling stations.
- Provide a safe plant located far from populated area with high HSSE practices
- Meet demand for LPG in the western part of the country.
- Make LPG readily accessible to consumers.

1.3 The Environmental Impact Assessment Process

In accordance with the Environmental Protection Agency Act 1994, Act 490 (parts 1&II) and Environmental Assessment Regulations 1999, LI 1652, the National Environmental Policy institutes and implements an environmental quality control program requiring prior Environmental Impact Assessment of all new investments that would be deemed to affect the quality of the environment. Environmental Impact Assessment aims to achieve:

a) Compilation of all relevant information on the proposed LPG Bottling plant project to inform the permitting authority (Environmental Protection Agency) to aid the environmental approval process.

b) Identifying all important receptors and disclosing identified potential environmental impacts of project prior to project being started.

c) Determining the significance of impacts and identifying mitigation measures to alleviate any significant adverse impacts.

d) Ensuring modern, precautionary control alternatives are well considered in the project design.

e) Developing sustainable environmental practices.

The Environmental Assessment Procedure involves:

1. ***Registration***: Submission of relevant application by proponent to the EPA.
2. ***Screening***: Field verification visit by the EPA to determine level of impact assessment required.
3. ***Scoping***: Undertaking preliminary studies to identify impacts and relevant stakeholders for further consultation.
4. ***EIA Study***: Thorough study to identify environmental impacts and proposed mitigation measures; and submission of Environmental Impact Statement (EIS) to the EPA.
5. ***EIS Review***: Review of EIA study by the EPA to guide conformity to sustainability.
6. ***Decision Making***: Decision by EPA to permit or object to project.

GNGC has duly applied for a permit at the EPA Ellembelle Area Office. The Ellembelle Area Office screened the project and advised that a project of this nature requires full scale Environmental Impact Assessment study starting with a Scoping Study.

GNGC engaged Messrs GreeenDev Associates International Limited to conduct a Scoping Study and Environmental Impact Assessment for submission to the EPA for consideration of an environmental permit.

A Scoping Report was submitted to the EPA for review and the Agency requested for a Draft EIS. The preparation of this EIS therefore satisfies EPA's request.

(See Appendix 3 for the correspondence with EPA)

1.4 Approach & Methodology for Study

The following procedures were used in the performance of the study:

- Site visits and field survey to gather biophysical baseline data and socio-economic characteristics of the existing environment;
- Desktop research of international and local reports, publications, sustainability guidelines on operation of LPG Bottling plants.
- Identification, mapping and consultations with the relevant stakeholders.
- Identification and assessment of likely environmental, cultural and socio-economic impacts associated with the project;
- Development of mitigation and monitoring programs to guide environmental performance;
- Analysis of occupational health and safety hazards associated with the project, and development of best operating procedures for managing risks at the workplace;

2.0 POLICY, LEGAL, REGULATORY AND INSTITUTIONAL FRAMEWORK

This chapter explains the relevant policy, legislative and administrative requirements applicable to the project under the constitution of Ghana. It also highlights some international laws and standards that intend to optimize best industry standards and practices in relation to the project.

2.1 Legislative and Policy Requirements

The key legislative and policy requirements relating to industrial LPG bottling operations (which fall under the downstream petroleum sector) have been reviewed and grouped into six main areas, namely:

1. National environmental policy and related requirements
2. National Environmental Quality Standards
3. Framework for national planning and development
4. Downstream petroleum sector policy and requirements
5. National labour, safety and health requirements
6. International requirements and safeguard policies

2.1.1 National Environmental Policy and Related Requirements

- Ghana's Environmental Policy, 2012
- National Environmental Action Plan, 2014
- Environmental Protection Agency Act 1994, Act 490
- Environmental Assessment Regulations 1999, LI 1652
- Fees and Charges (Amendment) Instrument 2019, LI 2386
- Environmental Sanitation Policy, 2010
- Hazardous and Electronic Waste Control and Management Act 2016, Act 917
- Hazardous, Electronic and Other Wastes (Classification) Control and Management Regulations 2016, LI 2250
- Ghana National Climate Change Policy, 2013
- Riparian Buffer Zone Policy for Managing River Basins in Ghana, 2011.

Table 2.1 National Environmental Policy and Related Requirements		
Policy/Legal Framework	**Summary of requirement**	**Compliance/Applicability**
Ghana's Environmental Policy, 2012	The policy is fashioned for a holistic management of the environment, where people have access to clean air and water, decent housing and other necessities of life. The policy supports a new paradigm of sustainable development, based on coordinated environmental management to ensure quality of life of citizens and their living and working environments, as well as participation in decision making.	The implementation of the project should disrupt the quality of life in the community and not cause pollution to the air, water and soil
National Environmental Action Plan, 2014	The policy aims at sound management of resources and environment, and the reconciliation between economic planning and environmental resource utilization for sustainable national development.	Sound environmental management principles must be applied to the project.
Environmental Protection Agency Act 1994, Act 490	The EPA was established under the Environmental Protection Agency Act (Act 490 of 1994) as the leading public body responsible for the protection and improvement of the environment in Ghana. It is responsible for enforcing environmental policy and legislation, prescribing standards and guidelines, inspecting and regulating businesses and responding to emergency incidents. It is responsible for issuing environmental permits and pollution abatement notices for controlling waste discharges, emissions, deposits or other sources of pollutants and issuing directives, procedures or warnings for the purposes of controlling noise. The EPA has the authority to require an Environmental Impact Assessment (EIA), Preliminary Environmental Assessment (PEA), Waste Management Planning, etc. and is responsible for ensuring compliance with EIA procedures.	In that line an EIA has been requested for consideration of an environmental permit.The preparation and submission of this EIS therefore fulfills this policy.
Environmental Assessment Regulations 1999, LI 1652	The Environmental Assessment Regulations 1999 (LI 1652) enjoins any proponent or person to register an undertaking with the Agency and obtain an Environmental Permit prior to commencement of the project.	The company is currently seeking to obtain a valid permit.
Fees and Charges (Miscellaneous) Instrument 2019, L.I. 2386	This Act stipulates the fees and charges to be paid by proponents with respect to Environmental Permits and Certificates.	The company is committed to paying the various fees and charges that will be issued by the EPA
Environmental Sanitation Policy, 2010	In September, 2010, a revised Environmental Sanitation Policy of Ghana was produced. The overall goal of this new policy is to develop a clear and nationally accepted vision of environmental sanitation as an essential social service and a major determinant for improving health and quality of life in Ghana. The policy is a necessary tool required to help shape all efforts in dealing with the overwhelming challenges of poor sanitation in Ghana.	The company is expected to follow the guidelines of the policy ensure good housekeeping and avoid contamination of the environment.

Table 2.1 National Environmental Policy and Related Requirements		
Policy/Legal Framework	**Summary of requirement**	**Compliance/Applicability**
Hazardous and Electronic Waste Control and Management Act 2016, Act 917	This Act provides for the control, management and disposal of hazardous waste and electronic waste and for related purposes.	This act shall be used as guidance for disposal of hazardous waste from the facility.
Hazardous, Electronic and other Wastes (Classification) Control and Management Regulations 2016, LI 2250	This legal framework set the background for a new and innovative strategy towards a sustainable management of hazardous, e-waste and other wastes etc. in Ghana	The company must follow procedures stated in this legal framework for management of classification of e-waste and hazardous waste to enhance better control and management
Ghana National Climate Change Policy, 2013	The National Climate Change Policy is Ghana's integrated response to climate change. The policy aims to ensure a climate resilient and climate-compatible economy, while achieving sustainable development through equitable low-carbon economic growth for Ghana.	The promotion and use of LPG are a significant contributor to low carbon economic development as a substitute for fuelwood.
Riparian Buffer Zone Policy for Managing River Basins in Ghana, 2011.	It is a policy designed to provide comprehensive measures and actions that would guide the coordinated creation of vegetative buffers for the preservation and functioning of water bodies and vital ecosystems in Ghana.	The company will ensure it will abide with the respective buffer requirements

2.1.2 Ghana Standards for Environmental Quality

The relevant national environmental quality standards to be considered include:

- Ghana Standards for Health Protection - Requirements for Ambient Noise Control (GS 1222, 2018)
- Ghana Standards for Environment and Health Protection - Requirements for Ambient Air Quality and Point Source/Stack Emissions (GS 1236, 2019)
- Ghana Standards for Environmental Protection - Requirements for Effluent Discharge (GS 1212,2019)

2.1.2.1 Ghana Standards for Environment: Requirements for Effluent Discharge (GS 1212, 2019)

This provides standards for specific quality of effluent discharge for various undertakings including industries and commercial facilities. Since there isn't currently a specific set of standards for LPG Bottling Plants, the general industry standards will be used as the requirement.

Table 2.2: General Industry Standards for Effluent Discharge

Parameters	**Maximum Permissible Levels**
Temperature	$\leq 3^0$ C above ambient
Alkalinity (mg/l)	150
Colour (TCU)	200
COD(mg/l)	250
BOD_5(mg/l)	50
Oil & Grease(mg/l)	5
Conductivity(µS/Cm)	1500
pH	6-9
TDS(mg/l)	1000
Total phosphorus(mg/l)	2
TSS(mg/l)	50
Turbidity(N.T.U)	75
Nitrate as total Nitrogen (mg/l)	50
Total Coliforms (MPN/100ml)	400

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

This provides standards acceptable level for ambient air quality and point source emissions.

Table 2.3: GS 1236, 2019 Standards

Parameter	**Duration (Hours)**	**Maximum Limit (ug/m^3)**
Total Suspended Particle	24	150
PM_{10}	24	70
$PM_{2.5}$	24	35
Sulphur Dioxide (SO_2)	24	150
Nitrogen Dioxide (NO_2)	24	150

2.1.2.3 Ghana Standards for Health Protection: Requirement for Ambient Noise (GS 1222:2018)

This standard gives the noise level of ambient noise generation for various classified zones including heavy industries, light industries, commercial zones, and residential areas.

Table 2.4: GS 1222, 2018

Zones	Permissible Noise Level in dB(A)	
	Day (6:00am-10:00pm)	**Night (10:00pm-6:00am)**
Residential Area	55	48
Educational and health facilities, offices and law courts	55	50
Mixed Use	60	55
Areas with some light industry	65	60
Commercial areas	75	65
Light Industrial Areas	70	60
Heavy Industrial Areas	70	70

In terms of Compliance, GNGC is expected to have emissions below the Ghana Standards.

2.1.3 Framework for national planning and development

The key policies to be considered under this section include:

- National Land Policy, 1999
- Land Use and Spatial Planning Act, 2016 (Act 925)
- National Building Regulations, 1996 (LI 1630)
- Local Governance Act, 2016 (Act 936)
- Ghana Building Code, GS 1207 of 2018
- Persons with Disability Act 2006, Act 715

Table 2.5: Framework for national planning and development		
Policy/Legal Framework	**Summary of requirement**	**Compliance/Applicability**
National Land Policy, 1999	The main objectives of this policy are: • Ensure that socio-economic activities conform with the principles of sustainable land use. • Protect the rights of landowners and their descendants from becoming landless and • Provide mechanism for minimization and resolution of land dispute.	Management of GNGC will ensure that the project conforms with the land use and also the appropriate procedures are followed during the land purchasing from the owners.
Land Use and Spatial Planning Act, 2016 (Act 925)	An Act to revise and consolidate the laws on land use and spatial planning, provide for sustainable development of land and human settlements through a decentralised planning system, ensure judicious use of land in order to improve quality of life, promote health and safety in respect of human settlements and to regulate national, regional, district and local spatial planning and generally to provide for spatial aspects of socio economic development and for related matters	GNGC has ensured the site chosen for the project is suitable for industrial activity.
National Building Regulations, 1996 (LI 1630)	The core principle of the National Building Regulation is to provide guidelines for safety, health and governance. GNGC will ensure its plans and designs conform to the standards of the Nzema East Municipal Assembly.	GNGC will obtain the necessary building permit from the Nzema East District for its project.
Local Governance Act, 2016 (Act 936)	The Local Governance Act 2016 (Act 936) seeks to give a fresh expression to government's commitment to the concept of decentralization. It is a practical demonstration of a bold attempt to bring the process of governance to the doorstep of the populace at the Regional and more importantly, the District level. The Act establishes metropolitan, municipal and district assemblies as the highest decision making authority at the local level with powers to enforce zoning and building regulation as well as responsibility of waste management.	GNGC will ensure it abides with the rules and bye-laws enacted for the of the project area and shall work in accordance with provisions of the Nzema East Municipal Assembly
Ghana Building Code, GS 1207 of 2018	This code sets out requirements and recommendations for efficiency standards for residential and non-residential buildings and covers planning, management and practices	GNGC will ensure its contractors selected for the construction complies with the code.
Persons with Disability Act 2006, Act 715	An Act to provide for persons with disability, to establish a National Council on Persons with Disability and to provide for related matters.	GNGC shall ensure its facility is built to be disability-friendly.

2.1.4 Downstream petroleum sector policy and requirements

The requisite downstream petroleum sector policy include:

- National Energy Policy (2010)
- National Policy on LPG Promotion (2016)
- Cylinder Recirculation Model (CRM)
- Strategic National Energy Plan (SNEP, 2016)
- Sustainable Energy for All Action Plan
- Ministry of Energy Health, Safety, Security and Environments Manual for Energy Sector Organisation
- Energy Commission Act, 1997 (Act 541)
- National Petroleum Authority Act, 2005 (Act 691)

Table 2.6: Downstream petroleum sector policy and requirements		
Policy/Legal Framework	**Summary of requirement**	**Compliance/Applicability**
National Energy Policy (2010)	The goal of the National Energy Policy within the downstream of the petroleum sub-sector is to facilitate the universal access to adequate, reliable and cost-effective petroleum products such as LPG. The policy also includes directions on increasing access to petroleum products, petroleum sector reforms and petroleum pricing.	GNGC shall abide with the policy and follow directives for pricing and reforms within the sector to enhance accessibility to LPG
National Policy on LPG Promotion, 2016	The policy seeks to ensure safety, increase access and adoption of LPG and its goal to ensure at least 50% of Ghanaians have access to safe and environmentally friendly LPG for cooking (domestic and commercial) and increased industrial usage by 2020. The policy objectives include: • Developing a standard market-based structure safety, increased access and adoption of LPG • Ensuring the existence of robust and standard Health, Safety and Environmental practices in the production, marketing and consumption of LPG; and • Ensure the sustainability of supply under the new market structure.	The implementation of this project will increase the accessibility to LPG to enhance industrial usage
Cylinder Recirculation Model (CRM)	Under this model, consumers will not own their cylinders, but simply pay a deposit for the cylinders and exchange their empty cylinders for a cylinder filled with LPG on payment for the LPG.	The implementation of this project is a step to realizing the policy objective
Strategic National Energy Plan	The strategic plan provides fuel substitution strategies within the informal industries, commercial/service entities and residential sector to shift from firewood to charcoal and then to other cooking fuels such as LPG, kerosene and electricity.	The chosen project location is key to increasing accessibility of LPG to rural users and includes a plan for an efficient distribution network and back-up support to combat potential gas accidents.
Sustainable Energy for All Action Plan	The Sustainable Energy for All Action Plan (2012) outlines specific solutions and prioritized actions to accelerate the achievement of universal access to modern energy services, among others, , for cooking and productive use of energy by the year 2020. The plan also advocated for the use of the LPG cylinder recirculation model for the distribution of LPG to accelerate the uptake of LPG for cooking.	The facility will provide accessibility for cylinder bottling which is a key component for ensuring sustainable energy for all.

Table 2.6: Downstream petroleum sector policy and requirements		
Policy/Legal Framework	**Summary of requirement**	**Compliance/Applicability**
Ministry of Energy HSSE Manual for Energy Sector Organisation	The objective of the manual is to ensure that companies in the energy sector have laid down minimum requirements to guide their respective operational procedure and processes in managing health, safety, security and environmental issues. The manual is divided into four sections: • HSSE Management System; • Standard Operating Procedures; • Incident Notification and Investigation; and • Record Retention Standard	The facility will be managed in accordance with the provisions in the HSSE Manual for the Energy Sector.
Energy Commission Act, 1997 (Act 541)	The Energy Commission Act, 1997 (Act 541) established the Energy Commission and provided for its functions relating to the regulation, management, development and utilization of energy resources in Ghana. The Act also provides for the granting of licenses for the distribution and sale of electricity and natural gas, marketing and sale of petroleum products, among others.	The management shall obtain the requisite license for the marketing and sale of LPG from the proposed facility
National Petroleum Authority Act, 2005 (Act 691)	The National Petroleum Authority Act, 2005 (Act 691) established the National Petroleum Authority and provided for its functions on regulation and monitoring in the petroleum downstream industry, including: • Granting Licenses to applicants • Maintaining a register and that on licenses, petroleum products and service providers; • Protecting the interests of consumers and petroleum service providers; and • Investigating the operation of service providers to ensure conformity with best practice.	GNGC shall register the facility with the NPA

2.1.5 National labour, safety and health requirements

The provisions for health and safety for the proposed project will include:

- Factories, Offices and Shops Act 1970, Act 328
- The New Labour Act 2003, Act 651
- Occupational Safety and Health (OSH) Policy of Ghana, Draft 2004
- Workmen's Compensation Act PNDCL 187, 1987
- National Workplace HIV/AIDS Policy, 2012
- Public Health Act (2012) Act 851
- The Fire Precaution (Premises) Regulations 2003, LI 1724
- Control and Prevention of Bushfire law, PNDCL 229
- Ghana Standard Authority Decree, 1973 (NRCD 173)
- Boilers and Pressure Vessels Safety Regulations (LI 1663), 1970
- Imposition of Restrictions Act, 2020 (Act 1012).

2.7 National labour, safety and health requirements		
Policy/Legal Framework	**Summary of requirement**	**Mandate/Applicability to the Project**
Factories, Offices and Shops Act 1970, Act 328	The Factories, Offices and Shops Act of 1970 (Act 328) requires all operators of industrial facilities to register their facilities with the Chief Inspector of Factories Inspectorate Division.	GNGC will duly register the facility with the Factories Inspectorate Division.
The New Labour Act 2003, Act 651	Section 118(1) of the New 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	The company is expected to provide the appropriate safe working conditions for all workers. These will include good equipment, PPE, training and emergency response measures.
Occupational Safety and Health (OSH) Policy of Ghana, Draft 2004	The OSH Policy statement (Draft, 2004) is to prevent accidents and injuries arising out of or linked with or occurring in the course of work, by minimizing as far as reasonably practicable, the cause of the hazards in the working environment and therefore the risk to which employees and the public may be exposed. The engagement of skilled and unskilled workforce at various stages of project implementation reiterates the relevance of the OSH Policy to the proposed project.	Management of GNGC has its own safety policy and programs which are in line with this policy.
National Workplace HIV/AIDS Policy, 2012	The general objectives of the Policy among others are to provide protection from discrimination in the workplace to people living with HIV and AIDS; prevent HIV and AIDS spread amongst workers and provide care, support and counseling for those infected and affected.	Involvement of persons from different backgrounds in performing various project related activities as a workforce indicate the relevance of this Policy to the intended project.
Public Health Act (2012) **Act 851**	This act states that "A person who manufactures, labels, packages, sells or advertises a consumable product in a manner that is false, misleading, deceptive or misbranded as regards its character, nature, value additives, substance, quality, quantity, composition, merit or safety commits an offence"	Management will ensure it produces LPG of the highest quality to meet the standard.
The Fire Precaution (Premises) Regulations 2003, LI 1724	The Fire Precaution (Premises) Regulation 2003 (LI 1724) requires all premises intended for use as workplaces to have Fire Certificates.	The management of GNGC will follow appropriate procedures and obtain a fire permit for the facility as well as install the appropriate fire fighting equipment for the facility

2.7 National labour, safety and health requirements		
Policy/Legal Framework	**Summary of requirement**	**Mandate/Applicability to the Project**
Control and Prevention of Bushfire Law, PNDCL 229	Section 2 defines "starting of a bushfire". A person starts a bushfire if an action of that person results in the uncontrolled burning of a farm, forest or grassland. The Chief Conservator of Forests or the Chief Game and Wildlife Officer may authorize staring of fires by authorized officers in Conservation Areas under section 4.	Management will ensure it will not undertake bush burning during land preparation activities.
Ghana Standard Authority Decree, 1973 (NRCD 173)	This is an ACT to provide for promulgation of standards, for ensuring high quality of goods and other related matters.	The company is expected to use raw materials and manufacture products that comply with the local standards prescribed by the Ghana Standard Authority.
Boilers and Pressure Vessels Safety Regulations (LI 1663), 1970	These regulations shall apply to every steam boiler and every unfired pressure vessel to which an authorized safe working pressure has not been assigned by the Chief Inspector at the date of the coming into force of these regulations. Provided that where the Chief Inspector is of the opinion that the application of these regulations or part thereof to any steam boiler or unfired pressure vessel to which an authorized safe working pressure had been assigned at the date of the coming into force of these regulations is necessary to ensure the safety of any person or property he may in writing order that these regulations or part thereof shall apply thereto.	Management will ensure it works with the Factories inpectorate division to ensure that its pressure vessels are all safe for use.
Imposition of Restrictions Act, 2020 (Act 1012).	The Act provides for powers to impose restrictions on persons, to give effect to paragraphs (c), (d) and (e) of clause (4) of article 21 of the Constitution in the event or imminence of an emergency, disaster or similar circumstance to ensure public safety, public health and protection (section 1). Restrictions can be imposed if is reasonably required in the interest of defence, public safety, public health or the running of essential services; on the movement or residence within Ghana; to restrict the freedom of entry in to Ghana, or movement in Ghana, of a person who is not a citizen of Ghana; or for the purpose of safeguarding the people of Ghana against the teaching or propagation of a doctrine which exhibits or encourages disrespect for the nationhood of Ghana, the national symbols and emblems, or incites hatred against other members of the community. This includes social distancing for incidences such as COVID-19.	Management will ensure it follows all protocols under this act such as social distancing and hand sanitization to prevent the spread of COVID-19

2.1.6 International Requirements and Safeguard Policies

The international requirements relevant to safeguarding environmental, social, safety and health issues include:

- IFC Performance Standards (PS 1-8)
- IFC General Environmental, Health and Safety Guidelines
- United Nations Framework Convention on Climate Change (UNFCCC); and
- World LPG Association and UNEP Guidelines for good LPG Industry Safety Practices
- RAMSAR Convention on Wetlands of International Importance, 1971
- International Labour Organization (ILO) labour standards
- Nationally Determined Contributions
- Convention on the Conservation of Migratory Species of Wild Animals
- African Convention on the Conservation of Nature & Natural Resources
- Convention Concerning the Protection of the World Cultural and Natural Heritage

2.2 Institutional and Regulatory Framework

In order to facilitate sustainability of the proposed project, the project must be done in accordance with the frameworks of the following institutions:

- Environmental Protection Agency
- Ghana National Fire Service
- Department of Factories Inspectorate
- National Petroleum Authority
- Nzema East Municipal Assembly
- Ghana Standard Authority

Environmental Protection Agency

The Environmental Protection Agency (EPA) Act, 1994 (Act 490) mandates 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. Environmental Assessment Regulations 1999, LI 1652 enjoins any proponent or person to register an undertaking with the Agency and obtain an Environmental Permit prior to commencement of the project. It is also in line with the Legislative Instrument (Amendment) of 2019 (LI 2386) on fees and charges.

Ghana National Fire Service

The Ghana National Fire Service Regulations 2003, LI 1724 requires that all business establishments are not located in fire (hazard) prone areas and adequate fire defense measures are put in place. The GNFS will be consulted to inspect the proposed project site and make recommendations based on the site, block and fire plans submitted for approval. When the proposed LPG Bottling Facility is completed, the Fire Safety Department would be notified for another inspection for installations stated in the proposal and certification.

Department of Factory Inspectorate

Factories, Shops and Offices Act 1970 (Act 328) requires the registration of all facilities including LPG Bottling Facility with the Department. The inspection of the premises of the project will be carried out by the Inspectors of Factories. The block plans will undergo statutory examination to ensure compliance with the provision of the Act relating to health, welfare and safety. The project will be inspected during the constructional and operational stages before the registration.

National Petroleum Authority

The National Petroleum Authority Regulations 2005, Act 691 requires all entities engaged in commercial activities in downstream sector of the petroleum industry to apply for and be granted the necessary permit from the NPA. The Act also requires operators in the petroleum industry to be held responsible for any pollution damage caused or resulting from their operations and to take safety measures to remedy any pollution or damage caused.

Nzema East Metropolitan Assembly

The Local Government Act, 2016 (Act 936) empowers the Assembly to cause the stoppage of any physical development which unnecessarily interferes with the Assembly's programme, have negative impact on health, environment and economic activities in the Assembly. The siting and operations of the LPG Bottling Facility with Loading Gantry would have to be in compliance with the Nzema East Metropolitan Assembly's bye-laws on spatial planning. The Nzema East Metropolitan Assembly will base its building permit on the EPA, NPA and GNFS Approval

Ghana Standards Authority

The Standard Decree 1973 (NRCD 173) requires that every product produced or imported into the country meet standard specification. The Ghana Standards Authority will be consulted to provide directives on the product specifications.

2.3 GNGC Environmental and Health & Safety Policies

2.3.1 GNGC Environmental Policy Statement

Ghana National Gas Company is committed to conducting its business activities of gathering, processing, transporting and marketing of natural gas resources in Ghana in a manner that ensures the protection of the natural environment.

In line with the Company's policy on environmental protection, we shall:

- Set goals that motivate each member of our workforce to contribute to continuous improvement for environmental sustainability.
- Contribute to reduction in global flaring and Greenhouse Gasses emission by leading national discourse on the commercialization of natural gas resources in Ghana.
- Use materials and energy efficiently, and maintain operational integrity to minimize fugitive emissions and discharge.
- Comply with all applicable environmental laws, regulations and international codes and standards, and supervise contractors to manage environment in line with our environmental goals.
- Engage positively with our stakeholders and conduct business in a socially responsible and ethical manner.

In accordance with our business principles, we shall, as a minimum;

- Ensure adequate resources and systems are in place to manage environmental matters in line with sustainability development that incorporate livelihood programmes and needs of host communities and other stakeholders.

- Incorporate internationally acceptable standards in establishing environmental management systems by adopting the following best practices:
    a) Regularly assessing work activities to identify environmental aspects and mitigate impacts;
    b) Establishing clear lines of responsibilities and accountabilities for environmental management;
    c) Providing competence trainings to the workforce and consulting all interested parties on environmental matters;
    d) Promoting conservation of the natural environment through minimization of waste generation, avoidance of emissions to air, discharges to water and land and by reinforcing our environmental management strategies of reducing, re-using, recycling and safe disposal of waste;
    e) Maintaining adequate levels of emergency preparedness and response, and investigating all incidents leading to environmental impacts for corrective and preventive actions;
    f) Conducting periodic audits and reviews to ensure that the policy is implemented and updated as necessary for continual improvement on environmental performance.
- This Policy shall be clearly communicated to the workforce and all other interested parties with the intent that they are made aware of their individual environmental management obligations.

2.3.2 GNGC Health and Safety Policy Statement

Ghana National Gas Company is committed to protecting the health and safety of its workforce and others affected by the company's business activities in gathering, processing, transporting and marketing of natural gas resources.

In line with this commitment, we shall:

- Take appropriate measures designed to comply with applicable laws, HSE regulators and licensing requirements.
- Maintain the integrity of plant and equipment in a manner that ensures they are safe to operate and do not pose unacceptable levels of risks to health, safety and environment.
- Implement adequate systems to ensure the engineering of facilities and the execution of project construction activities incorporate adequate safeguards and risk control measures during the entire life cycle.
- Provide adequate training, information, instruction and supervision to employees in relation to their job roles, task requirements and related occupational health and safety matters.
- Set goals, objectives and targets, which motivate each member of the workforce to strive for continual improvement in our safety performance.
- Establish a system of controls to screen and select competent contractors and supervise them to manage the delivery of work packages in line with the law and our health, safety and environmental goals.
- Strive to institutionalize operational discipline amongst the workforce in the pursuit of attaining excellence in the day-to-day operations of plant and equipment.

- Plan and prepare for possible emergencies involving our facilities to enable us respond safely to mitigate impacts in the event of any incident.

Invest all incident to learn from their causes and take appropriate actions to prevent recurrence

- Measure and benchmark our health and safety performance with peers in the industry and maintain open communications with our stakeholders and regulators on health and safety matters.
- Periodically evaluate the effectiveness and suitability of the systems and framework put in place for the attainment of our health and safety goals; and to ensure continual improvement of the system.
- In all work activities we shall be guided by the following key principles on safety which Managers and Supervisors shall reinforce:

Do it safely or not at all.

There is always time to do it right

When in doubt find out.

- This policy shall be clearly communicated to the workforce and all persons working under the control of Ghana Gas with the intent that they are made aware of their individual health and safety obligations, and the Policy shall be made available to interested parties where necessary.
- The Chief Executive Officer (CEO) has the overall authority and responsibility of ensuring that adequate resources are provided to enhance the smooth implementation of the Health and Safety Policy.

(See Copies of the Environmental Policy Statement; and Health & Safety Policy in Appendix 4)

3.0 PROJECT DESCRIPTION

3.1 Overview of the Project

An LPG Bottling Plant is one of the units in a Cylinder Recirculation Model (CRM). The philosophy of the model requires that LPG Bottling Plants are sited away from residential and populated areas. In addition, they will acquire, label or classify, maintain and fill empty LPG cylinders which will be subsequently distributed to consumers and households via retail outlets. This model of LPG distribution is highly endorsed by the Government of Ghana (GoG) for the achievement of its policy goal of ensuring that majority of Ghanaians have access to clean, safe and environmentally friendly LPG for domestic, commercial and industrial usage by 2030.

The proposed project aims at the construction of an LPG Bottling Plant at Axim in the Nzema East Municipality in the Western Region to serve the LPG needs of those in the region and beyond. It is designed to have an initial installed capacity of 1200 cylinders/hour. It is fashioned after the American, European and Indian Standards with fully automatic and semi-automatic electronic filling carrousel. It will fill various sizes of cylinders for the domestic and commercial markets. The domestic market includes 3 kg, 6kg, 12kg and 14.5kg and the commercial market is dependent on demand but may include 35kg, 50kg and the above. The plant will be scalable to allow for its capacity to be doubled to 2,400 cylinders per hour in the near future.

3.2 Site Location and Setting

The proposed site for the Bottling Plant is located at Axim in the Nzema East Municipality of the Western Region, approximately 36km from the LPG loading Gantry in Anokye and has 17 coordinates presented in Table 3.1. The proposed site is also depicted in Figure 3.1. (Google Earth Map).

Table 3.1: Coordinates of the Proposed Site at Axim

WGS84 UTM30N meters		
Pt	**Northing**	**Easting**
1	541016.237	583482.032
2	541020.037	583584.192
3	541016.335	583650.88
4	541024.492	583723.128
5	540832.509	583725.038
6	540663.063	583724.274
7	540466.729	583487.391
8	540314.718	583315.477
9	540263.73	583303.645
10	540266.935	583039.125
11	540378.263	583022.615
12	540530.569	583102.003
13	540564.501	583184.696
14	540614.578	583315.081
15	540697.732	583368.119
16	540808.857	583417.059
17	540893.886	583444.346

Figure 3.1: Proposed Site marked in yellow on Google Earth Map-Axim

3.3 List of Machinery and Equipment

Table 3.2 contains the prospective equipment and machinery list for the project.

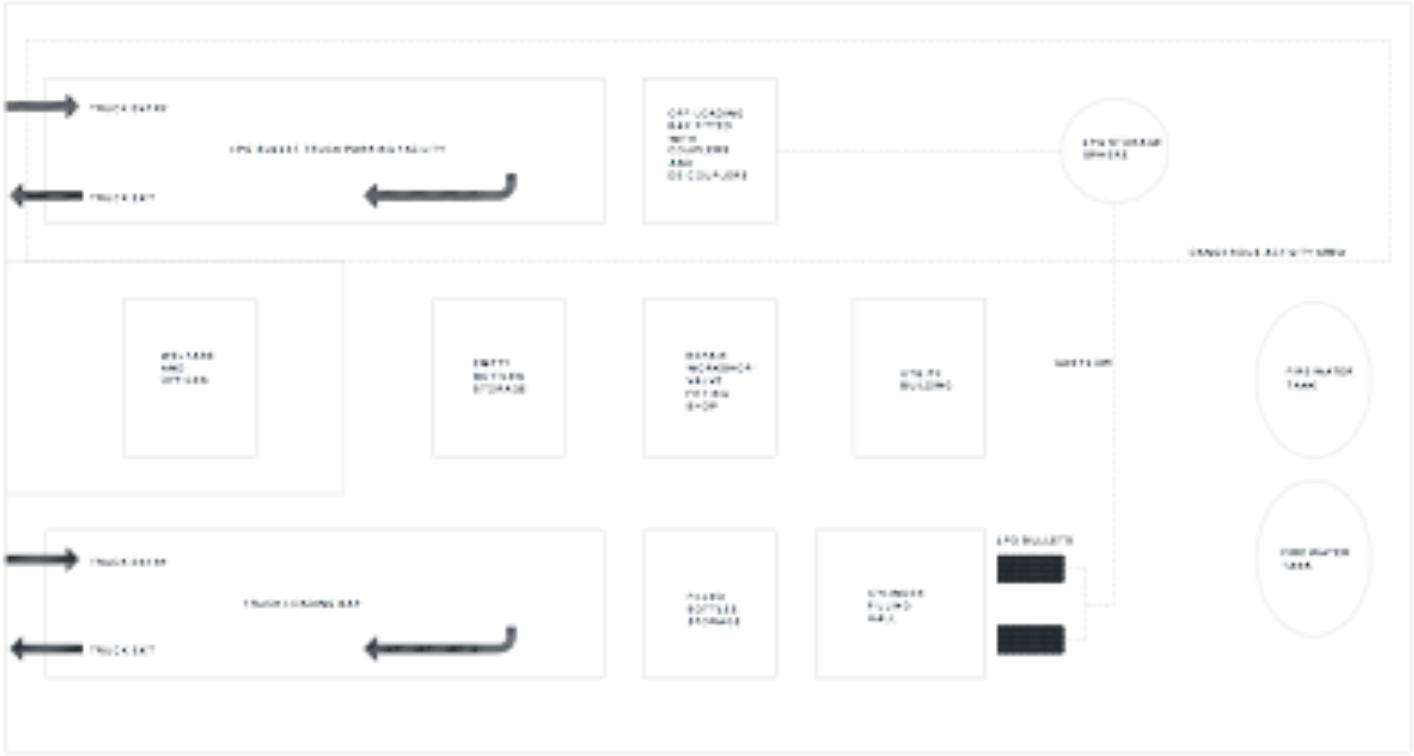
Table 3.2: Prospective Equipment and Machinery List

S/N	Description of Items	Quantities	Capacities
1.	Horton Sphere LPG Storage Tank	1	600MT
2.	Cylinder Filling Machines	12	1200cyl/hr
3.	Cylinder Washing and Brushing Machine	2	1200cyl/hr
4.	Gas Detector Panel	6	One per shed and in storage area + 1 for control room
5.	Fire Pumps, Fire Extinguishers and Equipment	5	120/Varied
6.	Fire Water Storage (Above Ground)	2Nos	60m^3
7.	Cylinder Hydrostatic Test Machine	1	1200cyl/hr
8.	Cylinder Painting Machine	1	120cyl/hr
9.	Cylinder Loading/Unloading Machine	2	1200cyl/hr
10.	Testing Pool (Horizontal Type)	1	1200cyl/hr
11.	Air Compressor	3	Total 0.9m^3 @12kg/cm^2 air pressure
12.	Oily Water Separators	2	Total 20m^3
13.	LPG Compressors and Pumps	6	3×75CFM 3×30m^3/hr
14.	Pressure Washing Machines	3	1200/hr
15.	Sandblasting Equipment	3	3 cylinders at a time
16.	Water Treatment Plant	1	2000litres/hr
17.	LPG Purging and Recovery Equipment	In-Line Facility	4 cylinders at a time
18.	Cylinder Weighing Scales	4	500-1000kg
19.	Cylinder Sealing Machine	4	8 stations

The afore-mentioned equipment and machinery in the Bottling Plant is designed as per the separation distance requirement specified in NFPA 58 and Ghanaian Standard GS 1006-3. The equipment and machinery will be 2020 models and sourced from UK, India, Turkey and USA.

3.4 Project Design, Components, Planning and Layout

The conceptual design proposal have been prepared and the final designs are still at an early stage of development (GNGC is yet to receive the FEED from the Engineering, Procurement, and Construction Contractor). The final details will be worked up as soon as the Environmental Impact Assessment Study is approved to enable the proposal on mitigation measure to be incorporated including the consideration of all public consultation feedback. Figure 3.2 below shows the general functional layout of the project.



PROJECT:	TITLE: BLOCK PLAN LAYOUT	CONSULTANT:	DESIGN CONSULTANT:	CLIENT:
PROPOSED LPG BOTTLING PLANT AT AXIM	DATE: NOVEMBER, 2021.	GreenDev Associates International Limited	LEED CONSTRUCTION COMPANY TEL: +233 246 103 971	GHANA NATIONAL GAS COMPANY LIMITED

3.4.1 Main Project Components

The main project components will comprise of:

- LPG Filling Line
- Horton Sphere LPG Storage Tank
- Cylinder Pallet Holding Area for Empty and Filled Cylinders
- Cylinder Inspection and Maintenance Workshop
- Truck Parking Area
- Utility Building
- Welfare, Offices and Control Rooms
- Fire Protection System
- Security

LPG Filling Line

The LPG filling cylinder system will consist of an automated and semi-automated carousel systems to refill the cylinders. The plant is designed to have an initial installed capacity of filling 1200 cylinders/hour. It is fashioned after the American, European and Indian Standard with fully automatic and semi-automatic electronic filling carrousel. The system would consist of 4 carousel and a conveyor belt and will be located under an open-air structure. The carousel will be required to fill 3 kg, 6kg, 12kg, 14.5kg, 35kg, 50kg and the above. As part of the filling process, cylinders will undergo valve leakage test after filling before finally loaded into pallets.

Horton Sphere LPG Storage Tank

LPG Storage at the Bottling Plant will be held in a 600 MT Horton Storage Sphere Tank having a design pressure and temperature of 17. 1 bar and -20 °C and +55 °C respectively. The LPG Storage area is a concreted area designated as the Tank Farm/Depot is sited a safe distance away from the bottling plant and connected by pipelines for both liquid and vapour return transfers. The capacity of a typical Horton Sphere Storage Tank ranges from 600 MT to 500 MT with corresponding volumes of $500m^3$ to $8500m^3$.

The tank farm to house the Horton Sphere Tank is a layout arrange on a reinforced concrete area of about $500m^2$ with floor slot demarcation of $20m^2 \times 5m^2$ allowing for sufficient space around and between any additional tanks that would be installed in the future.

The LPG storage area will be fenced and sited close to the security station within the plant. Adequate provision will be made for electrical earth connectors, firefighting monitors, hydrants and other relevant appliances.

Cylinder Pallet Holding Area for Empty and Filled Cylinders

The cylinder pallet holding area will serve as a temporary storage for both empty and filled cylinders. Both empty and filled cylinders will be moved in and out of this area using a forklift.

Cylinder Inspection and Maintenance Workshop

A workshop to serve as an inspection and maintenance area will be situated close to the cylinder filling hall to check damage foot ring, body, valve and shroud of cylinders. Defective cylinders that are beyond repair capacity at the maintenance workshop will be declared damaged and unsuitable for circulation. Maintenance activities that involve welding or ignition activities will be completely avoided.

Trucks Parking Area

The Bottling Plant will have two (2) concreted waiting areas for trucks that will come to offload empty (new/previously filled) cylinders and those that will load the filled cylinders for the market or to vendors. The total land area for the empty and filled cylinder packing area is about 400 m × 400 m. The areas will be suitably demarcated with signages to allow for the proper organization of the place. It will be enclosed with a security personnel/guard in charge of both areas. The truck parking area will accommodate about 20 BRV's at a time in addition to the vehicles of staff and visitors.

Utilities Building

A utilities building will be established to assist with the provision of utilities such as Compressed Air, Water and Electricity Supply for the smooth operation of the facility.

Welfare, Offices and Control Rooms

The office block will have General Office space for staff members. There will also be Meetings and Conferences Rooms, Kitchen, Archival Room, Changing Rooms, Control Rooms and Rest Rooms.

Fire Fighting System

The design of the facility provides for an on-site fire-fighting station in accordance with both national and international practices. The fire-fighting system will include;

- Water Tank
- Fire Engine
- Sprinkler protection system
- External and Internal Fire Hydrant
- Fire Alarm System
- Hosereel System
- Evacuation Communication System
- Essential Ventilation System
- Portable Fire Extinguishers

Ghana National Gas Company will acquire the compulsory Fire Insurance Cover as indicated under section 183 of the Insurance Act 724, 2006. The station will be manned by competent trained Fire Officers in consultation with the Ghana National Fire Service. The Fire Officers from the GNFS will ensure that Fire Fighting facilities and Fire Alarm Systems proposed for installation are in line with the Fire Certificate.

Security

Adequate provision has been made to fence the whole land area of 64 acres to separate the development from the rest of the area. It is planned that additional safety measures will be provided especially at those boundaries that are close to human settlement and other industrial establishments. The day to day security management/responsibility will be outsourced to a reputable security company.

3.4.2 Ancillary and Support Facilities

The ancillary and support facilities to be included in the project are:

- Piping facilities
- Utilities- Compressed Air, pump for LPG and pump for firefighting and Electricity
- Power Distribution and Lighting Systems
- Road Access and Landscaping
- Waste Disposal Unit
- Water Supply System, etc.

3.4.3 BRV/Haulage Truck Safety Requirement and Specification

The loading/unloading facility is designed in accordance with International Standards. It is therefore imperative that the Bulk Road Vehicles (BRVs) that goes to the Anokye Gantry for loading and subsequently to the Bottling Plant at Axim for unloading of the LPG meets the following minimum requirement that will ensure the safe operation of the facilities. The BRVs shall be of 50m^3 capacity with the specifications in the Table 3.3.

Table 3.3: Bulk Road Vehicles Specifications

S/N	Design Code	ASME Section VIII Div.2 Latest Edition
1.	Semitrailer	Triple-axel semitrailer minimum 12 tyres and 2” kingpin
2.	Design Pressure	Minimum 17.5 kg/cm
3.	Design Temperature	-20 to +55 °C
4.	Radiography	100% of all butt-welded seams
5.	Certification	DNV GL or other recognized international inspection agency
6.	Hydro-test Pressure	25kg/Crr
7.	Material of Construction	SA 537 cl. Normalized Steel as per ASME standards

3.5 Key Project Activities

The main project components consist of the following:

1. Loading and Unloading LPG
2. Delivery of Bulk LPG to Bottling Plant
3. LPG Storage in the Horton Sphere Storage Tanks
4. Cylinder Filling Processes
5. Dispatch to Bulk Consumers

3.5.1 Loading and Unloading LPG

The BRVs proceeds to the Anokye gantry to load LPG after which it moves to the Bottling Plant for discharge at Axim.

3.5.2 Delivery of Bulk LPG to Bottling Plant

The Horton Sphere Tank will receive the LPG from the BRVs which serves as the temporal haulage vessel for the LPG. BRVs will then make a return trip to refill and come back. The total storage capacity of the BRVs is 120 MT and is designed in ten units to refill the Horton Sphere Tank one at a time. Each fill of BRVs is estimated to last between 8 to 12 hours of production time approximately equal to one shift.

3.5.3 Storage into Horton Sphere Tank

LPG will be temporarily stored under specified conditions in the Horton Sphere Tanks prior to cylinder filling process.

3.5.4 Cylinder Filling Process

3.5.4.1 Filling Line Inspection

Cylinders are first sent to the cylinder service and inspection area for each cylinder markings, serial number and identification inscriptions are checked.

In addition, a visual inspection is carried out to check for dents, any rusty physical condition and inherent damage. Cylinders with defects will be transferred to the service conveyor unit to allow for a more comprehensive check after which they will be separated into either reparable or irreparable cylinders.

3.5.4.2 Cylinder Wash

At this stage cylinders are made to pass through a pressure washing machine system where they are washed with water. The Cylinder Washing Unit is designed to provide maximum surface cleaning of the cylinders. It consist of a washing cabinet, high pressure water pump, water reservoir, control systems, dyeing section and effluent water area. Depending on the surface condition of the cylinder, they are either sent to the filling line directly or to the painting shed for painting before been sent to the filling line.

The cylinder washing machine automatically provides dye to the outside of the LPG cylinders. During the dyeing of cylinder, the air tight seals in the cabin prevents the spread of the paint to the outside. The machine can dye a maximum of two cylinders at a time. The cylinders are dyed without any human interference and the system is designed as ex-proof.

3.5.4.3 Hydrostatic Test

During the hydrostatic test of the cylinders, they are subjected to compressed air and pressurized water. Air and water are applied with high pressures inside of the cylinders to check whether there are points of leakages or not. The machine will test about 500-1200 cylinders units per hour. The pressurized water will be sourced from installed Mechanized Boreholes in the Bottling Plant and Ghana Water Company Limited water supply to the facility.

3.5.4.4 Filling Process

The filling process start with a check of the empty cylinder or the tare weight of each cylinder and to determine the fill quantity which is consequently followed by:

- Connecting the fill head
- Set the tare
- Fill to preset quantity
- Check for any leakage at the filling head

3.5.4.5 Weight Check

Each filled cylinder is directed to the weighing scale and checked for the level of fill. Overfilled and under filled cylinders that fail the test will be sent to the adjustment conveyor rectification

3.5.4.6 Leak Detection

Leak detection will be carried out on each of the filled cylinders and any found to leak will be evacuated for a more detailed check using the Gas Panel Detector.

Fixed Gas and Flame Detection system will be installed around the Horton Sphere.

Gas Panel Detector for Cylinders

For the purposes of operations and warnings being observable, each Gas Detector Panel will connects to an alarm and four (4) gas detectors. Gas leakage level in each gas detector will be observed on the product display screen. In addition, leak rate will also determined. A leaking cylinder will be moved to a special evacuation area and then marked defective to be sent to the approved cylinder repair company repairs.

Cylinder repairs beyond basic valve replacement and similar minor issues will not be performed at the premises of the bottling plant but will be sent in batches to an approved cylinder repair and refurbishment company for repairs.

3.5.4.7 Sealing and Labeling

The final stage of the filling process is to affix a security seal to the valve and ensure the labels and warning signs are properly placed and displayed on each cylinder after which it is moved to the storage area for subsequent distribution. The block flow diagram for the entire process is presented in Figure 3.3.

3.5.6 Dispatch to Bulk Distributors/Consumers

The filled LPG cylinders will be safely loaded into bullet trucks for dispatch to bulk distributors and consumers

3.6 Environmental-Based Process Flow Chart

Figure 3.3 shows the Environmental Based Process flow diagram for the proposed LPG bottling process at the plant. The blue text indicates main operational processes, the black indicates related processes and the red text shows the associated impacts and risks.

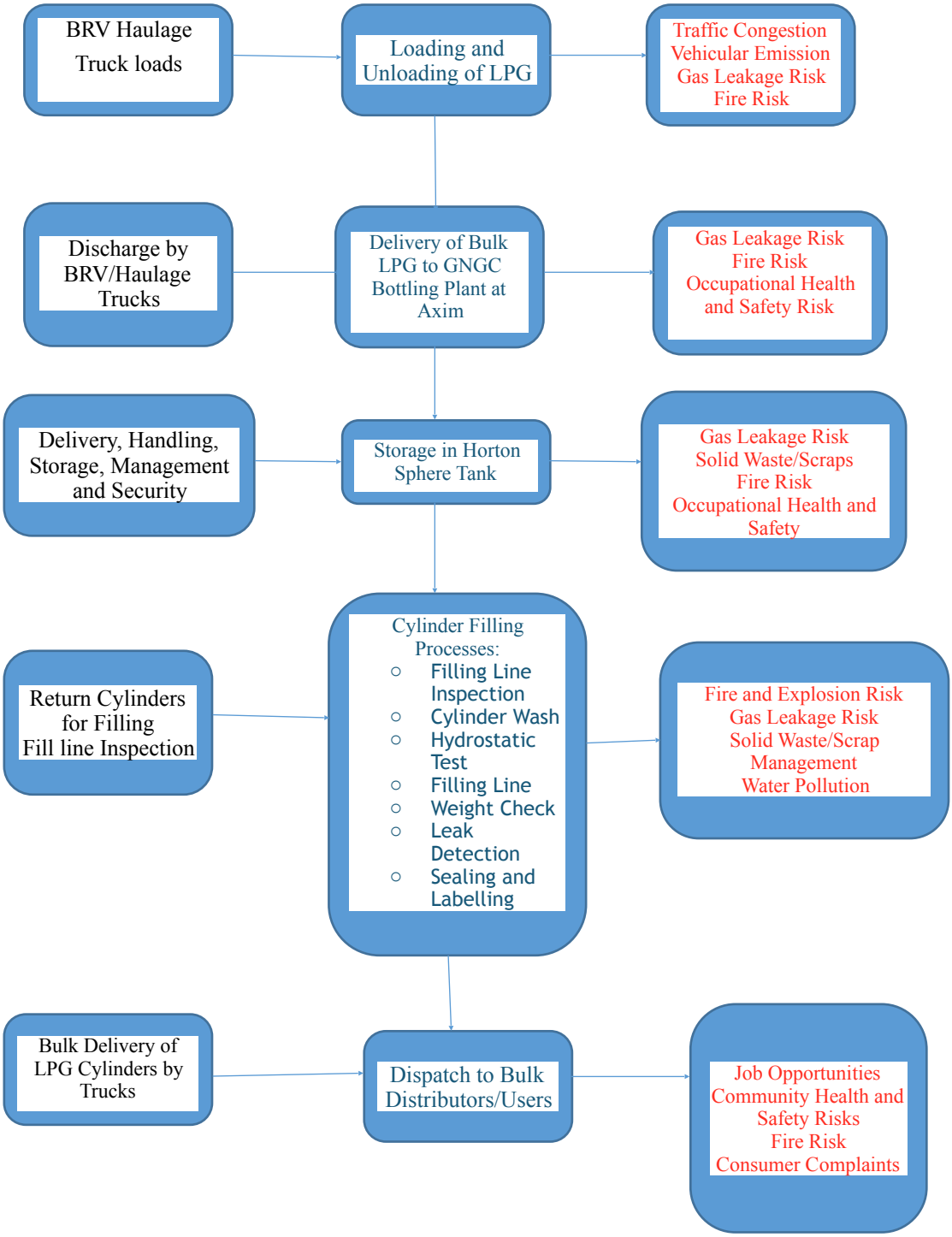


Figure 3.3: Environmental-Based Process Flow Chart

3.7 Utility Requirements

The construction and occupancy periods of the project will require water and energy. Water will be expended for mixing mortar and sanitary activities during the construction period, while water will be used for domestic purposes such as washing, cleaning, scrubbing etc. during the occupancy phases. It is expected that 1000 m^3 of water will be used monthly during the peak construction period while 2,500 m^3 will be consumed monthly during the operation phase.

Construction phase will consume about 1,200 kWh monthly at peak periods. Energy will be used highly during the operational phase. It is expected that approximately 14,000 kWh will be consumed monthly during the operation phase. Water will be sourced from installed Mechanized Boreholes in the Bottling Plant and Ghana Water Company Limited water supply to the facility. Also, electricity will be sourced from the Electricity Company of Ghana's Grid.

3.8 Raw Material & Product Requirements

The construction phase will require on raw materials such quarry products, steel ingots, cement, wood, electrical cables and switches, glass windows, iron rods, paints, finishing agents, etc. Cement, electrical poles, iron rods, paints, finishing agents, and quarry products will be sourced from local manufacturers and the local market. Glass windows will be sourced from both the local and international market.

3.9 Labour/Manpower Requirements

The pre-development, construction and operation phases of the project will require personnel of varied skills for both technical and managerial activities. The pre-development and construction phases will require technical personnel such as foremen, cleaners, forklift/excavator/bulldozer operators, plumbers, electricians, welders, architects, security men, civil engineers, electrical engineers and project managers. The number of people estimated to be available for the site activities is an average of one hundred and twenty (120) persons on a daily basis.

The operational phase will require about two hundred personnel in the first three years. This would include professional and unskilled labour.

3.10 Pre-Development, Construction and Operational Phase Activities

Proposed works consists of the following stages:

1. **The Pre-development**

The Pre-Development activities involves the acquisition of land, construction engineers profiling the site and designing /drawing of the entire mixed-use infrastructure.

2. **Construction phase**

This would involve civil works such as shoring, dewatering, drilling, excavation, digging, backfilling, concrete works, structural formations & fabrications, surface levelling, and haulage of items such as sand, stone, wood. There will be a high dependence on heavy-duty equipment and manual methods for the performance of these activities. The heavy-duty equipment includes compaction rollers, tipper trucks and concrete mixers. Manual methods will include digging of trenches with using pickaxes and shovels, casting of mortar, and haulage of items with wheelbarrows. Carpentry works such as nailing, fixing of roofs and doors will also be performed during the construction phase. The construction phase will take a period of 18 - 24 months.

3. **Operational Phase Activities**

This will involve operation of all the facilities in the LPG Bottling plant.

4.0 CONSIDERATION OF ALTERNATIVES

In the course of the Project Development, many critical decisions have been made in relation to, for instance the series of processes, the location and type of technologies in the proposed development.

The alternatives that were assessed include:

1. No project, Avoid or Postpone Alternative
2. Location/Site Alternatives
3. Access Road and Transport Options
4. Plant Technology Options

4.1 No Project, Avoid or Postpone Alternatives

Option A, Do Nothing: The "Do Nothing" option would mean that the current environmental assessment and implementation being done on-site are brought to a halt, since this option means not proceeding with the construction of the project. This option also means that, all the potential impacts on the environment i.e. bio-physical, socio-economic and cultural would not occur.

Option B, Proceeding with the Project: Proceeding with the construction of the LPG bottling plant on the proposed site is the preferred option since the site has already been acquired by the developer. This option means that there should be an objective assessment of the alternatives by weighing the impacts of continuing with the project.

4.2 Location/Site Alternatives

Selecting a suitable site for an LPG tank farm is relevant for the overall long term efficiency and a lot of many factors come into play when deciding where to put the tanks. It may be very difficult if not almost impossible to get everything that is desirable at a single site however the location should contain an optimum mix of the desirable requirement for the setting to be feasible for the long term economic justification of the bottling plant.

Prior to the selection of the Axim site, three other potential sites at namely Tiboko 1, Tiboko 2 and Aiyinase, all located in the Western region were identified and evaluated against a number of planning, environmental, commercial, geotechnical and transport considerations. The criteria used included:

- Sites of sufficient size and topography to accommodate the scale of facilities needed in the designed layout (minimum site size of approximately 10 hectares with an extra space for expansion)
- Site with an undulating ground and stable soil structure.
- Locations free from vexatious and abnormal planning and constraints.
- Sites in accessible locations and as close as possible to the Takoradi Harbour in order to reduce trucking distance and transport distance during project development and implementation.
- Sites with no potential for traffic impacts.
- An area accessible from the existing road system without requiring a major road construction.
- Sites with no land litigation issues.
- Site should exhibit no negative environmental influences, which cannot be corrected or acceptably mitigated. Environmental impacts includes but are not limited to: excessive noise or

physical hazards from vehicular or air traffic; high tension power lines; high pressure natural gas transmission lines; sanitary landfills; stored hazard materials on or near the site; buried or spilled toxic/chemical waste and prime agricultural soils classification.

4.3 Access Road and Transport Options

Imported equipment and materials for construction would be delivered for installation via the Takoradi Port and then by road to the project site at Axim. Access road from the Takoradi Harbor is about 60 km, which is a well-constructed tarred road via the Takoradi-Agona Rd/N1 and Agona-Elubo Rd/N1.

There is also a major connecting road from the Anokye gantry (LPG loading point) to the project site which is about 36 km via the Agona-Elubo Rd/N1. The Bullet Trucks would use the eastern route for entry to the site and exit via the western route of the site.

Find attached the General Layout plan of the facility in Appendix 5. The layout provides entry and exit routes.

4.4 Plant Technology Alternatives

Several options exist when considering what type of filling plant to invest in during project implementation. In all of these options the ancillary features that are associated with filling plants such as on-site storage of LPG, treatment and maintenance of cylinders as they are brought to the plant, quality control examination of the filled cylinders before they leave for the market are all necessary. Based on various considerations, GNGC chose to rely on fully automatic and semi-automatic electronic filing carrousel.

The options available for filling may vary depending on several circumstances. They include the simple manually operated type, to filling plants that can be stored and transported in containers, to a fully automatic filling carousel.

Table 4.1: LPG Cylinder Filling Options

S/N	Type of Filling Option	Description	Advantages	Disadvantages
1.	Stand-Alone Filling Plant	It is the simplest form of cylinder filling system but operates in isolation	Simple to operate, does not require specialized skill and expertise	Not very suitable for high duties
2.	In-Line Filling Plant	In-Line Filling Plants in its simplest form can just be one stand-alone filling head but it is usually common to have several of them in series or installed on a single carousel	The design of the filling head is very common and uses either a load cell or mass flow principle to measure the contents of the cylinder. The filling operation with this kind of head can be manual, semi-automatic or fully automatic	They are flexible enough to handle cylinders of different sizes and different valves. They are also modular in design allowing units to be added as the demand increases.
3.	Containerised Filling Plant	This type of plant consist of a filling container, workshop and technical room, spaces for storing empty and filled cylinders and fire-fighting equipment. This type of filling plant are prefabricated modular designed plants that can be moved from one point to another depending on demand and include bulk ISO tank. Containerised plants are mostly preferred where the demand for LPG in a country or in a region of a country have not reached a point to justify a more permanent facility.	Each of the components of the plant are in containers allowing them to be linked as modular units. Even the storage facility can be containerized within an ISO tank. They are very compact and can be installed on a 50m × 50m piece of land. Even though they are modular they still have all the required features of a permanent facility.	It is imperative that although the facilities maybe containerized and temporary all aspects of a cylinder filling plant must comply with the requirement applied to a more permanent arrangement. This includes location, off site risks, operational and emergency procedures and all aspect relating to the safe storage, handling and filling of cylinders on site.
4.	Automatic Filling Carousel	In producing for high demand markets, where there are perhaps a thousand plus of cylinders to be filled in a day, this option becomes the best choice for the situation. The principle behind this is to use filling head configured in a circular way where the empty cylinder enters the carousel, get filled as it rotates and then leaves the carousel filled at the same point it entered.	They have a very high capacity filling capability of up to about 2000 cylinders per hour. The flow through the plant can be semi or fully automatic depending on the type of valve installed with the option of upgrading later. With fewer operators the risk of human error is annulled increasing the safety of operations, especially because of the risk in handling limiting personal injury. This is the preferred filling technology per the production goal of the proposed bottling plant. The carousel may be linked to a computer using the Internet of Things (IoT) to manage data from the cylinders entering and leaving the filling plant. Carousel are also known for their accuracy and their check scales that meet the relevant standard i.e OIML R 76/E45501.	The only disadvantage of this option is the expensive technology and specialize human personnel to manage it. This notwithstanding, Ghana National Gas Company is committed in making the appropriate investment in terms of the acquisition of the technology and the hiring of competent staff to man the facility. This option is chosen as it meets the project objectives and requirements.

5.0 BASELINE INFORMATION OF THE AFFECTED ENVIRONMENT

The proposed site for the project is in Axim, in the Nzema East Municipality of the Western Region of Ghana. This chapter provide information on the biophysical and socio-economic characteristics of the project area. It is critical to study the nature of the project area in these terms as the can be impacted by the project or can impact the project.

A preliminary field survey and literature research was conducted to gather information on existing conditions of the project site, immediate surroundings, and the municipality in which the proposed project will take place.

This section describes the biophysical and socio-economic environment of the project area in terms of:

1. Climatic and Atmospheric Conditions
2. Geology
3. Topography
4. Drainage
5. Ecology
6. Air Quality
7. Noise Levels
8. Population
9. Land Use
10. Social Services
11. Commercial Activities
12. Cultural Heritage

5.1 Biophysical Environment

5.1.1 Location and Size

The proposed site for the bottling plant project is a 63.31 acre land located about 2 km North-West of the Axim Township, in the Nzema East District of Ghana. The site is centred on longitude 2°14'52.30"W and latitude 4°53'24.10"N. It is largely undeveloped and about 100 m away from the Agona-Elubo road (N1) on its northern boundary and 400 m away from the Gulf of Guinea to the south.

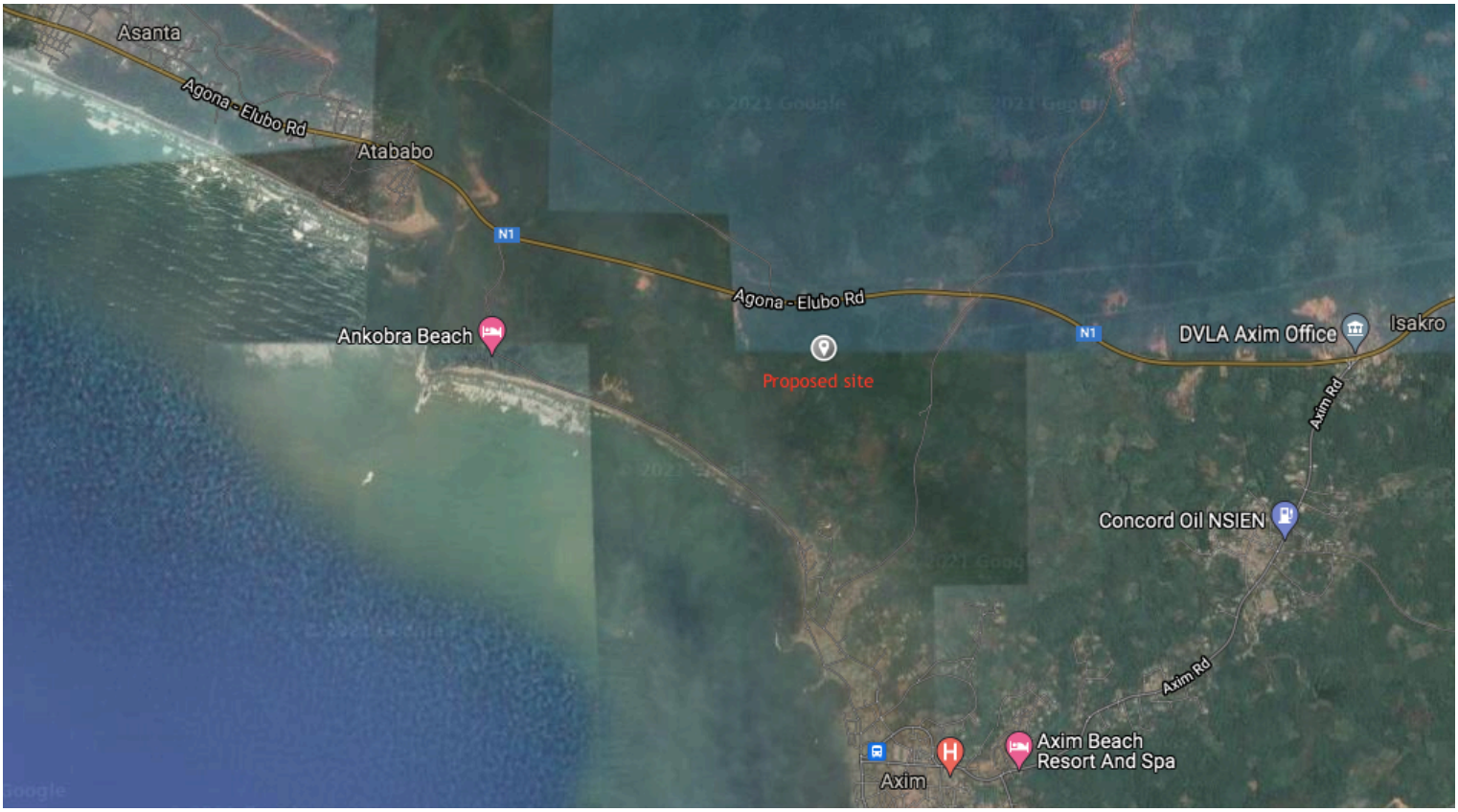


Figure 5.1: Google image showing location for the proposed bottling plant at Axim

5.1.2 Climate

The general baseline conditions of the climate in the project area are discussed in this section. Ghana is positioned just a few degrees north of the equator and thus has a typical tropical climate. The southwest Monsoon and Northeast Trade Winds are the air masses that influence the climate. The northeast trade winds which originate from the northern anticyclone passing over the Sahara Desert brings in dry and high dust load air producing a period of dry weather. The southwest monsoon winds which pass over the Atlantic Ocean brings along humid air over the tropics resulting in a period of rain. Generally, two seasons (dry and wet seasons) are characteristic of the climate in Ghana as a result of these air masses. The peak of the wet season (rainy) occurs from May to July and between September and November. The dry season occurs between November and February with little or no rainfall. The dry period is longer in the north where the northeast trade winds is severe.

The annual rainfall in the region ranges from 730 mm to 3,500 mm with a rainfall figures decreasing from the coast inland. The annual percentage of rainy days is generally greater than 60%. Diurnal temperate ranges between 26^0C and 33^0C while annual variation in temperatures ranges is relatively small, ranging between 2^0C and 4^0C. Relative humidity is generally high, over 60% all year round and greater than 80% in the mornings.

In order to properly represent the climate spanning the project area, data on relative humidity, temperature, rainfall and wind speed covering the period 2015-2020 was obtained from the nearest Ghana Meteorological weather station which is the Axim Weather Station GHM00065465, located on Latitude 4.8670, Longitude: -2.2330 at an elevation of 40.0m.

Rainfall

Axim experiences rainfall throughout the year. The coolest time of the year is between April and July when the main rainfall occurs. The mean peak period of rainfall is in the months of April to June and in October, with the highest peak value of 90mm in June (figure 5.2). The lowest rainfall is in January of 7mm which is characteristic of harmattan (dry season).

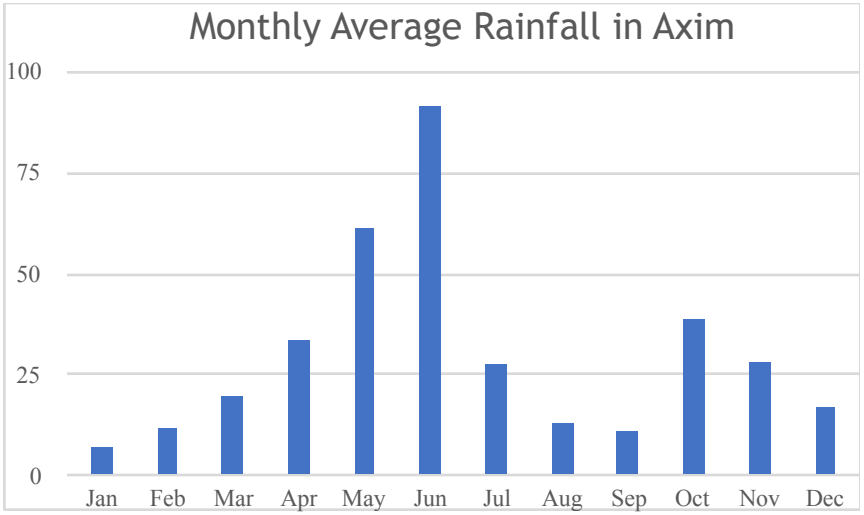


Figure 5.2: Monthly average Rainfall in Axim (Ghana Meteorological Agency)

Temperature

The 5-year average minimum and maximum temperature is 24.9^{0}C and 30.5^{0}C respectively (figure 5.3). Variations in temperature both annually and daily are quite small. Temperature is generally high from February to May and from November to December with peak temperatures recorded in March. Lower temperatures between June and October with the coolest month in June.

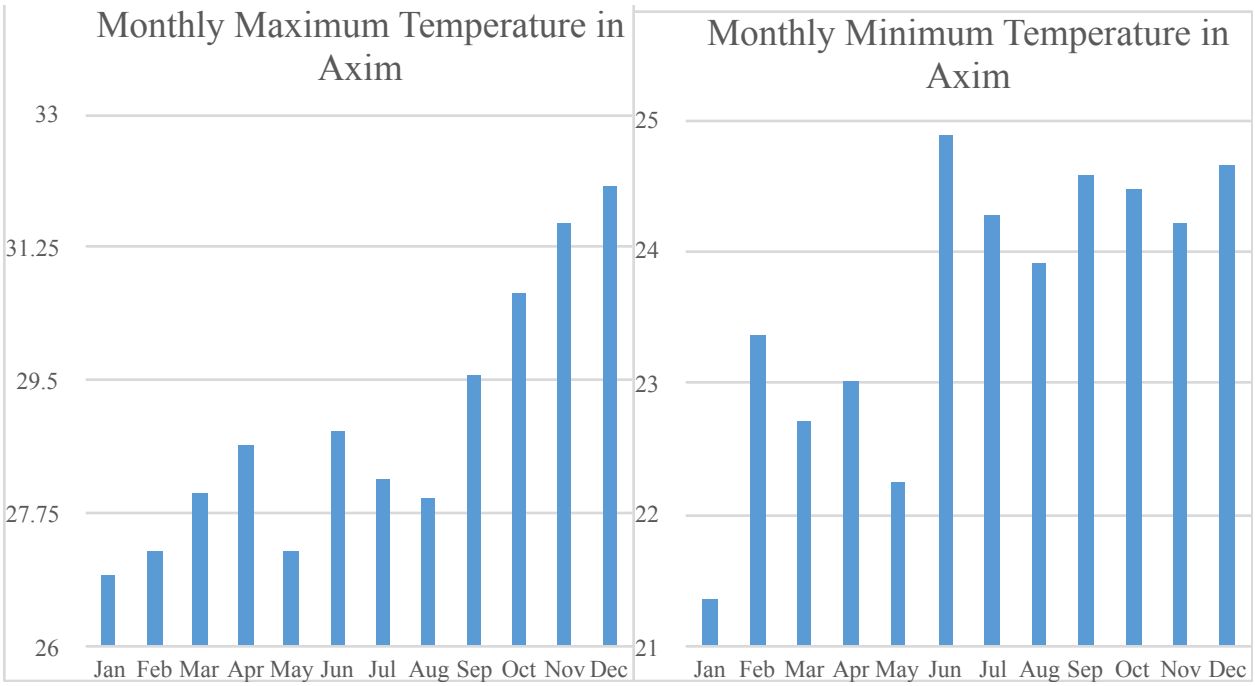


Figure 5.3: Monthly Maximum and Minimum Temperature in Axim (Ghana Meteorological Agency)

Relative Humidity

The relative humidity in Axim ranges from 77% to 91%. The mean annual relative humidity in value is 85.0%. During the dry season, the average relative humidity is at 82% which rises to 85.0% during the rainy season (figure 5.4).

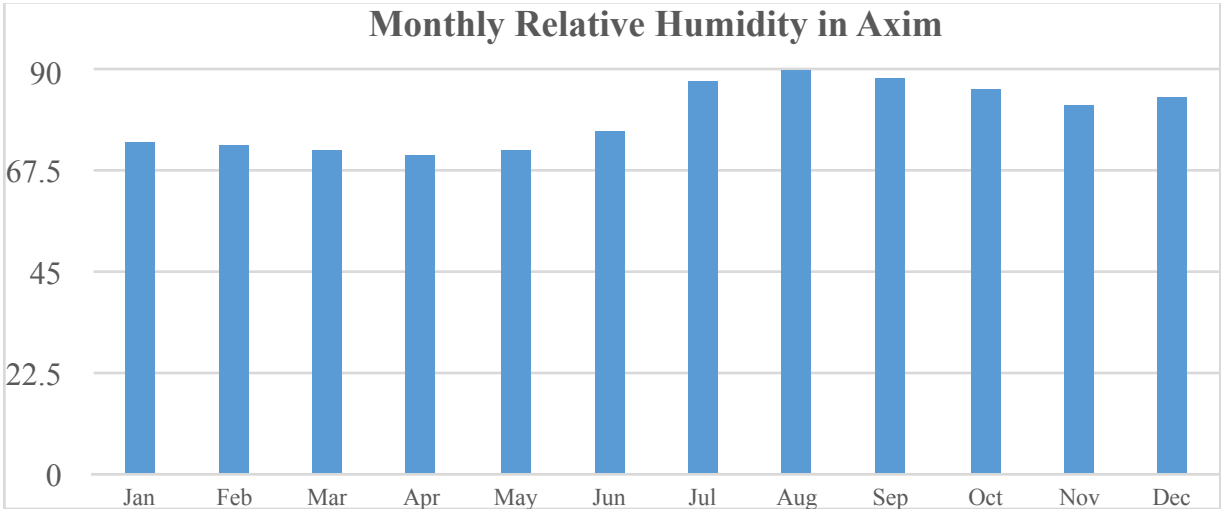


Figure 5.4: Monthly Relative Humidity in Axim (Ghana Meteorological Agency)

Wind Characteristic

Wind speed and direction is influenced directly by the north-east and south-west trade winds as well as the position of the Inter Tropical Convergent Zone. The wind experienced at any given point is vastly dependent on the local topography and other factors. The wind speed in Axim experience little or no seasonal variations throughout the year.

The average windspeed is 2.61 knots. The windiest month is in September with a windspeed of 3.4 knots (figure 5.5). The prevailing wind direction in the project area is from the south to the northeast.

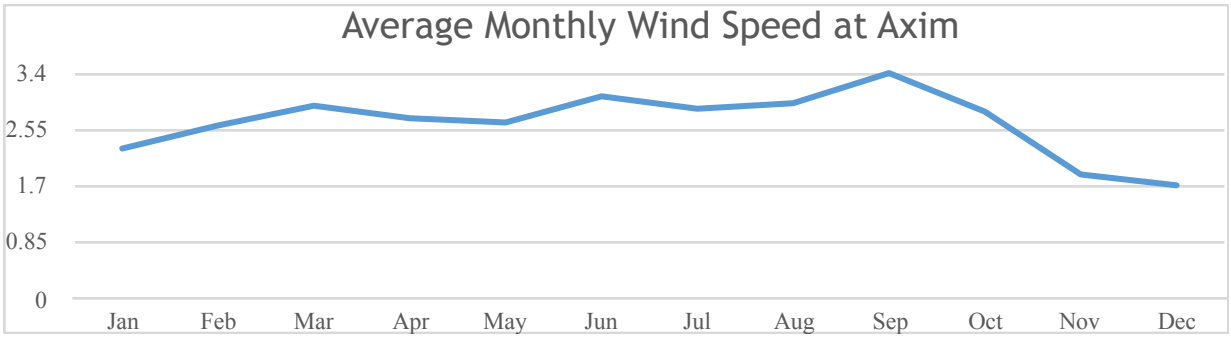


Figure 5.5: Wind Speed Characteristics in Axim (Ghana Meteorological Agency)

5.1.3 Topography

The terrain of the Nzema East Municipality (NEM) is generally undulating with elevations ranging from 2m above sea level and the highest point at about 190m above sea level. This has been modelled with data extracted from Google earth and presented in figure 5.6 below;

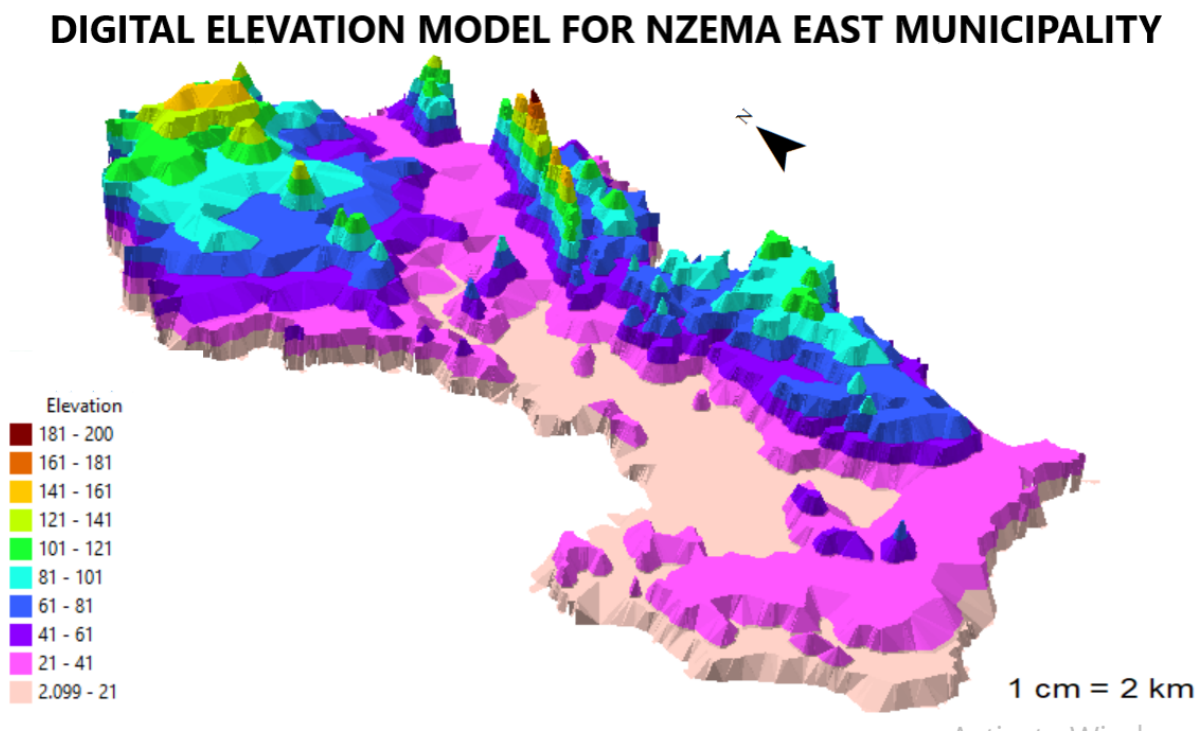


Figure 5.6: 3D DEM for Nzema East Municipality

The District is mainly drained by the Ankobra River and its major tributaries like the Ahama and Nwini rivers. The landscape has therefore been generally modified by the Ankobra River and winds from the south through geomorphological processes.

On the project site to the south west (SW) of the district, elevation ranges from 10m to about 48m. Figure 5.7, shows the digital elevation model of the site generated from Google Earth extracted elevations. The site is hilly on some parts (towards the East) and nearly flat on other parts with slopes from 0 to 17^{o}. A slope map for the site has been presented in Figure 4.8.

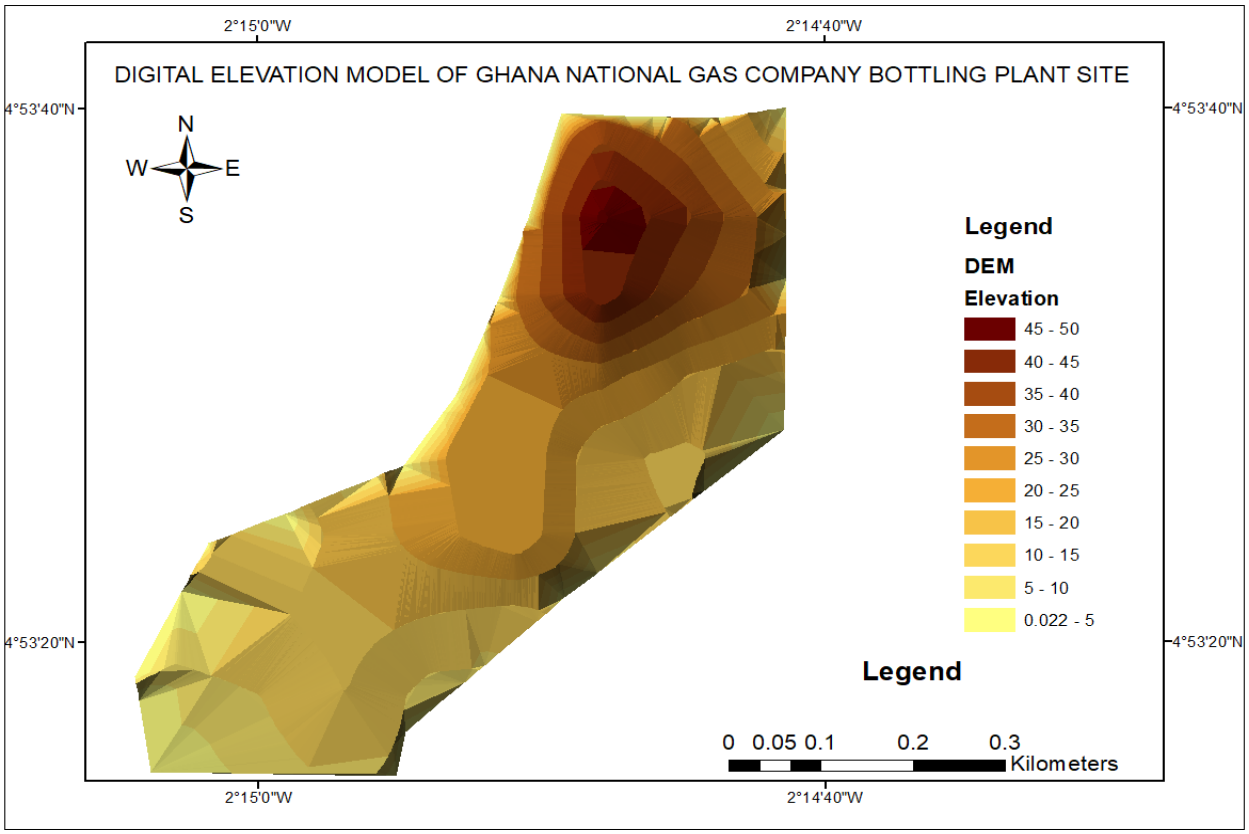


Figure 5.7: 3D DEM of GNGCBP site

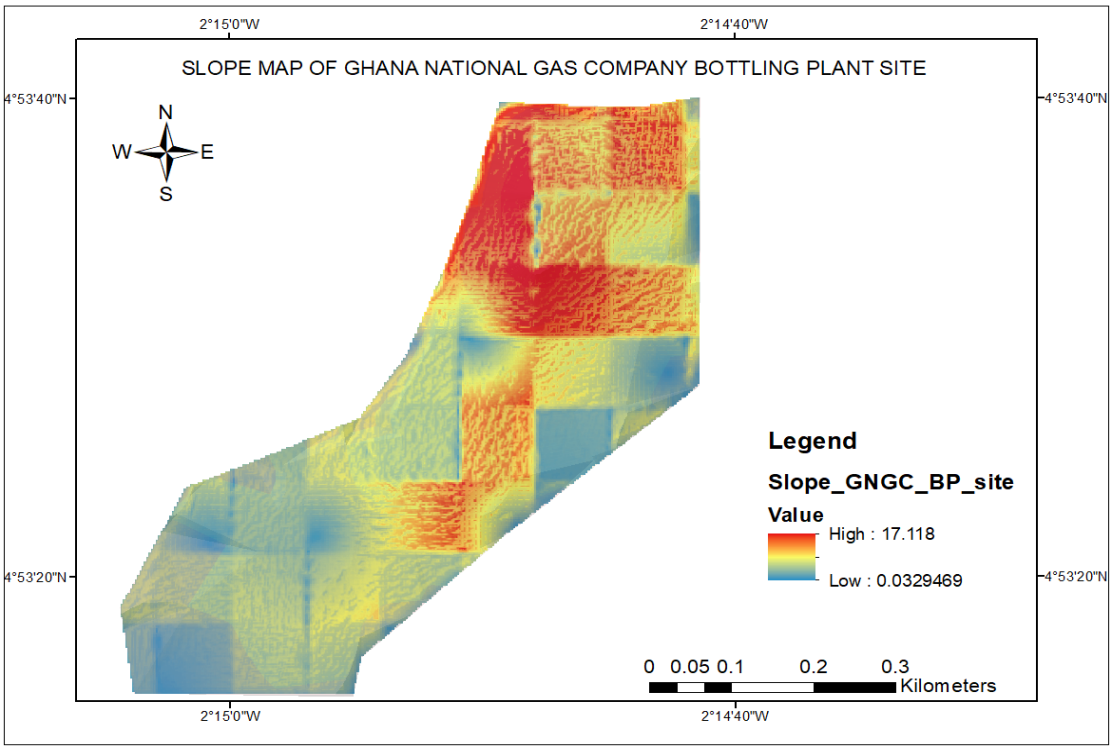


Figure 5.8: Slope map of GNGCBP site

5.1.4 Geological Resources and Soil

The guidelines and recommendations of the Institute of Geologist of Ireland (IGI) publication 'Geology in Environmental Impact Statements – A Guide' (2002) was also taken into account in the preparation of this section, whereby groundwater issues are included in the Hydrology and Drainage Section.

The Nzema East Municipality is mostly underlain by Precambrian rocks of the Birimian formation and the Tarkwaian sandstone-association, Quartzite and Phyllites types which contain economic minerals like kaolin, silica, and gold.

The Birimian formation has been folded, metamorphosed and in some places assimilated by granitoid bodies. The metamorphism is considered to be low-grade greenschist facies. However, grades of amphibolite facies are common and grades up to granulite facies do occur in several localities. Faulting tends to follow the strike of the folds and trends perpendicular to the latter.

The Meta-volcanic Birimian unconformably overlies the Meta-sedimentary Birimian and takes up 20% of the area occupied by the whole Birimian. The series consists of great thicknesses of basaltic and andesitic lavas, beds of agglomerates, tuff and tuffaceous sediments. Pillow lavas have been observed frequently in the meta-volcanic Birimian.

The basic volcanics and pyroclastics have been altered largely to chloritized and epidotised rocks that have been loosely grouped together as greenstones. Where the greenstones have been subjected to dynamo-thermal metamorphism, they have been converted to hornblende schists and amphibolites. Impure arenaceous sediments which have been recrystallised and resemble very fine grained diorites grade with increasing grain size into diorites.

Rocks of the Tarkwaian Group are thought to rest unconformably on the Birimian and are concentrated mainly at the South-western part of Ghana in the Tarkwa area where they outcrop in a NE-SW trending belt. The belt stretches from near Axim to the edge of the Voltaian basin near Agogo, a distance of about 250km with a width of about 16km.

The Tarkwaian rocks consist of thick series of argillaceous and arenaceous sediments (mainly arenaceous) in the lower members of the system. The Tarkwaian sediments have been subjected to low-grade metamorphism i.e. middle greenschists to middle almandine-amphibolite facies. The higher grades are uncommon and often associated with intrusive rocks (figure 5.9).

The Tarkwaian Group is considered to be of shallow water continental origin derived from the Birimian and associated granites.

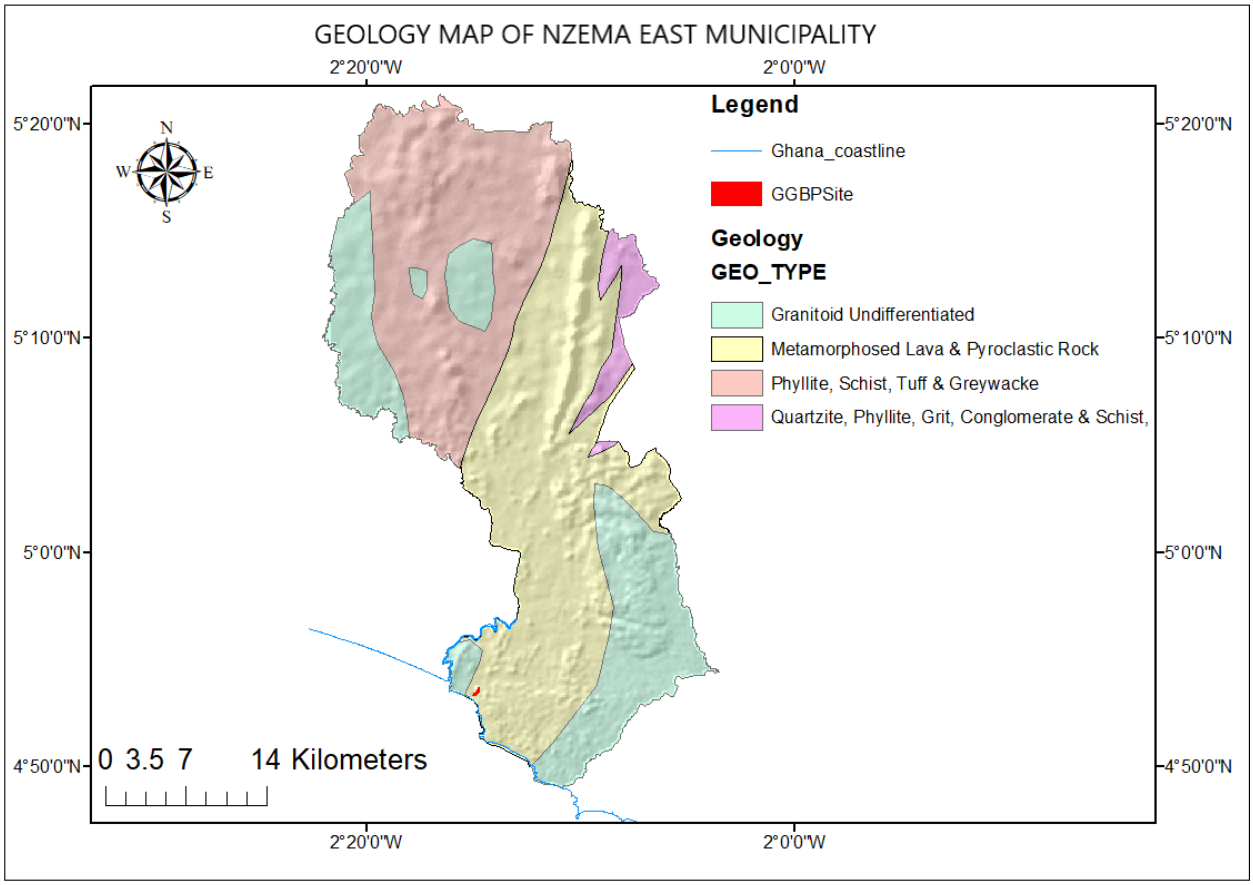


Figure 5.9: Geology of Nzema East Municipality

On the proposed site for the bottling plant near Axim, boulders of quartzite and some metamorphosed feldspathic sandstone believed to belong to the Banket series of the Tarkwaian formation have been exposed (figure 5.10). The Banket Series represents a fluviatile series with a thickness varying between 120-600m being greater south and west of Tarkwa. It is essentially an accumulation of high energy, coarse clastics, represented by conglomerates, grits, quartzites, which have suffered low-grade metamorphism.

Figure 5.10: Quartzite exposed on the GNGCBP site

Seismicity

A number of significant earthquakes have struck southern Ghana in the past, some with destructive effects. Seismic activities, including major and minor ones, have been going on quite regularly over the centuries to the present. The earliest recorded earthquake in Ghana occurred at about 2:00 p.m. on 18 December 1636 in the Axim district in southwestern Ghana near the border between Ghana and the Ivory Coast. Its surface magnitude (Ms) was 5.7 and the maximum intensity was IX on the MSK scale (Ambraseys and Adams, 1986).

The Axim region earthquakes come from reactivated faults linked to the St Paul's fracture zone, which go through southern Cote D'Ivoire to Ghana. Seismotectonic movements along the St

Paul's transform and fracture zones have quieted since 1879. But movement along the Romanche Transform fault and Fracture zone is active, causing ongoing seismicity of southern Ghana (figure 5.11).

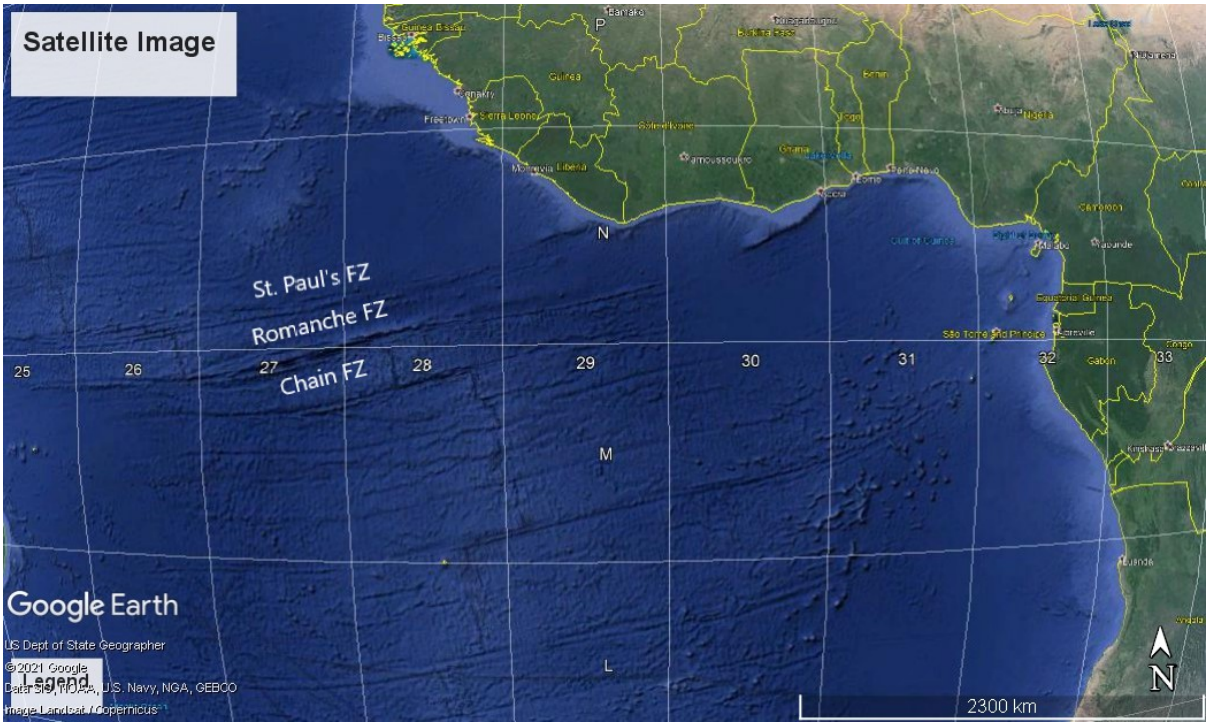


Figure 5.11: Regional map showing fault system of the Atlantic fracture zone (modified after Google Earth, 2021)

The seismicity of southern Ghana emanates from fault systems of the Atlantic fracture zones dominated by the Romanche and St. Paul's fracture zones. According to Kutu (2013), the epicentres of earthquakes in Ghana are located both onshore along the coastal regions of Ghana and her neighbouring countries and offshore in the Gulf of Guinea, hence, the causative forces and faults must be acting from that whole region. Major faults in southern Ghana were traced off shore and vice versa onshore.

Two seismogenic regions of Ghana are recognized, as the Axim-Elmina seismic and Accra-Ho seismic regions. The Axim-Elmina region earthquakes come from reactivated faults in the St Paul's fracture zone system offshore in the Gulf of Guinea through Cote D'Ivoire into Ghana (figure 5.12).

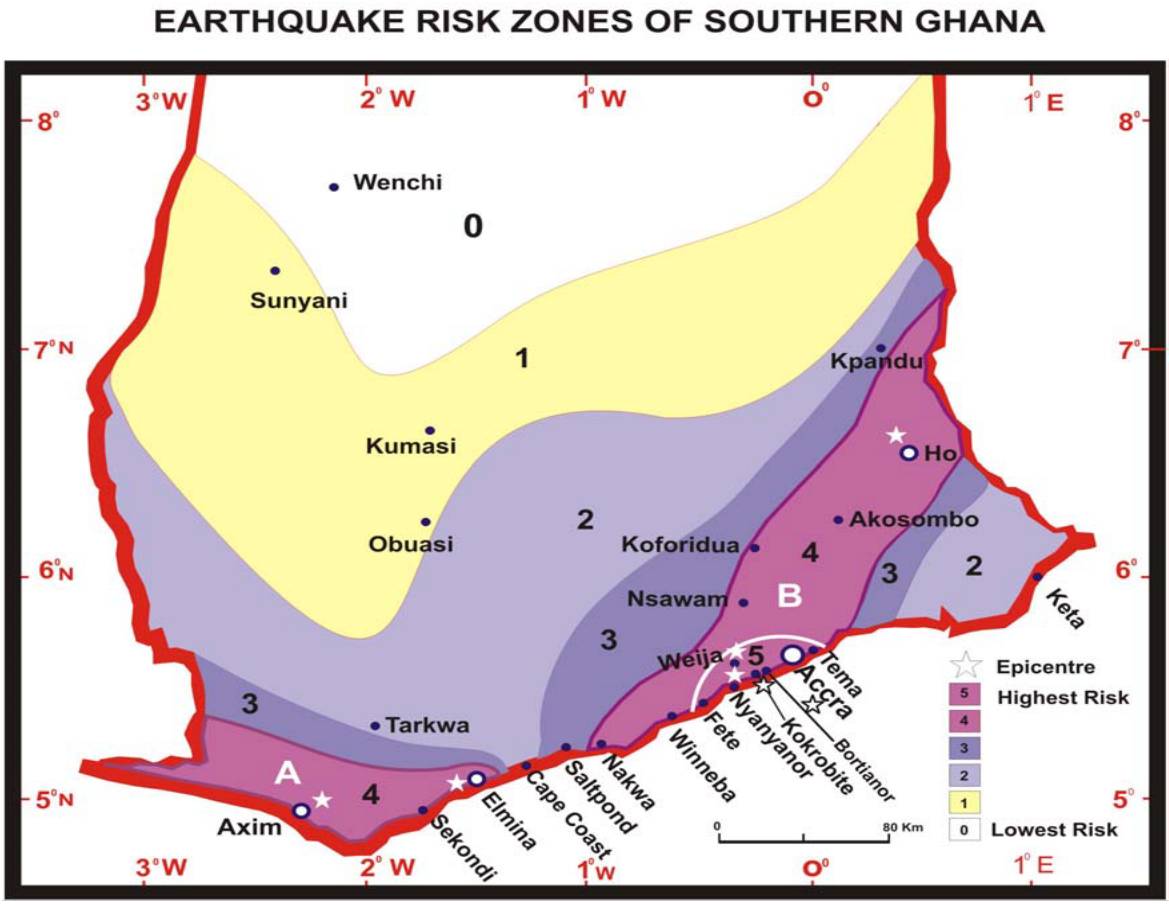


Figure 5.12: Map of Southern Ghana showing two seismic regions, A and B, together with the seismic hazard zones (courtesy Kutu, 2013).

The Nzema East Municipality is known to be a tectonically active region and as such, rocks in the region have been folded and faulted. Some faults in the region are shown in figure 5.13 and generally trend in the NE-SW direction. The map however, does not show any significant faults in the region proposed for the project.

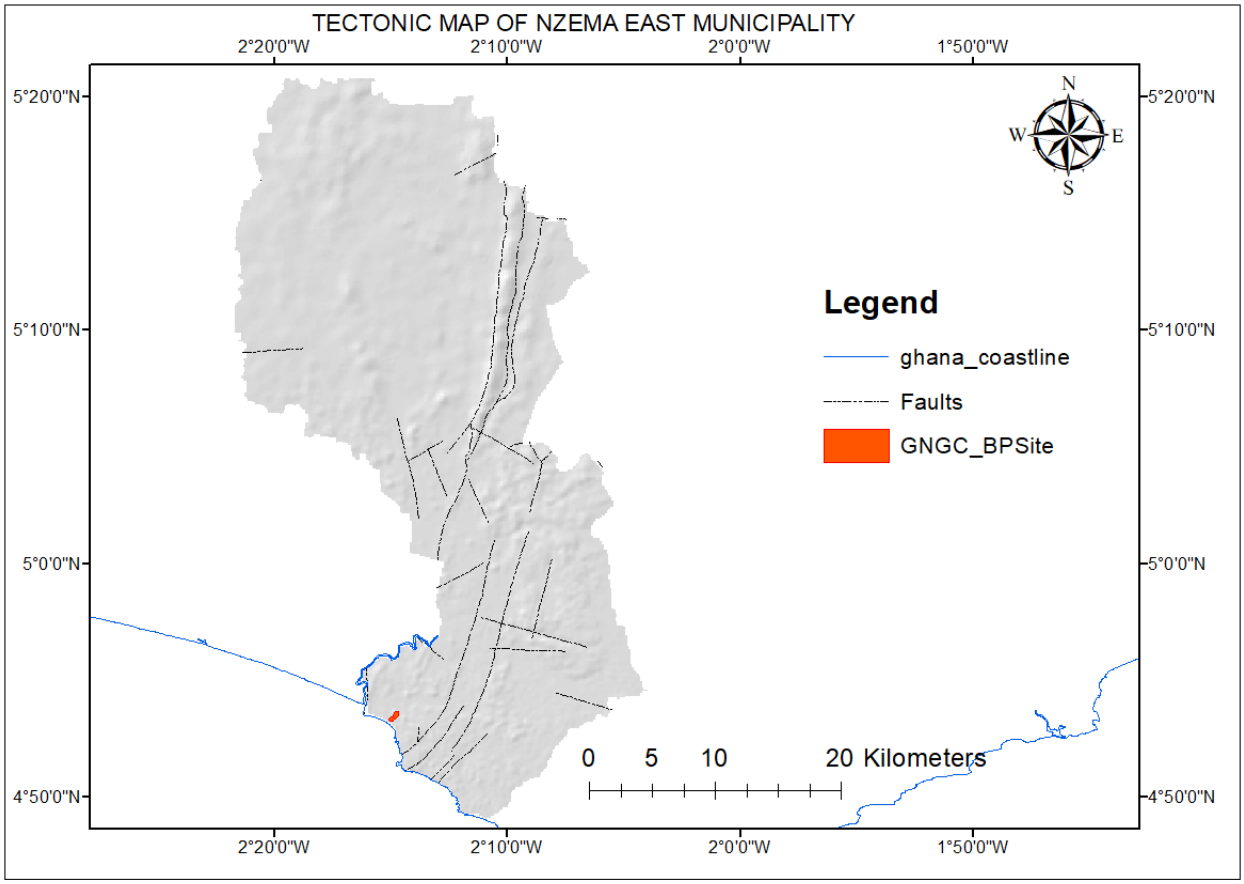


Figure 5.13: Tectonic map of the Nzema East Municipality

Soil

The Nzema East Municipality is underlain by three (3) soil types namely ferralsols, fluvisols and acrisols (figure 5.14). Most of these soils are acidic and low in nutrients due to high leaching as a result of the high rainfall in district.

The project site near Axim is largely covered with ferralsols. They are deeply weathered, reddish (hematite) soils derived from the underlying metamorphosed parent rocks. They have a clay assemblage dominated by low activity clays (mainly kaolinite) and a high content of sesquioxides. Ferralsols generally have good physical properties but are chemically poor. The

limited stock of plant nutrients which are in a constant process of cycling with most nutrients make the ideal for shifting cultivation with full fertilization required for sedentary agriculture.

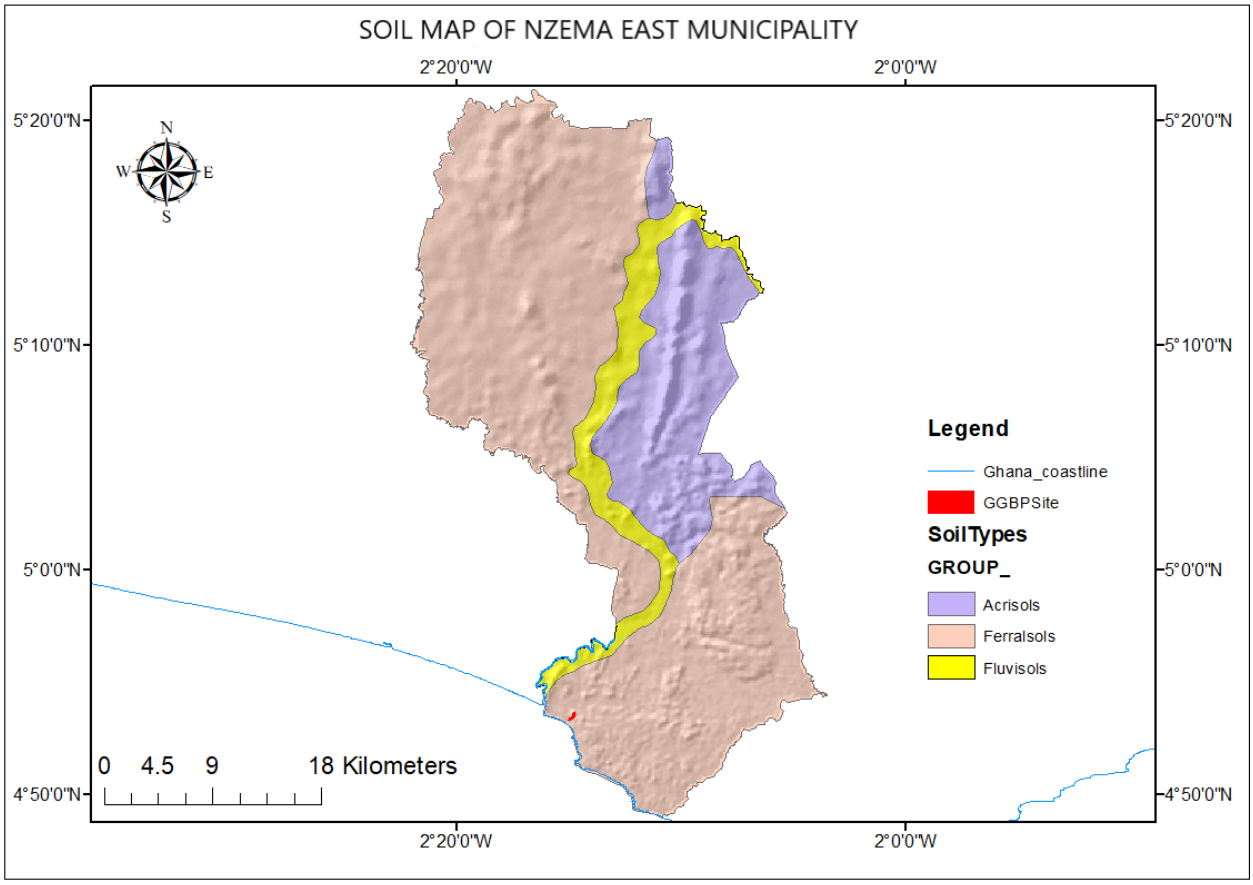


Figure 5.14: Soils map of Nzema East Municipality

Site Specific Soil Environment

Soil samples were therefore obtained from the site to establish the physical and chemical properties. Ten (10) sample points (Figure 5.15) were randomly selected and samples collected from depths of 20 cm (figure 5.16). These samples were sent to the Ecological laboratory at the University of Ghana for analysis.

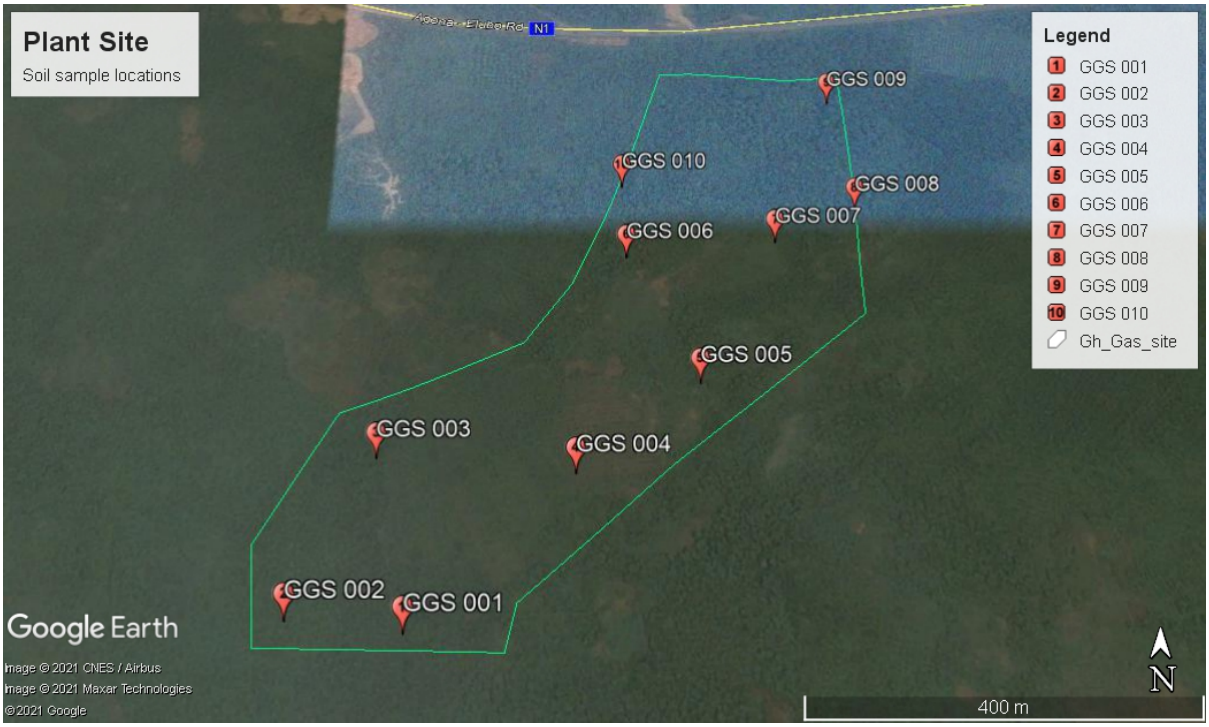


Figure 5.15: Soil Sample locations (Source: Google Earth)

Figure 5.16: Photos showing sampling activities

Summary of results for the sampling activities have been presented the Tables 5.1 & 5.2.

Table 5.1: Lab Results for Soil Samples GGS001 - GGS005

ID	Parameter	Unit	GGS 001	GGS 002	GGS 003	GGS 004	GGS 005
1	Location	Longitude	2°14'58.8" W	2°15'02.9" W	2°15'00.3" W	2°14'52.9" W	2°14'48.2" W
		Latitude	4°53'15.6" N	4°53'15.9" N	4°53'21.9" N	4°53'21.3" N	4°53'25.0" N
2	pH (H_2O)		5.3	4.9	5.2	5.3	5.2
3	E. Conductivity	(ds/m)	0.191	0.192	0.126	0.092	0.094
4	A. Phosphorus	(mg/kg)	9.94	9.66	10.2	9.1	19.7
5	O/C	(%)	2.23	2.39	1.11	2.33	2.55
6	O/M	(%)	3.85	4.12	1.92	3.85	4.4
7	T. Nitrogen	(%)	0.12	0.15	0.07	0.11	0.16
8	Ca	(cmol+/kg)	0.666	0.371	0.854	0.849	0.748
9	Mg	(cmol+/kg)	1.29	0.419	0.722	1.549	1.14
10	Na	(cmol+/kg)	0.0119	0.00082	0.00028	0.00044	0.1507
11	K	(cmol+/kg)	0.071	0.031	0.485	0.061	0.049
12	SAND	(%)	64	78	77	33	35
13	CLAY	(%)	10	10	11	22	21
14	SILT	(%)	26	12	13	45	43
15	TEXTURE		Sandy Loam	Sandy Loam	Sandy Loam	Loam	Loam

Table 5.2: Lab Results for Samples GGS006 - GGS010

ID	Parameter	Unit	GGS 006	GGS 007	GGS 008	GGS 009	GGS 010
1	Location	Longitude	2°14'51.0" W	2°14'44.9" W	2°14'41.5" W	2°14'42.0" W	2°14'51.1" W
		Latitude	4°53'30.4" N	4°53'31.1" N	4°53'32.7" N	4°53'38.3" N	4°53'33.8" N
2	pH (H_2O)		4.8	4.9	5.3	5.2	5
3	E. Conductivity	(ds/m)	0.088	0.309	0.0962	0.0951	0.0713
4	A. Phosphorus	(mg/kg)	9.94	11.3	9.66	11.9	13.2
5	O/C	(%)	1.44	3.27	3.51	2.11	3.83
6	O/M	(%)	2.47	5.64	6.05	3.62	6.6
7	T.Nitrogen	(%)	0.09	0.2	0.22	0.12	0.24
8	Ca	(cmol+/kg)	0.657	0.681	0.767	0.625	0.534
9	Mg	(cmol+/kg)	1.03	0.824	1.79	0.982	0.69
10	Na	(cmol+/kg)	0.00052	0.044	0.00061	0.00043	0.052
11	K	(cmol+/kg)	0.054	0.051	0.026	0.084	0.032
12	SAND	(%)	21	36	35	35	37
13	CLAY	(%)	23	20	18	21	19
14	SILT	(%)	57	44	47	44	43
15	TEXTURE		Silty Loam	Loam	Loam	Loam	Loam

Table 5.3: Soil Test Results Interpretation

SOIL PROPERTIES	**Unit**	**LOW**	**MEDIUM**	**HIGH**	**% RECOVERIES**
pH (H_2O)		5.4-5.7 (ACIDIC	6.5-7.2 (MOD	7.3-7.9 (ALKALINE	
Elect. Conductivity	(ds/m)	<0.2-0.7	0.8-1.2	2.5-5.0	
Avail. Phosphorus	(mg/kg)	10 – 20	20 – 30	30 – 60	
O/C	(%)	0.60 – 1.00	1.00 – 1.80	1.80 – 3.00	
O/M	(%)	1.00 – 1.70	1.70 – 3.00	3.00 – 5.15	
TN	(%)	0.05-0.15	0.15-0.25	0.25-0.50	
C:N RATIO	(%)	8 – 10	10 – 15	15 – 25	
Ca	(cmol+/kg)	2 – 5	5 – 10	10 – 20	95.66
Mg	(cmol+/kg)	0.3 – 1.0	1 – 3	3 – 8	97.45
Na	(cmol+/kg)	0.1 – 0.3	0.3 – 0.7	0.7 – 2	93.45
K	(cmol+/kg)	0.2 – 0.3	0.3 – 0.7	0.7 – 2	96.7

(See Appendix 7 for the lab results)

Observations

The soil results were compared to soil standards (Table 5.3). It has been observed that the pH of the soil was ranging from 4.8 to 5.3 indicating the soils are acidic in nature. The conductivity of the soil ranges from 0.0713 to 0.309 ds/m. Since the EC value is less than 0.8 dS/m, the soil is said to be Non-saline in nature.

The texture of the soil sample is predominantly loam as shown by 50% of the samples collected and analysed. Soil organic content varied from 1.11 to 3.83%, which indicates medium to high levels of organic matter.

The total nitrogen content ranges from 0.07 to 0.24% in the locality and the phosphorus content varies between 9.1 to 19.7 mg/kg. This indicates that the soil has low quantities of Nitrogen and Phosphorus.

The potassium content varies from 0.026 to 0.485 cmol+/kg, which indicates that the soils have low quantities of potassium.

4.1.5 Hydrology and Drainage

The Nzema East Municipality of the Western Region of Ghana, is underlain by crystalline basement aquifers with typical weathered/fractured aquifer properties, the basement aquifers have low to moderate productivity (0.5 - 2 L/s) with significant intergranular and fracture flow. In some cases however, these major aquifers are overlain by relatively low permeability unconsolidated sediments that are not shown on the map (figure 5.17) that serve as aquifers.

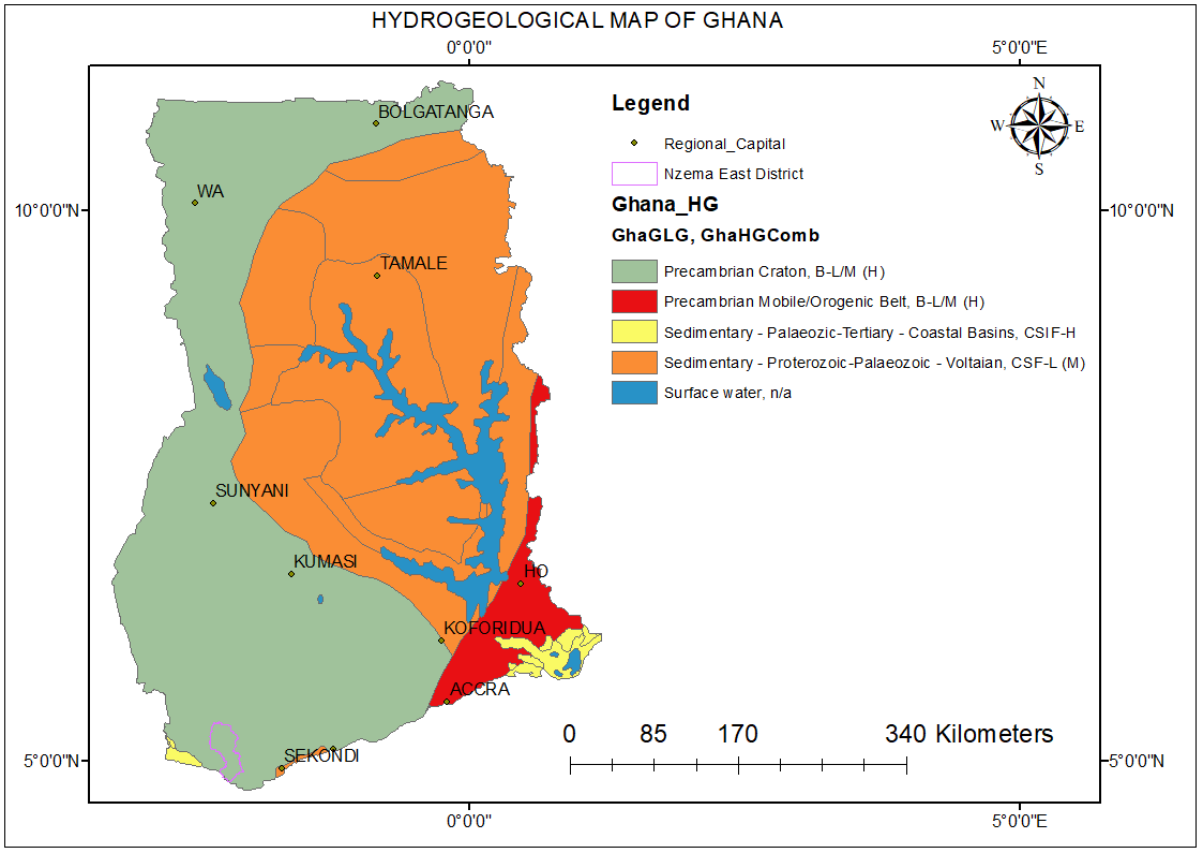


Figure 5.17: Hydrogeological map of Ghana site modified after BGS, UK, 2021

Drainage

The Municipality has a dendritic drainage system (figure 5.18) with about 6 sub-tributaries (streams), which merge into tributaries of the main Ankobra River. These streams are seen to feed the Ankobra and is strongly influenced to the overriding gradient of the land.

Surface drainage is mainly ephemeral; water from heavy storms drains away by sheet flow, resulting in short lived floods.

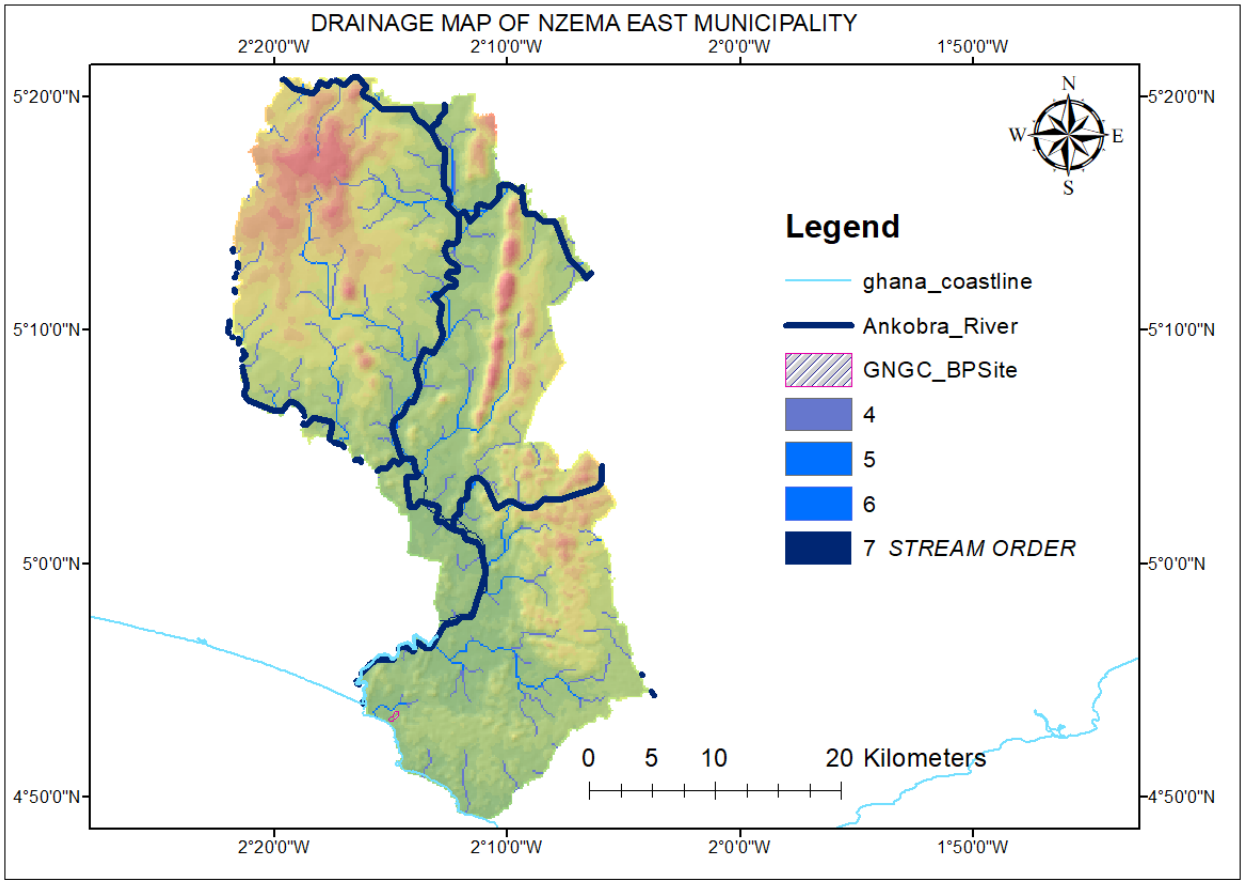


Figure 5.18: Drainage map of Nzema East Municipality

On the main site however, there is a parallel drainage system due to long, uniform slopes (figure 5.19). The watercourses run swift and straight, with very few tributaries, and all flow in the same direction. The region with higher order streams (6) are largely waterlogged or with high water tables. The surface pools are created because the soil (high clay) in that region are largely saturated. The drainage basin on site (blue region) results from water flowing from the saturated soil downward to deeper layers which feeds the groundwater reservoir. As a result, the groundwater table rises. This was evident by the high water table of about 0.5 m observed at that region on site.

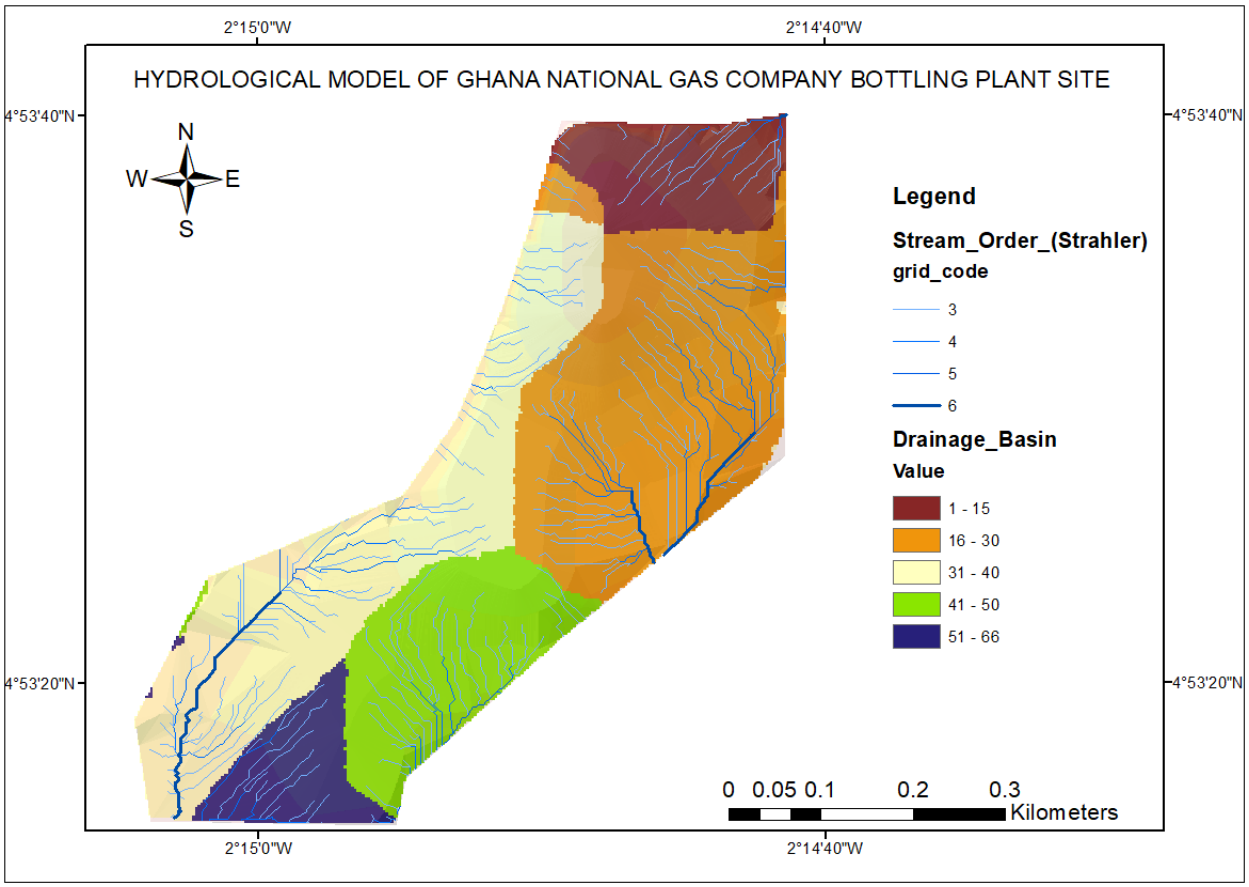


Figure 5.19: Drainage of GNGCBP site

Ground and surface water samples

Samples of surface and groundwater were collected from 7 locations for physical and chemical tests (figure 5.20).

Figure 5.20: Map showing Sampling Points for Surface and Groundwater

Groundwater

Groundwater was sampled from 4 point North-East and South-West of the plant site. The groundwater table was measured from the 2 wells in the Axim Township.

Table 5.4: Information on Sampled Boreholes around the Site

	Type	Sample ID	Distance from site	Depth to water table
GW 1	Mechanized borehole	BH 1	1.4 km	n/a
GW 2	Mechanized borehole	BH 2	1.25 km	n/a
GW 3	Well	BH 3	1.08 km	3.0 m
GW 4	Well	BH 4	1.06 km	2.6 m

n/a: not available

Table 5.5: Water Quality Results of Sampled Groundwater

Parameter	**Unit**	**GW1**	**GW2**	**GW3**	**GW4**	**WHO Standard**	**Ghana Drinking Water Quality Standard**
Physical Parameters							
pH		7.32	7.42	6.12	5.85	6.5-8.5	6.5-8.5
Elect. Conductivity	(uS/cm)	1000	687	172	420	300-700	
Turbidity (NTU)	(NTU)	0.5	0.2	3.7	3.6	5	5.00
Salinity	ppt	0.5	0.3	0.1	0.2	0.2-0.25	-
Total Dissolved Solids	(mg/l)	641	440	112	273	<1000	1000
Total Suspended Solids	(mg/l)	0	0	0	0	-	0.00
Nutrients and Other Chemical Test							
Dissolved Oxygen, DO	(mg/l)	6.31	5.06	4.67	4.58	-	-
Biochemical Oxygen Demand (BODs)	(mg/l)	2	3	8	6	6-9	-
Sulphate	(mg/l)	31	3	1	6	<250	250
Nitrate, NO_3	(mg/l)	2	1	5.8	15.7	50	50
Nitrate, NO_3 as NO_3-N (mg/l)	(mg/l)	0.1	0.1	1.3	3.6	10	50
Fluoride (F-) (mg/l)	(mg/l)	<0.01	<0.01	<0.01	<0.01	1.5	1.5
Total phosphorous, T-PO4-P	(mg/l)	0.27	0.28	0.41	0.33	0.1	
Ammonia, as NH_4-N (mg/l)	(mg/l)	0.06	<0.01	<0.01	0.28	0.05	1.50

Parameter	**Unit**	**GW1**	**GW2**	**GW3**	**GW4**	**WHO Standard**	**Ghana Drinking Water Quality Standard**
Chemical Oxygen Demand (COD)	(mg/l)	8	6	171	72	7.5	7.5
Total Hardness (as $CaCO_3$)	(mg/l)	424.75	366.84	44.62	814.89	500	500
Chloride (Cl-)	(mg/l)	79.7	33.2	13.3	88.62	<250	250
Sodium (Na+)	(mg/l)	24.8	19.98	14.42	106.9	200	200
Potassium (K+)	(mg/l)	0.116	0.214	0.113	0.834	30	
Calcium	(mg/l)	81.99	44.63	5.356	66.44	250	200
Magnesium	(mg/l)	53.43	62.02	7.587	157.6	150	150
Heavy Metals							
Dissolved Mercury (Hg)	(mg/l)	0.00009	0.00011	0.00013	0.00013	0.0005	0.0005
Dissolved Arsenic (As)	(mg/l)	0.0001	0.00011	0.00016	0.00016	0.00001	0.00001
Dissolved Iron (Fe)	(mg/l)	0.002	0.07	0.139	0.041	<0.3	0.30
Dissolved Cadmium (Cd)	(mg/l)	0.63	0.002	0.15	0.292	0.003	0.003
Microbial Test							
Total Coliform	(cfu/ 100ml)	$8.6*10^1$	0	$4.0*10^1$	$3.5*10^1$	0	0
Fecal (E.coli)	(cfu/ 100ml)	$2.0*10^1$	0	$2.4*10^1$	$1.1*10^1$	0	0

(See Appendix 7 for the lab results)

Brief Description of Groundwater Samples

GW1

All physical Parameters of GW1 were below the WHO and Ghana Standard except for Electrical conductivity which were above the Ghana standard and implies it didn't conform to the standards.

For nutrients and Chemical tests, Total Phosphorous, Ammonia and Chemical Oxygen Demand were above the standards which implies non-conformance. For the Heavy Metals test, dissolved cadmium was above the standard. The microbial tests results showed that the GW1 sample didn't meet the standard for Microbial and Total Coliform.

GW2

All physical Parameters of GW2 were below the WHO and Ghana Standard which implies conformance to the standards. For nutrients and Chemical tests all parameters were below the standard except Total Phosphorous. For the Heavy Metals test, dissolved iron was above the standard which implies non-conformance. The microbial tests results showed that the GW2 sample was below the standard and implies conformance.

GW3

All physical Parameters of GW3 were below the WHO and Ghana Standard which implies conformance to the standards. For nutrients and Chemical tests all parameters were below the standard except Total Phosphorous and Chemical Oxygen Demand. For the Heavy Metals test, dissolved cadmium was above the standard which implies non-conformance. The microbial tests results showed that the GW3 sample didn't meet the standard and implies non-conformance.

GW4

All physical Parameters of GW4 were below the WHO and Ghana Standard which implies conformance to the standards. For nutrients and Chemical tests all parameters were below the standard except Total Phosphorous and Chemical Oxygen Demand. For the Heavy Metals test, dissolved cadmium was above the standard which implies non-conformance. The microbial tests results showed that the GW3 sample didn't meet the standard and implies non-conformance.

Surface Water

Three locations were sampled for surface water. These included the Nzuble (Black water) stream, downstream Ankobra and upstream Ankobra. The results for the physicochemical tests have been presented in the table below.

Table 5.6: Water Quality Results of Sampled Surface Water

Parameter	Unit	Ankobra Upstream	Ankobra Downstream	Nzuble	WHO Standard	Ghana Drinking Water Quality Standard
Physical Parameters						
pH		6.48	7.28	6.7	6.5-8.5	6.5-8.5
Elect. Conductivity	(uS/cm)	17800	38900	133	300-700	
Turbidity (NTU)	(NTU)	26.9	23.7	3.3	5	5.00
Salinity	ppt	10.5	16.1	0.1	0.2-0.25	-
Total Dissolved Solids	(mg/l)	11000	23700	86	<1000	1000
Total Suspended Solids	(mg/l)	14	8	9	-	0.00
Nutrients and Other Chemical Test						
Dissolved Oxygen, DO	(mg/l)	4.3	3.5	4.95	-	-
Biochemical Oxygen Demand (BODs)	(mg/l)	124	318	12	6-9	-
Sulphate	(mg/l)	621	109	14	<250	250
Nitrate, NO_3	(mg/l)	13.8	10	5.9	50	50

Nitrate, NO_3 as NO_3-N (mg/l)	(mg/l)	3.1	2	1.3	10	50
Fluoride (F-) (mg/l)	(mg/l)	0.04	0.53	<0.01	1.5	1.5
Total phosphorous, T-PO4-P	(mg/l)	0.38	0.31	0.2	0.1	
Ammonia, as NH_4-N (mg/l)	(mg/l)	0.24	0.59	0.23	0.05	1.50
Chemical Oxygen Demand (COD)	(mg/l)	476	1520	34	7.5	7.5
Total Hardness (as $CaCO_3$)	(mg/l)	940.11	104.78	8.525	500	500
Chloride (Cl-)	(mg/l)	21270	22.15	46.52	<250	250
Sodium (Na+)	(mg/l)	120.4	20.31	16.57	200	200
Potassium (K+)	(mg/l)	0.711	0.134	0.111	30	
Calcium	(mg/l)	116.9	19.12	0.993	250	200
Magnesium	(mg/l)	157.41	13.85	1.468	150	150
Heavy Metals						
Dissolved Mercury (Hg)	(mg/l)	0.0002	0.00018	0.0011	0.0005	0.0005
Dissolved Arsenic (As)	(mg/l)	0.0004	0.00013	0.0017	0.00001	0.00001
Dissolved Iron (Fe)	(mg/l)	0.045	0.001	2.296	<0.3	0.30
Dissolved Cadmium (Cd)	(mg/l)	0.019	<0.01	0.14	0.003	0.003
Microbial Test						
Total Coliform	(cfu/ 100ml)	$6.5*10^1$	$9.7*10^1$	$9.3*10^1$	0	0
Fecal (E.coli)	(cfu/ 100ml)	$6.0*10^1$	$2.2*10^1$	$1.6*10^1$	0	0

(See Appendix 7 for the lab results)

Brief Description of Surface Water

Ankobra Upstream

All physical Parameters of the Ankobra upstream sample were above the WHO and Ghana Standard except for pH which was below the Ghana standard and implies the sample didn't conform to the standards.

For nutrients and Chemical tests, BOD, sulphate, Total Phosphorous, COD, Total Hardness, Chloride and Magnesium were above the standards which implies non-conformance. For the Heavy Metals test, dissolved cadmium, dissolved arsenic and dissolved iron were above the standard. The microbial tests results showed that the Ankobra upstream sample didn't meet the standard for Microbial and Total Coliform.

Ankobra Downstream

All physical Parameters of the Ankobra downstream sample were above the WHO and Ghana Standard except for pH which was below the Ghana standard and implies the sample didn't conform to the standards.

For nutrients and Chemical tests, BOD, Total Phosphorous, Ammonia and COD were above the standards which implies non-conformance of the sample to the standards. For the Heavy Metals test, all parameters were below the standard. The microbial tests results showed that the Ankobra Downstream sample didn't meet the standard for Microbial and Total Coliform.

Nzuble Stream

All physical Parameters of the Nzuble sample were below the WHO and Ghana Standard implying conformance to the standards.

For nutrients and Chemical tests, BOD was above the standards which implies non-conformance of the sample to the standards. For the Heavy Metals test, dissolved mercury, dissolved arsenic, dissolved iron and dissolved cadmium were above the standard implying non-conformace. The microbial tests results showed that the Nzuble sample didn't meet the standard for Microbial and Total Coliform.

5.1.6 Vegetation

In Ghana, the immediate coastal zone vegetation is broadly mapped as strand and mangrove. On a broad scale, the regional vegetation pattern of the area inland of Axim across the project site and extending west towards Takoradi is dry semi-deciduous forest. Mangrove communities could be found within the coastal lagoons and along the banks of the Ankobra River.

On the Axim-Ankobra stretch of the coast, human activities have greatly influenced the vegetation cover, causing a low diversity in plant species occurring along the beach.

Halophytes

Mangroves and Mangrove Associates

Five species of mangroves were identified on the site around the Ankobra estuary. They are: *Rhizophora mangle Rhizophora racemosa*, *Avicennia germinans*, *Laguncularia racemosa* and *Conocarpus erectus.* The mangrove forest is dominated by the black and red mangroves, *Avicennia germinans* and *Rhizophora racemosa* respectively (CRC & FoN, 2011). Some mangrove associates were also observed in the area. They include: *Achrostichum aureum*, *Dalbergia escastophyllum* and *Machaerium lunatum.*

Other Halophytes

On the Axim-Ankobra stretch, only a few coconut trees (*Cocos sp*) were observed around the Ankobra beach resort. Together with the coconut trees was a semi dense population of the facultative halophyte, almond trees (*Prunus sp).*

5.1.7 Flora and Fauna

The Nzema East Municipality, where the project is situated, is in the coastal evergreen forest zone in the western region of Ghana. Common flora in the area include various species of trees, shrubs, mangroves and grassland species. Dominant vegetation within 2km radius of the project site is characterized by flora of the Imperata cylindrical (Spear grass) association, Cocos nucifera, Cyperus articulatus, Ipomoea pes-caprae, Opuntia vulgaris, Paspalum vaginatum, Phoenix reclinata, Sporobolus virginicus, Thespesia populnea, and Triumfetta rhomboidea.

There are mosaic of grass species and weed species. The grass species found include sedge Pycreus polystachyos, Gamba grass (Andropogon gayanus), Kazungulu grass (Setaria sphacelata) and spear grass (Imperata cylindrical). Weed species like Mimosa pudica were also found on the site. There was also growing neem trees on site.

Mangroves found in the municipality include red mangroves (Rhizophora racemosa), Rhizophora mangel and Rhizophora harrisonii and the white mangroves Avicennia germinans and Laguncularia racemosa. The red mangroves occur in open lagoon systems which have regular tidal exchange whereas the white mangroves are primary colonists of closed lagoons (Sackey et. al., 1993).

Further inland, the area is dominated by grasses and sedges; while native shrubs are present in limited numbers on one of the higher knolls near the west boundary of the site. Wild oil palms, raffia palm and cultivated rubber trees are scattered throughout the site at elevations ranging from 4m to 7m.

According to EPA (2004), Rocky beaches occur at Takoradi, Princess town, and Axim with considerable colonization by barnacles. They also support a wide variety of macroalgae which

serve as important microhabitats for epifauna and fish. There are also a wide variety of molluscs, and crustaceans including littorinid snails and crabs. The sandy beach fauna is dominated by the ghost crab, Ocypoda cursor, and the rocky beaches by bivalves, whelks, limpets and crabs e.g. Grapsus grapsus. Other commonly encountered fauna include isopods, amphipods, mysids and polychaetes.

The marine fishery resources in the municipality are most exploited by artisanal fisherfolk, using both manually operated and motorised canoes. The sardinellas (Sardinella aurita and Sardinella maderensis) are the most exploited small pelagics. Other small pelagic fishes of economic importance are the chub mackerel (Scomber japonicus), scads (Decapterus spp.), jack mackerels (Caranx spp.), horse mackerels (Trachurus spp.), the bumper (Chloroscombrus chrysurus), and the anchovy (Engraulis encrasicolus). Four species of shrimps (Crustacea), i.e. the pink shrimp Penaeus notialis, the tiger shrimp Penaeus kerathurus, the rose shrimp Parapenaeus longistrostris and the white shrimp Parapeneopsis atlantica are the most abundant of the shrimp resources in the area (Mensah and Quaatey, 2002).

Sea turtles such as the Leatherback (Demochelys coriacea), Hawksbill (Eretmochelys sp.), and the Green turtle (Chelonia mydas), are occasionally found in the Axim area. These trutles are listed as endangered in the CITEs Redbook.

A number of notable estuaries are present along the western part of the Ghanaian coastline where large rivers enter the sea. The Ankora river enters the Gulf of Guinea some 4 to 5km west of the project site. The Ankobra estuaries is about 15 km long and orientated perpendicular to the coast. The Ankobra estuary has branch into numerous tidal creeks surrounded by mangrove swamps. Twenty five (25) species of the total thirty one (31) species of fish found in the Ankobra come

from the sea. The only freshwater elements are Chrysischthys nigrodigitatus (Bagridae) and the Cichlidae species Tilapia zillii, T. guineensis and Sarotherodon galilaeus. The black-chinned tilapia Sarotherodon melanotheron and the goby Periophthalmus barbarus (designated as Periophthalmus papilio in the list) are the only typically brackish water fish recorded in the list.

Marine mammals like Dolphins (Stenella and Delphinus spp) and sharks have often been caught in drift gill nets. Shark species of the family Carcharinidae dominated by Rhizopionodon acutus are mostly landed. Whales e.g. the humpback Megaptera novaeangliae and the melon-headed Peponocephala electra occasionally beach on the shores of Ghana or are accidentally caught in fishing nets (Ofori-Danson, et al., 2003)

Terrestrial Fauna

Butterflies

Ghana has an estimated 1,000 species of butterflies - as many species as North America and Europe combined. It is impossible to select specific places because butterflies are everywhere, however, a few of the species.

Insects

Insect are among the most diverse groups of animals on the planet, including more than a million described species and representing more than half of all known living organisms. Some likely insects found in and around the project area include, Lepidoptera nymphalidae, Lepidoptera papillionidae, Lepidoptera pieridae, Coleoptera cerambycidae, Cerambycidae, Scarabaeidae, Cerambycidae, Scarabaeidae, Dictyoptera blattidae, Araneae lycosidae, Araneae salticidae, Scorpiones Scorpionidae.

Birds

According to Ntiamoa-Badu et. al (2000), there are about 728 bird species in Ghana. 408 species of this total are non-passerine (perching) and 320 are passerine. It is also believed that 494 are resident and 176 are regular seasonal migrants with about 100 species coming from the Palearctic region. Six of the total species of birds found in Ghana are considered threatened, while 12 species are classified as near-threatened. The country's location on the East-Atlantic and the Mediterranean flyways, serve as a very important transition zone for the migratory water birds. There are 36 important Bird Areas (IBA) in Ghana according to Birdlife International for critical bird habitats in Ghana of which six occur along the coast including the Amanzule wetlands in the Western region. Most of the coastal wetlands harbor about 70 species of resident and migratory bird life (Ntiamoa-Baidu et al., 2000).

Amphibians and Lizards

Common fauna at the project site and its immediate environs include common lizard (Agama agama), and insects such as butterflies, and ant species such as Formicinae and Tetraponera *Bufo regularis* (Common Toad), *Amietophrynus maculatus* (Flat-backed Toad), *Afrixalus dorsalis* (Brown Banana Frog).

Mammals

Common species of mammals that can be found in the Nzema East Municipality include: Heliosciurus sp (Sun squirrel), *Hybomys trivirgatus* (Temminck's striped mouse,), *Fukomys zechi* (Ghana mole-rat,), *Thryonomys swinderianus* (Greater cane rat,). Antelops likely to be found in the evergreen forest of Ghana include, roan, Kob, waterbuck and bushbuck. Other mammals include, warthog, grasscutters, *Crocidura oliveri,* White-toothed shrew, *Crocidura bottegi,*

Bottego's shrew; *Nanonycteris veldkampi,* Veldkamp's dwarf bat, Rhinolophidae *Hippodideros commersoni* Commerson's leaf-nosed bat, *Tatera kempi,* Kemp's gerbil, *Uranomys ruddi ,* Brush-furred rat, *Mastomys erythroleucus* Multimammate rat.

5.1.8 Coastal Resources

Three main coastal resources were identified around the proposed project site.

Seashore Ecosystem

Ghana's 550-kilometre coastline stretches from Denu in the East to New town on the West. Geomorphologically, the coastline is divided into three: The Eastern, Central and Western coast. The entire coast of Ghana supports high biological diversity given that it has various forms of habitats and connecting ecosystems. These include sandy and rocky beaches, coastal lagoons, estuaries and salt marshes. All sandy beaches in Ghana are breeding grounds to five species of sea turtles. Sea turtles have been listed, globally, as endangered species and as such are protected in Ghana by the Wildlife Division of the Forestry Commission.

Ghana's coastal area is also a hotspot for settlement given that about a quarter of the country's population reside in the coastal area. The over population in Ghana's coastal area exerts more pressure on the coast and its resources as well. Aside direct anthropogenetic pressures, such as land use, the coastline of Ghana is battling erosion associated with sediment transport and sea level rise associated with global warming. This has led to major sea defence projects along the coast of Ghana.

Axim is a well-known coastal town in Ghana. In the fishery sector, it is popular for the landing of diverse fish species which include large pelagics such as the tuna. For the past couple of years,

Axim has been in the news due to coastal related issues. The prominent ones among them being the construction a fishing harbor and also a 5-kilometre sea defence wall project. Construction of the sea defence wall especially, is expected to completely change the geomorphology of the beach. Making it to transition from a, largely, sandy beach with patches of rocks the original Axim coast is, to a fully rocky beach.

Estuarine Ecosystem

Estuaries are where rivers discharge into the sea. They are highly productive brackish water systems which serve as habitats to some unique flora and fauna. They also serve as breeding grounds for some marine and freshwater fish species.

Within a 5-kilometer buffer zone, west of Axim, from the proposed project site, is the Ankobra river estuary. Although it has been reported to have high levels of Mercury and arsenic in the past and still records high turbidity, the Ankobra estuary supports many livelihoods in the immediate community. Fishing from the estuary serve as a major source of income for some inhabitants around the Estuary.

Mangrove Ecosystem

Adjacent the Ankobra Estuary is a mangrove swamp which spans from the mouth to the upper reaches. Mangroves swamps are exceptionally important ecosystems. They provide various ecosystem goods and services that make them particularly important. They sequester atmospheric carbon, help in flood attenuation, serve as feeding ground to a wide variety of birds including migratory birds, they are also breeding and nursery grounds for some fish species and

reptiles. Mangroves are, however, vulnerable to anthropogenic pressures such as encroachment and over exploitation. The exploitation of mangrove trees for fuel wood around the Ankobra led to its depletion in time past. However, there's a mangrove restoration project on going in the area.

Aquatic Fauna

During site visit and data collection, variety of aquatic animals were encountered. The list was also complemented with findings from literature and supplemented by data from the zonal office of the Fisheries Commission in the Nzema- East district.

Aquatic Invertebrates

Sampling was done during low tide in the intertidal and subtidal zones by the use of transects and crab burrow counting and handpicking methods. Due to the transitioning of the coast under study from sandy to rocky, species diversity encountered was generally low. However, ghost crabs, echinoderms and molluscs dominated the area (figure 5.21). None of the species observed has been listed under IUCN's red list.

Table 5.7: List of Aquatic invertebrates encountered on the shore from Axim to Ankobra

Scientific Name	**English Name**
Arbacia lixula	Black sea urchin
Ocypode africana	Ghost crab
Nerita atrata	Sea snail
Patella safiana	Limpets
Cthamalus dentata	Toothed barnacles
Echinometra lucunter	Rock-boring sea urchin
Echinollitorina granosa	Litorina
Crassostrea tulipa	Oyster
Cyprae sp.	Cowry shell
Clanculus sp.	

Figure 5.21: Some invertebrates encountered on the Axim-Ankobra seashore A) Ghost crab B) *Echinollitorina granosa* C) Sea urchin D) Limpets and Sea Urchin

Aquatic Vertebrates

Fish Species

Fish were generally observed from commercial landings from beach seiners and handing the Ankobra estuary. Table 5.8 shows a list of the fish species encountered on the field and their corresponding IUCN status. Overall, the landing was dominated by *Chloroscombrus chrysurus,* the Atlantic bumper other fish species were also found and identified. Of all the fish species that where encountered, the cassava croaker was the only fish which has been listed as endangered. However, the Senegal left-eyed sole fish, *Cynoglossus senegalensis,* is also listed as nearly threatened (figure 5.22).

Table 5.8: Fish species encountered and their IUCN status

Scientific Name	**English Name**	**IUCN Status**
Trichiurus lepturus	ribbon fish	Least concern
Pseudotolothus typus	long neck croaker	Least concern
Sardinella maderensis	flat sardinella	Vulnerable
Sardinella aurita	round sardinella	Least concern
Pseudotolithus senegalensis	Cassava croaker	Endangered
Cynoglossus senegalensis	tonguesole fish	Threatened
Chloroscombrus chrysurus	Atlantic bumper	Least concern
Ephippion guttifer	Prickly puffer	Least concern
Periopthalmus rouxi	Mud skipper	Least concern
Coptodon zillii	Tilapia zillii	Least concern
Sierrathrissa leonensis	pygmy herring	Least concern
Chrysichthys nigrodigitatus	bagrid catfish	Least concern
Clarias anguillaris	mud fish	Least concern

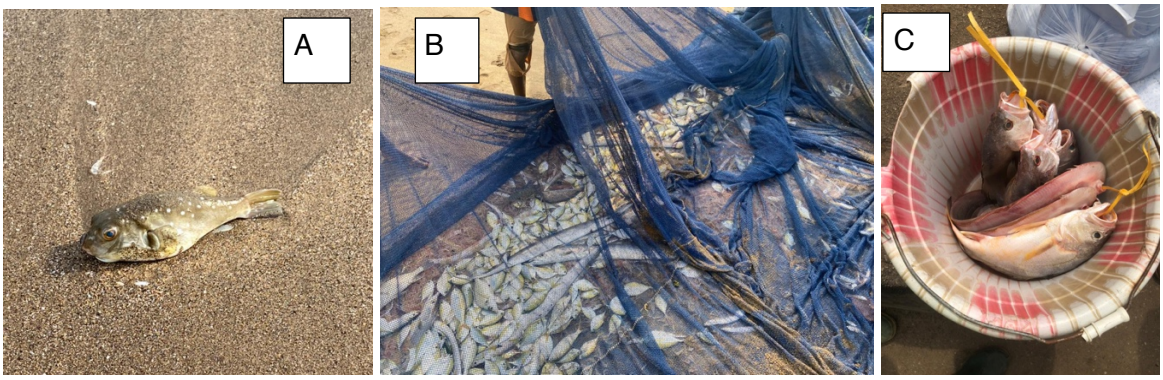


Figure 5.22: Landings from Beach seine **A**) Prickly puffer **B)** Total catch of one of the beach seine nets **C)** Some of the fish species observed from beach seine landing

Sea Turtles

In general, all sandy beaches in Ghana are noted as hotspots for sea turtles to lay their eggs. The nesting season of sea turtles commence from September and ends in January every year. During these times, the turtles swim to shore and lay their eggs in the sand. When the eggs finally hatch, the newborn find their way slowly back into the sea. This activity has for some years now been hindered by many activities of which can all the link to increased human activities on beaches. The western coast of Ghana has over the last decade become a busy coast following the discovery and exploration of oil and gas. Many migrations linked issues especially, land use has been on the rise along the Western coast threatening the survival of sea turtle eggs.

Meanwhile, sea turtles are of global concern as five out of all seven species that occur worldwide are currently threatened by extinction. Internationally, they are protected by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

In Ghana, four species occur on our coast annually and for that reasons they are protected by the Wildlife Division.

On the western coast, from the Axim to Ankobra stretch, four species of sea turtles are reportedly seen on the coast. These are: hawksbill (*Eretmochelys imbricata*), leatherback (*Dermochelys coriacea*) loggerhead (*Caretta caretta*) and Olive ridley (*Lepidochelys olivacea*). Not only have these species been reported to nest on the shore, but they have also been seen close to shore feeding in the relatively shallower waters and sometimes end up entangled in fishing net.

5.1.9 Baseline Ambient Air Quality and Noise Level

The ambient air quality is affected by both natural and anthropogenic elements within the area. Anthropogenic emission accounts for most of the characteristic of the ambient air quality in Ghana. The anthropogenic activities contributing to air quality in the area is biomass burning and controlled burning for agricultural purposes. Emissions from natural sources are relatively low. Sea spraying and harmattan are the predominant contributors of ambient air quality from natural sources. The air quality at the project site would be affected by the general air quality of the region.

Urbanization has resulted in challenges in air quality managements in Ghana. Data from 2006-2015 showed monitor readings with concentrations well above PM10 guidelines set by both Ghana (70 μg/m^3, 24-hour mean) and WHO (50 μg/m^3, 24-hour mean) (MESTI, 2017). Roadside sites tend to show higher concentrations than commercial and industrial sites, which in turn show higher concentrations than residential sites. Harmattan conditions during the dry season carries along fine particulate from the Sahara Desert resulting in high particulate matter concentrations across the country.

The project site is surrounded by secondary forest with the closest industrial and commercial active area being about 5km away. Therefore, there are no major sources of air pollution in the area. Ambient air quality is likely to be disturbed during the constructional phase of the project. However, this condition will be temporal with the air quality restoring back to normal after the constructional phase.

5.1.9.1 Methodology and Results for Baseline Ambient Air Quality Assessment

Particulate Emissions ($PM_{2.5}$ and PM_{10}).

This sampling methodology was based on US EPA air quality sampling protocol.

Baseline environmental studies on air quality and noise levels was conducted at the project site and other receptor areas within Axim. The monitoring was conducted on 2nd February 2021 to 8th February 2021.

Particulate matter was sampled using a MiniVol Air Sampler set to a flow rate of 5L/min at the designated site. Samples were taken at approximately 1.6 meters above the ground level to prevent the collection of ground level dust temporarily made airborne by gusting winds. The sampler was oriented in the direction of wind flow. The Minivol's pump draws air at the set flow rate (i.e 5L/min) through particle size separator (impactor) and then through a 47mm filter, and the particulate sample is caught on the filter mounted in a sampling unit. PM_{10} and $PM_{2.5}$ samples is achieved by use of impactors. The sampling was undertaken for 24 hours at the sampling location. The filter paper was stabilized before and after sampling in desiccators. The filter paper was pre-weighed and post-weighed before and after sampling and dust concentrations were computed using gravimetric techniques by this methodology.:

$$\mu g/m^3 = \frac{\text{Net dust weight (mg) x 1000 x 1000 } (L/m^3)}{\text{Flow Rate } (L/\text{min}) \text{ x Sample time (min)}}$$

Gaseous Emission (NO_2 and SO_2)

Sampling was done with the Forensic MultiGas Detectors which is a feature–rich hand held monitor with the ability to accurately measure multiple target gases in real time. The sensors for *NO_2 and SO_2* works on Gas Sensitive Electrochemical (GSE) technology.

Table 4.9: Air Quality Sampling Location Descriptions

Location Tag and Description		**GPS Coordinates**	
Location ID	**Location Description**	Northing	Western
AQL1 – South	Air quality monitoring was conducted at the southern end boundary of the project site, towards Axim township	4˚53’15.16”	2˚14’58.68”
AQL2 - West	Air quality sampling was undertaken at the western end boundary of the project site.	4˚53’28.19”	2˚14’52.83”
AQL3 - East	The air quality monitoring equipment were set-up at the eastern end boundary of the project site, towards the rubber plantation.	4˚53’23.58”	2˚14’47.97”
AQL4 - North	The monitoring was conducted at the northern end boundary of the project site, towards the Agona – Elubo road.	4˚53’39.15”	2˚14’44.55”
AQL5 – Nzema East Light Industrial Area	Air quality monitoring was conducted at the western end of the Nzema East Light Industrial and Commercial Area.	4˚53’22.43”	2˚13’30.60”
AQL6 – Akyinim Community	Air quality sampling was undertaken at the northwestern side of Akyinim community, on the football field towards the project site.	4˚52’52.84”	2˚14’50.21”

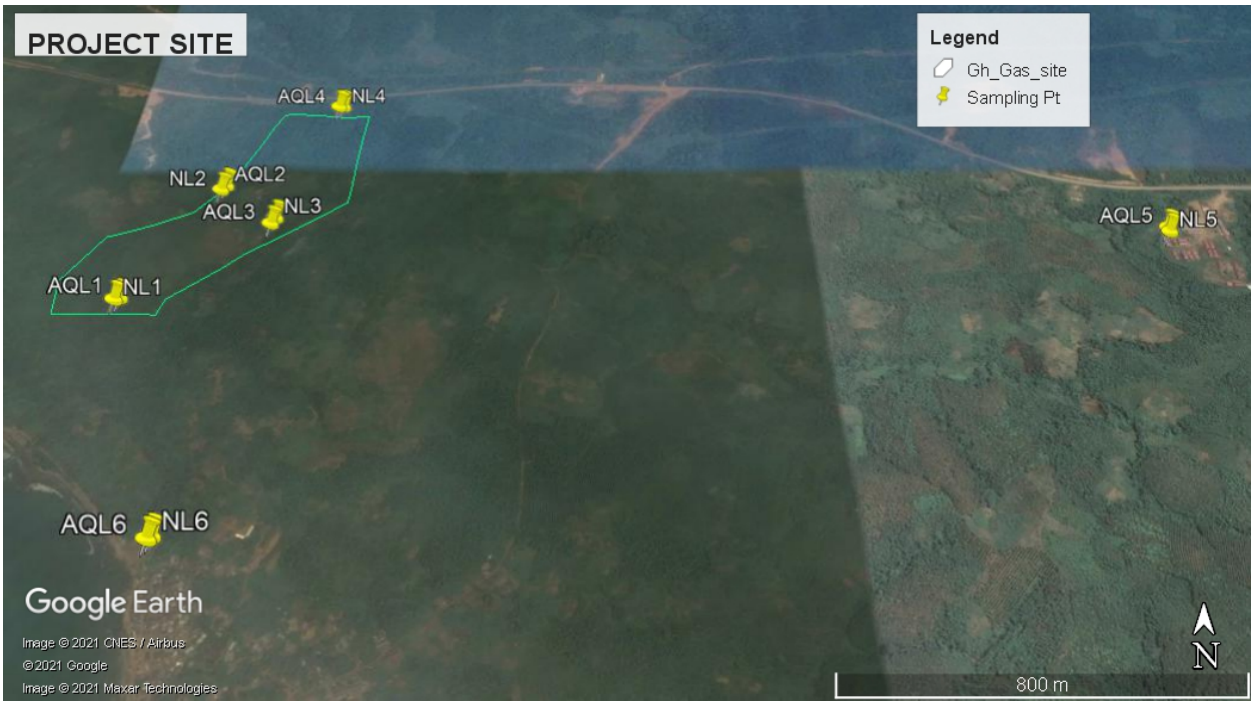


Figure 5.23: Map of the Project Area Showing the Sampling Locations

	
AQL1	**AQL2**
	
AQL3	**AQL4**
	
AQL5	**AQL6**

Figure 5.24: Evidence of Ambient Air Quality Monitoring

Table 5.10: Air Quality Results measured over 24-Hour Period

Location ID	Date		Dust Concentration (µg/m³)		Gaseous (µg/m³)	
	Started	Stopped	PM_{10}	$PM_{2.5}$	NO_2	SO_2
AQL1	02-02-21	03-02-21	72.2	43.5	8.2	2.8
AQL2	03-02-21	04-02-21	42.9	28.6	<0.1	<0.1
AQL3	04-02-21	05-02-21	42.4	28.2	<0.1	<0.1
AQL4	05-02-21	06-02-21	42.7	28.6	18.5	8.6
AQL5	06-02-21	07-02-21	42.7	28.5	32.9	22.8
AQL6	07-02-21	08-02-21	78.9	51.4	24.6	17.1
Ghana Standard (GS 1236:2019)			**70**	**35**	**150**	**50**

Sources of Air Emissions at the Project Site

1. Pollen grains from the surrounding vegetation
2. Fugitive particles in the atmosphere blown by wind from the uncovered grounds.
3. Infrequent vehicular movement at the project site
4. Vehicular movement on the Agona–Elubo roadj

Sources of Emissions at Akyinim and Nzema East Light Industrial and Commercial Area

1. Vehicular and tricycle movement on the old Axim–Ankobra road
2. Pollen grains from the surrounding vegetations
3. Fugitive particles in the atmosphere, blown by wind from uncovered surfaces
4. Vehicular movement on the Agona–Elubo road
5. Vehicular and tricycle movement within the light industrial and commercial area
6. Hot works at some workshops at the light Industrial and commercial area
7. Particulate from a sawmill at the light Industrial and commercial area.

5.1.9.2 Methodology and Results for Ambient Noise Level Assessment

Noise monitoring was recorded over a 24-hour period for day and night at each monitoring station, in accordance with the Ghana Standard Test Method for ambient Noise levels assessment. Continuous sound recordings were made using Class 1 PCE-432 (Logging Environmental 1/3 Octave Band) Sound Level Meter. The equipment was calibrated on site with an acoustic calibrator to 114 dB(A) before the start of each day's measurement to ensure accurate recordings. The sound level meter was mounted on a tripod stand with the device elevated at a height of about 1.5 meters above ground level and inclined at an angle of about 45^0.

The sound meter was set to fast response time for all measurements. The equivalent (LA_{eq}), maximum (LA_{max}), minimum (LA_{min}) and Background noise (LA_{90}) as well as statistical values for LA_{10}, LA_{50} and LA_{95} noise levels were computed and recorded over the same period (day and night) at the monitoring stations.

Table 5.11: Environmental Noise Levels Recorded over 24-Hour Period

Table 2: Noise Level Sampling Location Descriptions		**GPS Coordinates**	
Location ID	**Location Description**	Northing	Western
NL1 – South	Noise recording was conducted at the southern end boundary of the project site, towards Akyinim township	4˚53’14.97”	2˚14’59.09”
NL2 - West	Noise Level measurement was undertaken at the western end boundary of the project site.	4˚53’27.64”	2˚14’53.18”
NL3 - East	The Noise monitoring equipment was set-up at the eastern end boundary of the project site, towards the rubber plantation.	4˚53’24.32”	2˚14’47.70”
NL4 - North	Noise monitoring was conducted at the northern end boundary of the project site, towards the Agona–Elubo road.	4˚53’39.26”	2˚14’44.14”
NL5 – Nzema East Light Industrial Area	Noise level measurements was conducted at the western end of the Nzema East Light Industrial and Commercial Area.	4˚53’21.92”	2˚13’30.59”
NL6 – Akyinim Community	Noise Level measurement was undertaken at the northwestern side of Akyinim community, on the football field towards the project site.	4˚52’53.08”	2˚14’49.94”

	
NL1	**NL2**
	
NL3	**NL4**
	
NL5	**NL6**

Figure 5.25: Evidence of Ambient Noise Level Monitoring

Table 5.12: Environmental Noise Levels Recorded over 24-Hour Period

Location ID	Time	Noise Level in dB(A) Recorded						
		LA_{eq}	LA_{max}	LA_{min}	LA_{10}	LA_{50}	LA_{90}	LA_{95}
NL1	Day (6:00 – 22:00)	**43.9**	69.7	37.6	45.4	43.2	40.9	40.4
	Night (22:00 – 7:00)	**50.5**	77.4	39.7	52.9	49.1	45.3	43.7
NL2	Day (6:00 – 22:00)	**43.2**	71.9	31.7	43.8	39.2	36.6	35.3
	Night (22:00 – 7:00)	**55.1**	64.2	39.0	59.0	53.6	43.0	41.6
NL3	Day (6:00 – 22:00)	**39.4**	76.4	31.8	40.8	37.2	34.9	34.4
	Night (22:00 – 7:00)	**60.0**	75.8	37.8	64.4	54.3	50.8	45.9
NL4	Day (6:00 – 22:00)	**48.1**	77.5	30.8	50.8	43.5	36.8	35.3
	Night (22:00 – 7:00)	**52.0**	67.1	41.9	54.7	51.6	47.5	46.5
NL5	Day (6:00 – 22:00)	**47.8**	75.3	33.5	49.5	43.8	39.8	38.8
	Night (22:00 – 7:00)	**57.0**	93.1	43.0	59.7	55.1	50.1	49.3
Ghana Standard (GS 1222:2018)	Day (6:00 – 22:00)	**70**	-	-	-	-	-	-
	Night (22:00 – 7:00)	**60**	-	-	-	-	-	-

Sources of Noise at the project site

1. Noise resulting from tidal waves at the south end boundary
2. Shrieking of birds at the surrounding vegetation and on the project site
3. Operations of a chain-saw machine close to the project site
4. Chirping of crickets and other insects in the night causing higher noise recordings
5. Vehicular movement on the Agona–Elubo road close to the north-end boundary
6. Infrequent vehicular and motor bicycle movement at the project site

Sources of Noise at Akyinim and Nzema East Light Industrial and Commercial Area

1. Noise generated by some kids playing close to the sampling point
2. Noise from an ambulance plying the old Axim–Ankobra road
3. Noise generated by the tidal waves at Akyinim
4. Infrequent vehicular movement and tricycles on the old Axim–Ankobra road
5. Noise from the operations of a sawmill at the light Industrial and commercial area
6. Vehicular and tricycle movement within the Nzema East Light Industrial and commercial area
7. Vehicular movement on the Agona–Elubo road
8. Noise from activities of a chop bar within the Nzema East Light Industrial and commercial area
9. Shrieking of birds from the surrounding vegetations
10. Chirping of crickets and other insects in the night
11. Croaking of frogs at the wetlands at Akyinim

5.2 Socio-Economic Baseline

5.2.1 Establishment of the Municipal Assembly

The Nzema East Municipal Assembly was established by L I 1917 on 25th January 2008. It was formerly known as Nzema East District Assembly until it was split into two districts namely Nzema East Municipal Assembly and Ellembelle District Assembly.

5.2.2 Geographical Location

The Nzema East Municipality is one of the Seventeen (17) administrative authorities in the Western Region of Ghana. It is located on the Southern end of the region between longitude $2^0$05" and $2^0$35" West and latitude $4^0$40 and $5^0$20 North. The municipality is bounded on the West by Ellembelle District, North by Wassa Amenfi West District, East by Tarkwa-Nsuaem Municipality Prestea Huni Valley and Ahanta West and on the South by the Gulf of Guinea with about 9km stretch of sandy beaches.

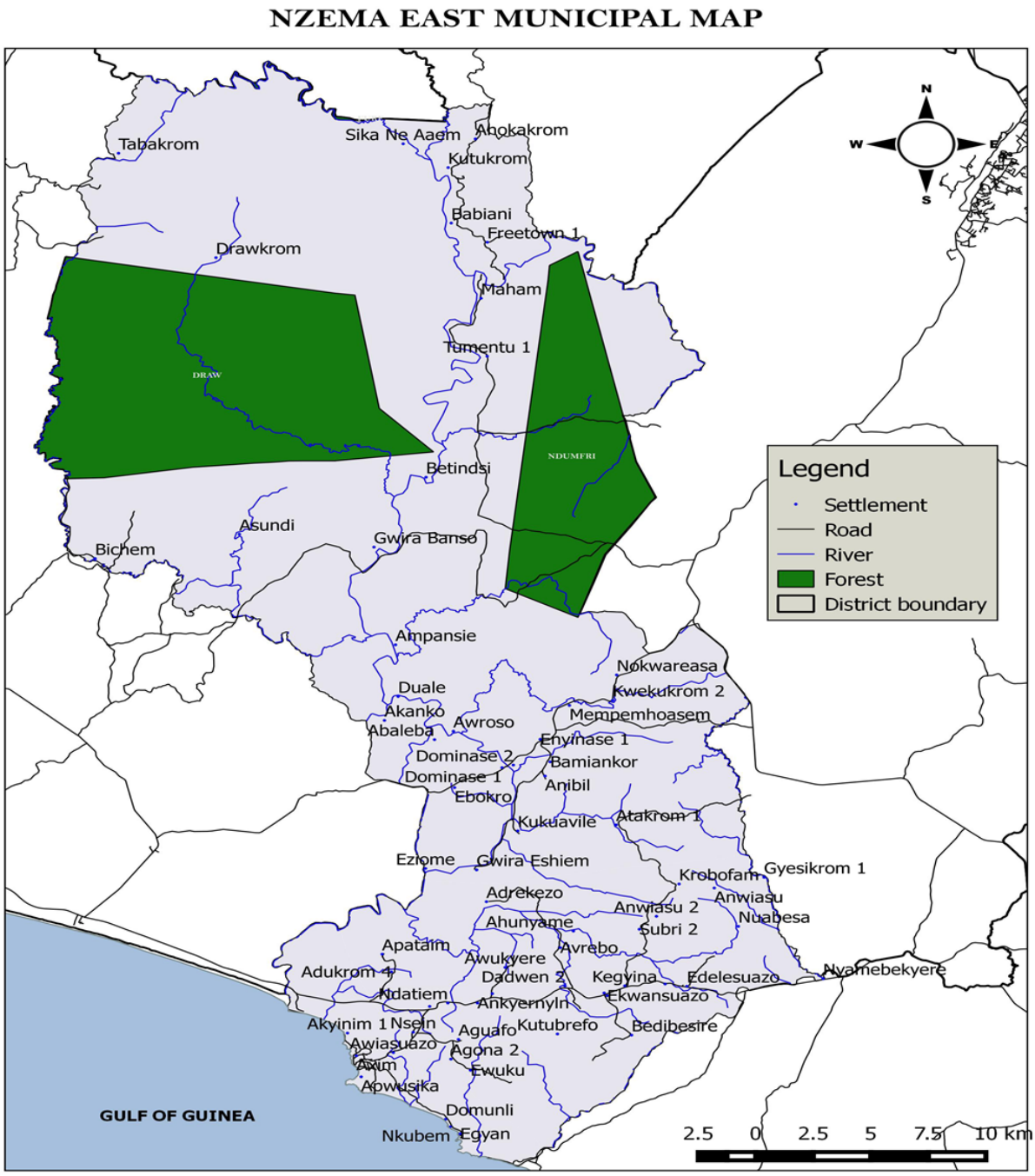


Figure 5.26: Map of NEMA
Source: Ghana Statistical Service (2014)

5.2.3 Spatial Distribution and Population

The Nzema East Municipality covers a total land area of 2,194 sq km. Its population as at 2010 stood at 60,828 and is currently (2021) estimated to be approximately 90,000; about 80,933 as at September 2020. The population of the Municipality constitutes less than five percent of the Western Region's population and has a slightly female dominant population of 50.8 percent (GSS, 2014).

There are about 120 communities in the area. The major communities are Axim, the municipal capital, Nsein, Gwira, Banso and Bamiankor. All the communities are grouped under three main urban and zonal councils; Axim, Nsein and Bamiankor. The Biamamkor area has the largest geographical area in the municipality, covering more than two thirds of the entire space of the municipality. The project affected communities currently identified i.e Ayisakrom, Brawire, Adukrom, Brawire and Apatiam all located within the Axim and Nsein zones. Among the projects affected communities, only Apatiam has a significant population size which is recognized as part of the first 20 largest communities, ranked 16th, in the area.

5.2.4 Agriculture and Economic Activities

It is estimated that over 65% of the economically active population are engaged in agriculture (including fishing) and agro-processing. Cassava is the major food crop produced by the farmers in the area. Though there are quite a number of farmers associations in the communities as well as vast arable lands for cassava production. It is gathered that the Cassava value chain has not been fully exploited in the area. Cocoa is a major cash crop produced in the area, with over 35,000 hectors of land currently used. Most parts of the land in the Municipality are undulating,

therefore very unsuitable for mechanized farming (use of tractors for land preparation). Shared cropping is the common land tenure system. There are acidic and low in nutrients due to high leaching. Leaching is the result of the high rainfall in the Municipality. The municipality boasts of a number of natural resources, commonest amongst them being Basalt, Gold, Gravel, Clay, and Rainforest Bamboo. NEMA is also a major fishing area with lots of activities and potential for fish farming and aquaculture development. Currently, there are over 650 canoes and 13 landing sites in the municipality and this makes it one of the busiest fishing areas in the entire country.

5.2.5 Mining and Natural Resources

Mining Large deposits of gold have been discovered at Ankyeryin and its surrounding areas and prospecting is ongoing. Adamus Resource Limited, a mining company, has been established at Salma in the Ellembelle District but some of their mining areas are in the Nzema East Municipality. It commenced commercial production in 2004 and contributes to the internally generated funds of the Assembly and also provides employment opportunity for the people

5.2.6 Education

The Municipality has a total of 244 educational facilities ranging from pre-school to SHS/TVET with a total student population of 23,740. The student population in the area is largely dominated by females (61.2%). There is no tertiary institution in the entire municipality, apart from a distance learning study center of the University of Cape Coast at the Nsein Senior High School.

5.2.7 Health

Nzema East Municipal Assembly (NEMA) has a Municipal Hospital, three functioning polyclinics and 16 CHPS compounds with a Medical staff strength of 99. Most of the CHIP compounds are located in the rural communities. There is also a functional National Health Insurance Office with an active membership of 35,585 and 18 credential facilities.

5.2.8 Peace and Security

The municipal is widely noted as a peaceful area. It has a divisional police command and a district police office as well as a fully established fire service department with an operational fire tender. The Municipality also host an office of the National Ambulance service complemented with other private ambulance operators.

5.2.9 Social Equity and Development

The Municipality is currently benefitting from social protection interventions such as the Livelihood Empowerment Against Poverty (LEAP) program with approximately 1400 beneficiary households. Also, there are 30 schools which are currently implementing the Ghana School Feeding Programme (GSFP) with a total of 9255 pupils comprising of 4700 boys and 4555 girls benefiting.

5.2.10 Road and Transport

The municipality has a total of 335km feeder roads and 34km urban roads. Other water resources such as the Ankobra river and the sea (Gulf of Guinea) also serve as a means of transportation for some communities through the use of automated boats. There are two major transport unions: Ghana Private Roads and Transport Union (GPRTU) and PROTOA with dotted stations across the municipality. Long buses, mini buses (Urvan, Mexcedes Benz Sprinters) and small taxis link the municipal capital directly to various towns and cities (Accra, Kumasi, Tarkwa, Takoradi, Elubo) on daily bases.

Figure 5.27: Boat installed on the Ankobra river

5.2.11 Tourism

Tourism is one of the major activities in the district. The municipal is the host to a number of tourist sites which attracts tourists from diverse parts of the country and the world. Notable among the tourist sites are the tomb and house of one of the historical fathers of Ghana, Alfred Paa Grant and the over five century old Castle Santo Antonio. There is also a Boboayisi Island. The beautiful Ankobra estuary and a 13 km sandy, coastline which has been identified as a potential for good leisure is also found in the Municipality.

5.2.12 Market and Inflation

Currently, there is no modern market in the entire Municipality. Markets are organized under sheds and other traditional structures. Weekly market activities are organized at Axim, Adukrom and Dominase.

5.2.13 Financial Inclusion

Banking facilities in the Municipality include Ghana Commercial Bank, Ahantaman Rural Bank, Lower Pra Rural Bank and Nzema Manle Rural Bank. Most of these banks are all located in the southern portions of the Municipality which, according to the municipal agriculture office (2020), further exacerbate the located inequalities and socio-economic disparities in the Municipality.

6.0 PUBLIC PARTICIPATION/STAKEHOLDER ENGAGEMENT

6.1 Stakeholder Consultations

6.1.1 Introduction to Concept of Stakeholder Consultations

Stakeholder consultation is a major component of every Environmental Impact Assessment (EIA) process. It strengthens the value of impact assessment and informs project planning and decision-making. Effective stakeholder consultation also helps in building trust and credibility, provides a platform for effective information management and also facilitates the development of positive, long-term relationships with the project proponent, its neighbors, and other stakeholders in the quest for sustainable project development and implementation.

6.1.2 Purpose of stakeholder Consultations

This report documents the stakeholder engagements which were conducted at the Ghana National Gas Company Bottling Plant project area in the Nzema East Municipality as part of the EIA process. The stakeholder engagement was conducted during the scoping phase of the EIA process. The scoping phase engagement began from March 1, 2020 and still has some few stakeholders who are yet to respond to the stakeholder team in terms registering their concerns and recommendations. Depending on the outcome and resultant decisions from the scoping phase engagement the team will have a clearer view on possible further engagements or not. The consultation process was guided by the EPA's Environmental Assessment Regulations 1999, (L.I. 1652), which specifically state in Section 12 that an EIA on a proposed undertaking must deal with matters including, *"Consultation with members of the public likely to be affected by the operation of the undertaking."*

6.1.3 Objectives

The general objective of the consultations was to share detailed project information with stakeholders and solicit their views, inputs and concerns regarding the Project. It was also to inform stakeholders, including the communities, key institutions and interest holders in the project area, about the project's potential impacts and to recommend mitigation measures. The consultations also sought to encourage the active involvement of the stakeholders in the EIA process as well as the project. Specific objectives of the consultations were, therefore, to:

a) Provide adequate and accessible information to stakeholders to enable them to:
    i. Understand the context of the EIA process.
    ii. Be informed and educated on the Project and its potential impacts.
    iii. Identify issues of concern, comment on alternatives and make suggestions for improved benefits.

b) Provide opportunities for stakeholders to comment and provide input (local knowledge and experience) to be documented for consideration as part of the EIA process.

c) Build community understanding and support for the EIA process and the Project in general and,

d) Factor stakeholders' comments and views into project planning and decision making.

6.1.4 Consultation values

The consultation approach was guided by the core values of the International Association of Public Participation (IAP2) which are built on the following tenets.

i. Public participation promotes sustainable decisions by recognising and communicating the needs and interests of all participants, including decision-makers.
ii. The public should have a say in decisions about actions that could affect their lives
iii. Developing the understanding that the public's contribution may influence decisions
iv. Pursuing and facilitating the involvement of those potentially affected by or interested in a decision.
v. Providing feedback to the public with the information they need to engage in a meaningful way; and
vi. Providing feedback to the public on how their inputs affect a decision

6.1.5 Regulatory framework

GNGC operations are based on the principles of environmental sustainability. In addition to GNGC own Principles and Environmental and Social Safeguard Standards, the stakeholder engagement process was executed in compliance with the national legislation and regulations related to public consultation as outlined in the following subsections.

Environmental Protection Agency Act, 1994 (Act 490)

The Environmental Protection Agency Act, 1994 (Act 490), amongst other aspects, established the EPA and provided for the powers and functions of the EPA. A key function of the EPA is to oversee EIAs in Ghana.

Environmental Assessment Regulations, 1999 (LI 1652)

LI 1652 regulates listed undertakings by requiring that the EPA must register any such undertaking(s) and that the Agency must issue an environmental permit for that undertaking to continue. The following Stakeholder Engagement Plan (SEP) considerations per the above requirements were followed:

i. Section 5 (1) emphasises the importance of the stakeholder in the decision-making process:[1]
ii. "*The Agency shall on receipt of an application and any other relevant information required, as an initial assessment, screen the application taking into consideration (c) the concerns of the public, if any, and in particular concerns of immediate residents, if any*".

iii. Section 12 indicates that an EIA for an undertaking must deal with matters including, "Consultation with members of the public likely to be affected by the operation of the undertaking".

iv. Section 15 (1), which emphasises the public involvement in the review of an environmental impact statement (EIS).

6.2 Consultation Processes

This stakeholder engagement has been conducted as part of the GNGC EIA project, specifically, the scoping phase. The consultation processes involved meetings with key stakeholders and institutions. Key considerations for the selection of stakeholders included those who were likely to be affected by the project, who had influence over it, or who had an interest in the project.

The opinions and influence of these stakeholders could affect the outcomes of the project. GNGC recognizes that consulting with these stakeholders from the outset is essential to secure their buy-in and ensure that stakeholders have a sense of ownership of the project.

6.2.1 Stakeholder Identification

Stakeholder identification for the scoping phases was based on proximity to the project area, interest in the project, influence on and/or being affected by the project activities. The main stakeholder groups were selected from the following clusters:

i. Groups in the communities within the concession (six communities)
    a) Traditional authorities.
    b) Farmers and land owners
    c) Local communities which are likely to be directly affected by the project.

ii. Local government authorities (District Assemblies and Coordinating Directorates).

iii. Regional government authorities

iv. Other government institutions which may be involved or have direct interest (EPA, Ghana National Fire Service, Ghana Atomic Energy, etc.)

v. Neighbouring private related businesses

vi. Transport unions and local contractors

6.2.2 Approach and Methodology

The approach and methodology applied to this study were influenced by the need to ensure broader stakeholder participation, reliability and validity of issues gathered. GNGC has a commitment to engage stakeholders in decision-making processes, improve communication, share information and obtain views and feedback to enhance the process. The participation of GNGC technical staff afforded a mutual exchange of information and immediate communication feedback between the project proponent, the consultant and stakeholders. It also provided GNGC with some valuable insights into understanding the perceptions, concerns, and interests of stakeholders. The consultations with the various groups of stakeholders helped to:

i. Explain the proposed project.

ii. Provide the alternatives being considered.

iii. Highlight commitments to key guiding principles; and

iv. Respond to stakeholder questions and issues, where appropriate.

The methodology employed for the scoping engagements included the following:

i. The Project was introduced to stakeholders in the form of oral presentations, charts and other electronic media depending on the nature and characteristics of the stakeholder group.

ii. After every presentation, stakeholders were given the opportunity to comment, provide suggestions and raise any concerns or issues regarding the Project. All comments, suggestions, concerns, and issues raised were documented and compiled into a Comment and Response Report.

iii. Some of the engagements were in the form of face-to-face key informant, group interviews and Focus Group Discussions (FGDs) whiles others were done through self-administered instrumentation.

iv. Focus group meetings were undertaken to enable as many stakeholders as possible to participate in the meetings; and

v. The meetings were conducted in Twi and/or English and were documented (photos, completion of attendance registers and note-taking).

vi. Meetings were held at venues easily accessible and convenient to stakeholders.

vii. Small group meetings were conducted in the local languages to ensure stakeholders felt comfortable during the consultation processes.

6.3 Consultation Activities

6.3.1 Technical Consultations with Regulatory Authorities

Technical consultations were also held with government agencies, including the EPA, Ghana National Fire Service, Nzema East Municipal Assembly, Ghana Highways Authority. Some other stakeholders like the Ghana Atomic Energy, The Ghana Energy Commission and the Petroleum Commissions were written to by way of provision of project information and a request made for their expert view and concerns since the covid-19 situation called for them to minimize one on one meetings. However, the project consultants are yet to receive their comments and recommendations for consideration. Details of the other issues raised in the engagements are presented in the comments and response register and a summary of the outcomes is provided in Table 6.3

6.3.2 Community Engagements

The scoping phase stakeholder engagement began from March 1st, 2020. A total of 25 meetings and 120 participants were organized. These included key community leadership bodies such as traditional authorities, farmers, landowners, assembly members, committee members, youth representatives as well as people/businesses in close proximity to the project site.

Table 6.1 shows the list of the stakeholders engaged.

6.3.3 Publication of Scoping Notice

A scoping notice was published in the May 11th 2021 published edition of the Daily Graphic Newspaper. See Appendix 6 for the Published Scoping Notice.

Table 6.1: List of Details of Stakeholders Engaged

Date	Stakeholder Group	Venue/Mode of Consultation	Nº. of Participants
12/09/2020	Traditional Priests and Priestesses of Axim	Axim Traditional Palace	5
	Chiefs and Elders of Axim	Palace of the Chief	11
09/03/2020	Traditional leaders from Lower Axim Traditional Councils	Palace of the Chief	6
9/03/2020	Traditional leaders from Upper Axim Traditional Councils	Palace of the Chief	5
9/03/2020	Jomoro Traditional Council	Councils' Palace	10
9/03/2020	Nzema East Municipal Assembly	Municipal Coordinating Council Hall	5
9/03/2020	Nsein Traditional Council	Palace of the Chief	7
10/03/2020	Ayisakro Community	Community center	About 100
10/03/2020	Adukrom Community	Community shed	About 100
10/03/2020	Apataim Community	Community Shed	About 100
11/03/2020	Ankobra Community	Community Shed	About 100
11/03/2020	Akyinim Community	Community Shed	About 100
11/03/2020	Brawire Community	Community Center	About 100
12/03/2020	MPH Construction Firm	Work Camp	4
12/03/2020	China Harbour Engineering Construction Limited	Work Camp	4
7/10/2020	Member of Parliament of Gwira Evalue	MP's Office	2
02/02/2021	Forestry Commission-NEMA	FC Municipal Office, NEMA	1
02/02/2021	Management of Ankobra Beach Resort	Resort reception	2
02/02/2021	Management of Ghana National Fire Service, NEMA-Axim	Municipal Office, GNFS-NEMA	1
02/02/2021	Ghana Private Road Transport Union (GPRTU)- Drivers Association	GPRTU station (Under Shed), Esiama	8
03/02/2021	Leadership of Poultry farmers Association	Ishmael Poultry Farm-Esiama	1
03/02/2021	Electricity Company of Ghana-Esiama	ECG-Esiama office	1
03/02/2021	NEMA Municipal Chief Executive and Coordinating Council	Office of the Municipal Coordinating Director, NEMA	3
25/03/2021	Energy Commission, Head Office	Via letter	N/A

Engagement with Affected Farmers

Engagement with Traditional leaders

Engagement with Ayisakrom Community

Engagement with Lower Axim Traditional Council

Engagement with Bawire Community

Engagement with Adukrom Community

Engagement with Apatam Community

Engagement with Nsein Traditional Council

Figure 6.1: Evidence of consultation meetings

See Appendix 6 for Evidences of Stakeholder Consultations and the Scoping Notice.

6.4 Outcome of the Consultations

The issues and concerns raised during the various meetings were noted and are included in the attached Comments and Response Report.

The key issues were grouped into the following themes and the details are presented in the next sections.

a. Accident and Explosion Management
b. Employment
c. Livelihood and Compensations
d. Safety and Security
e. Environmental Impact
f. Road Usage and Infrastructure
g. Environmental Pollution
h. General Issues

Table 6.2: Criteria for ranking of issues identified

Criteria	Reasons
Regulatory	Require their express opinion and meet institutional standards.
Financial interests	Will the stakeholder make or lose money because of the project?
Moral and ethical values	Does the stakeholder believe the project deserves social acceptance?
Rights	What legal rights such as occupational health & safety may be affecting the stakeholder's opinion?
Political opinions	Could political opinions be triggering support or opposition to the project?
Business interests	Does the stakeholder expect the project to boost or shrink business revenue?
Knowledge	How knowledgeable is the stakeholder about the project? Support is often directly proportional to knowledge.
Demographics/improved livelihoods	Things like age, median income and access to employment opportunities can greatly affect opinions
Environmental stewardship/ safety	Is the project's environmental footprint bringing certain stakeholders on-board or driving them to oppose it? Is it environmentally friendly?
Value of ownership	Does the stakeholder stand to gain or lose something of value such as their farm or quiet neighborhood?

6.4.1 Identification of Key Stakeholder Issues

The following key issues were identified from the stakeholder engagement.

6.4.1.1 Livelihood and Compensation

The following issues and concerns were raised about lands and livelihoods:

a.Stakeholders expressed fear of losing their livelihoods since they would no longer have the opportunity to use their lands for agriculture purposes.

b.Stakeholders suggested that GNGC gives prior information ahead of crop compensation.

c.Participants from the communities were concerned about the negative impact the project will have on their livelihoods.

d.Traditional authorities employed GNGC to pay land compensation to lands acquired for the construction of the project

e.Expressed concerns about potential future land scarcity and entreated for a fair compensation.

6.4.1.2 Environmental Impact

Destruction of species of flora and fauna during the land clearing

a) Participants sought to understand if a full scale EIA will be conducted.
b) Concerns about the usage of the Highway, traffic issues and what will be done to mitigate impacts from heavy trucks

6.4.1.3 Employment

a) Stakeholders requested that people from their communities be employed in various capacities they qualify.
b) Community members expressed that GNGC should train locals and community members for job opportunities.

6.4.1.4 Safety, Accidents and Explosion Management

a) Members were upbeat about the likelihood of accidents and outbreaks from fire in the area.
b) Stakeholders inquired how outbreak of fire and other related issues will be managed.

6.4.1.5 General Social Issues

a) Some participants expressed that the needed permits and documentation should be obtained from the necessary authorities before the project starts.
b) Some stakeholders implored on GNGC to synchronize its CSR projects with the Assembly's Medium term development projects.
c) Community sensitization and awareness creation should be embarked upon.
d) Stakeholders admonished GNGC to implement community support programs in order to support the development of the areas they are situated.

6.5 Observations from Stakeholder Engagements

Among the concerns raised by stakeholders, most of the issues were linked to the employment, compensation and livelihoods, accident and fire explosion and local community development. It was gathered that most of the stakeholders, in raising their concerns, drew their experiences from previous similar projects around the area and from elsewhere. Stakeholders, however, were largely in support of the actualization of the new project.

6.5.1 Comments and Response Register

Details of issues and comments raised by stakeholders during the various meetings have been compiled into a Comments and Response Register. This report forms a record of the issues raised and details the responses of Ghana National Gas Company Limited (GNGC) on how their concerns will be addressed. Photos of some of the communities and groups engaged are provided. The stakeholder comments register is provided in Table 6.3.

Table 6.3: Stakeholder Comments Register

Name (Community/ Organisation/ Designation)	**Issues/Comments**	**Response**
The Municipal Coordinating Director (NEMA)	Pointed out that permits should be obtained from the assembly before the project starts.	Environmental impact assessment will be conducted in conjunction with the assembly before the commencement of the project. Necessary documentations like building permit, zoning status etc.. will be obtained from the Assembly before construction begins.
Mrs Dziddzorm NUKUNU (Assistant manager-Ankobra Beach)	What will be the mode of transportation for the trucks?	The mode of transportation will be by road. .
	Will they be using the beach road? If yes, what do you intend to do to improve the road since you will be plying on it	The beach road may not be used during the construction stage but if the need arises to use that access road, civil works will be carried out to better it and all safety and precautionary measures will be undertaken to prevent any negative environmental impact on possible receptors.
	What will you do to reduce the noise pollution and traffic your movement will create?	Environmental impact assessment will be conducted and all identified impacts will be mitigated such as regularly servicing of trucks, possible traffic impact assessment to be carried out in order to engineer a better mitigation action.
	The various impacts of the project need to be properly mitigated	Environmental impact assessment will be conducted and all identified impacts will be mitigated.
The Municipal Coordinating Director (NEMA)	GNGCL should synchronize its CSR projects with the Assembly's Medium term development projects.	Ghana Gas Company will regularly engage the Assembly and therefore will be abreast with issues and areas that needs to be prioritized for the company's CSR
	The plant should have its own fire station with modern fire appliance (tender)	This will be considered by management.
	The assembly should be the first to be informed in the temporary and permanent job offers that the project will generate so that we can make some search.	GNGCL's CSR projects are implemented after thorough needs assessments and prioritization of felt needs. All stakeholders, including the assembly will be engaged depending on the nature of the issues.

Name (Community/ Organisation/ Designation)	Issues/Comments	Response
Peter Kojo Quayson (Divisional Officer-Ghana National Fire Service -Axim)	The LPG bottling plant will create employment	Yes, projects of this nature create employment opportunities.
	There could be explosion and related injuries and Death	Environmental impact assessment will be conducted and all identified impacts will be mitigated. The bottling plant will have its own firefighting station,the highest safety precautionary measures will be employed at the operations of the LPG Plant
	Educating the communities on the risk associated with the project	Hired staff will be inducted on safety before start of work at the Plant and visitors will also be taken through safety induction before assessing facilities at the plant.
	The location should not be close to the town	The site of the Bottling plant is amply away from human settlement
	Involve Ghana national fire service from the beginning	The GNFS will be integrated into the operations of the of the plant, through periodic trainings and assessments.
	The company should be safety conscious	The Company will have a safety department that will take care of safety aspect of the operations of the Plant.
	Built permanent fire station with modern fire appliance (TENDER)	Firefighting tenders will be available at site. The bottling plant will have its own firefighting station to ensure community and company safety.
	Deployment of service personnel on standby duties and construction of fire hydrant in the plant	GNGCL will work with the GNFS in ensuring fire safety at the plant.
Hon. Catherine Afeku (MP)	The project will offer employment opportunities for the youth and help reduce the unemployment rate in the area.	GNGCL will ensure qualified local content is satisfied in the hiring of personnel

Name (Community/ Organisation/ Designation)	Issues/Comments	Response
Farmers Association (Rep 1)	Our crops are our livelihoods. GNGCL should ensure that those of us affected are adequately compensated.	Fair and adequate compensation would be paid to all affected farmers.
Farmers Association (Rep 1)	What is the procedure for the compensation of the lands being taken from the farmers?	lands valuation division of the lands commission would be in charge of all land issues and would be in the community to explain issues to the project affected persons.
Frank Kpoka (Municipal Chief Executive-NEMA)	Re-echoed the opportunities that the project brings and pleaded with members of the municipality to support the project.	
	Precautionary measures should strictly be adhered to	Environmental impact assessment will be conducted and all identified impacts will be mitigated.
	Our indigenous people should be prioritized during employment to help bridge the unemployment gap among our youths, especially those with the unskilled labour	Qualified skilled community members will be considered for employment alongside laborers and clerical workers.
	The municipal requires a lot of support or help in the areas of health and education so that the company's corporate social responsibility should be directed to this focus area. Usually, companies do not consult the beneficiaries of the CSR.	GNGCL's CSR projects are implemented after thorough needs assessments and prioritization of felt needs. All stakeholders, including the assembly will be engaged depending on the nature of the issues.
Clement Kwakye (Range Manager-Forestry Commission , Axim)	Possible endangered species of flora might be destroyed during the land clearing.	Environmental impact assessment will be conducted, and all identified impacts will be mitigated using appropriate ecological solutions .

Name (Community/ Organisation/ Designation)	**Issues/Comments**	**Response**
Municipal Planning Officer (NEMA)	Traffic assessment needs to be done before such a project is executed. Ghana Gas company must help improve Akyire to Ankobrah road which could be a traffic relief measure.	Environmental impact assessment will be conducted and all identified impacts will be mitigated. Anticipated traffic impact will be mitigated with possible creation of alternative access roads to help ease the main Elubo road of heavy traffic.
	Soil micro-organism and the ecosystem will be disrupted	Environmental impact assessment is being conducted and all identified impacts will be mitigated.
	The forestry service needs to be consulted before lands are cleared of the site fall within the forest resource	The ecological studies findings will be shared with the forestry unit to aid the forestry in its conservational programs.
Raymond Quayson (Drivers-Association-Member)	Cost of Gas is exorbitant	The price of gas is regulated by the National Petroleum Authority.
	There should be skills and capacity building for the youth in the area to afford better employment opportunities	GNGCL will consider such programs .
	In the past, we were consulted on similar projects, our concerns recorded but we never got feedback.	All inputs and concerns will be reported for the needed action to be taken.
Joseph Eduku (Drivers-Association-Member)	The community leadership have failed us in the past because the chiefs were given some employment protocols and other contracts but they failed to consider some of us. There should be open and transparency in employment processes	Hiring of personnel as a way of meeting local content or inclusion will be conducted based on merit.

Name (Community/ Organisation/ Designation)	Issues/Comments	Response
Raymond Quason	The project will help improve the socio-economic conditions in the area	And the region as well.
Traditional authorities	Expressed their appreciation for siting the Plant at Axim because of its numerous employment and development opportunities for surrounding communities. Pleaded with Ghana Gas to support them with the completion of an operation theatre at their hospital and a car for the traditional council through their Corporate Social Responsibility activities.	Assured of GNGCs CSR projects after thorough needs assessments and prioritization of felt needs.
Ishmael Ismeal Farms (0504320658)	There would be noise and air pollution during the project construction and as a result of vehicular movement	Environmental impact assessment is being conducted and all identified impacts will be mitigated.
Mr. Annan (ECG Manager-Esiama)	The gridlines on the main Elubo road might be impacted especially when high truck carrying materials or equipment to the site. The truck heights needs to be checked to avoid contact with the lines.	Constructional and operational Health and safety and protocols will strictly be adhered to, to avoid damages caused to any state properties . The ECG may be consulted further if the need be.
	The bottling plants needs to be discussed with the ECG so that an appropriate energy/ power provision will be considered	The ECG Will be contracted on possible energy request.
Energy Commission	A letter was written to request for guidelines on how to construct and operate the LPG Bottling plant.	The Energy Commission replied providing guidelines indicating that consultations with necessary stakeholders must be done and proper mitigation against fire and explosion must be provided

7.0 IMPACT IDENTIFICATION AND PREDICTION

This chapter provides details of the potential environmental and socio-economic impacts that were identified and would require further assessment and analysis during the Impact Assessment study. It constitutes the potential positive and negative impacts of the proposed project throughout its entire life cycle.

An impact is considered as "any change to the physical, biological or social environment, whether adverse or beneficial, wholly or partially resulting from the project activities, facilities, products or services".

Evaluation of Impacts

In evaluating the degree of potential impacts, the following factors have been taken into consideration:

- Impact Severity: The severity of an impact is a function of a range of considerations including the following:

- impact magnitude;
- impact duration;
- impact extent;
- legal and guideline compliance; and,
- characteristics of the receptor/ resource that is affected.

- Likelihood of Occurrence:

How likely is the impact to occur?

- Severity Criteria for Environmental Impacts

In evaluating the severity of potential environmental impacts, the following factors have been taken into consideration:

· Receptor/ Resource Characteristics: The nature, importance and sensitivity to change of the receptors or resources that could be affected;

· Impact Magnitude: The magnitude of the change that is induced;

· Impact Duration: The time period over which the impact is expected to last;

· Impact Extent: The geographical extent of the induced change; and

· Regulations, Standards & Guidelines: The status of the impact in relation to regulations (eg. discharge limits), standards (eg. environmental quality criteria) and guidelines.

Impact severity has been categorised using the following subjective scale:

· Slight;

· Low;

· Medium; and

· High.

Likelihood of Occurrence

The likelihood (probability) of the pre-identified events occurring has been ascribed using the following qualitative scale of probability categories (in increasing order of likelihood):

A. Extremely unlikely (eg never heard of in the industry);

B. Unlikely (eg heard of in the industry but considered unlikely);

C. Low likelihood (eg such incidents/impacts have occurred but are uncommon);

D. Medium likelihood (eg such incidents/impacts occur several times per year within the industry); and

E. High likelihood (eg such incidents/impacts occurs several times per year at each location where such works are undertaken).

Likelihood is estimated on the basis of experience and/ or evidence that such an outcome has previously occurred. Impacts resulting from routine/planned events (i.e., normal operations) are classified under category (E).

Impact Matrix

Table 7.1: Impact Significance

	Impact Likelihood				
Impact Severity	Extremely Unlikely	Unlikely	Low Likelihood	Medium Likelihood	High Likelihood
Slight	Negligible Impact	Negligible Impact	Negligible Impact	Negligible Impact	Negligible Impact
Low	Negligible Impact	Negligible Impact	Negligible Impact	Negligible to Low Impact	Low Impact
Medium	Negligible Impact	Negligible Impact	Low Impact	Lowto Medium Impact	Medium Impact
High	Negligible to Low Impact	Low Impact	Medium Impact	High Impact	High to Unacceptable Impact

Significance Criteria

Significance criteria for negative/adverse impacts (i.e., relative ranking of importance) are defined in *Table 7.2.* It is important to note that impacts are considered without the implementation of mitigation measures. The need for and appropriate method of mitigation would be determined on the basis of the impact assessment.

Table 7.2 Significance criteria

Significance	Definition
Positive Impact	An impact that is considered to represent an improvement on the baseline or introduces a new desirable factor
Negligible Impact	Non-detectable change
Low Impact	Detectable but not significant
Medium Impact	Significant; amenable to mitigation; should be mitigated where practicable
High Impact	Significant; amenable to mitigation; require the adoption of management or mitigation

7.1 Pre-Development Phase Impacts

Pre-development activities include site visits for feasibility studies, surveying and land acquisition procedures. Other activities would include architectural planning, cost estimation, award of construction contracts, purchase of building materials etc. The likely impacts envisaged to occur include:

- Socio-Economic Impacts
- Occupational Health and Safety Issues
- Land litigation and compensation Issues

7.1.1 Socio-Economic Impacts

The pre-development phase will directly generate employment and business opportunities for architects, land surveyors, research consultants, geological engineers, etc.

The takeover of the land for the project will lead to the immediate loss of livelihood of 45 farmers whose farms will be affected by the project.

This impact can be classified as medium with medium likelihood of occurrence.

7.1.2 Occupational Health and Safety Issues

Pre-development activities such as site visits, geological studies have potential to pose occupational hazards to persons involved. Some of these occupational hazards include bruises, sores, and minor fractures that can be incurred from pre-development activities involving mounting survey equipment, walking through the bush, etc.

This impact can be classified as low with medium likelihood of occurrence.

7.1.3 Land Litigation and Compensation Issues

Land litigation can arise if the management of GNGC fails to identify the landowners for appropriate land acquisition procedures. Inability to use the appropriate channels and procedures to acquire the land can leave some custodians of the land dissatisfied and cause them to take entrenched positions to indulge in protracted litigation with the company. This can lead to delays and stall the development plans for the project.

This impact can be classified as a low to medium impact with medium likelihood of occurrence.

7.2 Construction Phase Impacts

This would involve shoring, dewatering, drilling, excavation, digging, backfilling, concrete works, structural formations & fabrications, surface leveling, and haulage of items such as sand, stone, wood. There will be a high dependence on heavy-duty equipment and manual methods for the performance of these activities. The heavy-duty equipment includes compaction rollers, tipper trucks and concrete mixers. Manual methods will include digging of trenches with pickaxes and shovels, and haulage of items with wheelbarrows. Carpentry works such as nailing, fixing of roofs and doors will also be performed during the construction phase. There will also be electrical engineering works such as installation of electrical cables; transformers, lighting, air conditioners, fire alarms, etc. The impacts associated will include:

- Solid waste generation and Associated Work Camp Impacts
- Liquid Waste Generation and Associated Work Camp Impacts
- Impact on ecosystem
- Impact on Air Quality
- Generation of Noise and Vibration
- Occupational Health and Safety Hazards
- Public Health and Safety Issues and Associated Work Camp Impacts
- Impacts on Land Form and Visual Scenery
- Traffic Impact
- Erosion Impacts
- Transfer of Industrial Knowledge and Technology
- Generation of Employment and Business Opportunities

7.2.1 Solid Waste Generation and Associated work camp impacts

Construction is associated with the generation of solid wastes in forms such as excavated earth, concrete debris, scrap metals, wooden pallets, rubbers, cardboards, shredded HDPE pipes, broken glass, plastics, rugs, etc. A construction camp will be set up within the site to serve as a base for storing materials and fabrication works, thus the presence of humans and the work activities will lead to the generation of solid wastes such as food leftovers, worn-out clothing, etc. There will also be generation of office-like wastes such as waste papers after usage by construction project managers during documentations on site.

This impact can classified as high in nature with a medium likelihood of occurrence.

7.2.2 Liquid Waste Generation and associated work camp impacts

Civil works will result in the release of watery construction residues. This impact will be limited to the project site and its immediate periphery. Humans at the construction site will also require to urinate and rinse/wash clothing thereby contributing to the generation of liquid wastes. This impact can be classified as a low to medium impact with a medium likelihood of occurrence.

7.2.3 Impacts on Ecosystem

Site clearance and subsequent conversion of undeveloped land into an LPG Bottling Plant facility with predominantly built-up areas will lead to the loss and reduction of biodiversity species of flora and fauna. Flora that will be affected include Imperata cylindrical (Spear grass) association, Cocos nucifera, Cyperus articulatus, Ipomoea pes-caprae, Opuntia vulgaris,

Paspalum vaginatum, Phoenix reclinata, Sporobolus virginicus, Thespesia populnea, and Triumfetta rhomboidea.

Fauna species that will be affected include Heliosciurus sp (Sun squirrel), *Hybomys trivirgatus* (Temminck's striped mouse,), *Fukomys zechi* (Ghana mole-rat,), *Thryonomys swinderianus* (Greater cane rat). Amphibians and Lizards on the project site will greatly reduce in number.

This impact will be have a high significance and high likelihood of occurrence.

7.2.4 Impact on Ambient Air Quality

Activities anticipated to occur during the construction phase include shoring, dewatering, drilling, excavation, digging, backfilling, concrete works, structural formations & fabrications, surface leveling, haulage of items such as sand, stone, wood to the project site, etc. The afore-mentioned activities will lead to the generation and re-suspension of particulate matter in the atmosphere within the project area.

The use of heavy-duty construction equipment such as bulldozers, drilling rigs, excavators, trucks, etc. will result in the release of noxious gases such as sulphur dioxide, carbon monoxide and nitrogen dioxide. The construction staff and people living/working in very close proximity to the project site will be the predominant group exposed to the gaseous emissions.

Site clearing will result in immediate removal of most flora species that serve as carbon sinks thus the construction phase can contribute to the steady increase in green house gases like Carbon Dioxide (CO_2). The absence of flora to absorb CO_2 for its photosynthetic activities will lead to the abundance of the gas in the atmosphere.

This impact will be medium in severity and have high likelihood of occurring.

7.2.5 Generation of Noise and Vibration

Noise will be generated from operation of heavy-duty equipment such as excavators, concrete-batching vehicles, tipper trucks, and other activities like hammering and metalwork. The revving of engines of construction equipment, vibration of pneumatic tools, electric motors, etc. will also contribute to the generation of noise. Workers and nearby neighbours will be most prone to noise generated on the site. This impact will have medium significance with medium likelihood of occurrence.

7.2.6 Occupational Health and Safety Hazards

The work process will lead to the construction staff being exposed to varied forms of hazards such inhalation of dust; exposure to high levels of noise; and construction related injuries such fall from heights, cuts and bruises. The use of machinery also poses safety risks to the workers since there can be accidents. This impact is medium impact with a likelihood of occurrence.

7.2.7 Public Health and Safety Issues

The movement of project materials and heavy-duty equipment to the site through the nearby settlements will create unusual traffic and pose safety risks to the public in the event of an accident. Some of the skilled labour force to be contracted for the project will also have to migrate from their homes and live in places that are in close proximity to the project site. Naturally, people have needs for association and sexual relationships and in such an instance when they migrate from their homes for a long period would require to satisfy such needs at their

new base thus creating an opportunity for transmission of communicable diseases such as STDs, Hepatitis B, COVID-19 etc. between the migrated project workers and community members.

This impact can be classified as a medium impact with a medium likelihood of occurrence.

7.2.8 Impact on Landform and Visual Scenery

Potential landscape disfigurement as a result of cuts and fills and the modification of the original soil conditions due to compaction by construction machinery and vehicles is possible.

Existing topography of the area will be altered during the construction activities. Hence,change of topography of the site during construction of the proposed LPG storage and bottling plant will occur. The clearing of the already existing vegetation and associated earthworks will alter the aesthetic quality the project site. The green nature of the site will be replaced with scenes of cleared bare land, parked construction equipment, heaped sand and dust suspension.

This impact will have a medium impact of occurrence with high likelihood of occurrence.

7.2.9 Traffic Impacts

The construction phase will require the frequent movement of vehicles to and from the site to deliver project building materials, construction equipment and personnel. There will be increased traffic due to the increased use of the road for such purposes. Increased traffic has potential to trigger traffic irregularities by other road users. Irregularities such as inappropriate parking, overtaking and use of fringes of the road can cause accidents and loss of lives. The frequent use of the road by construction vehicles can derail the quality nature of the road.

This impact can be classified as a low to medium impact.

7.2.10 Erosion and Drainage Impacts

Construction will require removal of vegetation which will expose the soil to wind and rain action that can wash away the topsoil and deposit it into natural drainage pathways located around the site and cause silting. The water runoff from the construction site during heavy rainfall in monsoon months may cause some increase in the quantity of suspended solids and turbidity in the runoff in natural drains and surface waters. However, there will be no significant impact on groundwater of the area during the construction phase.

This impact can be classified a medium impact with a medium likelihood of occurrence.

7.2.11 Transfer of Industrial Knowledge and Technology

The project developers will use the best international industry standards in the delivery of project goals, thus the local engineers and artisans to be recruited will gain exposure to excellent work ethic, procedures and new technology.

This impact can be classified as a positive impact with a high likelihood of occurring.

7.2.12 Generation of Employment and Business Opportunities

The construction will generate direct employment for local artisans such as carpenters, masons, welders, foremen and security personnel. The construction will create employment for approximately seventy (70) people. There will also be business opportunities for suppliers of construction material. There will be an increased patronage of items sold by vendors. The heavy-duty construction equipment will also require regular servicing and replacement of parts thus

will generate business opportunities for those in the automobile sales and service industries. The access to jobs and businesses will boost economic empowerment of beneficiaries.

An increase in economic activity will generate revenue for government via Value Added Tax (VAT), With-Holding Tax (WHT), Pay-As-You-Earn (PAYE), etc.

This impact can be classified as a positive impact with a high likelihood of occurring.

7.2.13 Generation of Waste Oil

There is potential for release of waste oil from heavy duty equipment and field vehicles being used on the site. Heavy duty equipment fueling can also be a source of waste oil on the site.

This impact can be classified as low to medium impact.

7.3 Operational Phase Impacts

The anticipated impacts include:

- Generation of Employment, Business Opportunities and Tax Revenues
- Increased Demand for Utility Supply
- Dust and Gaseous emissions
- Noise Generation
- Solid Waste generation
- Liquid waste Generation
- Sanitation and hygiene impacts
- Waste Oil Generation
- Occupational Health and Safety Hazards
- Public Health and Safety Issues
- Hazardous Chemical Spills
- Traffic Impacts
- Potential Water Pollution
- Fire & Explosion Hazards

7.3.1 Generation of Employment and Revenue

The project is expected to create two hundred (200) direct job opportunities for local persons. This will provide income for these persons and their families who are dependent on them. The operation of the facility will also boost income of logistics , vehicle maintenance and accommodation service providers in the project area. This impact will lead to the generation of tax for government. This impact can be classified as a positive impact with high occurrence.

7.3.2 Increased Demand for Utility Supply

The project will require approximately 14000 kWh of electricity per annum and 2,500 m^3 of water per annum. Thus will directly have an impact on the energy and water demand in the project area. This impact can be classified as low impact in terms of severity and low likelihood.

7.3.3 Dust and Gaseous Emissions

The sources and types of emissions are as follows:

- VOC Emissions from offloading and bottling operations
- Noxious gas emissions from the bottling line
- Dust (TSP, $PM_{2.5}$ and PM_{10}) and exhaust gases (SO_2 and NO_2) from the use of generators and diesel powered trucks
- Air-blown dust from movement of vehicles around the site.
- Green House Gases from use of air-conditioning units for the offices

This impact can be classified a medium impact in terms of severity with high likelihood of occurrence.

7.3.4 Noise Generation

The operation of the the trucks, conveyors and bottling machinery will lead to the generation of noise. The machines are fitted with motors and engines which rev and make roaring noises when being operated at high capacities. This impact can be classified as a low impact with a low likelihood of occurrence.

7.3.5 Solid Waste Generation

The anticipated solid wastes envisaged includes packaging material, metal scraps, wooden pallets during maintenance works, office wastes and worn-out clothing. It is estimated that approximately 400 kg of solid waste will be generated per annum.

This impact can be classified as one of medium likelihood with a medium severity.

7.3.6 Wastewater Generation

Liquid wastes will be of three (3) in nature, namely:

- Effluent from cylinder washing purposes
- Greywater from the washroom sinks, showers and sinks.
- Blackwater from the washroom toilet facilities.

This impact can be classified as one of medium likelihood with a medium severity.

7.3.7 Waste Oil Generation

The potential sources of waste oil are:

- Leakages and spills from the diesel trucks and forklifts.
- Spills from forklift and other equipment servicing
- Spills during fueling of the generators

This impact can be classified as one of medium likelihood with a medium severity.

7.3.8 Hygiene and Sanitation Impacts

It is important to always keep the workplace tidy to avoid unhygienic and unsanitary conditions such as growing of mould, yeast and fungi in certain places of the facility such as the washroom and gutters. The presence of mould, yeast and fungi can pose health risks to staff and visitors.

This impact can be classified as one of medium likelihood with a medium severity.

7.3.9 Hazardous Chemical Spills

Hazardous chemicals are chemicals with their properties either been reactive, flammable, radioactive, corrosive and/or toxic. Hazardous chemicals will be generated wastes that may be generated include used lead-acid batteries; aerosol cans; excess paints, thinners, solvents; used oil, medical wastes from first aid activities.

During bottling, the is possibility of LPG leakage and waste oil spills from the Diesel Generator and equipment servicing. Used lubricant spillages into the soil can cause ecological impacts to land and plants within the project area. Human exposure to spillages can pose health hazards.

This impact can be classified as one of medium likelihood with a medium severity.

7.3.10 Traffic Impact

This refers to potential vehicular traffics and road user challenges that can emanate from transporting LPG and empty cylinders from source to the bottling plant and also filled LPC cylinders from bottling plant to customers.

There will be increased use of the road for such purposes. Increased use of the road has potential to trigger traffic irregularities by other road users. Irregularities such as inappropriate parking, overtaking and use of fringes of the road can cause accidents and loss of lives. The frequent use of the road by BRVs and bullet trucks can derail the quality nature of the road.

This impact can be classified as one of medium likelihood with a medium severity.

7.3.11 Water Pollution

The water bodies identified in the project vicinity include the Gulf of Guinea (sea), Nzuble and the Ankobra which are all beyond a 600m radius from the site. It is therefore expected that storm water run-off from the site will pass through drainage networks and finally shed its sediment load in the sea, grasses and shrubs around the sites. With the product (LPG) involved, there will therefore be no possibility of surface water pollution.

Waste oil spills (from Diesel generator and equipment servicing) to the ground can however negatively impact the quality of groundwater.

This impact can be classified as one of medium likelihood with a medium severity.

7.3.12 Public Health and Safety Risks

Persons located close to the project will be exposed to a myriad of impacts such as noise, gaseous emissions, traffic jams and at worst incidences of fire and explosion. LPG leakages can create respiratory issues for the immediate person working and living within the site.

This impact can be classified as one of medium likelihood with a medium severity.

7.3.13 Occupational Health and Safety Hazards

A hazard is any substance or circumstance which is likely to cause injury or damage due to its inherent properties (explosive, flammable, poisonous, corrosive, oxidizing, or otherwise harmful). The main hazards associated with the storage and handling of LPG (flammable liquids) are fire and explosion, involving either the liquid or the vapour given off from it. Fires and explosions occur when vapour or liquid released meets an ignition source.

Common causes of such incidents include,

1. Inadequate design and installation of equipment;
2. Inadequate inspection and maintenance;
3. Failure or malfunction of equipment;
4. Lack of awareness of the properties of flammable liquids;
5. Operator error, due to lack of training;
6. Exposure to heat from a nearby fire;
7. Inadequate control of ignition sources;
8. Electrostatic discharges;
9. Heating materials above their auto-ignition temperature;

10. Dismantling or disposing of equipment containing flammable liquids;
11. Hot work on or close to flammable liquid vessels

Examples of occupational hazards that can affect workers include heat stress, burns, scalds, severe injuries from accidents, irritability from exposure to noise, fatigue, etc.

This impact can be classified as one of high likelihood with a medium severity.

7.3.14 Fire, Potential Pressure Build-Up and Explosion Hazards

A project with its main raw material being LPG should have adequate fire management systems including prevention, management and fighting equipment put in place. The refined LPG product is highly inflammable; this makes fire one of the main impacts. Potential pressure build up of the gas can cause explosion and rupture of the tank system, thus proper venting systems and tank designs must be adopted to store the LPG at appropriate pressure to avoid explosion. Adequate mitigation measures must be put in place.

The presence of fuel and electrical cables poses a fire and explosion risk. The fuel tanks and electrical cable installations must be arranged in a manner that ensures they are at reasonable distances from each other.

7.3.14.1 Fire and Explosion Risk Modeling

7.3.14.1.1 Objective of the study

The main objective of the risk assessment study is to identify major risks of the project and to evaluate off-site consequences of identified hazard scenarios.

The specific objectives of this study are as follows:

- Identifying the potential failure scenarios for release of flammable/ toxic material in the LPG storage and bottling installation.
- Carrying out consequence analysis for significant accident scenarios.
- Estimating the off-site risk due to the project.

7.3.14.1.2 Guidelines and Software

The consequence analysis for the modeled scenarios has been performed using DNV‟s software PHAST (Process Hazard Analysis Software Tool) Version 8.22 which allows assessment of situations which present potential hazards to life, property and the environment, and to quantify their severity. PHAST examines the progress of a potential incident from the initial release to dispersion including modeling of pool spreading and evaporation, and flammable and toxic effects.

Phast is a comprehensive hazard analysis tool applicable to all stages of design and operation across a wide range of process industries. Its theory and performance have been independently reviewed as part of the European Commission (EC) funded project – Scientific Model Evaluation of Dense Gas Dispersion Models (SMEDIS), and it has excelled in both areas.

PHAST modeling calculates distances effect produced by hazardous events. PHAST is integrated into safety and meets regulatory requirements. It uses unified dispersion modeling to calculate the results of the release of material into atmosphere. The salient features of this package:

1. It gives the consequence results in terms of – Flammable, Toxic and Explosion effects.

- Flammable parameters covered under this package is- Defines the LEL and UEL zone.
- Jet fire and pool fire scenario along with their respective effect zones (risk contour).
- Flash fire and fire ball envelope

2. Toxic parameters-

- Cloud concentration at user defined time as well as location
- Categorize the toxic results in terms of ERPG, IDLH and STEL values.
- Summarize results in terms of equivalent toxic dose along with effect zones.

3. Explosion parameters-

- Categorize the explosion effects in terms of over-pressure levels along with distance covered.
- BLEVE (Boiling Liquid Expanding Vapor Explosion)

7.3.14.1.3 Methodology

The following steps are involved in quantitative risk assessment (QRA):

- Identification of the hazards.
- Selection of potential loss or failure scenarios.
- Simulation of release source model on DNV‟s PHAST, Version 8.2
- Estimation of the consequence of failure events
- Plotting the consequence contour on site map

The methodological flow diagram of QRA is shown in Figure 7.1

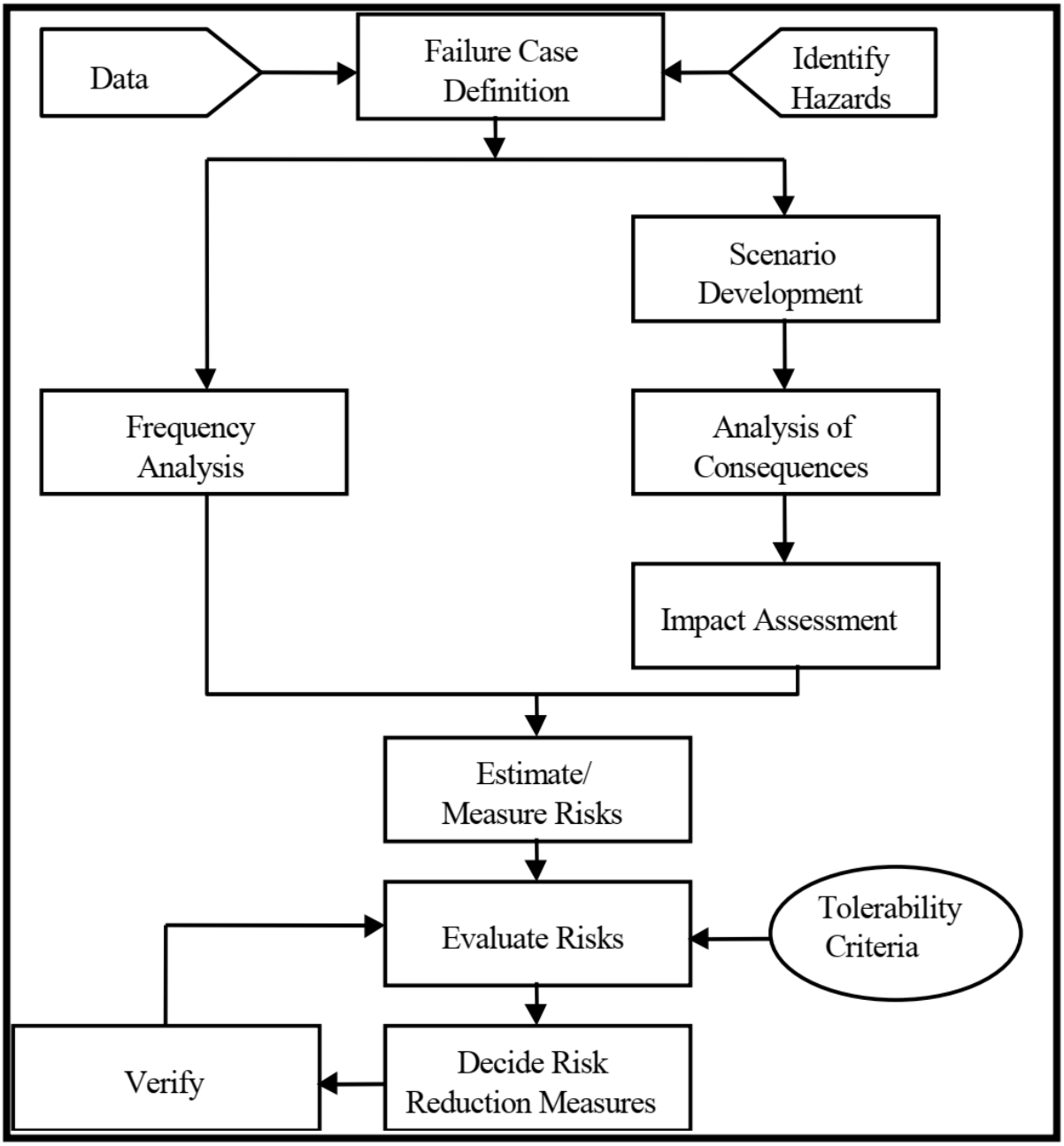


Figure 7.1: methodological flow diagram of QRA

7.3.14.1.4 Consequence Analysis

Consequence analysis for the selected failure scenarios is carried out using DNV Phast 8.22 software. Consequence analysis provides results for the following:

- Dispersion of toxic clouds to define concentrations
- Heat radiation intensity due to jet fire and pool fire
- Explosion overpressure

Quantitative Risk Analysis

The quantitative risk analysis is carried out using the renowned software package PHAST Risk (SAFETI). The following input data are required for the risk calculation

- Process data for release scenarios (material, inventory, pressure, temperature, type of release, leak size, location, etc.)
- Estimated frequency of each failure case
- Distribution of people in the plant/ adjoining area
- Distribution of wind speed and direction (climatic data)
- Ignition sources

The failure frequencies for different types of equipment are estimated using generic failure rate database published by organization such as International Oil & Gas Producers Association (OGP Report No. 434-1 “Process Release Frequencies” for equipment & piping).

For objective and comprehensive risk analysis, a whole range of leak sizes is considered in each section containing large inventory of hazardous material

- Small leak (5 mm diameter)
- Medium leak (25 mm diameter)
- Large leak (100 mm diameter)
- Catastrophic rupture.

Extract of generic failure rates for equipment/items relevant to this study is shown in Table 7.3

Table 7.3: Generic Failure Rates for Equipment

Equipment Item	**Leak size**		
	5 mm	**25mm**	**100mm**
2” Pipe	1.80E-05	7.00E-06	0
2” Flange	7.60E-06	4.00E-06	0
Pressure Vessel	2.00E-04	1.00E-04	5.10E-04

The results of quantitative risk analysis are commonly represented by the following parameters:

- Individual Risk
- Societal Risk

This study is focused on the Societal Risk. Societal risk parameter considers the number of people who might be affected by hazardous incidents.

Societal risk criteria indicate reduced tolerance to events involving multiple fatalities. For example, a hazard may have an acceptable level of risk for one fatality, but may be at an unacceptable level for 10 fatalities.

Risk Assessment

Based on the results of QRA, necessary measures may be implemented to reduce the risk to ALARP. For this purpose, Phast Risk software provides the information regarding risk contribution from each leak scenario modelled.

Quantitative Risk Analysis

The failure scenarios and relevant input data for the QRA of the project are shown in Table 7.4.

Table 7.4: Failure scenarios and relevant input data

No.	Description	Material/ Phase	Temp. (^{0}C)	Pressure (kg/cm^{2}g)	Leak Size (mm)	Leak Frequency (per year)
LPG Storage Bullets (Tanks)						
1	LPG Storage Sphere	LPG Liquid	30	7.11	5	3.0E-04
					25	8.0E-05
					100	3.0E-04
2	LPG Mounded Bullet Liquid Pipeline	LPG Liquid	30	15	5	3.0E-04
					25	1.0E-04
					100	3.0E-05
3	LPG Tanker Loading Bay	LPG Liquid	30	9.11	5	5.0E-05
					25	1.5E-05

Population Data

From the map and site visit, there are no living household or developments within a 5km radius of the project site. The population of people within a 5km at any time is less than 5 persons. The boundaries of the project are secondary forest.

Ignition Sources

Ignition sources are strictly controlled in the LPG bottling plant area. All electrical equipment and fittings are flame-proof type. In case of gas leakage, ignition of the gas will result in damage due to fire or explosion. The electrical and instrument items will conform to electrical hazardous area classification. Flame-proof electrical items will be installed in the classified areas and these will not be ignition source. Vehicles inside the plant are provided with spark arrestors in the exhaust.

No vehicle is allowed inside the premises without approved spark arrestor in the engine exhaust.

The ignition source considered in the risk analysis is the substation.

Weather parameters

Weather parameters play a significant role in dispersion analysis. The notable parameters for assessing the atmosphere are wind speed, atmospheric stability, ambient temperature, humidity and topographic parameters.

Atmospheric stability represents the vertical turbulence in the air due to temperature differentials caused by heating of the earth by solar radiation. Atmospheric stability effects are represented through Pasquill parameters as follows shown in Table 7.5.

Table 7.5: Pasquil parameters

Stability Class	Atmospheric Condition
A	Very Unstable
B	Unstable
C	Slight Unstable
D	Neutral
E	Stable
F	Very Stable

The relationship between wind speed and atmospheric stability is shown in Table 7.6

Table 7.6: Relationship between wind speed and atmospheric stability

Wind speed (m/s)	Day time: Solar Radiation			Night Time Cloud Cover		
	Strong	Medium	Slight	Thin	Medium	Overcast
<2	A	A-B	B	-	-	D
2-3	A-B	B	C	E	F	D
3-5	B	B-C	C	D	E	D
5-6	C	C-D	D	D	D	D
>6	C	D	D	D	D	D

Category D (neutral) is the most probable at sites in moderate climates and may occur for up to 80% of the time. Weather data (monthly average maximum & minimum temperature and rainfall) were provided in the climate data chapter.

The representative weather parameters for the site considered in this study are >6D.

Hazardous Properties of LPG

The flammable consequences of LPG release from equipment are mainly the following:

- Jet fire/ pool fire/ flash fire
- Vapor cloud explosion

The properties of LPG relevant to this QRA study are:

Composition:	Mixture of Propane and Butane
Normal Boiling Point:	(-)6^{0}C
Lower Flammable Limit (LFL):	1.8% (vol)
Upper Flammable Limit (UFL):	9.5 % (vol)
Auto ignition temperature:	410–580 ^{0}C (approx.)

LPG is stored as liquid under pressure. LPG vapours are heavier than air and disperse close to ground level. LPG odorized with ethyl mercaptan is received in the plant so as to provide warning in case of leakage.

Consequence Analysis for Jet/Pool Fire Radiation

- Jet/ Pool Fire Radiation

The effect from jet fire and pool fire is thermal radiation intensity on the receptor surface as shown in Table 7.7

Table 7.7 Damage Effect due to Jet/ Pool Fire Radiation

Heat Radiation Intensity (kW/m^2)	Observed Effect
4	Sufficient to cause pain to personnel if unable to reach cover within 20s; 0% lethality
12.5	Minimum energy required for piloted ignition of wood, melting of plastic tubing
37.5	Sufficient to cause damage to process equipment

- **Vapour Cloud Explosion (CVE)**

When a large quantity of flammable vapour or gas is released, it mixes with air to produce sufficient mass in the flammable range and is ignited, the result is a vapour cloud explosion. In the LPG plant, large release of LPG from equipment or piping has potential for vapour cloud explosion. The damage effect of vapour cloud explosion due to overpressure is show in Table 7.8.

Table 7.8: Damage effect of vapour cloud explosion due to overpressure

Over-pressure Effect (bar)	**Observed Damage**
0.021 (0.3 psig)	Safe distance (probability 0.95 of no serious damage below this value); projectile limit; some damage to house ceiling; 10% of window glass broken.
0.069 (1 psig)	Repairable damage; partial demolition of houses; steel frame of clad building slightly distorted.
0.138 (2 psig)	Partial collapse of walls of houses
0.207 (3 psig)	Heavy machines in industrial buildings suffered little damage; steel frame building distorted and pulled away from foundations.

Result of Consequence Analysis for LPG Supply Pipeline Rupture

The rupture scenario is considered for the LPG Bullet Supply Line located above the ground. It is expected that the rupture of the transfer line will result in LPG gas release and dissipate into the atmosphere. In the event of an immediate ignition, a jet fire will occur. The heat intensity, or thermal radiation flux, is expected to be highest at the centre of the jet fire. The heat radiation decreases with distance from the centre, depending on wind speed and atmospheric stability.

Table 7.9: Scenario for LPG Bullet Supply Line Rupture

Scenario Description	**Consequence Effect**	**Radiation Effect @ 7.8/D**		**Overpressure**
Full Bore Rupture of LPG Bullet Line	Jet Fire Explosion	4.0 kW/m^2	40.6m	0.02068 bar
		12.5 kW/m^2	29.9m	0.1379 bar
		37.5 kW/m^2	23.2	0.2068 bar

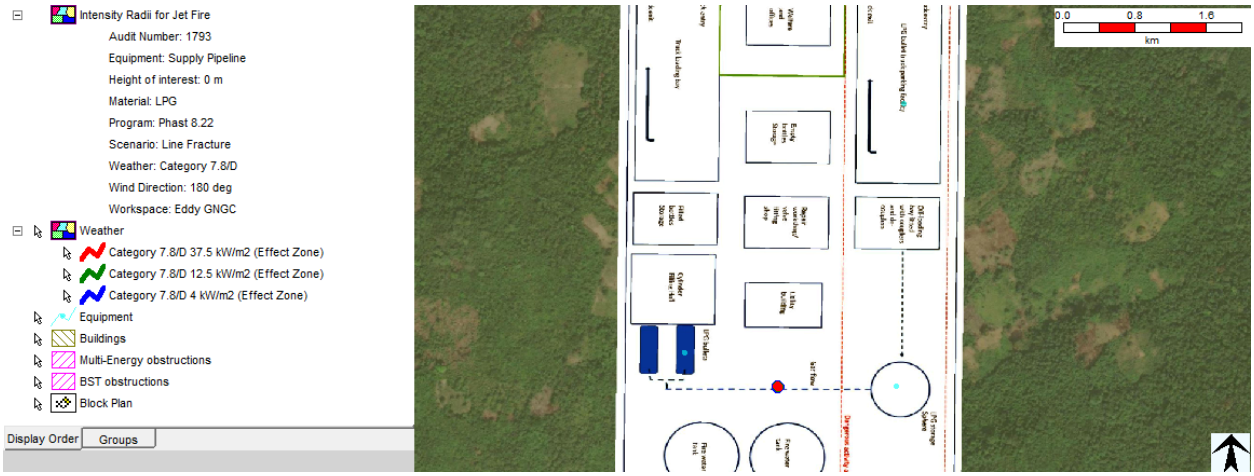


Figure 7.2: Image of Jet Fire Intensity Result

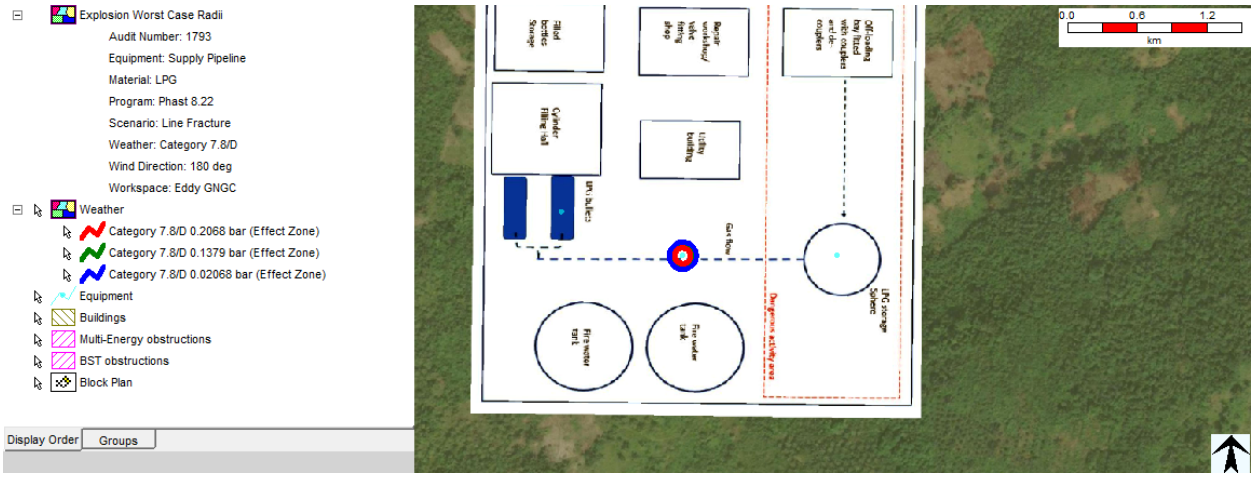


Figure 7.3: Image of Explosion Result

Consequence of Analysis for *LPG Storage Sphere Leak (600MT)*

A variety of leak scenarios are considered and modelled for the LPG Storage Sphere. LPG leaks of sizes 5mm (small leak), 25mm (medium leak), 100mm (large leak) scenarios and catastrophic rupture of the 600Mt storage sphere. It is expected that the LPG gas release from leaks will be dissipate into the atmosphere and ignite forming a jet fire. Medium leaks, large leaks and catastrophic rupture will result in pool fire and explosion.

Table 7.10: Jet Fire Results of Modeled Scenarios

Scenario	Flame Length (m)	Radiation Intensity		
		4.0 kW/m^2	12.5 kW/m^2	37.5 kW/m^2
5mm Leak	6.1	13.2	9.8	7.7
25mm Leak	24.6	57.4	42.2	32.8
100mm Leak	80.6	191.2	141.5	110.0

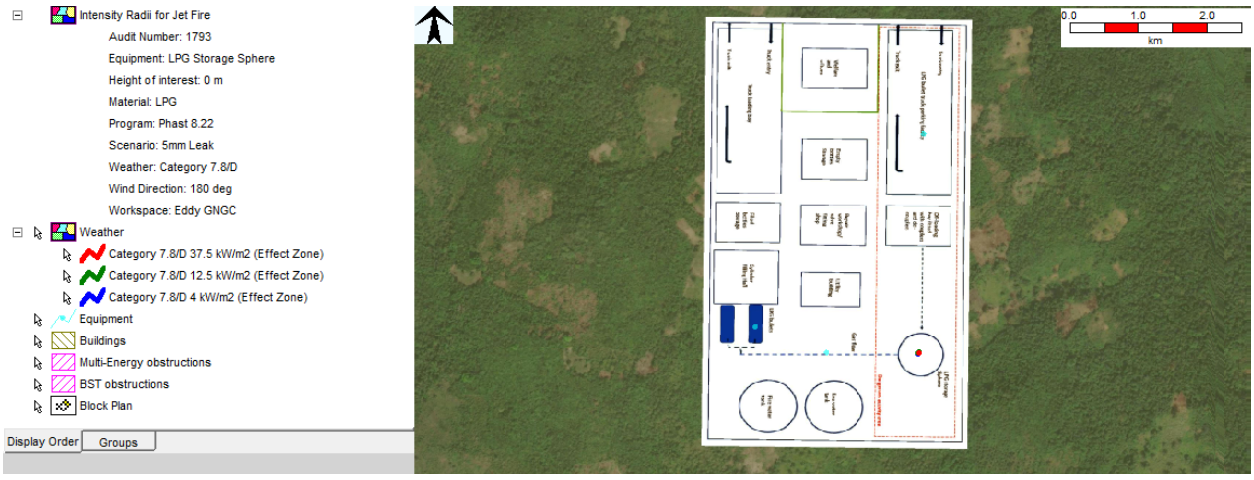


Figure 7.4:Image of 5mm Leak Jet Fire Intensity Result

Figure 7.5:Image of 25mm Leak Jet Fire Intensity Result

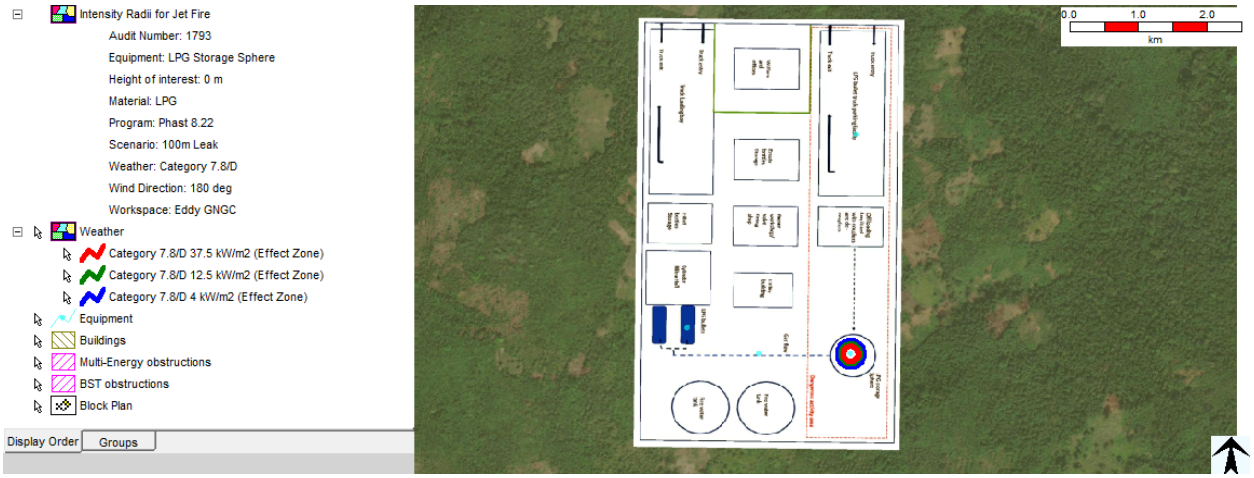


Figure 7.6:Image of 100mm Leak Jet Fire Intensity Result

Table 7.11: Explosion Results of Modeled Leak Scenarios

Scenario	Overpressure Level (bar)	Maximum Distance (m)	Diameter (m)
25mm Leak	0.02068	191.5	182.9
	0.1379	117.8	35.6
	0.2068	113.3	26.7
100mm Leak	0.02068	848.7	857.4
	0.1379	503.3	166.7
	0.2068	482.5	124.9

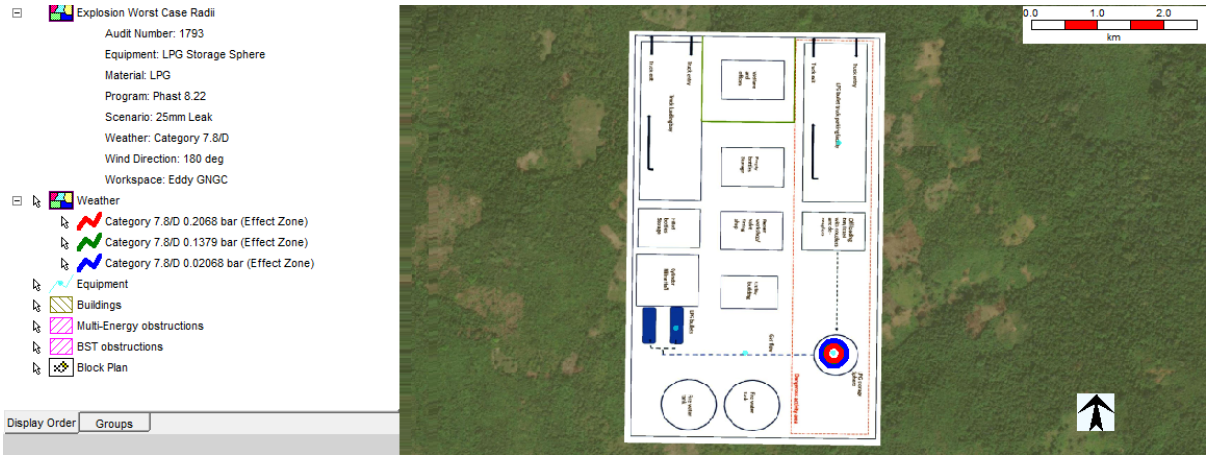


Figure 7.7:Image of 25mm Leak Explosion Result

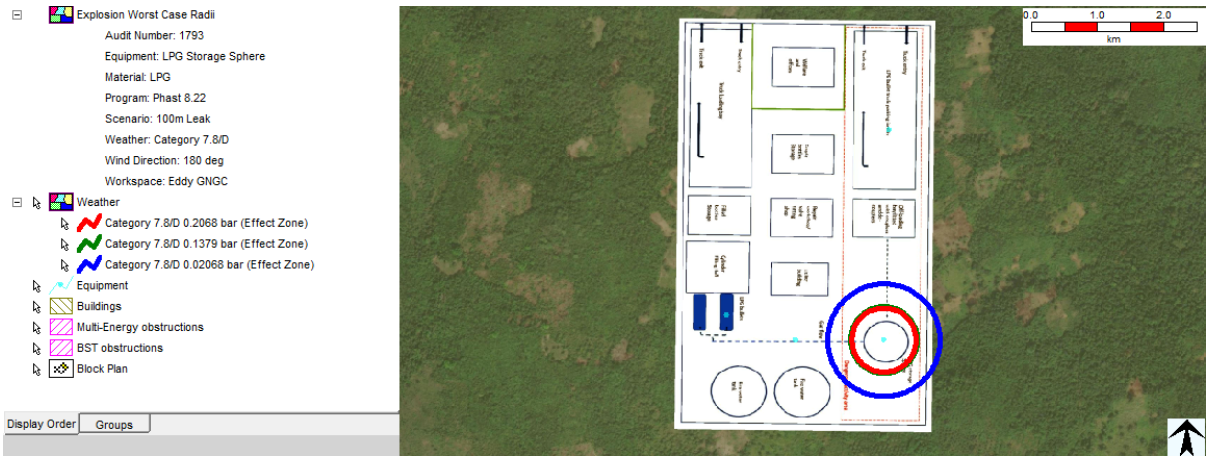


Figure 7.8:Image of 100mm Leak Explosion Result

Consequence of Analysis for Catastrophic Rupture of 600 MT LPG Bullets

In the event of catastrophic rupture of 600 MT LPG bullets, Various outcomes may occur including late pool fire, fireball and explosion. The consequence analysis under stability class 7.8D.

Table 7.12: Result of Catastrophic Rupture of LPG Storage Sphere

Scenario Description	**Consequence Effect**	**Radiation Effect @** 7.8/D (m)		**Overpressure** (bar)
Catastrophic Rupture of Storage Sphere (600MT)	Late Pool Fire	4.0 kW/m^2	667.3	n/a
		12.5 kW/m^2	442.8	n/a
		37.5 kW/m^2	281.3	n/a
	Fireball (Diameter: 489.2m)	4.0 kW/m^2	1465.5	n/a
		12.5 kW/m^2	876.1	n/a
		37.5 kW/m^2	511.5	n/a
	Explosion	4.0 kW/m^2	3529.0	0.2068
		12.5 kW/m^2	1626.2	0.1379
		37.5 kW/m^2	1564.59	0.2068

Figure 7.9:Explosion Worst Case Radii

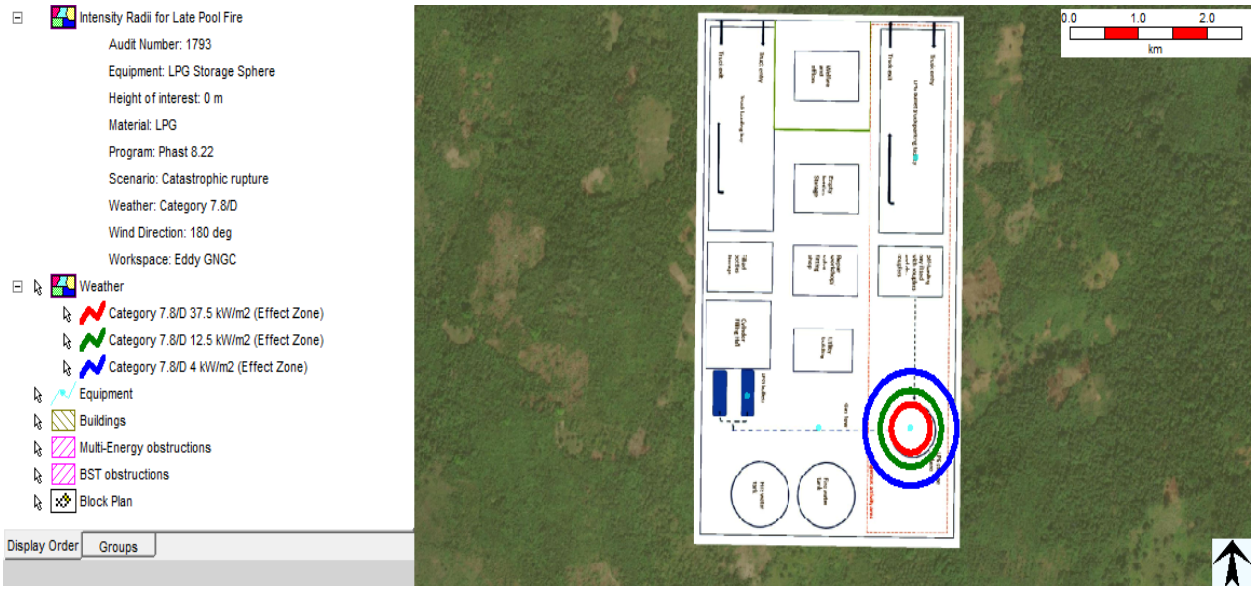


Figure 7.10:Intensity Radii For Late Pool Fire

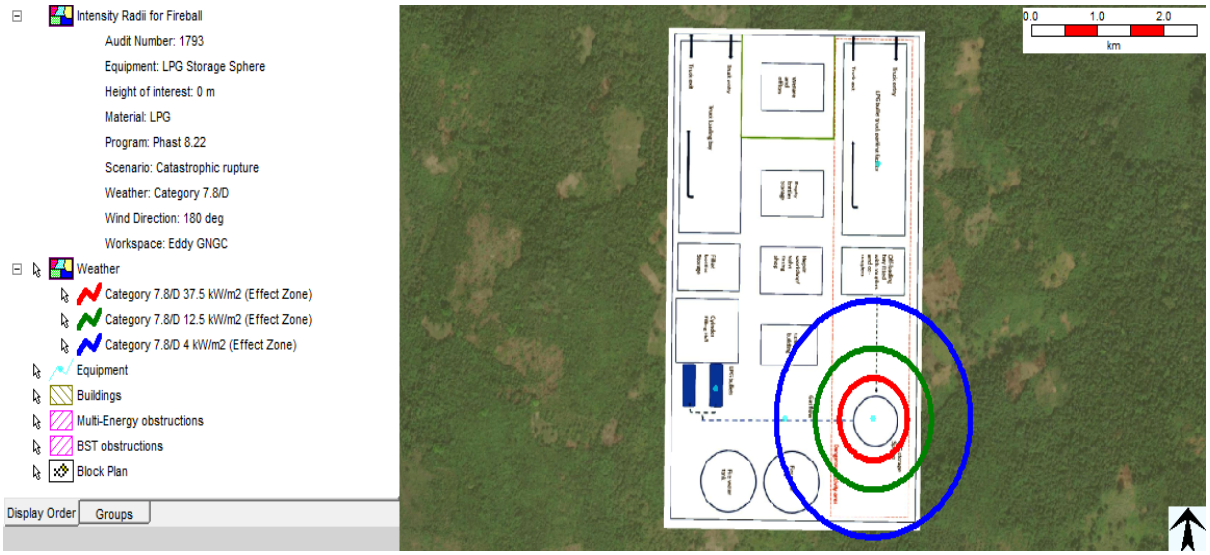


Figure 7.11:Intensity Radii for Fireball

Consequence of Analysis for LPG Filling Sphere Leak

A variety of leak scenarios are considered and modelled for the LPG Storage Sphere. LPG leaks of sizes 5mm (small leak), 25mm (medium leak), 100mm (large leak) scenarios and catastrophic rupture of the 100Mt storage sphere. It is expected that the LPG gas release from leaks will be dissipate into the atmosphere and ignite forming a jet fire. Medium leaks, large leaks and catastrophic rupture will result in pool fire and explosion.

Table 7.13: Jet Fire Results of Modelled Scenarios

Scenario	**Flame Length (m)**	**Radiation Intensity**		
		4.0 kW/m^2	12.5 kW/m^2	37.5 kW/m^2
5mm Leak	6.1	13.2	9.8	7.7
25mm Leak	24.6	57.4	42.2	32.8
100mm Leak	80.6	191.2	141.5	110.0

Figure 7.12: Image of 5mm Leak Jet Fire Intensity Result

Figure 7.13:Image of 25mm Leak Jet Fire Intensity Result

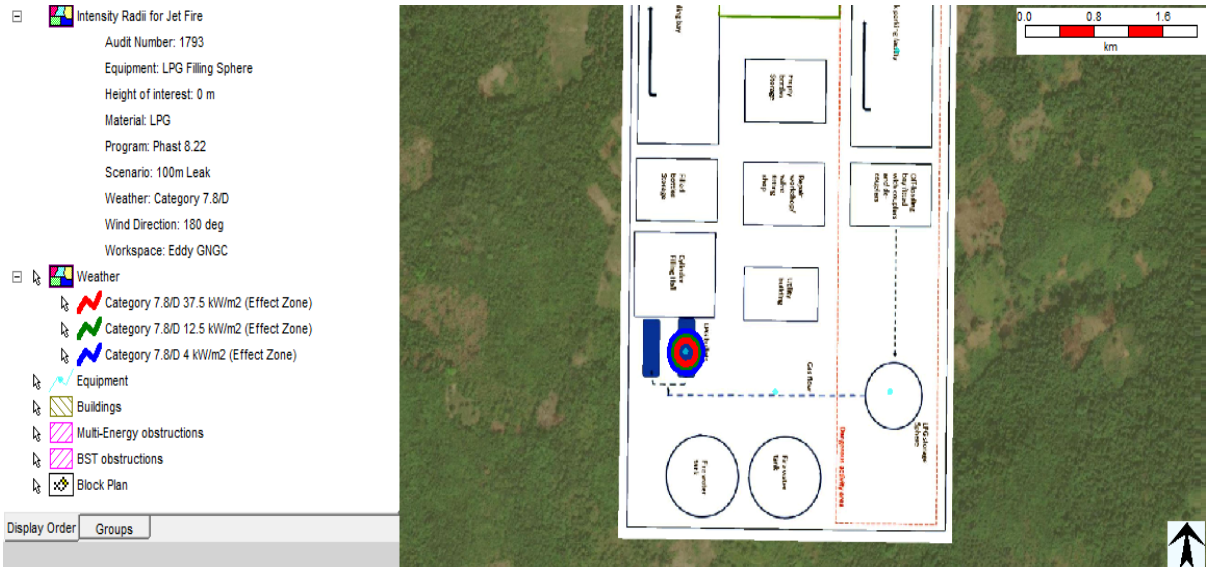


Figure 7.14:Image of 100mm Leak Jet Fire Intensity Result

Table 7.14: Explosion Results of Modelled Leak Scenarios

Scenario	Overpressure Level (bar)	Maximum Distance (m)	Diameter (m)
25mm Leak	0.02068	191.5	182.9
	0.1379	117.8	35.6
	0.2068	113.3	26.7
100mm Leak	0.02068	848.7	857.4
	0.1379	503.3	166.7
	0.2068	482.5	124.9

Figure 7.15: Image of 25mm Leak Explosion Result

Figure 7.16: Image of 100mm Leak Explosion Result

Catastrophic Rupture OF 100 MT LPG Bullets

In the event of catastrophic rupture of 100 MT LPG bullets, Various outcomes may occur including late pool fire, fireball and explosion. The consequence analysis under stability class 7.8D.

Table 7.15: Result of Catastrophic Rupture of LPG Storage Sphere

Scenario Description	**Consequence Effect**	**Radiation Effect @** 7.8/D (m)		**Overpressure** (bar)
Catastrophic Rupture of Storage Sphere (100MT)	Late Pool Fire (Diameter: 89.3m)	4.0 kW/m^2	320.0	n/a
		12.5 kW/m^2	210.5	n/a
		37.5 kW/m^2	133.9	n/a
	Fireball (Diameter: 269.2m)	4.0 kW/m^2	826.3	n/a
		12.5 kW/m^2	488.1	n/a
		37.5 kW/m^2	281.9	n/a
	Explosion	4.0 kW/m^2	1970.2	0.2068
		12.5 kW/m^2	888.4	0.1379
		37.5 kW/m^2	861.3	0.2068

Figure 7.17: Explosion Worst Case Radii

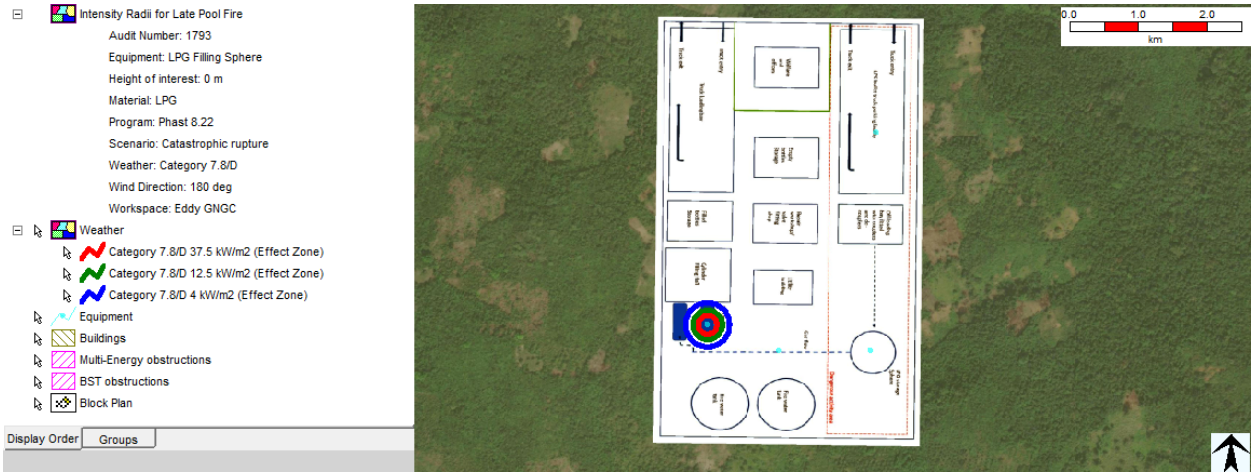


Figure 7.18: Intensity Radii For Late Pool Fire

Figure 7.19:Intensity Radii For Fireball

Consequence Analysis for 30m³ LPG Bullet Truck

The catastrophic rupture of a 30m³ capacity LPG Bullet truck scenario was modelled which will re. scenarios and catastrophic rupture of the 30m³ storage sphere. It is expected that the LPG gas release from leaks will be dissipate into the atmosphere and ignite forming a jet fire. Medium leaks, large leaks and catastrophic rupture will result in pool fire and explosion.

Table 7.16: Jet Fire Results of Modeled Scenarios

Scenario	Flame Length (m)	Radiation Intensity		
		4.0 kW/m²	12.5 kW/m²	37.5 kW/m²
5mm Leak	7.2	15.8	11.8	9.2
25mm Leak	29.1	68.5	50.4	39.2
100mm Leak	95.3	224.8	165.9	129.3

Figure 7.20:Image of 5mm Leak Jet Fire Intensity Result

Figure 7.21:Image of 25mm Leak Jet Fire Intensity Result

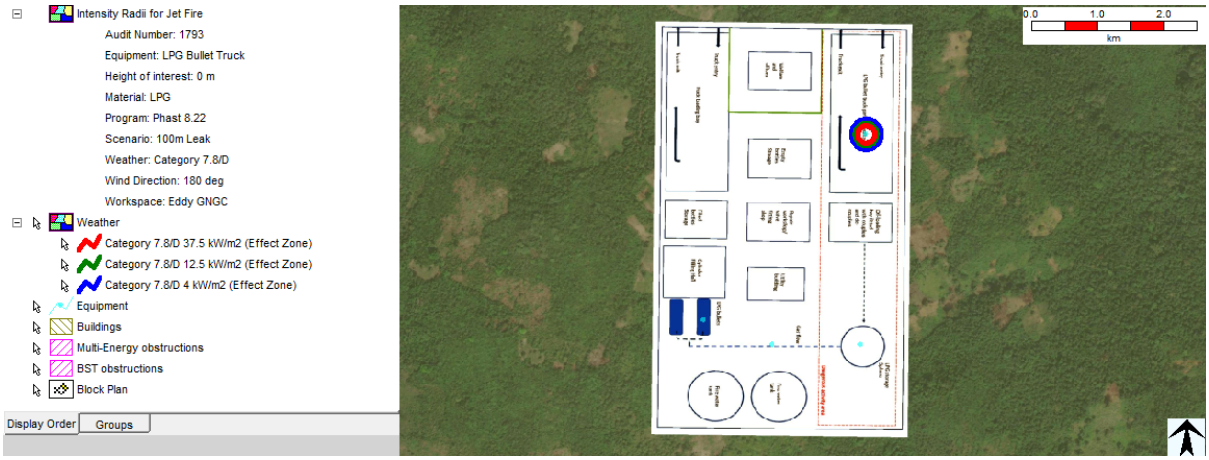


Figure 7.22: Image of 100mm Leak Jet Fire Intensity Result

Table 7.17: Explosion Results of Modeled Leak Scenarios

Scenario	Overpressure Level (bar)	Maximum Distance (m)	Diameter (m)
25mm Leak	0.02068	235.2	230.3
	0.1379	142.4	44.8
	0.2068	136.8	33.6
100mm Leak	0.02068	1030	1040
	0.1379	611.1	202.1
	0.2068	585.8	151.6

Figure 7.23: Image of 25mm Leak Explosion Result

Figure 7.24: Image of 100mm Leak Explosion Result

In the event of catastrophic rupture of 30m^3 LPG bullets truck, Various outcomes may occur including late pool fire, fireball and explosion. The consequence analysis under stability class 7.8D.

Table 7.18.: Result of Catastrophic Rupture of LPG Storage Sphere

Scenario Description	Consequence Effect	Radiation Effect @ 7.8/D (m)		Overpressure (bar)
Catastrophic Rupture of Bullet Truck (30m^3)	Late Pool Fire (Diameter: 36.6m)	4.0 kW/m^2	159.1	n/a
		12.5 kW/m^2	105.7	n/a
		37.5 kW/m^2	66.9	n/a
	Fireball (Diameter: 144.2m)	4.0 kW/m^2	489.9	n/a
		12.5 kW/m^2	287.5	n/a
		37.5 kW/m^2	165.9	n/a
	Explosion	4.0 kW/m^2	974.6	0.2068
		12.5 kW/m^2	449.8	0.1379
		37.5 kW/m^2	434.8	0.2068

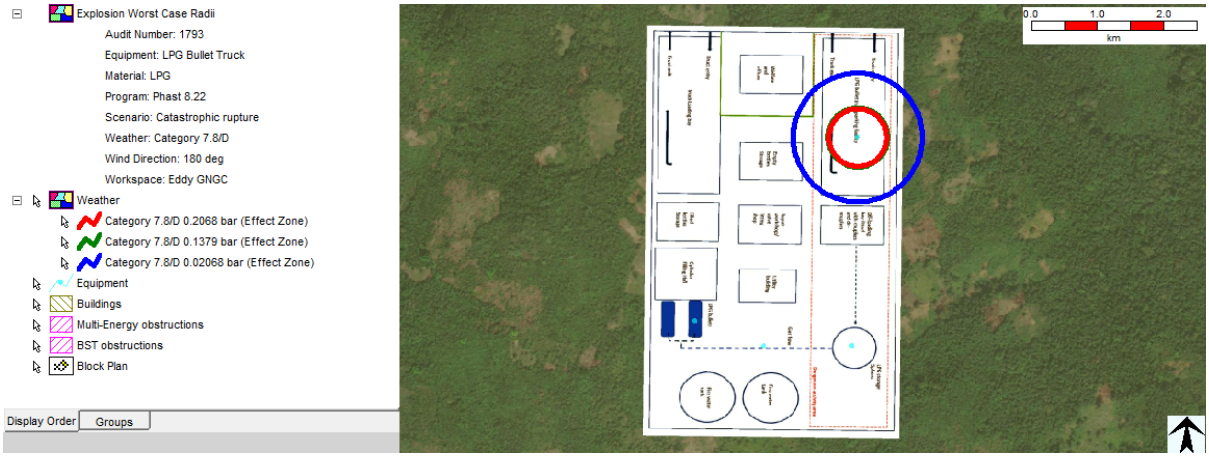


Figure 7.25: Explosion Worst Case Radii

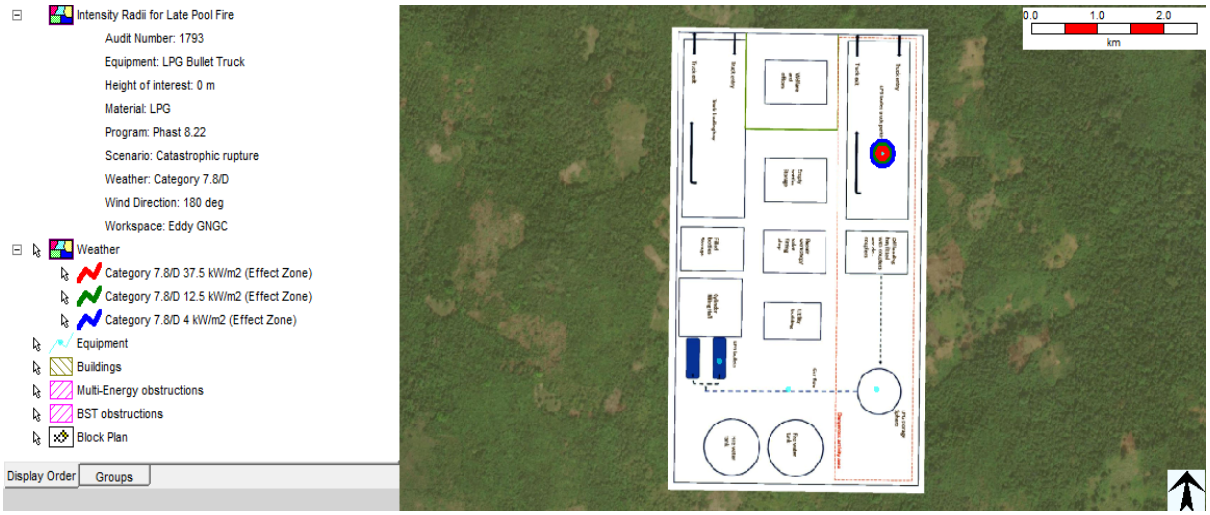


Figure 7.26: Late Pool Fire

Figure 7.27: Fireball intensity

7.3.14.1.5 Conclusive Analysis of Consequences

The risk posed by the LPG Bottling Plant is calculated based on a number of factors including consequences, population data, failure frequency, ignition sources etc. A Quantitative Risk Analysis (QRA) is used to determine the risk caused by the use, handling, transport and storage of hazardous substances.

Societal Risk

The societal risk provides information on the risk of the LPG Plant to the neighbouring population. Societal risk is the probability of a certain number of victims per year. In calculating the group risk, demographic data relating to the presence of humans is necessary.

The need for the societal risk computation arises due to the fact that society views multiple fatalities from the same accident far more seriously than single fatalities from numerous accidents.

The number of people affected by each incident outcome case is given by

$$N_i = P_{x,y}. P_{f,i}$$

Where

N_i = number of fatalities resulting from incident outcome case i

$P_{x,y}$ = number of people at location x, y

$P_{f,i}$ = the probability that incident outcome case i will result in a fatality

at location x, y from the consequence and effects model.

- **Results of Societal Risk Analysis**

As seen on the site map and overlays of explosion radius of the site, there are no human population (settlement/ facility) within 5km radius around the proposed LPG Bottling Plant, Hence, there will not be any societal fatality in an unlikely event of accidental release of LPG. An individual risk analysis will be performed during the operational phase of the plant, when the distribution of workforce is allocated, to determine the individual risk arising from an explosion or fire.

8.0 PROPOSED MITIGATION & ENHANCEMENT MEASURES

The mitigation measures provide management guidelines for ensuring the impacts of the proposed project are minimized. The mitigation measures are intended to ensure construction and operation in a manner that prevents adverse environmental impacts.

The general rules followed in designing these measures are:

a) Minor impacts occur where effects are experienced, but the impact magnitudes are sufficiently small and well within accepted standards, and/or the receptors are of low sensitivity/value.

b) Reduction of major and moderate impacts: moderate impacts are impacts within accepted limits and standards. Moderate impacts may cover a broad range, from a threshold below which the impact is minor, up to a level that might be just short of breaching an established (legal) limit.

c) Avoidance of major impacts: major impacts are impacts where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resources/ receptors.

The proposed mitigation measures have been taken into consideration based on costs, feasibility and ease of implementation. The mitigation measures have been designed specifically to remedy the negative impacts during the pre-development, construction and operational phases.

8.1 Mitigation for Negative Pre-Development Impacts

8.1.1 Mitigation Against Negative Socio-Economic Impacts

Farmers whose livelihood will be affected shall be identified and duly compensated. Additionally, these farmers will be engaged during the land preparation activities to ensure they have immediate means of employment to support their families.

8.1.2 Management of Occupational Health and Safety Issues

GNGC will actively ensure there is limited exposure to occupational hazards during site survey and project feasibility phase by ensuring that personnel visiting the site wear the basic personal protective clothing.

8.1.3 Mitigation Against Land Litigation and Compensation Issues

Management must follow due procedures for identifying land owners and regulatory stakeholders for a smooth land acquisition, registration and compensation process. This will ensure that the company transacted business with the right land owners so as to avert litigation issues that delay the development of the project.

8.2 Mitigation for Construction Phase Impacts

8.2.1 Management of Ambient Air Quality Impacts

Some measures to be applied will include water dowsing of surfaces to reduce suspension of dust; servicing and tuning of engines of construction vehicles to ensure proper combustion so the exhaust is not laden with high levels of noxious gases; and provision of nose-masks for workers.

8.2.2 Management of Noise Impacts

Noise will be managed by ensuring the equipment are operated at their installed capacities. The work plan for the construction will be designed to prevent concurrent performance of tasks which can create loud noises at the same time. Work will be limited to daytime hours of 6:30 am and 5:30 pm.

8.2.3 Wastewater Management

Slurry material will stored in metallic containers/barrels and reused for concrete mixing. There would also be proper estimations of materials to prevent leftovers/wastage. There will be mobile toilet facilities for collection of urine and blackwater which will be generated by workers. The contents of the movable units will be emptied when full and disposed at appropriate sites.

8.2.4 Solid Waste Generation

Wooden pallets and metal scraps would be separated and packed nicely. Wooden pallets would be carted off site and sold to local carpenters. Excavated earth would be used for re-stabilizing areas demarcated for lawns. There will be provision of skips for the collection of wastes that will go to the landfill. A waste management company shall be contracted to collect and safely dispose the wastes. The waste management company shall be required to provide a trail document to ascertain the frequency of collection and final destinations of disposal.

8.2.5 Resource Consumption Management

Proper estimation of all raw materials will be done to ensure efficient utilization of resources. Construction staff will be educated to make judicious use of raw materials.

8.2.6 Impact on Ecosystem

The clearance of vegetation will be limited to the areas required. Excavated top soils during earthworks will be reserved and reused for re-filling areas demarcated for lawns. The topsoil will be used as surface layer during re-filling to ensure that the lawns to be developed have access to soil nutrients. This action will also allow for the re-creation of a habitat for soil microorganisms.

8.2.7 Traffic Impact Management

Noting the risks associated with transportation of project materials and equipment to the site, management has made provisional plans to ensure that the proposed routes are checked to ascertain their suitability prior to the movement of the project materials. Obstacles will be cleared to ensure that the smooth transportation of items to the site. Management will also ensure it employs or contracts professional drivers with valid driving licenses. Similarly, drivers will be trained to adhere to traffic regulations and also as a way of enhancing their professionalism.

The trucks to be used for the transportation will be checked to ensure they are in good condition before they are put on the road. The access route to the site from the main road will be graded, compacted and filled with literate to ensure it is in good condition at all times.

8.2.8 Management of Work Camp Impacts

Workers will be given education on issues such as hygiene, HIV/AIDS, and the conducts that are legally admissible in the project area. This is to help workers avoid practices/vices that can pose health risks and or unpleasant situations. Issues of racism and ethnocentrism will be discussed to ensure workers identify as people of equal rights and opportunities.

8.2.9 Management of Occupational Hazards

It will be a strict requirement for workers to appropriately use the basic personal protective equipment while on site. Workers will be given basic training to enable them adhere to the highest safety standards.

8.2.10 Management Public Health and Safety Issues

A fence wall has been erected to prevent unauthorized access to the site. Items such as quarry aggregates being conveyed to the site in trucks will be covered to prevent material spillage onto the roads. Signages will be placed around the site to alert the public of ongoing construction works.

8.2.11 Management of Visual Impacts

There will be spraying of the ground prior to earthworks to ensure that there is limited suspension of dust in the atmosphere. Trucks and equipment will be neatly packed within the project site to keep the place tidy. A fence wall shall be erected to screen off the site.

8.2.12 Erosion and Drainage Issues Management

Exposed land surfaces shall be compacted and stabilized to prevent erosion impacts. Vegetation removal shall be limited to only areas required. Drainage with receptacles shall be engineered to prevent washing away of soil sediments into watercourses.

8.2.13 Waste Oil Management

Equipment and vehicles will be serviced at workshops off-site to prevent waste oil spills on site. Fuel tanks of these equipment will be checked regularly to ensure they are not leaking. In the event of a spill, it will be cleaned with sand and the sand used for cleaning will be collected in containers for collection by and EPA permitted waste oil management company (upon arrangements with the company) for safe disposal.

8.3 Mitigation for Operational & Maintenance Phase Impacts

8.3.1 Management of Increased Pressure on Utilities

It would be required for machines to be operated at their installed capacities. Capacitors and Transformers will be installed on site. Equipment will be turned off when they are not in use. Management will ensure equipment are regularly serviced to ensure their output is efficient to avoid the potential for drawing more energy than required. Washrooms must also be fitted with taps with automatic shut off valves when not in use. This would help reduce the consumption of water and subsequently also reduce the expenditure for water supply.

8.3.2 Management of Dust and Gaseous Emissions

Gaseous emissions will be controlled with a myriad of measures to ensure both point source emissions and fugitive particulate emissions are effectively controlled.

Table 8.1: Proposed Mitigation for Dust and Gaseous Emissions

Emission	Proposed Control Measures
Fugitive Particulate emissions from movement of vehicles	• The car park and internal access routes will be paved with concrete blocks to reduce the resuspension of dust in the ambient environment • A speed limit of 10km/hr will be enforced on site.
GHG Emissions from air-conditioning units	The company will ensure it purchases and installs air-conditioning units that only use HCFCs.
Leakage from the bottling Facility	• Usage of camlock fittings at the gantry and bottling line during product discharge to eliminate spills and emissions. • Provision of forecourt dispensers with automatic shut-off devices and break-away couplings. In addition, the nozzles being used at the gantry must have features such as internal vapor channel and vapor suction spout. • The design of the facility must incorporate high circulation of air within the facility. This will ensure that the concentration of volatile organic compounds is kept significantly below the lower flammable limit. • Preventing overflows during storage tank and cylinder filing by regularly monitoring transfers. • Storing solvents used in the cleaning vehicle parts in closed containers to prevent evaporation.

Additionally, workers will be provided with nose masks to limit their exposure to noxious fumes.

8.3.3 Management of Noise Impacts

Management will ensure there is periodic (quarterly at best) troubleshooting and servicing of machinery to ensure they are in good conditions to prevent noises generated from malfunctioning capacitors, motors and squeaking parts. Machineries will also be operated at/below their installed capacities to prevent roaring noises that occur as a result of the machines being overworked.

8.3.4 Solid Waste Management

Care will be taken to ensure proper management of wastes by implementation of these measures:

- Bins would be provided for collection of wastes. Bins would be colour-coded as blue for paper; green for plastic and glasses; brown for organic wastes and other types of wastes for segregation of wastes.
- Segregated papers, plastics and glasses would be sent to appropriate industries for recycling. Cardboard boxes, plastic gallons etc. in good condition will be kept for reuse. Recycling companies in close proximity to the site shall be considered when operation commences.
- Raw material packaging will be disposed off based on directives in their MSDS.
- Management of GNGC will contract a competent solid waste management company (approved by NEMA to work in the area) for timely collection and safe disposal of all its wastes. A trail document shall be developed to update the management on the final destinations of its wastes.

8.3.5 Wastewater Management

The following management systems shall be applied:

- Installation of a grease trap and effluent handling system for the treatment of liquid wastes from the facility.
- Greywater from washrooms and sinks will be channeled via the effluent handling system before being discharged into the external drainage courses. Drainage will be constructed with concrete to ensure no seepage of hazardous wastewater enters the environment.
- Blackwater will be channeled into septic tanks and septic management companies shall be contracted to collect and dispose it safely.

8.3.6 Waste Oil Management

Measures to be adopted for waste oil management include:

- Provide appropriate transfer tool/equipment for generator re-fueling.
- Check for leakages and spills and make provisions for spill kits clean-up materials/tools.
- Drip pans shall be provided for collection of waste oil during equipment servicing.
- Building a bund wall which is 110% the capacity of the storage tanks for the Genset diesel tanks. The bund wall will be connected by a sump to an enclosed chamber. Spillages into the bonded area will be drained into the enclosed chamber.
- Waste oil will be collected in drip pans and transferred to well labelled storage drums for storage at a designated storage area and management will sell the drained waste oil directly to EPA certified waste oil recycling companies.

8.3.7 Sanitation and Hygiene Management

Approved disinfectants and detergents will be used for regular cleaning and scrubbing of the washroom, gutters and offices to ensure the workplace is hygienic at all times.

8.3.8 Occupational Health and Safety Management System

- Medical assessment will be conducted for workers prior to engaging them. Health surveillance will be done to continuously diagnose early symptoms for treatment. Management will also ensure all workers are provided with Health Insurance packages.
- Provision of PPEs such as nose masks, helmets, gloves, heat protective clothing, reflectors and goggles for workers. Management will adopt the strict usage for facility operations.
- Proper ventilation will be provided to enhance quick displacement of heat within the facility.
- Provision of a well-stocked First Aid Kit.
- Ensuring there are emergency response measures such as response steps, contact numbers, alarms and signages displayed boldly to enhance quick handling of emergencies. There must be regular safety training programs and toolbox meetings to enhance adherence to safety measures and knowledge in emergency response measures.
- In event of chemical fumes, ventilation channels shall be used to disperse the gas and neutralization of the gas with its soluble substance. Face masks and nose masks shall be made readily available
- Regular liaison with Factories Inspectorate Department and Ghana National Fire Service for guidance on key safety measures to adopt.

A Health and Safety Management System will be developed in accordance with international standards and in-line with Ghana National Gas health and safety policies. The Health and Safety Management Plan (HSMP) involves documenting all individual aspects of the operations of the LPG Bottling Plant assessing the health and safety issues and implementing appropriate control measures to reduce any hazards identified.

The plan will include but not be limited to the following issues:

- safe work method statements
- health and safety roles and responsibilities
- hazard identification
- risk management and control measures
- emergency response procedures
- accident and incident reporting
- training and monitoring

All workers of the facility will need to comply and demonstrate commitment to meeting the objectives of the health and safety plan.

8.3.9 Managing Fire and Explosion Hazards

There will be provision of fire-fighting equipment and trained personnel to handle fire emergencies. Flammable materials, ignition sources and explosive items would be kept at reasonable distances from each other and also away from vegetative materials, fabrics and papers. The facility would be registered with the Ghana National Fire Service to ensure regular surveillance by the regulator. This would also help in the installation of fire-fighting equipment at the appropriate places.

8.3.10 Managing Public Health and Safety Risks

Exposure of the public to gaseous emissions will be limited by the coupling of the nozzle fittings. There will be adequate parking space within the facility premises to prevent parking of vehicles on the fringes of the road. There will also be traffic wardens to assist vehicles entering and leaving the facility.

The company shall be receptive to its neighbors and regulators by designating a liaison role to the HSE Officer to allow for quick response and addressing of complaints.

8.3.11 Management of Hazardous Chemical Spills

Drainage systems must been installed to collect chemical spills and channel it into the effluent handling systems made up of impermeable material to prevent leakage into the environment.

Chemical materials such as Lubricants and cleaning agents shall be stored based on their Material Safety Data Sheet (MSDS). Access to these materials and products will be restricted to only highly trained personnel. The MSDS shall be made available to all staff and regular training shall be conducted to ensure high awareness.

8.3.12 Management of Traffic Impacts

Management shall ensure adequate parking space is available for all types of vehicles that operate within the facility. Additionally, traffic control systems and wardens shall be used to ensure traffic is duly regulated. Schedules for delivery of LPG to the site and dispatch of items from the site shall be developed to prevent heavy traffic around the site. Separate spaces shall be delineated for walkways and driveways within the facility. All items shall be transported in their respective special purpose vehicles.

9.0 PROVISIONAL ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

This chapter presents the environmental management framework and monitoring regime that would be followed to address the impacts and risks associated with the project. It represents an outline for the planning, implementation, monitoring and review of the effectiveness of mitigation measures outlined in this document.

9.1 Development of an Environmental Management System/Framework

Some of the institutional arrangements that will be considered in guiding long-term environmental sustainability and compliance with environmental regulations will include:

- Use of the environmental policy and system
- Identification of Environmental Aspects
- Creation of Environmental Quality Targets
- Employee training
- Use of Employee and Management Manuals
- Environmental Quality and Performance Monitoring
- Environmental Audits and Reporting
- Environmental Action Plans/Programs

9.1.1 Use of an Environmental Policy and System

There shall be awareness creation of the company's environmental policy to drive good environmental performance at all levels of operations. Further, a system will be developed to address social and environmental impacts.

The system will be structured around the **Plan>Do>Check>Act** model for continual improvement. The five main elements of the EMS also correspond to the elements of international standards for environmental management systems. The elements are:

1. Environmental policy
2. Planning
3. Implementation and Control
4. Checks and control
5. Management review

Management proposes to use an all-inclusive approach to manage environmental issues. This will enhance the cohesion of issues identification and their management.

When the Environmental Management System has become routine, there can be a tendency to professionalize the environmental work, i.e. to let a few selected persons take over the responsibility. Although this may be an appropriate allocation of resources, it creates the danger of stagnation of the environmental management system, since it may discourage employees from addressing further environmental issues. In this phase, it is important to maintain a learning environment that allows everyone to contribute to further development.

When hiring new personnel, special attention will be given to introduce newcomers to the spirit that has been obtained during implementation of the Environmental Management System. There will be application of specific introduction sessions that do not focus on "bringing in line" the new staff/new team members, but rather alerting them to the openness with the way subjects are tackled. At the same time special attention would be given to make immediate advantage of the possible expertise or experience that newcomers bring along, since new eyes sometimes see the things that go unnoticed by those who have been in the same position for years.

9.1.2 Identification of Environmental Aspects

One key step in managing the environmental effects (impacts) of the facility operations will be to identify those activities that may directly affect the immediate environment/surrounding. The management will maintain formal systems for identifying and reviewing the elements of activities carried out during operations that have potential environmental impacts, and will set priorities for actions to reduce associated risks. The identification and evaluation of environmental aspects is controlled by Environmental Management System Procedure and Identification of Environmental Aspects procedure. This procedure incorporates a risk-based methodology for classifying and ranking the relative importance of environmental aspects at the facility. Ranking of aspects facilitates the setting of priorities in terms of setting objectives and targets for improvement. The elements that could potentially cause the greatest damage or risk are classified as significant environmental aspects; these elements form the focus of management programs (termed Environmental Action Plans) for improvement.

In determining significant environmental aspects, all operational and administrative support activities that fall within the scope of the EMS are considered with consideration given to:

- Use of land, water, fuel, energy and natural resources;
- Emissions to atmosphere;
- Discharges to water (surface and ground);
- Contamination of land;
- Solid and liquid wastes;
- Noise, odour, visual impact;
- Effect on ecosystems (*e.g*. depletion of biodiversity) and;
- Stakeholder concerns and potential influences.

Consideration will be further given to past, present and planned activities, and normal, abnormal and emergency conditions. Environmental Aspects will be subjected to periodic review to ensure that all significant aspects related to operations at the site are identified and detailed in a register.

9.1.3 Creation of Environmental Quality Targets

In line with the environmental management system's commitment to continual improvement, the planning process considers opportunities for setting environmental objectives and targets. Where practical, these should be measurable to allow evaluation of improvement. The process of setting targets will result in an action plan (program) for achieving those goals. These action plans will include a sequence of tasks/projects that are needed to achieve the target and will assign responsibilities and establish time frames.

Objectives and targets will be set up in conjunction with the HSE Manager and Departmental Heads for significant environmental aspects.

The setting of the targets will consider:

- GNGC's Environmental Policy;
- National Legislations and regulations;
- Environmental incidents and non-conformances;
- Internal and external EMS audits;
- Operational requirements, conditions and constraints;
- Business requirements;
- Financial requirements;
- Technological options; and
- Concerns of external parties

9.1.4 Employee Training

Management understands that the objectives of sustainability can only be achieved if all employees are oriented to conform to the standards. Thus management will endeavor to make all employees conscious of their obligation to protect the environment.

Such training will be interactive, investigating and challenging participants' attitudes to the environment and their understanding of their roles in relation to their work, the product they produce, and their opportunities in affecting its environmental impact.

9.1.5 Use of Employee Manuals

There would detailed documentations on the production process and emergency response system to enhance the conformity to standards by all. Workers will be given the required copies to boost their capacity to conform to requirements for environmental and safety management.

Vivid graphic images will be used to enhance ability of workers to understand the information in the manuals.

9.1.6 Environmental Quality and Performance Monitoring

In conformity with the formal monitoring requirements to be provided under the Schedule to the Environmental Permit, management finds it prudent to undertake appropriate monitoring of the effectiveness of the adopted control measures to demonstrate due diligence. The monitoring will cover areas such as noise levels, air quality and water quality.

9.1.7 Environmental Audits and Reporting

Management shall institute a standard form of independent auditing and reporting of its activities as a measure to assess the effectiveness of this PEMP as an operational document. This form of auditing referred to as compliance auditing will be conducted in accordance with relevant environmental laws, standards and policies, both at national and international (where relevant) levels. Auditing will be for the purpose of internal and external reporting.

9.1.8 Environmental Action Plans

Environmental Action Programs will be developed for the purpose of defining, assigning responsibility for, coordinating and controlling the activities and resources required achieving environmental objectives and targets within a defined time frame. Progress towards achieving environmental objectives and targets will be monitored regularly and parties responsible for individual aspects of Management Programs will report on progress in Management Review meetings. The action plans for rectifying environmental challenges and enhancing improvement has been given in an Environmental Management Action Plan detailing specific actions, objectives, targets, responsible personnel and proposed budget.

Table 9.1: Environmental Management Action Plan							
PRE-DEVELOPMENT PHASE							
Impact	**Identified mitigation action**	**Actual action**	**Objective**	**Target**	**Budget (GHS)**	**Time frame**	**Responsibility**
Occupational Health and Safety Issues							
Occupational Health and safety issues	Use of PPEs	Ensuring personnel are trained on safety issues and ensuring they use PPEs for site visits	To prevent injury on site	Limit workers exposure to occupational hazards	30,000.00	During feasibility studies	Project Manager
Environmental and Social Management Issues							
Land Litigation and Compensation issues	Deal with the rightful land owners	Identify rightful land owners and ensure proper valuation of food crops to enhance a better compensation system for people that previously owned or worked on the land for agricultural purposes. Ensure proper assignment of land lease to the company.	To prevent litigation issues that can stall or delay the project.	Maintain good relationship with community members to enhance community support for the project.	150,000.00	Prior to construction phase	Project Manager

CONSTRUCTION PHASE							
Impact	**Identified mitigation action**	**Actual action**	**Objective**	**Target**	**Budget (GHS)/ Month**	**Time frame**	**Responsibility**
Environmental Management Issues							
Impact on Air Quality	Dust suppression	Water Dowsing. Use of efficient fuels in heavy duty equipment Servicing of construction equipment which use fuel to run engines	Reduce dust emissions and noxious gas releases	< 35 ug/m^3 for $PM_{2.5}$ < 70 ug/m^3 for PM_{10} < 150 ug/m^3 for SO_2 < 150 ug/m^3 for NO_2 over a 24-hour monitoring period	6,000.00	During Construction	Site HSE Officer of Contractor
Generation of Noise	Identifying noise generation sources and efficiently conducting operations to ensure noise is at low levels	Servicing construction equipment Operating machineries at their installed capacities Limiting construction work to daytime hours of 6:30am to 5:30pm	Reduce loud noises on site	< 70 dB for both night and daytime hours	3,000.00	During Construction	Site HSE officer of Contractor
Ecological Impacts	Limit vegetation removal to areas required	Regrow lawns and trees after construction	To provide ecological balance on site	Permit to initiate activities that will lead to vegetation clearance		During Construction	Site HSE officer of contractor

CONSTRUCTION PHASE							
Impact	**Identified mitigation action**	**Actual action**	**Objective**	**Target**	**Budget (GHS)/ Month**	**Time frame**	**Responsibility**
Environmental Management Issues							
Wastewater Generation	Providing washrooms on site and containers for construction slurry	Installation of adequate washrooms for construction staff Estimation of materials to ensure there aren't left overs Provision of sizable containers for collection of construction slurry to be reused in concrete mixing	Prevent irresponsible disposal of wastewater generated during the construction phase	Collection and safe disposal of of bodily wastes.	4,000.00	During Construction	Site HSE Officer of Contractor
Solid Waste Generation	Reuse and disposal of unwanted items	Engaging an efficient waste management company and introducing waste management system that enhances segregation on site. Provision of sizable bins for collection of wastes. Selling wooden pallets to carpenters and storing scrap for later use in the factory. All other wastes will be collected in skips and transferred to the Kpone landfill site for safe disposal	Ensuring proper waste management practices are adopted on site	Carting wooden pallets off-site to carpenters Safe disposal of all other types of waste	3,000.00	During Construction	Site Safety HSE of Contractor

CONSTRUCTION PHASE							
Impact	**Identified mitigation action**	**Actual action**	**Objective**	**Target**	**Budget (GHS)/ Month**	**Time frame**	**Responsibility**
Environmental Management Issues							
Resource Consumption	Avoiding wastage	Estimations of right quantities of all materials and ensuring the quantities are supplied based on exact quantities needed	Utilizing resources efficiently	Using 100% of every material delivered to the construction site		During Construction	QA/QC of Contractor
Traffic Impact	Avoiding Traffic Irregularities	Training drivers to adhere to traffic regulations. Regularly servicing vehicles to ensure they are always in good condition.	Avoiding traffic irregularities	zero incidence of vehicular related accidents and irregularities	5,000.00	During construction	Site HSE Officer of Contractor
Work Camp Impacts	Sensitization	Educating construction workers on issues such as hygiene, communicable and transmitted diseases, equal rights, etc. Ensure workers are givcn vaccination if possible	Create awareness for health and human right issues	Cohesion among workforce and healthiness of the construction team	800.00	During Construction	Project Manager of Contractor
Occupational Health and Safety Issues	Preventive and control measures	Provision of required PPEs, First Aid Kits, Emergency Response Systems, safety signages for all construction activities Ensuring workforce are given safety training. Enforcing usage of PPEs and compliance to safety procedures for work.	Create a safe working environment	Zero accidents	20,000	During Construction	Site HSE Officer of Contractor

CONSTRUCTION PHASE							
Impact	**Identified mitigation action**	**Actual action**	**Objective**	**Target**	**Budget (GHS)/ Month**	**Time frame**	**Responsibility**
Environmental Management Issues							
Visual Impact	Preventing unsavory scenes emanating from the site	Building a perimeter wall to screen off unsavory sites Water dowsing the site and sand/ aggregate stockpiles to prevent suspension of dust from the site.	Limiting impact on visual amenity	Zero complaints about unsavory nature of the site		During Construction	Site HSE Officer of Contractor
Waste Oil Generation	Preventing waste oil spills and initiating clean up procedures in the event of a spill	Servicing machinery and vehicles off-site. Regularly checking the fuel tanks of machinery and vehicles to ensure they aren't leaking. In the event of a spill, sand will be used to clean up and the sand will be collected in containers. Bidi Group will be contracted to safely dispose the contents.	Containment and clean up of spills	Ensuring the site is not contaminated with oil spills		During Construction	Site HSE Officer of Contractor
Occupational Health and Safety Issue							
Public Health and Safety Issues	Limiting and eradicating any negative impact of construction on the nearby neighbors and community	Building a perimeter wall to avoid unauthorized access Signages will also be installed to notify the general public of ongoing construction works Properly transporting project materials through the town to avoid accidents.	Prevent complaints from the community on issues related to their public health and safety due to the project.	Zero public complaints about nuisance caused by the construction		During Construction	Site HSE Officer and Project Manager of Contractor

OPERATIONAL PHASE							
Impact	**Identified mitigation action**	**Actual action**	**Objective**	**Target**	**Budget (GHS)**	**Time frame**	**Responsibility**
Environmental Management Issues							
Increased Pressure on Utility Supply	Efficient utilization of utilities	Turning off equipments that are not in use to conserve electricity. Installation of automatic shut-off valves and adjustable flow regulators	To reduce costs for resource consumption	Resource Consumption must positively match production output	1,000 per month	During Operational phase	HSE Officer
Dust and Noxious gas emissions	Treatment of emissions prior to release and use of dust control measures	• Efficient couplings shall be fitted on nozzles to avoid gas leaks and VOC Emissions. • Use of efficient fuels in genesis and forklifts as the types of emissions are directly related to the level of emissions generated. • The car park and internal access routes will be paved with concrete blocks to reduce the resuspension of dust in the ambient environment • A speed limit of 10km/hr will be enforced on site. • The forecourt of the facility shall be developed in a manner that allows for easy circulation of air to ensure VOC emissions from gas leaks are quickly dispersed.	Ensure emissions meet regulatory standards/ guidelines	***Ambient Air Quality*** < 150 ug/m^3 for TSP < 70 ug/m^3 for PM_{10} < 150 ug/m^3 for SO_2 < 150 ug/m^3 for NO_2 over a 24-hour monitoring period at all fence line monitoring points	10,000 per month	During Operational Phase	General Manager and HSE Officer

OPERATIONAL PHASE							
Impact	**Identified mitigation action**	**Actual action**	**Objective**	**Target**	**Budget (GHS)**	**Time frame**	**Responsibility**
Environmental Management Issues							
Solid Waste Generation	Waste segregation, reuse and safe disposal	Care will be taken to ensure proper management of wastes by implementation of the following measures: • Bins would be provided for collection of wastes. Bins would be colour-coded as follows for segregation of wastes (Blue for paper; Green for plastic and glasses; Brown for organic wastes and other types of wastes) • Segregated papers, plastics and glasses would be sent to appropriate industries for recycling, Cardboard boxes, plastic gallons etc. in good conditions shall be kept for reuse. Organic wastes would be safely disposed at the appropriate dumpsites. • Workers will be trained on how to manage wastes based on color coding • Management of GNGC will contract a competent solid waste management company for timely collection and safe disposal of all its wastes. A trail document shall be developed to update the management on the final destinations of its wastes.	Segregate waste to prevent everything from going to the approved dumpsite	Reuse and recycle about 50% of wastes generated	1,000 per month	During Operational Phase	HSE Officer

OPERATIONAL PHASE							
Impact	**Identified mitigation action**	**Actual action**	**Objective**	**Target**	**Budget (GHS)**	**Time frame**	**Responsibility**
Environmental Management Issues							
Wastewater Generation	Chaneling wastewater into appropriate containment and carriage systems to avoid pollution of the external environment	The following management systems shall be applied: • Greywater from washrooms and sinks will be channeled into an effluent handling system before it is discharged into the external drainage. • Blackwater will be channeled into septic tanks and septic management companies shall be contracted to collect and dispose it safely. • Installing grease traps and ensuring there is effluent handling system for treatment. • Ensuring there is proper paving of the floor to avoid seepage into groundwater aquifers	Prevent polluted wastewater from being discharged into the environment	Effluent to be discharged will be required to meet guidelines	3,000 per month	During operational phase	HSE Manager
Waste Oil Generation	Avoid waste oil spillage to the bare ground	Measures to be adopted for waste oil management include: • Checking for leakages and spills and making provisions for spill kits to clean up spills. • Building a bund wall which is 110% the capacity of the storage tanks for the genes diesel tanks. The bund wall will be connected by a sump to an enclosed chamber. Spillages into the bunded area will be drained into the enclosed chamber and management will sell the drained waste oil directly to EPA certified waste oil recycling companies. • Cleaning spills and storing cleaned up spills into marked containers for collection by EPA certified waste waste oil recycling companies • Providing proper funneling to assist in generator re-fueling.	Prevention of Containment of waste oil spills	Zero waste oil spills to ground	1000 per month	During Operational Phase	HSE Manager

OPERATIONAL PHASE							
Impact	**Identified mitigation action**	**Actual action**	**Objective**	**Target**	**Budget (GHS)**	**Time frame**	**Responsibility**
Environmental Management Issues							
Hazardous Chemical Spills	Ensure there is proper containment systems	Drainage systems must been installed to collect chemical spills and channel it into the effluent handling systems made up of impermeable material to prevent leakage into the environment.	Avoid leakage into the environment	Contain hazardous chemical spills to avoid pollution	3,000 per month	During operations	HSE Manager
Occupational Health and Safety Issues							
Sanitation and Hygiene Impacts	Cleaning the workplace regularly	Approved disinfectants and detergents will be used for regular cleaning and scrubbing of the washroom, gutters, factory floor and and offices to ensure the workplace is hygienic at all times.	A safe, clean and healthy working environment devoid of diseases such as cholera, diarrhea	No penalties from regulatory authorities due to poor sanitary conditions	6,000 per month	During Operations	HSE Manager
Fire and Explosion Hazards	Ensuring fire and explosion risks are eradicated completely	There will be provision of fire fighting equipment and a trained personnel to handle fire emergencies. Flammable materials, ignition sources and explosive items would be kept at reasonable distances from each other and also away from vegetative materials, fabrics and papers. The facility would be registered with the Ghana National Fire Service to ensure regular surveillance by the regulator. This would also help in the installation of fire fighting equipment at the appropriate places.	Provide safe working environment	Zero fire and explosion incidents	5,000 per month	During operations	HSE Manager

OPERATIONAL PHASE							
Impact	**Identified mitigation action**	**Actual action**	**Objective**	**Target**	**Budget (GHS)**	**Time frame**	**Responsibility**
Environmental Management Issues							
Occupational Health and Safety Risks	Introduction of a well coordinated Occupational Health and Safety Management Program	• Medical assessment will be conducted for workers prior to engaging them. Health surveillance will be done to continuously diagnose early symptoms for treatment. Management will also ensure all workers are • Provision of PPEs such as nose masks, helmets, gloves, reflectors and goggles for workers. Management will adopt the strict usage for facility operations. • Proper ventilation will be provided to enhance quick displacement of heat within the facility. Workers will also be discouraged from spending long hours near the furnace during their shifts. • Provision of a well-stocked First Aid Kit. • Ensuring there are emergency response measures such as response steps, contact numbers, alarms and signages displayed boldly to enhance quick handling of emergencies. There must be regular safety training programs and toolbox meetings to enhance adherence to safety measures and knowledge in emergency response measures. Training must be done prior to engagement and regularly during operations. • Regular liaison with Factories Inspectorate Department and Ghana National Fire Service for guidance on key safety measures to adopt.	Provide a safe work place for employees and visitors	Zero accidents	4,000 per month	During operations	Production Manager and HSE Manager

OPERATIONAL PHASE							
Impact	**Identified mitigation action**	**Actual action**	**Objective**	**Target**	**Budget (GHS)**	**Time frame**	**Responsibility**
Health and Safety Issues							
Public Health and Safety Risks	Prevention of negative impacts on neighbors and the community	There will be adequate parking space within the facility premises to prevent parking of vehicles on the fringes of the road. There will also be traffic wardens to assist vehicles entering and leaving the facility. The company shall be receptive to its neighbors and regulators by designating a liaison role to the HSE Officer to allow for quick response and addressing of complaints.	Avoid litigation with neighbors over negative impacts	No complaints from neighbours	3,000.00 per month	During operations	Plant Manager and HSE Officer

9.2 Environmental Monitoring Plan

9.2.1 Purpose of Environmental Monitoring

Environmental Monitoring provides a basis for determining the pattern and nature of change resulting from the construction and operation of the facility. This will allow the company to notice its impacts, determine its level of compliance and develop action plans to rectify issues. Environmental Monitoring provides the means for assessing environmental management practices thus it is an important tool GNGC will apply in enhancing its environmental performance.

9.2.2 Proposed Monitoring Schedule, Budget and Responsibility

The table below provides the issues and parameters of concern and the phases to look out for these issues.

Table 9.2: Environmental Monitoring Plan for Construction Phase

CONSTRUCTION PHASE				
What to Monitor	**When to Monitor**	**How to Monitor**	**Who Monitors**	**Budget (GHS)**
Ambient Air Quality (TSP, PM_{10}, SO_X, NO_x, CO, VOCs)	Monthly	Test Methods and machinery in line the Ghana Standards	Site Safety Officer of Contractor	1500 per month
Raw Material Consumption	Weekly	Comparing Procurement sheets with project deliverables	Procurement Manager of Contractor	300 per month
Solid Waste Management	Daily	Visual inspection of site and waste trail documents	Site Safety Officer of Contractor	350 per month
Liquid Waste Management (Greywater exiting the facility)	Daily	Visual inspection of site and temporary washrooms and containers for carrying construction slurry	Site Safety Officer of Contractor	350 per month
Noise	Monthly	Noise Meters such as Casella	Site Safety Officer of Contractor	400 per month
Utilities	Monthly	Review of utility bills	Project Manager of Contractor	200 per month
Occupational and Public Health & Safety Issues including Traffic Impacts	Daily	• Observations • Review of incident records and complaint records	Site Safety Officer of Contractor	1000 per month
TOTAL				**4,100.00**

Table 9.3: Environmental Monitoring Plan for Operational Phase

OPERATIONAL PHASE				
What to Monitor	**When to Monitor**	**How to Monitor**	**Who Monitors**	**Budget (GHS)/Month**
Ambient Air Quality (TSP, PM_{10}, SO_X, NO_x, CO, VOCs)	Monthly	Outdoor Ambient Air Quality Monitors such as Minivol Sampler, Aeroqual, etc.	HSE Officer	11,500.00
Raw Material Consumption	Weekly	Comparing procurement sheets against production output	Plant Manager	300.00
Solid Waste Management	Daily	Visual inspection of site and waste trail documents	HSE Officer	400.00
Liquid Waste Management	Monthly	Sampling and laboratory analysis	HSE Officer	1,500.00
Noise	Monthly	Noise Meters such as Casella	HSE Offer	650.00
Utilities	Monthly	Review of utility bills	Plant Manager	200.00
Maintenance of Pollution control systems	Monthly	The systems will be checked regularly to ensure they are in optimal working conditon	HSE Officer	1,000.00
Occupational and Public Health & Safety Issues including Traffic Impacts	Daily	• Observations • Review of incident records and complaint records • Conducting assessment for workers to ascertain their comprehension of safety trainings and systems	HSE Officer	4,000.00
Management of hazardous spills and responsible transportation of chemicals	Daily	Ensuring special purpose vehicles and on-site storage/reception facilities are in good condition at all times	HSE Officer	1,000.00
TOTAL				**20,050.00**

9.3 Emergency Preparedness and Response Plan

9.3.1 Objective of Provisional Emergency Response Plans

Environmental incidents can present an immediate and unacceptable threat to the environment and humans. Natural events can also pose threats to the environment, humans and property. Both incidents and natural events are collectively referred to as "emergency situations" in this context. An Emergency Situation is a sudden and immediate threat to the well-being of the environment thus calls for immediate measures to minimize its adverse consequences. This plan has been prepared to cater for the following types of emergencies:

- Medical Injury including serious illnesses (heat stroke, heart attack)
- Fire
- Motor accidents
- Natural disasters (floods, etc.)
- Malfunctioned Pollution Control Systems
- Chemical Spills
- Potential explosion of chemicals

This Emergency Response Plan establishes a set of activities to enhance GNGC's readiness to respond to extreme events that could affect the biophysical environment and smooth operation of the project. The objective of the plan is to ensure the organization's readiness to minimize the adverse impact of such events by means of active responses to protect the health and safety of individuals as well as the integrity and functioning of physical structures. The basis for emergency response and planning is firstly incident prevention, and secondly rendering any incidents harmless.

The priorities for protection in an emergency situation are the following:

- Human life and health;
- The environment;
- Assets belonging to GNGC
- Maintenance of normal operations on site.

9.3.2 Key Emergency Response Systems

Some of the key systems to be instituted to enhance emergency response include:

- ***Emergency Communication System***

In the event of an emergency, communications shall be via the use of UHF radio, mobile phones, and shouting. A siren should be available to alert staff. A list of emergency contact numbers will be provided and will be posted on site notice boards. The appropriate emergency service shall be notified immediately in the event of an emergency. Some of the key emergency service contacts will include the nearest Ghana National Fire Service station, Ghana Police Service station, National Disaster Management Organization (NADMO) office, Hospital, and ambulance service.

- ***Site Register***

The company shall ensure it keeps an active register of workers, subcontractors, and visitors who report to the site. It will be a key requirement prior to entering the site. This register shall be used to ascertain numbers of persons present on site during roll calls for evacuation procedures.

- ***Assembly Point***

The company shall choose a primary assembly point in a location that is deemed safe should an emergency occur. This earmarked location shall be boldly signposted with the green/red Assembly Point sign. In the event that this assembly point is not appropriate then the HSE Manager shall nominate a second assembly point. The location of these assembly points shall be communicated to all workers and visitors during the site induction. For site work, the work group leader of each work group shall nominate the local assembly point and inform the HSE Officer and members of the work group.

- ***First Aid Facilities***

First aid facilities shall be located in every work vehicle and in the facility. First aid kits shall be easily accessible and left unlocked at all times. First aid kit locations and trained first aiders and contact numbers shall be displayed on site notice boards. First aid kits shall be kept clean and checked and restocked as necessary.

- ***Fire Equipment***

Fire-fighting equipment shall be located in every work vehicle and in the site office(s). Fire-fighting equipment shall be easily accessible at all times. Fire-fighting equipment locations and trained fire personnel and contact numbers shall be displayed on site noticeboards. Fire-fighting equipment shall be tested and tagged by a competent person every six months. Used fire extinguishers shall be promptly removed from service and replaced immediately with a full replacement.

9.3.3 Emergency Response Team and Responsibilities

The management of GNGC shall set up an Emergency Response Team (ERT). The management will appoint qualified personnel to be members of the team. The management will also make provision for the necessary administrative and logistics support to enhance the effectiveness of the Emergency Response Team.

The ERT shall consist of the HSE Officer, Plant Manager, Quality Control Officer and the Maintenance Engineer. The Emergency Response Team will be required to meet regularly and subject the Provisional Emergency Response Plan to review and update their knowledge of emergency responses.

Table 9.4: Roles and Responsibilities of Emergency Response Team.

Position	Emergency Response Team Delegation	Responsibilities
Managing Director, General Manager and Plant Manager	Management	• Hire a consultant to develop a Provisional Emergency Response Plan • Provide adequate resources to support the developed plan • Appoint qualified personnel to be part of the Emergency Response Team to effectively implement and update this plan.
HSE Manager	Emergency Response Team Leader	• Lead the ERT to review and update the plan, at least annually • Establish relationship and open communication line with the nearest Ghana National Fire Service station, Ghana Police Service station, National Disaster Management Organization (NADMO) office, Hospital, and ambulance service, as well as calling for their assistance when required. • If available, lead the roll out of emergency response actions. • Ensure regular training for the Emergency Response Team and workers on topics such as Emergency Responses, First Aid, Raising Alarm, Emergency Communication, Fire fighting • Keep records of incidents and accidents. • Lead investigation of all incidents and accidents • Perform Emergency Drills and ensure emergency systems are functional • Receive suggestions for updating emergency response plan and making recommendations to management • Display emergency contacts at vantage points.
• Assistant Production Supervisor • Maintenance Engineer • Quality Control Supervisor	Emergency Response Team Members (Assistant Production Supervisor acts as Assistant Team Leader)	• Serve as principal contact persons for emergency actions • Performing out emergency response actions • Assist in emergency-related data collection as well as helping review and update the emergency response plan • Assist in investigation and reporting to external authorities • Assist the Emergency Response Team Leader to perform tasks assigned to the Team. • Ensure emergency signage and equipment are functional
All Workers	Staff	• Quickly reporting all incidents/accidents to the ERT • Follow laid down procedures in the event of an emergency • Attend training programs

9.3.4 Emergency Response Actions

1. **Fire Emergency**

Small fires

The following steps and process shall strictly be adhered to and carried out in the event of an emergency to put out a small fire:

- The first person to sight the fire must shout FIRE!! FIRE!! FIRE!! And or sound the fire alarm if possible
- Inform the nearest Emergency Response Team member or any person who has training in fire-fighting; but if trained in fire-fighting must immediately secure the closest fire extinguisher and attempt to put out the fire
- Tackle fire in its very early stages at the source;
- Always put your own and other people's safety first. Make sure you can escape if you need to and never let a fire block your exit;
- If attempts to put out fire are failing in 2 minutes, immediately call the nearest GNFS office for assistance and advise.
- If the situation is solved, investigate the reason for the fire and clean the place;
- Report to the Emergency Response Team Leader and ensure adequate information of the incident is provided so it is recorded .

Large Fires

These are fires that cannot be put out by the trained fire fighters and the GNFS will have to be called to fight it. The evacuation procedures to follow include:

- Person who discovers the fire must Shout FIRE! FIRE! FIRE! And or Sound Fire Alarm if possible
- Immediately report to the nearest ERT member, and or personally call the GNFS to report with accurate information and head to the safest assembly point.
- ERT member must immediately call the nearest GNFS station and proceed with evacuation procedures by picking the safest assembly point
- ERT member must check on workers and carry out a fast, calm and secured evacuation;
- A head count will be conducted to ensure all workers and visitors (if any) are safe and present;
- First Aid must be administered to slightly injured persons
- If injuries are severe, they must be conveyed to the nearest Health Centre in the shortest possible time.
- When fire has been put out, an investigation must be conducted and report submitted to management and the relevant government regulatory agency
- The event must be recorded.

2. Explosion

Immediate Actions:

A. Protect your own life

In the absence of any direction from an ERT member, use your best judgement to remove yourself from danger by evacuating to a safe well secured place or the designated assembly point.

B. Protect the life of your fellow student or staff member

Call the Emergency contact numbers

Alert others in your immediate area to the danger, and act together for the benefit of everyone. Collectively try to identify the safest escape route.

C. Evacuate

- Evacuate the building/area as instructed to do so by an ERT member.
- ERT members will be the primary vehicle for ensuring everyone is out of danger through visual checks (in rooms, toilets, stairwells and halls) on exiting and a situational awareness of who would generally be in the building and where.
- Walk quickly and calmly to the assembly area. This area should be **uphill** and **upwind** to avoid gas (you may need an alternative assembly area).
- Remain in the assembly area in groups until instructed to leave by Emergency Response Team, or Fire and Emergency Services personnel.

D. Fire fighting

A gas explosion has the ability to start secondary fires by lighting surrounding combustibles such as vegetation and buildings. Thus the fire outbreak response steps provided on Page 89 and Page 90 should be be followed effectively

3. Flooding

- Person who detects rising water level must immediately raise an alarm, notify the next available ERT member or other colleagues with training in Flood Response Actions, or follow the laid-out flood response actions (if available)
- The ERT member or trained person must immediately sound an alarm to announce emergency and ask everyone to remain calm and follow directive, then proceed to ensure all electrical equipment are switched off.
- ERT member must quickly pick the highest location or secured platform and request everyone to move to that place.
- ERT member must conduct a quick headcount to ascertain safety of workers and visitors (if any)
- ERT member must contact the nearest NADMO office for directive and convey persons away from the site.
- ERT must take records of the event and officially report to agencies such as EPA, NADMO and Factories Inspectorate Division.

4. Accidental Or Medical

In the event of any accident or injury, the following procedures should be followed.

- If victim can move, he/she must report to an ERT member.
- The HSE Manager or ERT member, who is trained in administering first aid, will treat the injury.
- The HSE Manager or ERT Member will decide if the victim needs further treatment at the Medical Centre

  and if so will arrange for the victim to be sent to the nearest health centre immediately.
- The HSE Manager or ERT Member will investigate and take records of the accident/injury including

  the source and cause of the accident/injury.
- If the accident/injury is such that the victim cannot move by him/herself but can be moved, the workers present should assist him/her to the next available ERT Member to administer first aid and arrange for the person to be sent to the nearest Health Centre immediately.
- If the accident/injury is such that the victim cannot be moved, the workers present should put him in a stable condition and immediately call the ERT Member. The ERT Member will immediately arrange for medical staff from the nearest Health Centre to be brought to the site to attend to the victim.
- All accidents and injury will be recorded by the ERT Member.

5. Oil Spill Response Procedures

These procedures refer to accidental spills or releases of all petroleum products such as fuel, lubricants, grease etc. The procedures to follow include the following.

- Person who identifies the spill must quickly notify the next available HSE Committee member, trained person with knowledge in spill response actions or call GNGC Toll free 0800011095/0243200228.
- HSE Committee member and person who identifies spill must warn all persons nearby.
- HSE Committee member and trained person must turn off any ignition as burners, motors, and other spark-producing equipment
- HSE Committee member or person with spill response training must always assess the dangers of spill or release response first. If you cannot control and/or contain the spill without endangering your health or safety, then immediately call 192. If 192 service is not available in your area, call the fire service department. You should have these numbers
- HSE Committee member must control the source of the spill if possible: If there is a fire, be aware that spraying water on some chemicals can cause a chemical reaction that can make the situation worse. For small fires involving chemicals, use a fire extinguisher rated for all types of fires.
- Investigation must be carried out and Incident/Accident must be reported to the EPA.

NB: Small spills can be absorbed with paper towels or other absorbents. However, these materials can increase the surface area and evaporation rate, increasing the potential fire hazard if the material is flammable and airborne concentration reaches the flammability level.

A Spill Kit must be regularly available and should consist of but not limited to:

- Overalls
- Gloves
- Shoe protectors
- Glass or plastic collection container
- Plastic bags
- Wipes or paper towels
- Barricade tape

6. Chemical Spill Procedures

Emergency Actions

- Immediately alert area occupants and supervisor, and evacuate the area, if necessary.
- If there is a fire or medical attention is needed, contact GNFS and then the EPA
- Attend to any people who may be contaminated. Contaminated clothing must be removed immediately and the skin flushed with water for no less than fifteen minutes. Clothing must be laundered before reuse.
- If a volatile, flammable material is spilled, immediately warn everyone, control sources of ignition and ventilate the area.

Immediate Spill Response

- Wear personal protective equipment, as appropriate to the hazards. Refer to the Material Safety Data Sheet or other references for information.
- Consider the need for respiratory protection.
- The use of a respirator or self-contained breathing apparatus requires specialized training and medical surveillance. Never enter a contaminated atmosphere without protection or use a respirator without training. If respiratory protection is needed and no trained personnel are available, call the nearest healthcare facility, Red Cross or appropriate regulatory authority. If respiratory protection is used, be sure there is another person outside the spill area in communication, in case of an emergency. If no one is available, contact Public Safety.

- Using the chart below, determine the extent and type of spill. If the spill is large, if there has been a release to the environment or if there is no one knowledgeable about spill clean-up available, contact the nearest EPA office and GNFS for assistance.

Table 9.5: Reference for chemical spill handling

Category	Size	Response	Treatment
Small	up to 300 mL	chemical treatment or absorption	Neutralization or absorption spill kit
Medium	300 mL to 5L	Absorption	Absorption spill kit
Large	More than 5L	Call regulatory authority	Outside help

- Protect floor drains or other means for environmental release. Spill socks and absorbents may be placed around drains, as needed.
- Contain and clean-up the spill according to the table above.
- Loose spill control materials should be distributed over the entire spill area, working from the outside, circling to the inside. This reduces the chance of splash or spread of the spilled chemical. Bulk absorbents and many spill pillows do not work with hydrofluoric acid.
- Many neutralizers for acids or bases have a color change indicator to show when the spill is neutralized.
- When spilled materials have been absorbed, use brush and scoop to place materials in an appropriate container. Polyethylene bags may be used for small spills. Five gallon pails or 20 gallon drums with polyethylene liners may be appropriate for larger quantities.
- Complete a hazardous waste sticker, identifying the material as Spill Debris involving XYZ Chemical, and affix onto the container. Spill control materials will probably need to be

disposed of as hazardous waste. Contact the EPA CCMC for directives on how to safely disposal.

- Decontaminate the surface where the spill occurred using a mild detergent and water, when appropriate.
- Report all spills to the appropriate authorities and regulators

7. Fire or Explosion from Chemicals

1 Fire or explosion may occur from overheating, leakage, or spillage of flammable chemicals, or gases exposed to excessive heat, an open flame, or electric sparks in the laboratory. Be careful when working with flammable or explosive chemicals and avoid heat or electric sparks nearby. Safely operate electric equipment and any source of heat to prevent fire or explosion.

2 In case of a fire involving an individual's clothing, do not run since it might accelerate the fire. Stop, drop onto the ground with hands covering the face, and roll to extinguish the fire. If possible, use the safety shower to extinguish the fire.

3 In case of a lab fire or explosion, ensure your safety first and call emergency responders immediately for help.

4 Evacuate the building safely and pull fire alarms or notify nearby people, if possible.

5 Don't use elevators. Use stairs and locate the nearest exit.

6 If possible, shut down the electric power before evacuating.

7 Use a wet towel to cover the mouth and nose, if there is heavy smoke.

8 In case of a small fire, use a proper fire extinguisher and make sure an easy exit is available if you fail in extinguishing the fire. Here we listed the types of extinguisher and discussed the circumstances in which each extinguisher type should be used.

Types of fire.

Class A: Ordinary combustible solids such as paper, wood, clothes.

Class B: Flammable liquids such as petroleum oil and paint; and flammable gases such propane, methane and butane.

Class C: Electrical equipment such as appliances, motors.

Class D: Combustible metals such as sodium, aluminum and potassium.

Class K: Cooling oil and greases such as animal or vegetable fats.

Types of extinguisher.

Water and Foam: for Class A fires only. Not suitable for class B or C fires. Water and foam extinguish fire by reducing the heat and the foam helps to separate oxygen from the objects.

Carbon Dioxide: for Class B and C fires. Not effective for Class A fire. Carbon dioxide extinguishes fire by separating oxygen from the object and removing heat.

Dry Chemical: multipurpose dry chemical works for Class A, B and C and ordinary dry chemicals works for Class B and C only. Dry chemical extinguishes fire by interrupting the chemical reaction.

Wet Chemical: for Class K fire only. Wet chemical extinguishes fire by removing heat and separates oxygen from fuel elements.

Clean agent: for Class B and C. Clean extinguishers used halon or halocarbon agents to interrupt the chemical reactions.

Dry Power: for Class D only. Dry power takes away heat and separates oxygen to extinguish fire.

9. Be safe first and help others if possible.

10. Be aware of a second fire or explosion.

10.0 DECOMISSIONING PLAN

10.1 Decommissioning Process

Decommissioning would entail removal of project facilities and restoring the land to an acceptable condition for its subsequent use. The costs involved will be the responsibility of the management of GNGC. The activities and strategies involved in this phase shall follow the 3Rs hierarchy (reduction of the amount of waste generated, reuse of materials and recycling of any material, where possible). The following activities shall be implemented:

Storage Spheres/Tanks

The storage spheres shall be emptied and a company shall be contracted to to undertake tank cleaning and disposal of all sludge.
The shall be removal of the tanks from site and movement to a proper location for storage.

Cylinder Filling Line

The cylinder filling line shall be uninstalled and moved off site to an EPA Permitted storage yard.

Piping, Valves and Pumps

Pipes will be cleaned using PIG (Pipe Inspection Gadget) technology to ensure there is no hazard for for fire and explosion.
Safe measures shall be adopted to properly remove piping, valves and pumps from their positions and moved to a safe location for storage.

Buildings

Buildings and furniture shall be handed over to the local municipality or sold to an interested investor.
Where there are concrete floorings, these will be removed, transported offsite via dump trucks and given out for reuse as refilling materials.

Access Routes

The access roads would be allowed to naturally regenerate. Access roads may also be allowed for peasant farmers to access their farms and serve as roads to transport their farm produce. This is not expected to have residual adverse impacts on the land.

Energy Source

Electrical installations will be removed accordingly and sold to secondary users where required.

10.2 Environmental Management/Monitoring for the Decommissioning Phase

Table 10.1: Decommissioning Environmental Management Plan

Issues	**Recommended Mitigation**	**Responsible Party**	**Time Frame**	**Budget (GHS)**
Scraps and other debris on site	Use of an integrated solid waste management system i.e. through a hierarchy of options: Wastes generated as a result of facility decommissioning activities will be characterized in compliance with standard waste management procedures. The contractor based on the properties of the particular waste stream will select disposal locations. All buildings, machinery, equipment, structures and tools that will not be used for other purposes should be removed and recycled/ reused say in other projects Where recycling/reuse of the machinery, equipment, implements, structures, tools and other waste is not possible, the materials should be taken to an approved dumpsite.	Project Manager and Contractor	One-Off	85,000.00
• Vegetation Disturbance • Land Deformation	Implement an appropriate re-vegetation programme to restore the site to its original status During the re-vegetation period, appropriate surface water runoff controls will be taken to prevent surface erosion; Monitoring and inspection of the area for indications of erosion will be conducted and appropriate measures taken to correct any occurrences; Fencing and signs restricting access will be posted to minimize disturbance to newly-vegetated areas;	Project Manager and Contractor	One-Off	45,000.00
Occupational Hazards	Ensure that safety measures have been effectively integrated and positioned in respective areas of the project to control and manage fire outbreaks The safety of the workers should surpass as a priority of all other objectives in the decommissioning project	HSEQ Manager and Contractor	During Decommi ssinong	150,000.00

10.3 Guidelines for Decommissioning

In the event of decommissioning, the company shall follow the requirements specified in Ghana's Environmental Guidelines. A responsible approach as scheduled below shall be used in the event of decommission.

- A work plan/procedure for the decommissioning process shall be developed and circulated amongst the workforce and relevant stakeholders.
- A decommissioning permit shall be obtained from the EPA
- Consultations shall be held with all relevant institutions such as GNFS, FID and NADMO to ensure their inclusion for a safe decommissioning process.
- Notification and consultation of nearby neighbours.
- Plant, machinery and equipment that have not depreciated beyond recovery shall be dismantled and moved off the site to a secure location.
- Materials that have completely depreciated shall be sold to interested licensed scrap dealers.
- Adequate reclamation and site closure procedures shall be done to revert the site to its previous form as much as possible.
- The company shall negotiate with the Nzema East Municipal Assembly and other stakeholders, for a smooth transfer of all immovable assets to the local authority.

11.0 CONCLUSION

The Management of GNGC proposes to construct and operate an LPG Bottling Plant at Axim in the Nzema East Municipality of the Western Region of Ghana.. In line with the requirements of the Environmental Protection Agency, this Environmental Impact Statement has been prepared and the report is deemed to have adequately identified potential impacts of the project on the physical, biological and socio-economic/cultural environments, occupational safety, health and welfare of the employees. The report has also proposed mitigation measures to minimize/ eliminate the negative impacts, taking into consideration: cost, feasibility and practicability. A review of the identified impacts shows there will be some regular significant impacts on the environment (e.g. traffic, air quality, noise, generation of solid waste and liquid waste etc. during the development and operational) whilst others will be minimal, intermittent and local in nature.

The project cannot be carried out without any impacts on the environment since some impacts are unavoidable. However, the mitigation measures proposed are expected to be able to minimize the impacts so as to make them pose no threats to the continued sustainability of the environment.

The report has also identified the benefits of the proposed project and categorically that the project will help to increase the socio-economic activity in the area thus it will be beneficial on a national scale as the project will have a positive impact on meeting the nation’s industrialization objective.