



**Environmental Impact Assessment (EIA) for the Ghana National Gas Limited Company (GNGLC) Second Train Gas Processing Plant (GPP2) Proposed Construction and Operation at Atuabo.**

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## Environmental Impact Assessment (EIA)

**For**

### The Ghana National Gas Limited Company (GNGLC) Second Train Gas Processing Plant (GPP2) Construction and Operation

**At**

**Atuabo, Ellembelle District.**

February 2024

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## ABBREVIATIONS AND ACRONYMS

AIS	Atuabo Initial Station
AFC	African Finance Corporation
API	American Petroleum Institute
BLEVE	Boiling Liquid Expanding Vapor Explosion
BVS	Block Valve Station
CESMP	Construction Environmental and Social Management Plan
CHPS	Community Health Planning and Services
CDP	Carbon Disclosure Project
COP	Conference of Parties
COVID	Corona Virus Disease
CSR	Corporate Social Responsibility
DCS	Distributed Control System
EESL	Ecosystem Environmental Solutions Limited
E.I.	Executive Instrument
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EDA	Ellebelle District Assembly
EHS	Environmental Health and Safety
EMP	Environmental Management Plan
EPC	Engineering Procurement Construction
EPA	Environmental Protection Agency
ERM	Environmental Resources Management
ESDV	Emergency Shutdown Valve
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
FEED	Front End Engineering Design
FERA	Fire and Explosion Risk Assessment
FPSO	Floating Production Storage and Offloading
GDP	Gross Domestic Product
GIIP	Good International Industry Practice
GMA	Ghana Maritime Authority

GMMB.	Ghana Museum and Monuments Board
GMet	Ghana Meteorological Agency
GNGLC	Ghana National Gas Limited Company
GoG	Government of Ghana
GPHA	Ghana Ports and Harbours Authority
GPP	Gas Processing Plant
GSA	Ghana Standards Authority
GSS	Ghana Statistical Service
HIPPS	High Integrity Pressure Protection System
HIV	Human Immunodeficiency Virus / Acquired Immunodeficiency Syndrome
HSE	Health, Safety and Environment
HR	Human Resource
IAIA	International Association of Impact Assessment
IFC	International Financial Corporation
IFI	International Financial Institutions
JMI	John Moore International
IPCC	Intergovernmental Panel on Climate Change
JT	Joule Thomson
LOC.	Loss of Containment
LPG	Liquefied Petroleum Gas
LSIR	Location Specific Individual Risk
L.I.	Legislative Instrument
MMSCFD	Million Standard Cubic Feet per Day
MoU	Memorandum of Understanding
NEPAD	New Partnership for Africa's Development
NGL	Natural Gas Liquid
NPA	National Petroleum Authority
OAU	Organisation of African Unity
OEL	Odun Environmental Limited
OHS	Occupational Health and Safety
OPD	Out-Patients Department
PAPs.	Project Affected Persons
PS	Performance Standards
PHS	Public Health and Safety

PNDC	Provisional National Defence Council
PPE	Personal Protection Equipment
PPGPL	Phoenix Park Gas Processors Limited
QRA	Quantitative Risks Assessment
RoW	Right of Way
SCADA	Supervisory Control and Data Acquisition
STD	Sexually Transmitted Disease
TEN	Tweneboa-Enyenra-Ntomme
ToR	Terms of Reference
TCFD	Task Force on Climate-related Financial Disclosures
TICO	Takoradi International Company
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organisation
VRA	Volta River Authority
WBG	World Bank Group
WRC	Water Resources Commission

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# **EXECUTIVE SUMMARY**

## **INTRODUCTION**

Ghana National Gas Limited Company (GNGLC), also referred to as Ghana Gas, is a limited liability company with the mandate to own, manage, and develop a national network of gas pipelines, processing plants, and storage facilities. It is Ghana's first mid-stream gas business company and was incorporated in July 2011. The first phase of the Gas Processing Plant (GPP), Train 1, and associated facilities were installed in November 2014 at Atuabo in the Ellembelle District of the Western Region. The GPP Train 1 treats the raw feed dense phase gas from the Jubilee and Tweneboa-Enyenra-Ntomme (TEN) Fields- into Lean Gas, Liquefied Petroleum Gas (LPG), and Condensate (Natural Gasoline and traces of iso-pentane).

To meet the rising demand for its products, Ghana Gas intends to develop an extension of the GPP Train 1 in a second phase through the construction and operation of a second train of the GPP on a plot of land to the west of the existing Train 1 in Atuabo. The justification for the proposed extension is based on the energy policy of Ghana, which stipulates that the country's total energy supply has to grow significantly to support the development agenda goal. There is thus the need to increase the energy supply and expand the energy infrastructure in the country in a sustainable way. The goals of the petroleum sub-sector are to ensure, among others, the sustainable exploration, development, and production of Ghana's oil and gas and the indigenisation of the process.

To ensure legal compliance with Ghana's Environmental Assessment Regulations 1999 (L.I. 1652), Ghana Gas has initiated the process of securing an Environmental Permit for the project by registering the proposed undertaking with the Ghana Environmental Protection Agency (EPA). A response from the EPA stated that the proposed extension falls within the category of undertakings that requires an Environmental Impact Assessment (EIA). Ghana Gas has therefore contracted Ecosystem Environmental Solutions Limited (EESL) to carry out the EIA on her behalf.

An EIA is a process to identify, predict, and evaluate the environmental and social impacts of proposed activities or projects. It analyses the positive and negative impacts of the activity to:

- Provide information for decision-making by regulators, the public, and host communities on the environmental and social consequences of proposed undertakings.
- Promote sustainable environmental and socio-economic development through the identification of appropriate enhancement and mitigation measures.

The Environmental Impact Assessment was carried out using the following approach and methods:

**i. Literature Review:** The Consultant assembled and analysed data and information on the proposed project and the relevant environmental and socio-economic characteristics of the project area. Data and information were obtained from Ghana Gas and such sources as the Council for Scientific and Industrial Research, EPA, and Ellembelle District Assembly. The consultant also analysed the key policy, legislative and regulatory, and administrative/institutional frameworks relevant to the proposed project.

**ii. Scoping Exercise:** The Consultant organised a field visit to the project area at Atuabo and its environs, between 04 and 10 July 2021 with the objectives of informing the public about the proposed expansion of the activities of GNGLC and identifying the main stakeholders and their concerns and appreciation of the project. A draft Scoping Report with the Terms of Reference for the EIA was presented to the EPA on 14 September 2021. Comments received from EPA on the report dated 06 October 2021 requested the Consultant to, among others, proceed with the EIA.

**iii. Baseline Studies:** Following EPA's approval of the Scoping Report, the Consultant undertook another field trip between 03 and 08 April 2022 to the project area for further collection of baseline data and information. The field visits during stakeholder consultations and for data collection provided the opportunity for the Consultant to get acquainted with the project site and its area of influence and make observations and measurements on the natural and socio-economic resources of the project area resulting in the following baseline studies:

- Climate and air quality.
- Noise levels.
- Water resources.
- Fauna and Flora.

- Socio-economic status.

**iv. Identification and Evaluation of Potential Impacts:** The method involved matching the various activities under the different phases of the proposed project with the environmental and socio-economic components. Subsequently, the potential impacts were identified and evaluated based on legal and regulatory requirements, the magnitude of the impacts, the risk posed by impacts, public perception, and the importance of the affected environmental and socio-economic components.

**v. Mitigation of Potential Negative Impacts:** From the identification and evaluation of potential impacts, actions to be instituted by Ghana Gas to mitigate the moderate and significant potential negative impacts on the environmental and socio-economic components in the various phases of the project were proposed. It is noted that GPP Train 1 has been in existence since 2014 and has operated without any major disaster. Since Train 2 is an extension of Train 1 and is in the same area, mitigation measures that have been used successfully for Train 1 have also been proposed for the operations of Train 2. In addition, a Provisional Environmental Management Plan to be used to manage the operations of the GPP Train 2 has been formulated for the first 18 months.

Pursuant to the submission of the draft EIS document to the EPA, the agency's review, and comments and the Consortium's review, it became necessary to conduct a gap assessment on the draft EIS to address the EPA comments as well as update the EIS in accordance with the IFC Performance Standards and Equator Principles. To this end, the Consortium appointed Odun Environmental Limited (OEL) to conduct the gap assessment and associated studies, address the EPA comments and update the EIS in accordance with the IFC Performance Standards and Equator Principles requirements.

## **POLICY, LEGAL AND INSTITUTIONAL FRAMEWORKS**

The key national policies relevant to the proposed gas processing plant include the following:

- The Constitution of Ghana, 1992.
- National Environment Policy, 2012.
- National Energy Policy, 2010.

- Health, Safety, and Environmental Policy for the Energy Sector, 2016.
- Local Content Policy in the Oil and Gas Sector, 2010.
- National Land Policy, 1999.
- National Water Policy, 2007.
- Riparian Buffer Zone Policy. 2013.
- National Climate Change Policy, 2013.

The relevant environmental and social-economic legislation and standards/guidelines include:

- Environmental Protection Agency Act, 1994 (Act 490).
- Environmental Assessment Regulations, 1999 (L.I. 1652).
- Environmental Assessment (Amendment) Regulations, 2002 (L.I. 1703).
- Fees and Charges (Miscellaneous Provisions) Act, 2022 (Act 1080)
- Ghana Environmental Quality Standards.
- National Petroleum Authority Act, 2005, (Act 691).
- Energy Commission Act, 1997 (Act 541).
- Ghana National Fire Service Act, 1997 (Act 537).
- Administration of the Lands Act, 1962 (Act 123).
- State Lands Act, 1962 (Act 125).
- Labour Act, 2003 (Act 651).
- Water Resources Commission Act, 1996 (Act 522).
- Water Use Regulations, 2001 (L.I. 1692).
- Lands Commission Act, 2008 (Act 767).
- Local Governance Act, 2016 (Act 936).
- Factories, Offices and Shops Act, 1970 (Act 328).
- Hazardous and Electronic Waste Control and Management Act, 2016 (Act 917).
- Hazardous, Electronic and Other Waste (Classification) Control and Management Regulations, 2016 (L.I. 2250).
- Natural Gas Distribution and Sales (Technical and Operational) Rules, 2007 (L.I. 1911). (Standard of Performance) Regulations, 2007 (L.I. 1912).
- Natural Gas Transmission Utility (Technical and Operational) Rules, 2007 (L.I. 1913). (Standards of Performance) Regulations, 2008 (L.I. 1936).

- Natural Gas Pipeline Safety (Construction, Operation, and Maintenance) Regulations, 2012 (L.I. 2189).

Key international conventions and requirements applicable to the proposed project include:

- Convention on Biological Diversity, 1992.
- United Nations Sustainable Development Goals,
- United Nations Convention on the Law of the Sea, 1982.
- Convention for the Prevention of Marine Pollution from Land-based Sources, 1974.
- Convention for Wetlands of International Importance, 1971.
- The Paris Agreement, 2015.
- International Labour Organization (“ILO”) conventions covering Core Labour standards.
- Kyoto Protocol.
- United Nations (UN) Convention on Biological Diversity.
- UN Framework Convention on Climate Change.
- Convention on the Control of Trans-Boundary Movements of Hazardous Wastes and their Disposal (Basel Convention).
- Convention on the Conservation of Migratory Species of Wild Animals.
- Convention on the Conservation of Migratory Species (CMS).
- Montreal Protocol on Substances that Deplete the Ozone Layer.
- Convention Concerning the Protection of the World Cultural and National Heritage (World Heritage Convention).
- African Convention of Conservation of Nature.

Key international environmental and social standards applicable to the proposed project include:

- International Finance Corporation (IFC) Performance Standards (PSs).
- Equator Principles.

## **PROJECT DESCRIPTION**

### **Location and Land Acquisition**

The Ghana Gas GPP Train 2 is to be situated on the West side of the existing Train 1 facilities. Train 1 is located at Atuabo about 300 m to the North of the shores of the Gulf of Guinea. The

land for both GPP Train 1 and Train 2 has been acquired by Ghana Government's Executive Instrument, E.I. 51, 2014. Compensation has not been paid for the land however, it was noted during the additional stakeholder engagement that there is an ongoing court case to determine the rightful ownership of the entire GPP land however, the land litigation process has protracted. It is therefore recommended that management of GNGLC work together with the traditional authorities in the area to resolve the land litigation issue and pay the appropriate compensations.

### **Project Components**

The new GPP Train 2 will process dense phase gas from the Jubilee field (up to 100 MMSCFD) and TEN fields (up to 50 MMSCFD) using the same offshore gas supply and sales gas pipelines as the existing 150 MMSCFD-capacity GPP Train 1. In addition, the new train will be capable of processing up to 50 MMSCFD of dense phase gas from new fields (Aker) currently under investigation. Thus, the combined gas treatment capacity at Atuabo will be 350 MMSCFD on completion of Train 2.

The dense gas with natural gas liquid (NGL) will be treated and fractionated into propane (C3), butane (C4), pentane (C5), and stabilized condensate (C5+) components. The lean gas containing methane (C1) and ethane (C2) will be tied-in with the lean gas export from Train 1 and delivered into the onshore export pipeline to the existing Aboadze and Prestea power generation enclaves. The separated pure components C3 and C4 will be stored in their respective storage spheres and may be further blended as per internal market demand. The remaining C4+ components will be further fractionated to obtain a pentane/isopentane mixture (C5) and a stabilized condensate (C5+). Due to its low market value, the C5 mixture stream will be used preferably as fuel within the GPP Train 2 facilities, mainly for heaters. The stabilized condensate (C5+) will be sent to storage and then dispatched to the existing condensate loading station at the existing GPP Train1 facilities.

The new Train 2 plant will be composed of the following main process units:

- Unit 01 - Reception Facilities;
- Unit 10 - Inlet Separation and Fuel Gas System;
- Unit 20 – Chilling, Deethanization & Recompression;
- Unit 30 - Fractionation;
- Unit 40 - Dehydration;

- Unit 42 – Products storage and delivery.

The main auxiliary components are:

- Wastewater and stormwater management and drainage.
- Firewater system.
- Solid waste management.
- Venting and Flaring.

Fresh water for use on site, including potable use, will be provided from boreholes to be installed by the project. Electricity will be obtained by gas-powered generators on site.

## **CONSIDERATION OF ALTERNATIVES**

### **Siting of the Proposed Train 2 Gas Processing Plant**

The land on which GPP Train 1 is in Atuabo was acquired by a Ghana Government Executive Instrument (E.I. 51) in 2014. GPP Train 2 is to be constructed on the same piece of land next to the present location of Train 1. The Atuabo enclave was selected from amongst a total of five locations based on the following:

- Proximity to the Jubilee field.
- Availability of land to allow for future expansion and serve as relief land.
- Sparseness of population to minimise resettlement.
- Minimisation of cross-border issues.
- Constructability (minimum clearing and levelling of land).

Three of the above factors were in favour of Atuabo, which allowed it to be selected. These were minimisation of cross-border environmental issues, constructability, and sparseness of population. However, there has been a sharp rise in the population of the three communities fringing the GPP Train 1 (Atuabo, Asemnda, and Anokyi), referred to as the A3 communities, since 2010 because of the influx of people looking for jobs and opportunities associated with the operations of the GPP. Although the present location of Train 1 does not have as much land to serve as a relief compared to the other areas considered, an option that may be considered concerning the location of Train 2 is the inclusion in the design, the creation of a vegetative

buffer zone between the Asemnda community and the site for Train 2. Furthermore, acceptance of the location of Train 2 within the communities will improve if GNGLC accelerates the completion of issues on payment of compensation.

### **Resettlement of Nearby Communities or Relocation of GPP Train 2 (QRA/FERA/FRA)**

According to the Community Affairs Corporate Social Responsibility Policy of GNGLC, the GPP Train 2 was carefully planned to avoid the need for resettlement. It was observed during the scoping exercise that although concerns were raised about the closeness of the proposed site for Train 2 to the communities and the resulting safety issues, the issue of resettlement of the people of the A3 communities did not come out strongly. Although safety is the most paramount factor and it is not the communities that should have the final decision on whether they should be relocated or not, their main concerns were more to do with compensation for loss of land and crops, job security, signing of an MoU, improvement in drainage, and provision of emergency assembly points.

This is in addition to the proposal above to include in the zoning of the project area, a vegetative buffer area between the Asemnda community and the site for Train 2. Furthermore, rearrangement of the components of the proposed GPP can ensure that those closest to the nearby communities are the least dangerous. GNGLC's policy also states that, in the unlikely event that resettlement may be required, an independent valuation institution will be contracted to provide estimates on a replacement cost basis, and a resettlement programme will be instituted, which will include the formation of a special committee, whose members will be from within the community.

The option of relocation of Train 2 will result in major negative impacts, the key ones of which will be project delays and resulting negative economic impacts, considering the high demand for GNGLC's products. The search for a new location may take several years and have costly financial implications concerning land acquisition and payment of different types of compensation as well as linking the existing Train 1 to the new Train 2. Other difficulties include possible new or unanticipated environmental and social impacts and the inability to link efficiently with existing partners.

However, based on economic and physical displacement according to the IFC PS 5, there wouldn't be the need to resettle the closest community (Asemnda) to the proposed GPP2. A

Resettlement Scoping was conducted during the additional stakeholder engagement between October 9<sup>th</sup> to 23<sup>rd</sup>, 2023 and it emerged that the GPP enclave land acquired by the GoG, E.I. 51, 2014 had only farms at certain portions and GNGLC paid crop compensation to the farm owners who were not landowners. Moreso, there is a land dispute over the ownership of the GPP enclave which is being settled in court. GNGLC is committed to paying for the land once there is resolution and the land dispute is settled.

In addition to the Resettlement Scoping, Quantitative Risk Assessment (QRA) and Fire and Explosion Risk Assessment (FERA) were conducted to quantify and assess the fire and explosion risks of the proposed GPP2. The outcome of both studies indicates that Location Specific Individual Risk (LSIR) depicting the geographical distribution of risk puts Asemda at the least risk level in the event of fire and explosion at GPP2. Specifically, the modelled fire and explosion risk ascertained that there is one chance in 1,000,000 of being killed per year at Asemda if there should be fire and explosion at GPP2 (see Section 7.4.2).

### **The Need for Expansion**

There is ample justification for the expansion. For example, Ghana has discovered more oil and gas reserves in the recent past. Thus, apart from the Jubilee field, GNGLC currently receives dense gas feed from the TEN fields and more sources are expected to be available in the future. In addition, as Ghana's economy continues to expand and diversify, there is rising demand for GNGLC's products. These products will facilitate the anticipated expansion of industrial activities such as the Ghana Government's Petroleum Hub and will also directly support the achievement of the goals of Ghana's energy policy while creating many direct and indirect jobs.

### **Process Technology**

The GPP Train 2 will use new and improved technology to increase efficiency and diversify its end products. Thus, compared to Train 1, the new process technology will enable Train 2 to have:

- Higher recovery of LPG components using a turboexpander and the associated feed gas treatment requirements.
- LPG fractionation facilities (depropanizer and debutanizer columns) to allow separate propane and butane products.
- Pentane product in the liquid phase.

Just as for GPP Train 1, flaring of mainly iso-pentane will continue to guarantee the safety of the plant. Efforts will be made to expedite actions to seek potential users to utilise the gas being flared.

## **BASELINE INFORMATION**

### **Physical Environment**

Topographically, the project area is generally low in altitude. The land rises from the sea level to 137 m to the north in an undulating manner. The soils of the proposed project site belong to the Fredericksburg Association, which predominantly comprises the Krisin series, Fredericksburg Series, Princess Series, Assini Series, Atuabo Series, and Esiana Series. The proposed site lies in the extreme West of the coastline of Ghana and falls within the South–Western Equatorial Climatic Zone in Ghana, which experiences a bimodal rainfall pattern. The major season begins in March and peaks in June while the minor rainfall occurs between September and the middle of December. The general wind direction is predominantly South–West, which means the winds originate from the Gulf of Guinea.

Baseline studies on air quality showed that for Total Suspended Particulates, concentrations higher than or close to the Ghana Standards Authority (GSA) standards were observed at various locations in the project area. Overall, the highest concentrations of particulates occurred at Anokyi, which is located about 0.43 km southeast of GPP Train 1. The concentrations of all the noxious gases were however below their respective GSA standards. The results also indicated that noise levels in most of the communities were slightly above or below the GSA standard for residential areas during the day. Concerning the GPPs, noise levels recorded at both Train 1 and Train 2 sites were below the GSA standards for light industrial areas during the day and at night.

The Ellembele District is largely drained by the Southwestern Rivers System. The prominent river is the Ankobra with its major tributaries like the Ahama and Nwini Rivers. Indeed, the proposed project site is wholly drained by the Amansuri River in the south-western part and some other minor rivers and streams such as rivers Broma, Nobaya, and Amanzule; other minor rivers that drain the proposed site include the Ebi and Fia Rivers. Just as for GPP Train1, the Amansuri River will be the main surface water body that will potentially be impacted by the

operations of the proposed GPP Train 2. This river empties into the Amansuri lagoon which drains to the sea.

The results of physicochemical analyses of selected surface waters, including seawater, did not reveal any clear patterns. While the waters were slightly acidic and turbid, the presence of faecal coliform and *Escherichia coli* renders them unfit for direct human consumption and for primary contact activities such as swimming. Bacteriological analyses of groundwaters also showed the presence of faecal coliforms in five of the six locations studied.

### **Biological Environment**

In the wet semi-equatorial climate zone where the proposed project is located, the general vegetation comprises wet evergreen – moist evergreen forests in the south and moist semi-deciduous rain forest in the northern sections with a coastline stretching up to about 70 km and comprising patches of savanna vegetation. Thus, the general ecosystem of the project area is comprised of wetlands categorized into swamps with open broadleaved forest cover that are regularly flooded by fresh-brackish waters.

The natural vegetation of the Ellembelle District is comprised of such typical tree species as the African Walnut, *Coula edulis*; *Cynometra ananta*; Akadan *Cola chlamydantha*, Tenanfera *Cola umbratilis*, and Cherry Mahogany *Tieghemelia heckeli*; that form the principal timber species. In areas that are perennially flooded, Raffia Palm *Raphia hookeri*, and the herb *Cyrtosperma senegalense* are common. Further south towards the coast, on lands that are seasonally flooded can be found short grasslands such as *Panicum sp.*, *Setaria anceps*; *Hyparrhenia mutica*, among others, interspersed with various herbaceous and shrub species including *Tridax procumbens*; *Centrosema sp.* and *Chlomolaena odorata*. On lands that are permanently flooded where there is a mixing of fresh and saline waters red mangroves – *Rhizophora harisonii*; *Rhizophora mangle*; and *Rhizophora racemose* are observed. Along the length of the beaches of the district, coconut plantations are observed to form the major vegetation cover of the coastline.

The present vegetative cover of the proposed GPP Train 2 site does not reflect the natural vegetation type described above. The site is comprised of a mosaic of grassland and thicket interlocked with swamps of freshwater forests. The main species include Borassius Palm *Borassius aethiopium*; grass species of *Panicum*; *Setaria*; *Hyparrhenia* and *Anadelphia*.

Strands of Oil Palm *Elaeis guineensis* and *Calophyllum sp.*, are found included in pockets of forest thickets scattered at the site. Clearly, the site represents a regrowth of previous vegetation following recent clearing.

Several species known to occur in the district are of both national and international conservation concern. These include primates, birds, tortoises and pangolins, reptiles including snakes, monitor lizards, and crocodiles. These animals enjoy various levels of protection under international and national wildlife laws. However, because of previous anthropogenic activities around the proposed site (construction of Train I, roads to settlements, and clearing of sites), many of the original fauna of the proposed project site have left the area. Thus, the fauna of the area reported include rodents and reptiles such as lizards and snakes and insects including crickets, cockroaches, mosquitoes, bees, and termites.

### **Socio-economic Environment**

The Ellembelle District is one of the 14 administrative Metropolitan, Municipal and District Assemblies in the Western Region of Ghana. It shares boundaries with the Jomoro Municipal to the West, Wassa Amenfi West and Central Municipals to the North, Nzema East Municipal to the East and the Gulf of Guinea to the south. The district capital is Nkroful. The district is richly endowed with human and natural resources including mineral deposits (gold, kaolin, and silica), oil and gas, fertile soils, rivers and streams, and a good climate that supports a tropical rainforest with a variety of timber species, and cash crops. However, the heavy and prolonged rains associated with the semi-equatorial climate adversely affect cocoa harvests, especially the drying of beans, and aggravate the black pod diseases that attack cocoa. In addition, all the un-tarred roads become almost unmotorable during the rainy season. The effects of this on the economy of the district are obvious.

Available data from the Ellembelle District Assembly show that the population of the district for 2021 is projected to be 112,705, comprising 52% female and 48% male. The three communities immediately fringing the GPP Train project site, Anokyi, Asemnda (also known as Asemnda Suazo), and Atuabo, are generally referred to as the A3 Communities. Available data showed that there was a sharp rise in the population of these communities between 2010 and 2018. This sharp rise could be due to the commencement of the operations of the GPP Train 1 in 2014 which saw many workers of the GNGLC coming in from outside the area. Apart from the sharp rise between 2010 and 2018, the population in the A3 Communities has

seen a steady rise since 2018. Ethnically, the Nzema constitute the largest group in the area with 80% of the population. The remaining are Fante (9%) Ewe (4%), Mole-Dagbani (4%) and Ga-Adangbe (3%).

Available records show that the major health concern of the Ellembelle District since 2011 has been malaria. Although the incidence of malaria has been decreasing steadily since 2011, together with skin diseases, the same cannot be said about rheumatism which has seen a steady increase. Upper respiratory tract infections follow malaria, in terms of incidence in the district. It saw a steady increase but has been declining since 2020. The incidence of HIV/AIDS however has been increasing since 2018 to the point where the Ghana Aids Commission identified the EDA as the district with the highest incidence of HIV/AIDS in the Western Region in 2020.

## **PUBLIC PARTICIPATION AND STAKEHOLDER CONSULTATION**

Ghana's Environmental Assessment Regulations, 1999 (L.I. 1652), requires that an EIA begins with a scoping exercise the report of which shall set out the scope or extent of the EIA. Thus, at the beginning of the EIA process, the Consultant held discussions with various stakeholders to seek their concerns and appreciation of the project. Consultations were held between 04 and 10 July 2021 in Atuabo and surrounding areas. Other stakeholders – Environmental Protection Agency, National Petroleum Authority, Volta River Authority, and Water Resources Commission - were also consulted in Accra.

Pursuant to the review of the draft EIS by the EPA and the gap assessment of the EIS by the Consortium, additional stakeholder engagements were conducted between October 9 – 23, 2023.

The discussions focused on the following issues, among others:

- Awareness of the public of the proposed project.
- Commitment by the project proponent to pursue best environmental practices.
- Impacts of the operation of Train 1.
- Location of the project with respect to other communities.

- Potential impacts on human health and socio-economic activities.

Table ES 1 below presents a summary of the concerns and appreciation of the stakeholders. The concerns are presented based on their ranking according to how many times they were raised or came up for discussion during the consultations:

### Concerns

The need for Ghana Gas to strengthen communication and increase public awareness of the project ranked the highest as it was raised twenty (20) times by various stakeholders. Requests for more support from GNGLC to improve facilities in both local communities and public institutions concerned with health, education, and security ranked the second highest (16). The need for increased employment of local youth and use of local content was the third highest (14) with the same ranking as concerns for human safety because of the proximity of the proposed Train 2 to the communities of Asemnda and Anokyi.

Table ES 1 Summary Ranking of Concerns

Rank	Concern/Issue	Total
1	Communication and awareness creation	20
2	Request for more support from GNGLC – hospital, schools, police, communities	16
3	Local employment / content	14
3	Proximity of GPPs and safety	14
4	Land and compensation issues	11
5	Loss of livelihoods	10
6	Flaring, heat, and other impacts	9
7	Agreement / Memorandum of Understanding	7
7	Flooding and drainage	7
8	Youth training/capacity building	6
9	Emergency Assembly Points and involvement of communities in safety drills	5
9	Peaceful co-existence	5
10	Cumulative impacts of Trains 1 and 2	4
10	Specialist studies	4

Rank	Concern/Issue	Total
11	Acquisition of permits and approvals	3
11	Use of permitted companies	3
12	Football Park at Anokyi	2
12	General security	2
12	Encroachment of RoW and GPP	2
12	Restoration of the footpath to Anokyi	2
12	Increasing cost of living	2
12	Increasing social vices	2

Other high-ranking concerns included land and compensation issues (11), loss of livelihoods (10), gas flaring and its perceived impacts (9), and the need for an Agreement or Memorandum of Understanding (MoU) with the 3 communities (Atuabo, Asemnda, and Anokyi) before activities associated with Train 2 begin (7). In addition, the possibility of increased flooding (7) in the communities, especially Asemnda, and the need for an adequate drainage system as well as the construction of emergency assembly points (5) were issues of major concern. Of note is the need for GNGLC to conduct specific specialised studies (4) and for the Consultant to take into consideration the cumulative impacts of both GPPs in the EIA study (4). For example, it has been proposed that GNGLC conducts specialised studies on emission modelling of the GPPs and quantitative risk assessment of possible explosions as well on the cumulative impacts of the two trains, especially on-air quality using different scenarios.

Other concerns, although of low ranking, are considered equally important because they are specific local issues. These include the replacement of the football park at Anokyi and restoration of the footpath between Anokyi and Asemnda. Many of these concerns can be tackled as part of preparatory activities before actual construction of Train 2 starts.

### **Appreciation**

In general, and despite the various concerns raised, all the institutions consulted commended GNGLC for its activities as a national strategic asset. Specifically, the Ellebelle District Assembly noted that GNGLC has supported its efforts to manage the COVID-19 pandemic and has also supported the development of roads, education, and health facilities in addition to

paying taxes. The Saint Martin de Porres Hospital at Eikwe indicated that it has a cordial relationship with GNGLC (especially its Health, Safety and Environment (HSE) Department) and the hospital has participated in simulation exercises with GNGLC in the past. The District Education Office is aware of the support that GNGLC is giving to educational development in the nearby communities.

## **IDENTIFICATION AND EVALUATION OF POTENTIAL IMPACTS**

The overall significances of the various impacts were assessed separately for the various phases of the project as presented below. Under the circumstances where GPP Train 1 will be in operation during the construction of Train 2, some of the potential impacts from construction activities may result in cumulative effects that will lead to increases in levels of pollutants, which are currently considered safe, to levels above their respective standard regulations. The same also applies to the post-construction period when both GPPs will be in operation and cumulative impacts will occur concerning air quality, noise, and surface water quality as well as occupational and public health and safety.

### **Pre-construction Phase**

Potential positive impacts of moderate or high significance:

- Employment opportunities from recruitment of workers.
- Business opportunities for local experts and contractors.
- Improvement in knowledge and understanding of the impacts of Trains 1 and 2 arising from specialist studies and the possibility of providing effective mitigation measures.
- Improvement in the local economy due to the settlement of compensation issues arising from the acquisition of land for the construction of Train 1.

Potential negative impacts of moderate or high significance:

- Risk of accidents leading to injury or loss of assets
- Inability to start Train 2 project without relevant permits and approvals.
- Impacts of COVID-19 pandemic.
- Social conflict and delays in the start of project activities due to the inability to settle compensation issues and inadequate consultation with stakeholders.

## **Construction Phase**

Potential positive impacts of high significance:

- Employment opportunities resulting in improvement in the local economy and community relations.

Potential negative impacts of moderate or high significance:

- Gas and dust emissions reducing air quality and causing occupational and public health problems.
- Increased soil erosion.
- Loss of flora and degradation of faunal habitats and ecosystem services.
- Excessive use of water resources.
- Improper disposal of liquid and solid wastes causing water pollution and occupational and public health problems.
- Impacts of COVID-19 pandemic.
- Risk of accidents during construction leading to injury or loss of assets.
- Influx of migrant workers leading to increased demand for services as well as public health and social problems.
- Inability to start construction without relevant permits and approvals.
- Increased vehicular traffic associated with the incidence of accidents and injuries.

## **Operations Phase**

Potential positive impacts of moderate or high significance:

- Employment opportunities resulting in improvement in local and national economies.
- Supply of processed gas for domestic consumption in the country.
- Replacement of light crude oil with natural gas for power production.
- Payment of taxes and other levies leading to improvement in local and national economies.
- Improved community relationships and improvement in local and national economies from Corporate Social Responsibility (CSR) activities.

Potential negative impacts of moderate or high significance:

- Soil, surface water, and groundwater pollution, and increased occupational and public health risks.

- Increased occupational and public health risks from flaring, air pollution at the ground level and in the atmosphere.
- Increased occupational and public health and safety risks, e.g., from noise and air emissions.
- Increased demand for resources for combined GPP Trains 1 and 2 operations.
- Impacts of COVID-19 pandemic.
- Inability to operate smoothly without relevant permits and approvals.

### **Decommissioning and Closure Phase**

Potential positive impacts of moderate or high significance:

- Employment opportunities resulting in improvement in the local economy.
- Business opportunities for local administrators and entrepreneurs.
- Restoration of floral and faunal habitats and improved biodiversity.

Potential negative impacts of moderate or high significance:

- Occupational and public health and safety risks, e.g., from noise and air emissions.
- Soil, surface water, and groundwater pollution.
- Increased erosion of soils.
- Loss of business opportunities dependent on Train 2 operations.
- Loss of jobs by employees of the project.
- Inability to start this phase without relevant permits and approvals.

### **Flood Risk Assessment**

The flood risk assessment was carried out to assess the flood risk to the proposed GPP2 from all sources of flooding, including coastal, groundwater, fluvial and pluvial flooding. Flood risk assessments are essential for ensuring the safety and continuity of operations at gas processing plants to minimize the environmental and safety risks associated with flooding. They are crucial for informed decision-making on plant and facility design, disaster and emergency preparedness and planning, and regulatory compliance. As part of the flood risk assessment, flood inundation simulation was conducted covering the towns of Atuabo, Asemnda and Anokyi using HEC-RAS. The current condition shows the drainage point just north of the existing GPP1 has a minimal discharge capacity with attenuation of 80 to 90% of the incoming flow.

The flow difference results to the water stored at the west side of GPP area leaving it inundated and swampy for an extended period.

The existing GPP1 was assessed not to be affected by flooding. However, it was observed that some areas in the Anokyi community are susceptible to flood with minor depths of 0.0 – 0.50 meters for the most extreme flood events. It is important to note that this scenario is not caused or intensified by the GPP facilities.

Furthermore, the proposed GPP Train 2 area clearly impedes the natural flow of water which will cause the inundation level at the western section of the proposed GPP2 project site, albeit within the GPP Enclave, to rise even higher. This will then affect GPP1 and expand the inundation area without proper drainage, thus impact assessed as significant without any mitigation measures.

### **Quantitative Risk Assessment and Fire and Explosion Risk Assessment**

As part of the specialist studies to ensure the sustainability of the GPP2 project and safeguard occupational and public health and safety in accordance with the IFC Performance Standard 3 &4, both Quantitative Risk Assessment and Fire and Explosion Risk Assessment were carried out to identify all relevant hazards and potential accident scenarios to be associated with GPP2, calculate and model the risk level in terms of location specific individual risks within the GPP2 and its immediate vicinity.

The outcome of both studies indicates that Location Specific Individual Risk (LSIR) depicting the geographical distribution of risk puts the most severe risks and hazards at only the GPP2 and GPP1 projects sites. This means that in terms of occupational health and safety, the fire and explosion risks at GPP2 is highly significant with one chance in 10 to one chance in 10,000 of being killed per year with jet fire, pool fire and flash fire.

On the other hand, the modelled LSIR puts Asemnda at the least risk level in the event of fire and explosion at GPP2. Specifically, the modelled fire and explosion risk ascertained that there is one chance in 1,000,000 to one chance in 10,000,000 of being killed per year at Asemnda if there should be fire and explosion at GPP2. This also means that there is no chance of being killed at Anokyi and Atuabo. Thus, in terms of public health and safety, the fire and explosion

risks of GPP2 to the A3 communities (Asemnda, Atuabo and Anokyi) is low with minor significance.

## **MITIGATION OF POTENTIAL NEGATIVE IMPACTS**

From the identification and evaluation of potential impacts, measures have been proposed to mitigate the moderate and significant potential negative impacts on the environmental and socio-economic components in the various phases of the GPP Train 2 project. It is noted that GPP Train 1 has been in existence since 2014 and has operated without any major disaster. Since Train 2 is an extension of Train 1 and is in the same area, mitigation measures that have been used successfully for Train 1 have also been proposed in addition to other measures for the operations of Train 2.

### **Pre-construction Phase**

*Occupational Health and Safety* - The HSE Department shall continue to insist on the observance of all recommended protocols by teams during field inspections and surveys as well as during consultations.

*Regulatory Requirements* – Ghana Gas shall be guided by all the relevant government policies and regulatory frameworks such as the National Energy Policy, Environmental Assessment Regulations, 1999 (L.I. 1652), and the National Petroleum Act, 2005 (Act 691).

*Settlement of Compensation Issues* – Ghana Gas shall liaise with the Land Valuation Division of the Lands Commission to ensure that all associated court matters are settled, and fair compensation is paid within a reasonable period.

*Consultation with Relevant Stakeholders* - Ghana Gas shall strengthen its general collaboration with the relevant District and Metropolitan Assemblies and their decentralised departments to increase awareness of the project and to plan and implement activities prioritised by the Assemblies. Also, based on its Community Affairs Corporate Social Responsibility Policy and Practice, and as recommended by other stakeholders, it shall continue consultations with the relevant stakeholders to sign an agreement with the A3 Communities.

Also, to help understand the real and perceived potential impacts of the operations of GPP Train 1 and its combined operations with Train 2, Ghana Gas and the Consortium have carried out the following specialised studies as recommended by various stakeholders particularly the EPA:

- Quantitative Risk Assessment of GPP2.
- Fire and Explosion Risk Assessment of GPP2.
- Flood Risk Assessment to mitigate potential flooding within the GPP Enclave.

### **Construction Phase**

According to GNGLC's revised Requirements and Procedures for Contractors, all Contractors are required to *'strictly comply with the Ghana Gas Occupational Health and Safety, Environmental Policies and shall take all reasonable steps to ensure good health and safety of all persons likely to be affected by the contracted scope of work and shall endeavour to avoid harm to the environment by the execution of the contract'*. Contractors are also expected to carry out all work in accordance with the relevant statutory legislation.

Thus, during the construction phase, the HSE Department of GNGLC shall continue to require Contractors to submit job risk assessments and method statements, that include mitigative actions for all identified potential negative impacts on the environmental and socio-economic components such as from air emissions, noise, water pollution, and waste management. In collaboration with the Community Relations Department of GNGLC, the Contractor shall also inform all public and private stakeholders about his/her plans before commencement of the works. Furthermore, Ghana Gas shall use only permitted companies in sourcing materials and drilling boreholes while adhering to the Riparian Buffer Zone Policy of the Water Resources Commission (WRC).

### **Operations Phase**

Ghana Gas has developed an Environmental Policy, Occupational Health and Safety Policy, Community and Social Responsibility (CSR) Policy, and Waste Management Plan to ensure the safe operations of GPP Train 1. Ghana Gas intends to continue using these policies and principles to manage the operations of the GPP Train 2. Also, Ghana Gas shall use only

permitted companies to provide services during this phase. In response to the expected expansion in production, Ghana Gas shall strengthen its HSE Department to not only protect the GPPs that are important national assets but also to protect its workers and the public from the potential negative impacts. For example, GNGLC shall enhance the human, material, and financial resources of the Environmental Unit of the HSE Department.

***Air Quality*** - Ghana Gas shall:

- Widen the area of monitoring of its air emissions beyond the A3 Communities. For example, this may cover the stretch from Krisan to Ekebaku;
- Expand the scope of monitoring to include periodic night measurements and increase averaging times for monitoring of particulates to allow comparison with GSA standards.
- Implement a dust emissions control program including measures such as wetting and covering to minimize atmospheric dust from construction activities.
- Ensure all excavation activities are closely supervised to ensure minimal disturbance to surrounding land users and dust.
- Ensure vehicles and machinery are fitted with appropriate exhaust systems and emission control devices and devices are maintained in good working order.
- Ensure the use of equipment, generators, machines, and vehicles with atmospheric emissions meeting the standards set by EPA/GSA and industry best practice.
- Ensure all equipment and engines are maintained and operated as original designed.
- Ensure all equipment are properly operated according to standard operating procedure that will ensure safe operation of equipment/vehicle/generator while meeting best environmental emission targets.

***Noise*** – Mitigation measures shall include:

- Using well-maintained equipment and screens or muffling noisy systems.
- Ensuring that all personnel wear appropriate Personal Protection Equipment (PPE) such as ear plugs in areas of high noise.
- Maintaining a vegetative buffer between the Asemnda community and the site for Train 2.

**Soils** - Ghana Gas shall continue with mitigation measures that have resulted in no major spills since Train 1 operations began. These include:

- Maintaining bunds around the storage tank areas to contain any spills from the tanks.
- Storing obsolete or expired chemicals and waste oil on non-permeable surfaces.
- Ensuring that all process areas are paved.

**Wastewater Management** - In addition to recommendations made for the construction phase, GNGLC shall continue with the same mitigation actions used for GPP Train 1, based on its Environmental Policy and Waste Management Plan, by constructing a Wastewater Treatment System. In addition, Ghana Gas shall include surface water, seawater, and rainwater sampling in monitoring the physicochemical and biological quality of groundwater and effluents. Concerning the high levels of phosphates in effluents, Ghana Gas shall upgrade the treatment system to ensure their removal and educate staff on the need to reduce the quantities of soap used for domestic purposes.

**Solid Waste Management** - To expand the space available for storing both hazardous and non-hazardous wastes, Ghana Gas shall construct a waste storage facility. These shall be clearly marked with appropriate signage to alert both workers and visitors. In addition, it shall continue to:

- Segregate solid wastes into labelled colour-coded bins (GNGLC, 2019e; 2021a).
- Offer segregated plastic wastes to local community members to collect and sell to recycling companies.
- Store other hazardous and non-hazardous solid/liquid waste in the waste storage area before subsequent removed by licensed waste management companies.
- Reduce the quantities of solid wastes generated through increased awareness of good waste management practices.

**Occupational Health and Safety** – Based on its Environmental Policy, Waste Management Plan, and Occupational Health and Safety Policy, GNGLC shall provide safe and healthy working conditions for the prevention of work-related injury and/or ill health and eliminate hazards and risks.

**Public Health and Safety** - Within the context of its Environmental Policy, Ghana Gas shall:

- Continue with its community sensitisation on the company's proposed activities and on the prevention of bush fires and encroachment on the Right of Way (RoW) of pipelines.
- Involve the nearby communities in emergency drills and mass casualty exercises.
- Continue, with respect to the COVID pandemic, to provide support to the local health and administrative authorities as part of its corporate social responsibility activities.

**Regulatory Requirements** - Ghana Gas shall be guided by all the relevant regulations such as the Environmental Assessment Regulations, 1999 L.I. 1652, National Petroleum Act, 2005 (Act 691), Labour Regulations, 2007 (L.I. 1833), Water Use Regulations, 2001 (L.I. 1692), and the GSA Environmental Quality Standards for noise, air quality, and effluent discharges.

**Relevant Stakeholders** - Ghana Gas shall, through its Corporate Social Responsibility Policy and Practice, continue consultations with the relevant stakeholders to maintain a conducive environment for its activities. It shall also strengthen its collaboration with the associated District and Metropolitan Assemblies and their decentralised departments.

### **Decommissioning and Closure Phase**

GNGLC and its Contractors shall dismantle all structures and equipment and reclaim the project site according to a Rehabilitation and Decommissioning Plan. Most of the mitigation actions shall be as proposed for the construction phase. GNGLC shall also liaise with the responsible district assemblies to dispose of unmovable assets and use EPA-approved dealers for the disposal of scrap.

### **Flood Risk Mitigation Measures**

According to the FRA studies, the proposed GPP Train 2 area clearly impedes the natural flow of water which will cause the inundation level at the west side of the GPP2 project site to rise even higher. This will then affect GPP1 and expand the inundation area without proper drainage. Furthermore, stored water will seep through soil and embankments which can trigger other problems such as soil consolidation, erosion, piping phenomenon among others.

Thus, to prevent this scenario, a drainage culvert is then proposed to be constructed across the existing road. The discharge will be diverted to the coastal side, instead of the town of Anokyi.

This will effectively eliminate the flooding specifically at the community area. This will also discharge the storage at the west side of the GPP2 project site to prevent other potential major disasters that can occur.

The maximum water level reached for 100-yr flood event is computed to be 5.84 meters amsl. The inundation results at the end of 4-day flood simulation with GPP Train 2 and proposed drainage culvert have been provide.

The contributed flooding to the town of Anokyi, on the other hand, can be eliminated since no more flow will come from the west of GPP2. Nevertheless, saturation of the area can still be expected with local precipitation and runoff from its own catchment.

The discharge on the coastal area, however, imposes no substantial damage and negative effect due to minimal discharge with a peak of only 12.85 cms at a velocity of 0.43 m/s.

- The floor level will be elevated to at least 7.0 meters amsl or will be levelled with the existing GPP1 at an elevation of 8.0 meters to make sure a smooth transition of facilities and mobility in between the GPP areas. This will also allow enough freeboard from the maximum water level of the most extreme flood event.
- Floor surface will be sloped at a minimum of 1% gradient to allow runoff and avoid accumulation of rainwater that may disrupt operation of the facility, and movement of people and equipment.

### **Fire and Explosion Risk Mitigation Measures**

Fire and explosion risk reduction measures were made to improve the design or operation of the GPP2 facility that need to be made to reduce risks and enhance its functional and HSE performance. Risk reduction measures are usually proposed due to technical feasibility and practical measures in the following categories:

- **Prevention:** Activities that eliminate or reduce process incidents. Generally, prevention activities such as modifications in operating and maintenance practices, equipment, maintenance, inspection, personnel training, and audits may reduce the process incident occurrence rate.
- **Mitigation:** Activities that reduce the consequences associated with the occurrence. Mitigation measures may include installation of detection and isolation systems, fire suppression systems, structural enhancements, and emergency response planning.

Based on the QRA and FERA studies, the following preventative and mitigating risk reduction measures will be implemented by GNGLC:

- i. Since the study is based on the Philosophy stated at the blowdown philosophy that (In case of confirmed gas leak, involved area depressurization will be automatically initiated by the ESD system.), which have a great contribution for risk reduction measures, The facility will be provided with an effective fire and gas detection system that will take automatic action (Isolation & depressurization), based on confirmed detection of hydrocarbon gas release or fire. A fire and gas mapping study will be performed to ensure appropriate coverage of fire and gas detectors in GPP2.
- ii. Ensuring that ignition prevention is practiced onsite by the classification of hazardous areas, in addition to preventative maintenance on electrical systems and inspection activities. Work activities within hazardous areas will be controlled by the Permit to Work system.
- iii. Equipment, vessel, pumps etc. which are part of top risk contributing scenarios will be given priority in inspection.
- iv. Review the possibility of providing (analysing the pros and cons) water connection at the sphere bottom that can be used in the event of Loss of Containment (LOC) from bottom of the sphere.
- v. In case of sphere fires, the potential always exists for an Explosion/BLEVE. To reduce this risk, it is recommended to ensure that the emergency response plan includes following:
  - A. Mitigate fire from the maximum distance possible or use portable monitors or fixed fire monitors.
  - B. Cool spheres by flooding (externally) them with large quantities of water.
  - C. Leave the area immediately if you hear a rising sound from venting safety devices or see discoloration of the sphere.
  - D. For massive fires, use unmanned hose holders or monitor nozzles; and
  - E. Be aware that when BLEVE occurs, sections of the sphere can fly in any direction. Just avoiding the ends of sphere should not be considered for a safe operating procedure.
- vi. Ensure that fire responders (Emergency Response Team) to be aware of the hazards associated with tank fires, including BLEVE.

- vii. Ensure spill containment plan is in place to avoid spread of pool of liquid in case of LOC from large inventory equipment such as spheres and storage tanks.
- viii. Passive fire protection (PFP) will be provided for isolation and depressurization valves ESD/EDP/XV (which are considered in intolerable risk area) which is located inside the exceedance contour, based on the pool and jet fire events at 10 minutes at a thermal radiation level of 37.5 kW/m<sup>2</sup> with cumulative fire frequency of 1.0E-04/yr, in accordance with the requirement in API 2218 (see Appendix C).
- ix. Shifting of the occupational building zone include the (LAB-Control room – Warehouse – Workshop), slightly to the west to be totally inside the low-risk area (The 10-6 risk contour from jet fire & Pool fire reaching the workshop and warehouse – also the 10-6 risk contour from 0.14 barg overpressure reaching the workshop and control room), it is better to keep occupational building in the low-risk area (see Appendix C)..
- x. Ensure the drainage facilities are designed to sufficiently contain or drain to a safe area to limit the extent of pool fires and prevent escalation between process equipment.

## CONCLUSION

GNGLC intends to expand its activities with the construction and operation of a new and larger GPP Train 2 west to the existing Train 1 at Atuabo in the Western Region of Ghana.

There will be cumulative impacts from the operations of both GPPs that will use similar technologies including those associated with air emissions and the generation of liquid and solid wastes, a high proportion of which will be hazardous. Ghana Gas is aware that the implications for increased hazards to occupational and public health and safety require that it increases its efforts in terms of human, material, and financial resources to mitigate and control these potential negative impacts. These also require an expansion in the scope (area and parameters) of monitoring.

The expansion of the activities of Ghana Gas will support the industrialisation of Ghana in diverse ways while providing jobs and contributing to local development. However, worldwide concern is growing about the contribution of fossil fuel use to climate change and the survival of the planet. At the most recent global climate change conference, 197 countries including Ghana adopted the Glasgow Pact, which aims to turn the next decades into a period of climate action and support (Earth Negotiations Bulletin, 2021). Ghana was also a signatory to a

declaration (<https://www.gov.uk/government/publications/cop26-declaration-zero-emission-cars-and-vans>)

on accelerating the transition to 100% zero-emission cars and vans.

Renewable energy currently accounts for only 2.4 percent of the power generated in the country (<https://www.ghanaweb.com/Government-backs-VRA-Bui-Power-in-renewable-energy-drive-1380628>). However, the government intends to achieve a 10 percent renewable energy target by 2030 in line with the United Nations Sustainable Development Goals. In addition, the Government has completed the preparatory phase of the Scaling-up Renewable Energy Programme that would provide opportunities to both the public and private sectors in the deployment and use of renewable energy in the country.

It is a fact that Africa should be allowed to use its fossil fuel resources to develop itself and lift its population from the cycle of poverty (Ayuk, 2021). Similarly, it has been recently stressed that Ghana is not in a rush to transition from fossil fuels ([Ghana not in a rush to transition from crude oil to wind, solar energy – Energy Ministry \(ghanaweb.com\)](#)). While these policies may work for the next few decades, they may not be sustainable in the long term because of such possibilities as loss of interest by the larger global community in the use of fossil fuels, reduced markets for fossil fuel products, reduced investments in exploration as well as the rise and dominance of new or existing renewable energy technologies. GNGLC shall therefore consider how to diversify its activities, while at the same time, continuing to support Ghana's development with natural gas in the medium term (<https://www.ghanaweb.com/GhanaHomePage/Gas-is-best-option-until-renewable-energy-transition-Ghana-Gas-CEO-1387927>).

# CHAPTER 1. INTRODUCTION

## 1.1 Background to Project

Ghana National Gas Limited Company (GNGLC), also referred to as Ghana Gas, is a limited liability company with the mandate to own, manage and develop a national network of gas pipelines, processing plants and storage facilities. GNGLC contributes to Ghana's economic development by providing and operating the infrastructure required for gathering, processing, and delivering natural gas resources in a safe, cost-effective, and reliable manner for customers (GNGLC, 2019a).

GNGLC has commissioned to construct a new Gas Processing Plant (GPP Train 2) and associated facilities which will process raw gas from off-shore Ghana. The Project Sponsors for the development of the 300MMSCF Gas Processing Facility Project in Atuabo, Ghana also referred to as the 'Consortium' which includes Integrated Logistics Bureau Limited (INTELS), Axxela Ghana Limited (AXXELA), John Moore International (JMI), The Natural Gas company of Trinidad and Tobago Limited (NGC) and Phoenix Park Gas Processors Limited (PPGPL) with the African Finance Corporation (AFC) as Transaction Advisers and Lead arrangers.

GNGLC is Ghana's first mid-stream gas business company and was incorporated in July 2011. The first phase of the Gas Processing Plant (GPP), Train 1, and associated facilities were installed in November 2014 (<https://www.ghanagas.com.gh>). The GPP Train 1 treats raw feed dense phase gas from the Jubilee and Tweneboa-Enyenra-Ntomme (TEN) Fields -which are Floating Production Storage and Offloading (FPSO) vessels -into Lean Gas, Liquefied Petroleum Gas (LPG), and Condensate (Natural Gasoline and traces of iso-pentane).

With its headquarters in Accra, Ghana Gas currently operates the following key infrastructure (GNGLC, 2021a):

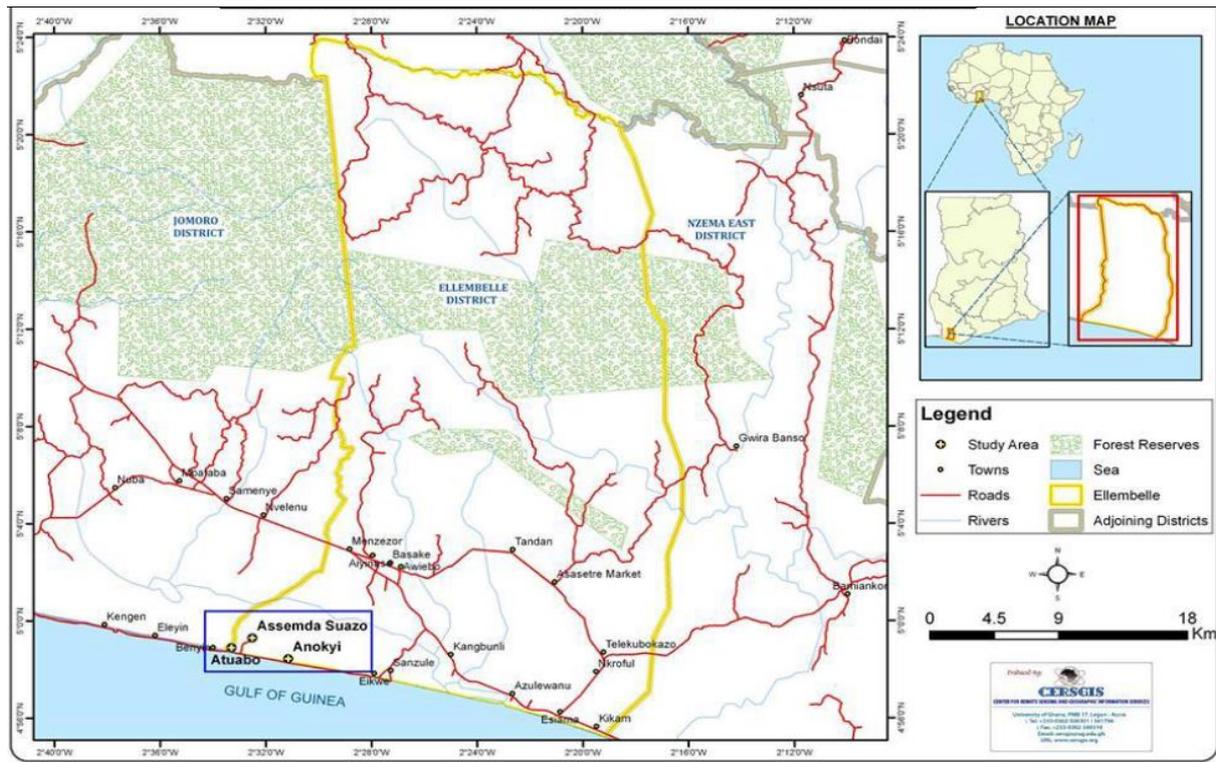
- Offshore gas export pipeline, which consists of a 12-inch (30.5 cm) diameter 58 km long subsea pipeline, transporting dense-phase gas from the FPSOs to the Gas Processing Plant, GPP Train 1;

- Gas Processing Plant at Atuabo in the Ellembelle District of the Western Region with a design capacity of 150 MMSCFD and operating capacity of 120 MMSCFD;
- Onshore gas pipelines, which consist of a 20-inch (50.8 cm) diameter 110 km Atuabo-Takoradi pipeline, that supplies gas to power generation companies (VRA, Ameri, TICO, and Karpowership) and manufacturing industries (Wangkang and Twyford);
- A 75 km Esiama-Prestea line, which supplies gas to Genser Energy;
- LPG truck-loading gantry located approximately 2.5 km from the GPP, near Anokyi, and connected to the GPP by an 8-inch (20.3 cm) pipeline.

GNGLC also has various stations, located mainly in the Western and Western North Regions to support, and facilitate its supply operations (GNGLC, 2021a). The stations can communicate with a Supervisory Control and Data Acquisition (SCADA) system for the purpose of transmitting invoicing information, monitoring the status of the stations, and performing other command functions. They are:

- i. The Atuabo Initial Station (AIS), which monitors activities at the GPP and the onshore and offshore gas pipelines. At the AIS, raw gas is received from offshore and measured before processing while the lean gas produced is monitored before leaving the GPP.
- ii. Four (4) Block Valve Stations (BVSs), two (2) each located on the Atuabo-Takoradi and Esiama-Prestea gas pipelines. These BVSs are used for pipeline protection, thus enabling isolation of any segment of the pipeline for maintenance work.
- iii. Three (3) Distribution Stations located in Esiama, Aboadze, and Eshiem that distribute lean gas through the onshore pipelines to power-generating companies and manufacturing industries.
- iv. Two (2) Regulating and Metering Stations at Prestea and Sekondi, which control the characteristics (flow rate, pressure, and temperature) of the lean gas to meet contractual specifications before delivery to customers.

To meet the rising demand for its products, Ghana Gas now wishes to develop an extension of the GPP Train 1 in a second phase through the construction and operation of a second train of the GPP at Atuabo in the Ellembelle District of the Western Region (Figure 1).



Source: Asamoah, 2014

Figure 1 Location of Proposed Project Area

Ghana Gas proposes to locate the second train on a plot of land next to the existing Train 1 (Plate 1-1) in Atuabo. The justification for the proposed project is based on the energy policy of Ghana, which stipulates that the country's total energy supply must grow significantly to support the development agenda goal. There is thus the need to increase the energy supply and expand the energy infrastructure in the country in a sustainable way (Ministry of Energy, 2010). The goals of the petroleum sub-sector are to ensure, among others, the sustainable exploration, development, and production of Ghana's oil and gas endowment and the indigenisation of the process. These goals are also expected to contribute significantly to Ghana's economic growth. In the United States, for example, the American Petroleum Institute (API) estimated that in 2019 the oil and natural gas industry had widespread economic impact on all sectors of the economy, accounting for 7.9 percent of total GDP (API, 2021).



Source: Google Earth 2021

Plate 1 Satellite View of Project Location

The proposed construction and operation of the GPP Train 2 will also have several socio-economic effects at the national, regional, and local levels. At the national level for example, it will contribute directly to government income tax and support diversification of the economy through its linkage with the increased production of fertilizer and bitumen, among others. Its products will also facilitate the expansion of industrial activities such as the Ghana Government's Petroleum Hub (Daily Graphic, 2019) and the proposed Petronia City (<https://youtu.be/xsGt8GrfxEw>) in Takoradi. Regionally and locally, it will support many direct and indirect jobs.

Ghana gas has an environmental policy that commits it to conduct its business activities towards ensuring the protection of the natural environment (GNGLC, 2021b). The aims include:

- Contributing to a reduction in global flaring and greenhouse gasses emissions by leading national discourse on the commercialization of natural gas resources in Ghana.
- Using materials and energy efficiently and maintaining operational integrity to minimize fugitive emissions and discharges.
- Engaging positively with stakeholders and conducting business in a socially responsible and ethical manner.

- Complying with all applicable environmental laws, regulations, and international codes and standards, and supervising contractors to manage the environment in line with its environmental goals.

To ensure legal compliance with Ghana's Environmental Assessment Regulations 1999 (L.I. 1652), Ghana Gas has initiated the process of securing an Environmental Permit for the project by registering the proposed undertaking with the Ghana Environmental Protection Agency (EPA). A response from EPA; reference letter CE 3156/06/20 dated 20 January 2020 (Appendix 1-1.1) stated that the proposed project falls within the category of undertakings that requires an Environmental Impact Assessment (EIA). Ghana Gas has therefore contracted Ecosystem Environmental Solutions Limited (EESL) to carry out the EIA on her behalf.

Pursuant to the submission of the draft EIS document to the EPA, the agency's review, and comments and the Consortium's review, it became necessary to conduct a gap assessment on the draft EIS to address the EPA comments as well as update the EIS in accordance with the IFC Performance Standards and Equator Principles. To this end, the Consortium appointed Odun Environmental Limited (OEL) to conduct the gap assessment and associated studies, address the EPA comments and update the EIS in accordance with the IFC Performance Standards and Equator Principles requirements.

## **1.2 Objectives of the Environmental Impact Assessment**

An Environmental Impact Assessment (EIA) is a systematic process to identify, predict and evaluate the environmental and social impacts of proposed activities or projects (UNEP, 2004). It analyses the positive and negative impacts of planned activity to provide information that allows for the introduction of environmental protection and social-economic considerations into the execution of the activity.

The general objectives of an EIA are therefore to:

- Provide information for decision-making by regulators, the public, and host communities on the environmental and social consequences of proposed undertakings.
- Promote sustainable environmental and socio-economic development through the identification of appropriate enhancement and mitigation measures.

The immediate objectives of the EIA study are to:

- Predict the consequences of all phases of the development of the GPP Train 2 at Atuabo from the environmental, social, economic, and cultural perspectives.
- Provide avenues for the involvement of the public, government, and private sectors in the assessment and review of the impact of the proposed project activities.
- Identify appropriate measures for mitigating the potential negative impacts of the project.
- Improve the environmental integrity and social acceptability of the project design.
- Ensure that resources are used appropriately and effectively.
- Meet the requirements of the Ghana EPA for the issuance of an Environmental Permit for GNGLC to commence the construction and operation of the GPP Train 2.

The long-term objectives of the EIA study are to:

- Protect human health and safety.
- Avoid irreversible changes and serious damage to the environment.
- Safeguard valued resources and natural ecosystems.
- Support the goals of environmental management and sustainable development.

### **1.3 Approach and Methods for the Environmental Impact Assessment**

Further to the registration of the project with the EPA by GNGLC, as indicated in Section 1.1 above, the following are the details of approaches and methods used for conducting the EIA.

#### ***1.3.1 Scoping and Terms of Reference for EIA***

According to Ghana's Environmental Assessment Regulations, 1999 (L.I. 1652), an EIA begins with a scoping exercise the report of which shall set out the scope or extent of the EIA and shall include a draft Terms of Reference (ToR) indicating the essential issues to be addressed.

The key objectives of the scoping exercise are to:

- Inform the public about the proposed expansion of the activities of GNGLC.
- Identify the main stakeholders and their concerns and appreciation of the project.
- Define reasonable and practical alternatives to the project activities, where relevant.
- Identify the key environmental and social-economic issues and impacts to be addressed.
- Set requirements for the collection of baselines and other information.
- Establish the Terms of Reference for the EIA for approval by the EPA.

To conduct the scoping exercise, the Consultant organised a field visit to the project area at Atuabo and its environs, between 04 and 10 July 2021. Stakeholders consulted included the Chiefs and people of Anokyi and Asemnda, government organizations including the Ellembelle District Assembly and its departments as well as the EPA office at Nkroful. Other stakeholders were consulted in Accra, and these included the EPA, Energy Commission, National Petroleum Authority, VRA, and Water Resources Commission. The Consultant provided the stakeholders with letters (Appendix 1-3.1) stating the purpose of the project and requesting comments with respect to their concerns and appreciation for the construction and operation of the GPP Train 2. Also, the techniques of focus group discussions, interviews, and one-on-one discussions were employed to assess the views of the stakeholders.

The responses of the stakeholders thus formed the bases of concerns and appreciation of the proposed project. Meetings were also held with the management of Ghana Gas. A draft Scoping Report with the ToR for the EIA study was presented to the EPA under a letter with reference GNGLC/TS.HSE/EPA.252/09/21 and dated 14 September 2021. Comments received from EPA on the draft report referenced CE 3156/07/25 and dated 06 October 2021 are presented in Appendix 1-3.2. The scoping notice has been published in the Ghanaian Times (Appendix 1-3.3) and Daily Graphic (Appendix 1-3.4). Chapter 6 of this Environmental Impact Statement (EIS) presents details of the scoping exercise.

### ***1.3.2 Environmental Impact Assessment Study***

The Consultant conducted the EIA study on behalf of Ghana Gas further to the approval of the Scoping Report by EPA. The EIA followed the requirements of the EPA as follows:

#### **i. Literature Review**

The Consultant assembled and analysed data and information on the relevant environmental and socio-economic characteristics of the project area with the objective of describing the area as it is currently and as it would be expected to develop if the project were not to proceed. Data and information were obtained from Ghana Gas and such sources as the Council for Scientific and Industrial Research, Environmental Protection Agency, and Ellembelle District Assembly. The Consultant also undertook field trips to the project area for validation of the literature and further collection of baseline data and information. Apart from the field visits and stakeholder consultations, desktop studies were also carried out on relevant documents about the proposed

project and similar projects and issues (GNGLC, 2013; GNGLC, 2021a; Asamoah, 2014; Pietro Fiorentini, 2019; UNEP & Clean Air Coalition, 2021; International Renewable Energy Agency, 2021; IPCC, 2021).

## **ii. Baseline Studies**

The field visits during stakeholder consultations and for data collection, in July 2021 and April 2022 respectively, provided the opportunity for the Consultant to get acquainted with the project site and its area of influence and make observations and measurements on the natural and socio-economic resources of the project area. The Consultant, therefore, conducted baseline studies, which included the following:

- Climate and air quality.
- Noise levels.
- Water resources.
- Fauna and flora.
- Socio-economic status.

### ***1.3.3 Layout of the Environmental Impact Statement***

As presented in the Terms of Reference of the scoping report approved by the EPA, the Environmental Impact Statement has the following layout:

Non-Technical Executive Summary.

Chapter 1: Introduction.

Chapter 2: Policy, Legal, and Administrative Requirements.

Chapter 3: Description of the Proposed Project.

Chapter 4: Consideration of Alternatives.

Chapter 5: Existing Baseline Conditions.

Chapter 6: Stakeholder Consultation.

Chapter 7: Identification and Evaluation of Potential Impacts.

Chapter 8: Mitigation of Potential Impacts and Enhancement Measures.

Chapter 9: Provisional Environmental Management Plan;

Chapter 10: Decommissioning and Closure.

Chapter 11: Conclusions.

Chapter 12: List of References.

Appendices.

## CHAPTER 2. POLICY, LEGAL, AND INSTITUTIONAL FRAMEWORKS

The chapter presents overviews of the key policy, legislative and regulatory, and administrative institutional frameworks relevant to the proposed project on the construction and operation of the GPP Train 2 by GNGLC.

### 2.1 National Policy Frameworks

The key national policies relevant to the proposed gas processing plant include the following:

- The Constitution of Ghana, 1992.
- National Environment Policy, 2012.
- National Energy Policy, 2010.
- Health, Safety, and Environmental Policy for the Energy Sector, 2016.
- Local Content Policy in the Oil and Gas Sector, 2010.
- National Land Policy, 1999.
- National Water Policy, 2007.
- Riparian Buffer Zone Policy. 2013.
- National Climate Change Policy, 2013.

Summary details of the policies and their relevance to the proposed project are presented in Table 1 below.

Table 1 Summary of National and Sector Policies

Policy Framework	Summary of Core Requirements	Relevance to the Proposed Project
The 1992 Constitution of Ghana	The 1992 Constitution provides a broad policy basis for environmental protection by requiring the State to take appropriate measures needed to protect and safeguard the environment for posterity. Under the Constitution, all untapped natural resources including oil and gas resources are vested in the President of Ghana for and on behalf of the people of Ghana. Thus, the right to explore and develop such	The Constitution is the basis for all policies and legislation in Ghana. The National Policy on Environment stems from its article 36(9) and is directly related to the proposed gas processing plant project, which may have multiple

<b>Policy Framework</b>	<b>Summary of Core Requirements</b>	<b>Relevance to the Proposed Project</b>
	resources is subject to an agreement or license granted by the government (acting through the Ministry of Energy) and approved by Parliament.	negative impacts on the environment.
National Environment Policy	The National Environment Policy was launched in 2012 to replace the 1995 policy, with the vision to manage the environment sustainably to benefit Ghanaian society. It aims to improve the surroundings, living conditions, and the quality of life of the entire citizenry, both present and future. It seeks to promote sustainable development by ensuring a balance between economic development and natural resource conservation.	The National Environmental Policy, in its quest to promote sustainable development while ensuring the conservation of natural resources, will guide the construction and operation of the proposed gas processing plant.
Ghana National Energy Policy	The Ghana National Energy Policy encompasses cross-cutting plans to manage the major challenges of the fast-growing energy needs for the national development agenda. It is intended to serve, among others as a decision-making platform for effective management and development of Ghana's energy sector and a guide to key stakeholders in the sector highlighting the definition and implementation of key activities in respect of their mandates.	The proposed GPP Train 2 is in line with the policy's call for investment in the energy sector to create jobs, added value, and export revenues.
Health, Safety and Environmental Policy for the Energy Sector	The policy describes the elements necessary to develop, implement, and maintain a high level of safety in all energy sector activities. The policy develops relevant regulations and standards, which will ensure that operators consider relevant information about hazards, environmental effects, safety, and security threats to their operations.	The relevance of the policy lies in the fact that the construction and operations of the gas plant require a high degree of safety, health, and environmental protection.
Local Content Policy	The Local Content Policy outlines strategies on how the Government intends to develop the oil and gas industry with optimal local content and local participation by enhancing national development, creating jobs, and effectively managing the potential revenue from oil and gas production and processing, in addition to ensuring security for oil and gas installations in the industry.	The legislation requires that an oil and gas company such as GNGLC must obtain 60 to 90 % of its goods and services from domestic sources within 10 years of its operation in Ghana.
National Land Policy	Among the guiding principles of the Ghana National Land Policy are: (i) optimum usage for all types of	The implementation of the project satisfies the principles of optimum

<b>Policy Framework</b>	<b>Summary of Core Requirements</b>	<b>Relevance to the Proposed Project</b>
	land; (ii) government facilitating equitable and reasonable access to land within the context of national land use planning and (iii) fair access to land and security of tenure. The policy provides for the protection of water bodies and the environment in the long-term national interest under any form of land usage, be it for human settlements, industry, and commerce, agriculture, forestry, mining, or gas processing.	usage of land by embarking on development such as the GPP Train 2 project and by the Government, represented by the Lands Commission, facilitating access to the land within the context of national land use planning.
National Water Policy	The National Water Policy is intended to provide a framework for the sustainable development of Ghana's water resources. The overall goal is to achieve sustainable development, management, and use of Ghana's water resources to improve health and livelihoods and reduce vulnerability while assuring good governance for present and future generations.	The use of water for various aspects of the construction and operations of the proposed GPP and the discharge of liquid and solid wastes from its operations make this policy very relevant to the proposed project
Riparian Buffer Zone Policy	The Riparian Buffer Zone Policy is designed as a harmonized document of all the dormant and fragmented regulations in the country concerning buffers bordering water bodies or river systems. Buffer zones as used in this policy context, refer to the existence of physical areas that separate either two ecological systems or an ecological system from other land use or that border a water body.	The relevance of the policy lies in its requirement for creating buffer zones to protect critical natural capital and aquatic ecosystems in the project's area of influence.
National Climate Change Policy	The National Climate Change Policy provides strategic direction and coordinates issues of climate change in Ghana. The three objectives of the policy are: (i) effective adaptation, (ii) social development, and (iii) mitigation. To address the adaptation issues, five thematic areas have been prioritised. These are (i) energy and infrastructure, (ii) natural resources management, (iii) agriculture and food security, (iv) disaster preparedness and response, and (v) equitable social development.	The relevance of this policy lies in the fact that the operations of the gas processing plant will generate greenhouse gases whose emissions need to be controlled to minimise further climate change.

## 2.2 Legislative and Regulatory Frameworks

This section presents a list of relevant environmental and social-economic legislation and standards/guidelines relevant to the construction and operation of the GPP Train 2 as follows:

- i. Environmental Protection Agency Act, 1994 (Act 490).
- ii. Environmental Assessment Regulations, 1999 (L.I. 1652);
- iii. Environmental Assessment (Amendment) Regulations, 2002 (L.I. 1703).
- iv. EPA Fees and Charges (Amendment) Act, 2022 (L.I. 1080).
- v. Ghana Environmental Quality Standards including:
  - Standard for Environmental Protection Requirements for Effluent Discharges (GS 1212, 2019).
  - Standard for Environment and Health Protection Requirements for Ambient Air Quality and Point Source/Stack Emissions (GS 1236, 2019).
  - Standard for Environment and Health Protection Requirements for Ambient Noise Control (GS 1222, 2018).
  - Standard for acoustics Guide for Measurements of Outdoor A-Weighted Sound Levels (GS 1253, 2018).
- vi. Energy Commission Act, 1997 (Act 541).
- vii. National Petroleum Authority Act, 2005, (Act 691).
- viii. Ghana Ports and Harbours Authority Law, 1986 (PNDCL 160).
- ix. Ghana Maritime Authority Act, 2002 (Act 630);
- x. Ghana National Fire Service Act, 1997 (Act 537).
- xi. Fire Precaution (Premises) Regulations, 2003 (L.I. 1724).
- xii. Administration of the Lands Act, 1962 (Act 123).
- xiii. State Lands Act, 1962 (Act 125);
- xiv. Land Use Spatial Planning Authority Act, 2016 (Act 925).
- xv. Labour Act, 2003 (Act 651).
- xvi. Water Resources Commission Act, 1996 (Act 522).
- xvii. Water Use Regulations, 2001 (L.I. 1692).
- xviii. Lands Commission Act, 2008 (Act 767).
- xix. Local Governance Act, 2016 (Act 936).
- xx. Factories, Offices and Shops Act, 1970 (Act 328).
- xxi. Factories Inspectorate Regulations.
- xxii. Hazardous and Electronic Waste Control and Management Act, 2016 (Act 917).

- xxiii. Hazardous, Electronic, and Other Waste (Classification) Control and Management Regulations, 2016 (L.I. 2250).
- xxiv. Survey Act, 1962 (Act 127).
- xxv. Ghana Meteorological Agency Act, 2004 (Act 687).
- xxvi. Fisheries Act, 2002 (Act 625).
- xxvii. Workmen’s Compensation Law, 1987
- xxviii. Natural Gas Distribution and Sales (Technical and Operational) Rules, 2007 (L.I. 1911); (Standard of Performance) Regulations, 2007 (L.I. 1912).
- xxix. Natural Gas Transmission Utility (Technical and Operational) Rules, 2007 (L.I. 1913); (Standards of Performance) Regulations, 2008 (L.I. 1936).
- xxx. Natural Gas Pipeline Safety (Construction, Operation, and Maintenance) Regulations, 2012 (L.I. 2189).

Details of the most relevant legal and regulatory frameworks and their relevance to the project are summarized in Table 2 below.

Table 2 Summary of National and Sector Acts and Regulations

National or Sector Acts/Regulations	Summary of Core Requirements	Relationship to Proposed Project
<b>Environmental Assessment</b>		
Environmental Protection Agency (EPA) Act, 1994 (Act 490)	The EPA was established under the Environmental Protection Agency Act, 1994 (Act 490) as the main 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. The EPA has the authority to require an EIA.	The proposed project will be developed in accordance with the Environmental Assessment Procedures as prescribed by the EPA.
Environmental Assessment Regulations, 1999 (L.I. 1652)	The Environmental Assessment Regulations, 1999 (L.I. 1652) enjoins any proponent to register an undertaking with the Agency and obtain an Environmental Permit prior to the commencement of the project. Fees shall be paid for the registration of the undertaking and issuance of the Environmental Permit as the Agency shall determine.	The proposed GNGLC gas processing project falls in Schedule 2 and therefore an EIA is mandatory for an Environmental Permit as per the regulations.
Fees and Charges	This instrument regulates the Fees and Charges (Miscellaneous Provision) Act 2022 (Act 1080), which	All stipulated fees and charges shall be paid to obtain the

<b>National or Sector Acts/ Regulations</b>	<b>Summary of Core Requirements</b>	<b>Relationship to Proposed Project</b>
(Miscellaneous Provisions) Act, 2022 (Act 1080)	specifies comprehensive rates, fees and charges collectable by Ministries, Departments and Agencies for goods and services delivered to the public. This is applicable to obtaining an environmental permit from the EPA.	required Environmental Permit from the EPA will be paid by GNGLC.
<b>Environmental Protection</b>		
Water Resources Commission (WRC) Act, 1996 (Act 522)	The Water Resources Commission Act 1996, (Act 522) established and mandated the Water Resources Commission as the sole agency responsible for the regulation and management of the utilisation of water resources and for the coordination of any policy in relation to them.  Section 13 prohibits the use of water (divert, dam, store, abstract), construction, or maintenance of any works for the use of water resources without a license.	The Act will guide the development of GPP in the catchment of Amansuri River and its water use and waste disposal during operations.
Water Use Regulation, 2001, (L.I. 1692)	Section 16 of the WRC Act, 1996 (Act 522) empowers the Commission to grant Water Rights (water use permits) to prospective users. The Water Use Regulations, 2001 (L.I. 1692) list activities for which water use permits are required including domestic, commercial, municipal, and industrial water use. The Regulations also prescribe the raw water charges and processing fees to be paid by prospective water users concerning the water use permits.	Any utilization of raw water resources for the proposed Train 2 project will require a water use permit.
Ghana Meteorological Agency Act, 2004 (Act 687)	This Act established the Ghana Meteorological Agency, which replaced the Meteorological Services Department. The Agency is to provide meteorological information, advice, and warnings for the benefit of agriculture, civil, and military aviation, among others and to mitigate the effects of natural disasters such as floods, storms, and droughts on socio-economic development and projects.	Climate information will be required for any development in the catchment of the Amansuri and in understanding the dispersion of emissions from the proposed gas processing project.
<b>Labour and Safety in the Workplace</b>		
The Labour Act, 2003 (Act 651)	Section 118 (1) of the Labour Act, 2003 (Act 651) stipulates that it is the duty of an employer to ensure that every worker works under satisfactory, safe, and healthy conditions. The provisions include maintaining at the workplace or plant, systems of work that are safe and without risk to health and taking steps to prevent contamination of the workplaces by	The Act will be used as a guide in developing acceptable employer-labour relationships at the gas processing plant.

<b>National or Sector Acts/ Regulations</b>	<b>Summary of Core Requirements</b>	<b>Relationship to Proposed Project</b>
	toxic gases, noxious substances, vapours, dust, fumes, and other substances or materials likely to cause risk to safety or health.	
Factories, Offices and Shops Act, 1970 (Act 328)	The Factories, Offices and Shops Act, 1970 (Act 328), as amended by the Factories Offices and Shops (Amendment) Law, 1983 (PNDCL 66), the Factories Offices and Shops (Amendment) Law, 1991 (PNDCL 275) 1 (a), and the Ghana National Fire Service Act, 1997 (Act 537) require all proponents to register with and, among others, notify the Chief Inspector of any accidents and dangerous occurrences. They also require posting in a prominent position in every factory, the prescribed abstract of the Act and other notices to safeguard the health and safety of workers. The Act complements the provisions made in the Factories (Dock Safety) Regulations 1960, (L.I. 86).	The Train 2 project will be registered with the Factories Inspectorate Division and any accident reported as per Act 328.
Workmen's Compensation Law, 1987	The Law provides for payment of compensation to workmen for personal injuries caused by accidents arising out and during their employment. The law places a large share of the burden of supporting workers injured at the workplace on the shoulders of the employers.	The Law applies to the gas processing project and the safety of all workers will be the responsibility of GNGLC.
Ghana National Fire Service Act, 1997 (Act 537)	The Act re-establishes the Ghana National Fire Service (GNFS) to provide for the management of undesired fires and to make provisions for related matters. Its objectives are to organize public fire education programmes to create and sustain awareness of the hazards of fire, heighten the role of the individuals in the prevention of fire, and provide technical advice for building plans in respect of machinery and structural layouts to facilitate escape from fire, rescue operations, and fire management.	The services of the Ghana National Fire Service will continue to be made available to GNGLC to avert potential fire outbreaks. GNGLC will obtain a Fire Permit and Certificate for Train2 before the commencement of the project.
The Fire Precaution (Premises) Regulations 2003, (L.I. 1724)	The Fire Precaution (Premises) Regulations 2003 (L.I. 1724) requires all premises intended for use as workplaces to have Fire Certificates and confers enforcement powers on the GNFS.	Fire Permit and Certificate will be obtained by GNGLC before the commencement of the Train 2 project.
<b>Development Planning</b>		

<b>National or Sector Acts/ Regulations</b>	<b>Summary of Core Requirements</b>	<b>Relationship to Proposed Project</b>
Local Governance Act, 2016 (Act 936)	The Act establishes and regulates the local government system and gives authority to the Regional Coordination Committees and the District Assemblies to exercise political and administrative power, provide guidance, give direction to, and supervise all other administrative authorities in the regions and districts respectively. The Assemblies are to initiate programmes for the development of basic infrastructure and be responsible for the development, improvement, and management of human settlements and the environment in their respective areas.	The proposed project is situated within the Ellembelle District. The Assembly shall be fully involved in the planning and implementation of the GPP Train 2.
<b>Land Regulations</b>		
Lands Commission Act, 2008 (Act 767)	The Commission manages public lands and any other lands vested in the President by the Constitution or by any other enactment. Function 5(e) of the Act requires that the Commission facilitates the acquisition of land on behalf of the Government. It formulates recommendations on national land use, advises on, and assists in the execution of, a comprehensive programme for the registration of title to land in consultation with the Title Registration Advisory Board, established under Section 10 of the Land Title Registration Act, 1986. The functions of the Land Valuation Division of the Commission include assessing the compensation payable upon acquisition of land by the Government (Section 22a). The other Divisions of the Commission include Survey and Mapping, and Land Registration.	The land for both GPP Train 1 and Train 2 has been acquired by Ghana Government's Executive Instrument, E.I. 51, 2014.
The Survey Act 1962, Act 127	The Survey Act, 1962 (Act 127) relates to geological, soil, and land surveys. Part I of the Act allows the Director of Geological Surveys to go to any part of the surface of any land or any underground passage to make surveys, take samples, make borings, and do and cause to be done all things necessary for carrying out a geological survey. The Act with its amendments, gave legal backing to the Director of Surveys to carry out cadastral and other surveys through official or licensed surveyors.	The required land area for GPP Train 2 was acquired during the development of Train 1. Technical surveys including geophysical surveys and feasibility studies, market demand analysis, and project designs have been completed.

## 2.3 Institutional Frameworks

This section presents an overview of the institutions that relate to environmental protection, administrative requirements, and other aspects of the proposed GPP Train 2. They include the Ministry of Environment, Science, Technology, and Innovation, Ministry of Energy, and Ministry of Transport and their sector agencies. A summary of these institutions and their relevance to the project are presented in Table 3 below.

Table 3 Key Sector Ministries and Agencies

Sector Ministry	Key Agencies	Relevance to the Project
Ministry of Energy	Energy Commission	Technical midstream and upstream oil and gas regulator.
	Bulk Oil Storage and Transport	Licensed by the Energy Commission in 2015 as the National Gas Transmission Utility.
	Public Utilities Regulatory Commission	The national entity responsible for economic regulation for electricity, gas, and water.
Ministry of Transport	Ghana Maritime Authority	Regulator for the maritime industry
	Ghana Shippers Authority	Manages Ghana's commercial shipping; protects and promotes the interests of shippers in international trade and transport logistics.
	Department of Urban Roads	Permission required for public road crossings
	Ghana Railway Authority	The operator of Ghana's railway network.
Ministry of Defence	Ghana Navy	Responsible for maritime security.
Ministry of Interior	Ghana National Fire Service	The national institution responsible for the prevention and management of undesired fire.
	Ghana Police Service	National institution responsible for law and order
Ministry of Employment and Labour Relations	Department of Factories Inspectorate	Regulations for health and safety of workers.
	Labour Department	Enforces labour laws and regulations and provides for the benefit of GNGLC and its employees.
Ministry of Water Resources and Sanitation	Water Resources Commission	The agency responsible for the regulation, management, and utilisation of water resources. It issues water rights to potential water users.
Ministry of Environment, Science, Technology, and Innovation	Environmental Protection Authority	Regulating the environment and ensuring the implementation of policies on the environment. Issues permits for development projects.
	Land Use and Spatial Planning Authority	Regulator for land use and spatial planning.

Sector Ministry	Key Agencies	Relevance to the Project
Ministry of Planning	National Development Planning Commission	Advises the President on development planning policy and strategy.
Ministry of Local Government	Ellebelle District Assembly	The planning authority is charged with the overall development of the District.

**2.4 GNGLC Environmental Policy**

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

In line with this commitment, GNGLC is committed to the following:

- Minimizing impacts of its operations on the environment through the prevention of pollution, sustainable resource use, mitigation of climate change and protection of ecosystems.
- Fulfilling its compliance obligations and environmental requirements.
- Promoting effective waste management strategies by reducing, re-using, recycling, and ensuring safe disposal of waste.
- Operating and maintaining its natural gas infrastructure in a manner that minimizes emissions to air and discharges to water and land.
- Engaging positively with interested parties and conducting business in a socially responsible manner.
- Periodically evaluating the effectiveness and suitability of its environmental management system to enhance its environmental performance and ensure continual improvement.
- Setting goals, objectives and targets which motivate each member of the workforce to contribute to its environmental performance.
- Ensuring that responsibilities and authorities for relevant roles within the environmental management system are assigned and communicated at all levels within the company.

GNGLC ensures that the Environmental Policy is clearly communicated to its workforce and all persons working under the control of the company with the intent that they are made aware of their individual environmental management obligations, and the Policy is also made available to interested parties where necessary.

The Chief Executive Officer (CEO) of GNGLC has the overall authority and responsibility of ensuring that adequate resources are provided to enhance the smooth implementation of the Environmental Policy.

## **2.5 International Conventions and Treaties**

The relevant International Conventions include:

- Convention on Biological Diversity, 1992.
- Convention for the Conservation of Migratory Species of Wild Animals, 1983.
- United Nations Convention on the Law of the Sea, 1982.
- Convention for the Prevention of Marine Pollution from Land-based Sources, 1974.
- Convention for Wetlands of International Importance, 1971.
- Convention on International Trade in Endangered Species of Wild Fauna and Flora, 1973.
- The Paris Agreement, 2015.
- International Labour Organization (“ILO”) conventions covering Core Labour standards.
- Kyoto Protocol.
- United Nations (UN) Convention on Biological Diversity.
- UN Framework Convention on Climate Change.
- Convention on the Control of Trans-Boundary Movements of Hazardous Wastes and their Disposal (Basel Convention).
- Convention on the Conservation of Migratory Species of Wild Animals.
- Convention on the Conservation of Migratory Species (CMS).
- Montreal Protocol on Substances that Deplete the Ozone Layer.
- Convention Concerning the Protection of the World Cultural and National Heritage (World Heritage Convention).
- African Convention of Conservation of Nature

Ghana is also party to international conventions and agreements relating to environmental and social issues which have been ratified. The ratified conventions relevant to this project are listed in Table 4 with their respective ratification status.

Table 4 Applicable International Convention/Treaties

Convention	Date Ratified
African Convention on the Conservation of Nature and Natural Resources, 1969 <i>* Ghana is yet to ratify the Revised version of this Convention which is yet to come into force.</i>	17 May 1969
African Convention on the Conservation of Nature and Natural Resources (Revised Version) adopted in Maputo on 11 July 2003	31 October 2003
Amendment to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, Geneva, 1995	9 June 2005
Agreement on the conservation of African-Eurasian migratory waterbirds, adopted at The Hague on 14 August 1996	1 October 2005
Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa, Bamako, 1991	2 July 2004
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, Basel, 1989	12 March 2003
Basel Protocol on Liability and Compensation for Damage Resulting from the Transboundary Movement of Hazardous Wastes and their Disposal, Basel, 1989	9 June 2005
Beijing Amendment to the Montreal Protocol	8 August 2005
Convention for the Safeguarding of the Intangible Cultural Heritage. Paris, 17 October 2003	20 January 2016
Convention on International Trade in Endangered Species of Wild Fauna and Flora, Washington, 1973	14 November 1975
Convention concerning the Protection of the World Cultural and Natural Heritage. Paris, 16 November 1972	04 July 1975
Convention Concerning the Protection of Workers against Occupational Hazards in the Working Environment Due to Air pollution, Noise and Vibration, Geneva, 1977	27 May 1986
Convention on the Conservation of Migratory Species of Wild Animals, Bonn, 1979	19 January 1988
Convention on Biological Diversity, Rio de Janeiro, 1992	29 August 1994
Copenhagen Amendment to the Montreal Amendment on Substances that Deplete the Ozone Layer, Copenhagen, 1992	30 September 2000
United Nations Framework Convention on Climate Change, New York, 1992	12 July 1992
International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC)	30 November 1990
International Plant Protection Convention, Rome, 1951	22 February 1991
International Labor Organization Declaration on Fundamental Principles and Rights at Work	1998, amended in 2022
Kyoto Protocol to the United Nations Framework Convention on Climate Change, Kyoto, 1997	30 May 2003

Convention	Date Ratified
London Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, London, 1990	24 July 1992
Minamata Convention on Mercury, Kumamoto, 2013	24 September 2014
Montreal Amendment to the Montreal Protocol	8 August 2005
Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal, 1987	24 July 1992
Montreal Amendment to the Montreal Protocol	8 August 2005
Protocol Concerning Cooperation in Combating Pollution in Cases of Emergency, Abidjan, 1981	20 July 1989
Protocol on Liability and Compensation	30 May 2003
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, Rotterdam, 1998	11 September 1998
United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa, Paris, 1994	15 October, 1994
United Nations Framework Convention on Climate Change, New York, 1992	6 September 1994
Vienna Convention for the Protection of the Ozone Layer, Vienna, 1985	24 July 1989

The international requirements relevant to the GPP Train 2 include:

### **i. Climate Change**

Human contributions to greenhouse gases have modified the atmospheric greenhouse layer, which plays an important role in moderating global temperatures. The threat of climate change is multidimensional, and its impacts transcend national borders. Facing the energy industry today is climate change impacts (CSIS, 2019). The impacts of climate change threaten the energy sector in multiple ways. Natural gas is a fossil fuel, mostly made up of methane. Methane is the second-most important greenhouse gas after carbon dioxide and a key driver of climate change. Using gas for energy creates greenhouse gas pollution, driving climate change in ways such as: a) burning gas for energy produces carbon dioxide, the most significant greenhouse gas. Even before it is burned to create energy, gas production processes release vast quantities of carbon dioxide and methane at every stage of its supply chain. In the short-term, one tonne of methane warms the atmosphere 86 times as much as one tonne of carbon dioxide. b) liquefying gas, a necessary step in preparing gas for export, is extremely energy intensive. This energy is most often provided by the consumption of fossil fuels, increasing the amount of greenhouse gases in the supply chain even more. c) fugitive emissions are emissions of greenhouse gas that occur during the extraction, processing, and transport of natural gas (<https://www.climatecouncil.org.au/resources/why-is-gas-bad-for-climate-change/>).

According to the IPCC (2021), the world must redefine how we use and produce energy, make and consume goods and services, and manage our land. Limiting the dangerous effects of climate change requires the world to reach net-zero CO<sub>2</sub> emissions and make major cuts in non-CO<sub>2</sub> gases like methane. Carbon removal can help compensate for harder-to-abate emissions, such as through natural approaches like planting trees or technological approaches like direct air capture and storage (<https://www.wri.org/insights/ipcc-climate-report>).

Thus, GNGLC would be committed to limiting greenhouse gas emissions of its processing plant as a climate change mitigation measure but would have to be committed to climate change adaptation by ensuring its physical structures and operations are resilient to envisaged physical impacts of more extreme weather events such as extreme temperatures, windstorms, and rainfall.

## **ii. Paris Agreement**

At the 21<sup>st</sup> Conference of the Parties to the United Nations Framework Convention on Climate Change (COP21) organized in Paris, France from 30 November to 11 December 2015, The Paris Agreement was signed. The Agreement calls for sustainable development by providing opportunities for the Parties to reduce their emissions through economy-wide and sectoral mitigation actions, in accordance with their state of development, their national circumstances, and in full compliance with the principles and provisions of the UN Framework Convention on Climate Change. Without doubt, climate change is a multi-faceted, complex global challenge that will require the cooperation of all countries to effectively implement the Paris Agreement in a manner that is fair, far-reaching and respects human values. The 26<sup>th</sup> Conference of the Parties (COP26), held in Glasgow, Scotland from 31 October to 12 November 2021, brought the Parties together to accelerate action towards the goals of the Paris Agreement by reaching net-zero greenhouse gas emissions by mid-century in order to limit temperature rise from global warming to within 1.5<sup>0</sup>C (Earth Negotiations Bulletin, 2021).

Therefore, GNGLC shall take cognisance of this as well as Ghana's greenhouse gas emissions control commitments to this Agreement, particularly through her Nationally Determined Contributions, and limit greenhouse gas emissions from the gas processing plant. Thus, the technologies to be deployed and operations of the plant would have to be state of the art, highly efficient and environmentally friendly.

### **iii. United Nations Sustainable Development Goals**

The Sustainable Development Goals are a universal call to action to end poverty, protect the planet, and ensure that all people enjoy peace and prosperity. Its 17 Goals build on the successes of the Millennium Development Goals but include new areas such as climate change, economic inequality, innovation, sustainable consumption, peace, and justice, among other priorities. The key goals that relate to the GPP Train 2 are Goal 2 on water, Goal 8 on economic growth and employment, Goals 12 and 13 on responsible consumption and production and climate change, respectively and Goal 16 on peace and justice.

### **iv. African Union Agenda 2063**

The African Union Agenda 2063 is Africa's development blueprint and master plan for transforming Africa into the global powerhouse of the future. It has a set of 7 Aspirations, which aim that by 2063, Africa shall be a prosperous continent, with the means and resources to drive its own development, with sustainable and long-term stewardship of its resources. This will include among other targets, a Pan-African High-Speed Train Network to connect all the major cities/capitals of the continent. To achieve this target, the indicative strategy considered is to implement high-capacity oil and gas pipelines.

### **v. New Partnership for Africa's Development**

The New Partnership for Africa's Development (NEPAD) was adopted by African Heads of State and Government of the OAU in 2001 and was ratified by the African Union in 2002 to address Africa's development problems within a new paradigm. NEPAD's main objectives are to reduce poverty, put Africa on a sustainable development path, halt the marginalization of Africa, and empower women. NEPAD, being an African Union strategic framework for Pan-African socio-economic development, addresses critical challenges facing the continent: poverty, development, and Africa's marginalization internationally and provides unique opportunities for African countries to take full control of their development agenda, to work more closely together, and to cooperate more effectively with international partners.

## **2.6 International Environmental and Social Standards**

The GNGLC/Consortium intends to seek financing from International Financing Institutions (IFIs) and therefore will require that the EIA process complies with the requirements of

international standards and guidelines. To this end the project’s compliance with the IFC Performance Standards and Equator Principles have been highlighted.

### 2.6.1 IFC Performance Standards (PSs)

The IFC PSs encapsulates the IFC’s Sustainability Framework which in turn delineates the IFC’s strategic dedication to sustainable progress and stands as an essential element within IFC’s risk management strategy. The PSs are a set of performance standards concerning environmental and social sustainability. They outline IFC’s commitments, functions, and accountabilities related to environmental and social sustainability.

The IFC Performance Standards are aimed at IFC's clients, offering guidance on recognizing risks and impacts and are structured to aid in avoiding, lessening, and managing risks and impacts as part of a sustainable business approach. This involves client engagement with stakeholders and obligations for disclosure concerning project-level activities. For direct investments, encompassing project and corporate finance provided through financial intermediaries, IFC mandates its clients to apply these Performance Standards to handle environmental and social risks and impacts, thereby amplifying development prospects. The Performance Standards are not exclusive to IFC’s clients, but other financial institutions also adopt the Performance Standards and apply them to ensure sustainability.

In all, the IFC PSs has eight (8) Performance Standards that Borrowers, and their projects must meet throughout the projects’ life cycle. The table below summarizes the PSs and their applicability to the proposed GPP2 construction and operation.

Table 5 IFC Performance Standards Applicability

IFC PS	Applicability to the Project	Reason for Applicability
<p><b>Assessment and Management of Environmental and Social Risks and Impacts – PS 1</b></p> <p>underscores the importance of managing environmental and social performance throughout the life of a</p>	<ul style="list-style-type: none"> <li>▪ To identify and assess environmental and social risks and impacts of the project.</li> <li>▪ To adopt a mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimize, and where residual impacts remain, compensate/offset them, where technically and financially feasible.</li> </ul>	<ul style="list-style-type: none"> <li>▪ The project will impact on both biophysical environment, and socio-cultural and livelihood of the project receiving areas.</li> <li>▪ All the stages of the project involve</li> </ul>

IFC PS	Applicability to the Project	Reason for Applicability
<p>project (any business activity that is subject to assessment and management).</p>	<ul style="list-style-type: none"> <li>▪ To adopt differentiated measures so that adverse impacts do not fall disproportionately on the disadvantaged or vulnerable, and they are not disadvantaged in sharing development benefits and opportunities resulting from the project.</li> <li>▪ To utilize national environmental and social institutions, systems, laws, regulations and procedures in the assessment, development, and implementation of projects, whenever appropriate.</li> <li>▪ To promote improved environmental and social performance, in ways which recognize and enhance Borrower capacity.</li> <li>▪ To establish a systematic approach to stakeholder engagement that will help Borrowers identify stakeholders and build and maintain a constructive relationship with them, in particular project-affected parties.</li> <li>▪ To assess the level of stakeholder interest and support for the project and to enable stakeholders' views to be considered in project design and environmental and social performance.</li> <li>▪ To promote and provide means for effective and inclusive engagement with project-affected parties throughout the project life cycle on issues that could potentially affect them.</li> <li>▪ To ensure that appropriate project information on environmental and social risks and impacts is disclosed to stakeholders in a timely, understandable, accessible, and appropriate manner and format.</li> </ul>	<p>stakeholders (Interested and Affected Parties) who have been engaged and will continue to be engaged to receive their inputs into the project development and enhance project acceptability.</p>

IFC PS	Applicability to the Project	Reason for Applicability
	<ul style="list-style-type: none"> <li>▪ To provide project-affected parties with accessible and inclusive means to raise issues and grievances and allow Borrowers to respond to and manage such grievances.</li> </ul>	
<p><b>Labour and Working Conditions – PS 2</b> recognizes that the pursuit of economic growth through employment creation and income generation should be accompanied by the protection of the fundamental rights of workers.</p>	<ul style="list-style-type: none"> <li>▪ To promote the fair treatment, non-discrimination, and equal opportunity of workers.</li> <li>▪ To establish, maintain and improve the worker management relationship.</li> <li>▪ To promote compliance with national labor and employment laws.</li> <li>▪ To protect workers, including vulnerable categories of workers such as children, migrant workers, workers engaged by third parties, and workers in the clients supply chain.</li> <li>▪ To promote safe and healthy working conditions, and health of workers.</li> <li>▪ To prohibit the use of forced labor and child labor.</li> </ul>	<ul style="list-style-type: none"> <li>▪ The project will involve both skilled and unskilled labor at both the construction and operation phases.</li> <li>▪ Worker's safety and congeniality of workers' condition is cardinal in the successful project implementation.</li> </ul>
<p><b>Resource Efficiency and Pollution Prevention and Management – PS 3</b> recognizes that increased economic activity and urbanization often generate increased levels of pollution to air, water, and land and consume finite resources in a manner that may threaten people and the environment at the local, regional, and global levels</p>	<ul style="list-style-type: none"> <li>▪ To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities.</li> <li>▪ To promote more sustainable use of resources, including energy and water.</li> <li>▪ To reduce project-related greenhouse gas emissions.</li> </ul>	<ul style="list-style-type: none"> <li>▪ The implementation of the project will involve the use of high quantities of resources such as fuel, electricity, water etc. and the release of resultant wastes into the environment.</li> </ul>
<p><b>Community Health, Safety and Security (CHSS) – PS 4</b> recognizes that project activities, equipment, and infrastructure can increase</p>	<ul style="list-style-type: none"> <li>▪ To evaluate risks and impacts to health and safety of affected communities during project life cycle.</li> <li>▪ To establish preventive measures consistent with GIIP, such as the WBG</li> </ul>	<ul style="list-style-type: none"> <li>▪ The GPP2 construction and operation will produce some risks and impacts to community health and safety.</li> </ul>

IFC PS	Applicability to the Project	Reason for Applicability
community exposure to risks and impacts.	<p>EHS Guidelines.</p> <ul style="list-style-type: none"> <li>▪ To identify risks and impacts and propose mitigation measures; and</li> <li>▪ To institute measures that will favour the avoidance of risks and impacts over minimisation.</li> </ul>	
<p><b>Land Acquisition, Restrictions on Land Use, and Involuntary Resettlement – PS 5</b></p> <p>recognizes that project-related land acquisition and restrictions on land use can have adverse impacts on communities and persons that use this land.</p>	<ul style="list-style-type: none"> <li>▪ To avoid, and when avoidance is not possible, minimize displacement by exploring alternative project designs.</li> <li>▪ To avoid forced eviction.</li> <li>▪ To anticipate and avoid, or where avoidance is not possible, minimize adverse social and economic impacts from land acquisition or restrictions on land use by (i) providing compensation for loss of assets at replacement cost and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected.</li> <li>▪ To improve, or restore, the livelihoods and standards of living of displaced persons.</li> <li>▪ To improve living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites.</li> </ul>	<ul style="list-style-type: none"> <li>▪ The land for both GPP Train 1 and Train 2, covering an approximate area of 398 ha (983 acres), has been acquired by the government’s Executive Instrument, E.I. 51, 2014.</li> <li>▪ A Resettlement Scoping has been done for GPP2 and based on economic and physical displacement., there is no need for resettlement however there is an ongoing court case to determine the rightful ownership of the entire GPP land thus compensation payment has protracted.</li> </ul>
<p><b>Biodiversity Conservation and Sustainable Management of Living Natural Resources – PS 6</b></p> <p>recognizes that protecting and conserving biodiversity, maintaining ecosystems services, and sustainably managing living and natural resources are fundamental to sustainable development.</p>	<ul style="list-style-type: none"> <li>▪ To protect and conserve biodiversity.</li> <li>▪ To maintain the benefits from ecosystem services.</li> <li>▪ To promote the sustainable management of living natural resources through the adoption of practices that integrates conservation needs and development priorities.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Although GPP2 project site generally is heavily modified by anthropogenic activities, there are few isolated relic species of vegetation types which could be impacted during construction.</li> </ul>

IFC PS	Applicability to the Project	Reason for Applicability
<p><b>Indigenous Peoples – PS 7</b> recognizes that Indigenous Peoples, as social groups with identities that are distinct from mainstream groups in national societies, are often among the most marginalized and vulnerable segments of the population.</p>	Not applicable <sup>1</sup>	
<p><b>Cultural Heritage – PS 8</b> recognizes the importance of cultural heritage for current and future generations.</p>	<ul style="list-style-type: none"> <li>▪ To protect cultural heritage from the adverse impacts of project activities and support its preservation.</li> <li>▪ To promote the equitable sharing of benefits from the use of cultural heritage.</li> </ul>	<ul style="list-style-type: none"> <li>▪ The project receiving area has cultural and historical resources which may interface with the proposed GPP2 construction and operation either directly or indirectly.</li> </ul>

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<sup>1</sup> PS7 is not applicable largely in Ghana.

The term “Indigenous Peoples”, as used in Paragraph 4 & 5 of the IFC PS7, is used in a generic sense to refer to a distinct social and cultural group possessing the following characteristics to varying degrees: 1) Self-identification as members of a distinct indigenous cultural group and recognition of this identity by others; 2) Collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories; 3) Customary cultural, economic, social, or political institutions that are separate from those of the mainstream society or culture; or 4) A distinct language or dialect, often different from the official language or languages of the country or region in which they reside.

Paragraph 6 of PS7 applies to communities or groups of Indigenous Peoples who maintain a collective attachment, i.e., whose identity as a group or community is linked to distinct habitats or ancestral territories and the natural resources therein. It may also apply to communities or groups that have lost collective attachment to distinct habitats or ancestral territories in the project area, occurring within the concerned group members’ lifetime, because of forced severance, conflict, government resettlement programs, dispossession of their lands, natural disasters, or incorporation of such territories into an urban area.

Interpretation of applicability: Based on the details provided, the requirements specified in IFC PS7 to define a group as an Indigenous People are not met, because the ethnic groups in the project receiving area, although self-identified as members of distinct cultural groups, have developed ethnic interrelation through commerce, marriage and migration such that the majority of the peoples are able to speak other dialects in addition to their own. The ethnic groups do not have customary cultural, economic, social, or political institutions that are separate from those of the mainstream society or culture in Ghana and do not have collective attachment to geographically distinct habitats or ancestral territories in the project receiving area and to the natural resources in the project areas (GSS 2010 PHC).

### **2.6.2 World Bank Group (WBG) Environmental Health and Safety (EHS) Guidelines**

The Environmental, Health and Safety (EHS) Guidelines are technical reference documents that address the WBG expectations regarding the industrial pollution management performance of its projects. These guidelines are designed to assist managers and decision-makers with relevant industry background and technical information that supports actions aimed at avoiding, minimizing, and controlling EHS impacts during the construction, operation, and decommissioning phases of a project or facility. The EHS Guidelines serve as technical references to support the implementation of the IFC PS, particularly in those aspects related to *PS 3: Resource Efficiency and Pollution Prevention and Management*, as well as certain aspects of occupational and community health and safety.

When host country (Ghana) regulations differ from the levels and measures presented in the EHS Guidelines, the project will achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, a full and detailed justification for any proposed alternatives is required. General WBG EHS Guidelines contain information on cross-cutting environmental, health, and safety issues potentially applicable to all industry sectors. These include the following areas/issues:

- Environmental
  - Air Emissions and Ambient Air Quality
  - Energy Conservation
  - Wastewater and Ambient Water Quality
  - Water Conservation
  - Hazardous Materials Management
  - Waste Management
  - Noise
  - Contaminated Land
- Occupational Health and Safety
  - General Facility Design and Operation
  - Communication and Training
  - Physical Hazards
  - Chemical Hazards
  - Biological Hazards
  - Radiological Hazards
  - Personal Protective Equipment (PPE)

- Special Hazard Environments
- Monitoring
- Community Health and Safety
  - Water Quality and Availability
  - Structural Safety of Project Infrastructure
  - Life and Fire Safety (L&FS)
  - Traffic Safety
  - Transport of Hazardous Materials
  - Disease Prevention
  - Emergency Preparedness and Response
- Construction and Decommissioning
  - Environment
  - Occupational Health and Safety

### **WBG Environmental, Health, and Safety Guidelines for Onshore Oil and Gas Development**

The EHS Guidelines for Onshore Oil and Gas Development include information relevant to seismic exploration, exploration and production drilling, development and production activities, transport activities including flowlines and pipelines, other facilities including pump stations, metering stations, pigging stations, compressor stations and storage facilities, ancillary and support operations, and decommissioning. For onshore oil and gas facilities located near the coast (e.g., coastal terminals marine supply bases, loading/offloading terminals), additional guidance is provided in the EHS Guidelines for Ports, Harbours, and Terminals.

For the GPP2 construction and operation, pollution prevention in accordance with EHS Onshore Oil and Gas Development Guidelines is provided in Chapter 8 of this EIS.

#### ***2.6.3 Equator Principles***

The Equator Principles are a set of principles that serve as financial industry benchmark for determining, assessing, and managing environmental and social risk in projects, particularly large infrastructure and industrial Projects that can have adverse impacts on people and on the environment. Financiers and advisors, work in partnership with clients to identify, assess and manage environmental and social risks and impacts in a structured way, and on an ongoing

basis. Such collaboration promotes sustainable environmental and social performance and can lead to improved financial, environmental, and social outcomes. Where appropriate, the Equator Principles Financial Institutions (EPFIs), encourage their clients to address potential or actual adverse risks and impacts identified during the Project Development Lifecycle.

Equator Principles are applicable to the GPP2 project since it is a large infrastructure and industrial project, can have adverse impacts on people and on the environment and require international financing and sourcing. The ten (10) Equator Principles (EPs) draw largely from the World Bank Group Sustainability Frameworks i.e IFC Performance Standards and the World Bank Environmental and Social Standards (ESS) because both the World Bank and the IFC are the largest public and private international financial institution that offer investment, advisory, and asset-management services to encourage both public and private sector development. Based on this premise, satisfying the conditions and requirements of the IFC Performance Standards, as applied to the GPP2, will satisfy the conditions and requirements of the Equator Principles.

EP1 requires that when a Project is proposed for financing, the EP Financial Institution (EPFI) will, as part of its internal environmental and social review and due diligence, categorize the Project based on the magnitude of potential environmental and social risks and impacts, including those related to Human Rights, climate change, and biodiversity. Such categorization is based on the International Finance Corporation's (IFC) environmental and social categorization process. The categories are:

**Category A** – Projects with potential significant adverse environmental and social risks and/or impacts that are diverse, irreversible, or unprecedented.

**Category B** – Projects with potential limited adverse environmental and social risks and/or impacts that are few, generally site-specific, largely reversible, and readily addressed through mitigation measures; and

**Category C** – Projects with minimal or no adverse environmental and social risks and/or impacts.

Based on the project features, scale and associated risks and impacts, magnitude of the E&S risks, the GPP2 project has been assessed to be **Category A**.

## CHAPTER 3. DESCRIPTION OF THE PROJECT

### 3.1 Location and Adjoining Land Uses

The Ghana Gas GPP Train 2 is to be situated on the west side of the existing Train 1 (Plate 2). Train 1 is located near Atuabo, about 1.5 km to the north of the shores of the Gulf of Guinea. As indicated in Plate 1, the Atuabo community is located on the shoreline, about 2 km south-west of Train 1. The overall layout is presented in Figure 2.



Source: GNGLC, 2019e

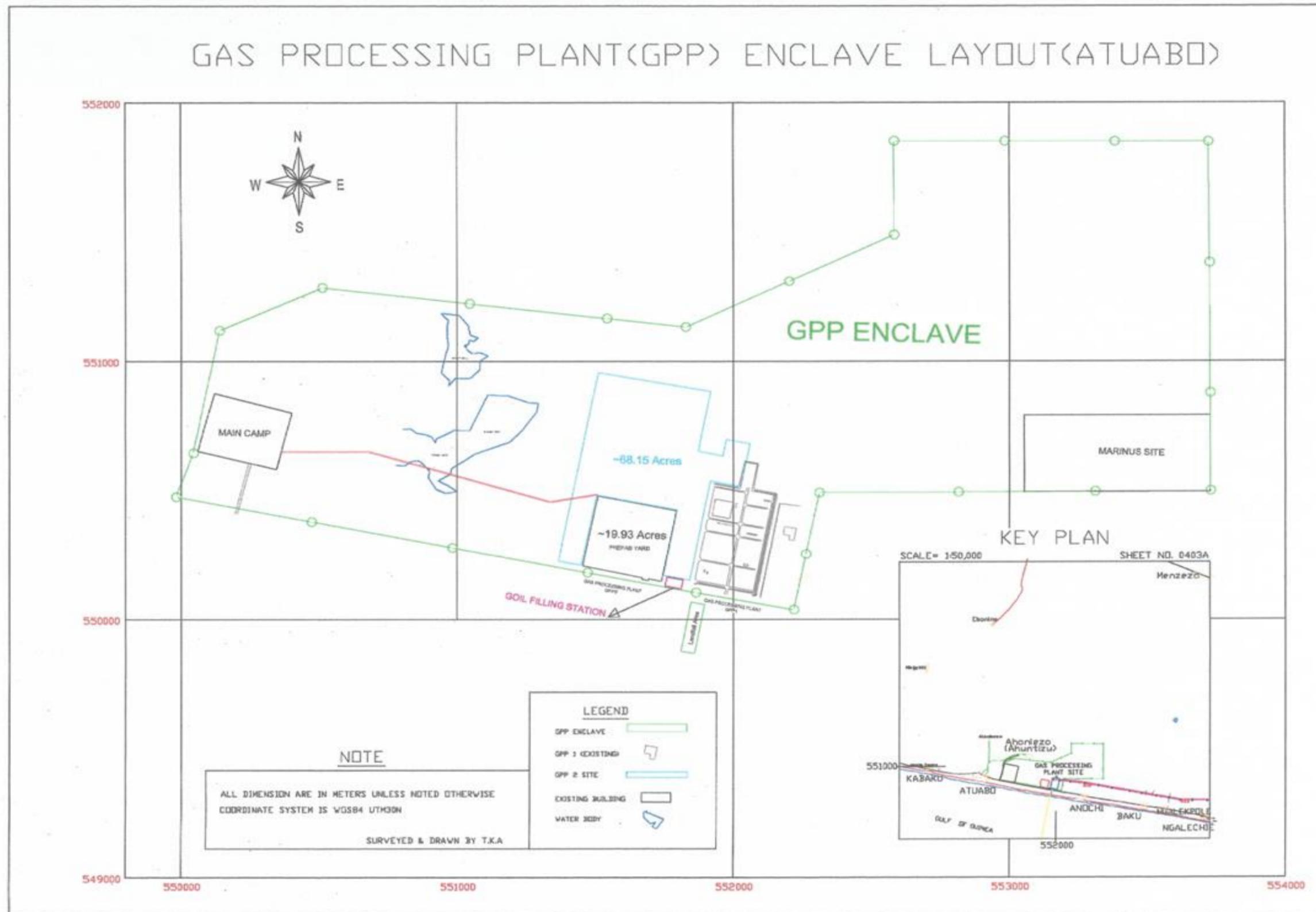
Plate 2 Existing GPP Train 1 and Facilities (looking southwards)

The site for the GPP Train 2 is thus bordered to the east by the existing Train 1. Further to the east, about 2.5 km from Train 1 is located the LPG truck loading gantry, which is connected to Train 1 by two sets of 8-inch pipelines and a 6-inch vapour return line. The Anokyi community is located about 0.43 km to the east of Train 1 while the Asemnda community lies 0.5 km north-west of the proposed site for Train 2. The Asemnda and Anokyi communities are under the Atuabo Paramount Chief but have their own chiefs who are subordinates to the Paramount

Chief who is therefore the owner of the land. Thus, reference is made to the GPP as located at Atuabo (Asamoah, 2014).

Land use in the proposed project area is therefore already dominated by GNGLC's existing facilities and infrastructure as exemplified in Plate 3-2, and the nearby communities including Atuabo, Anokyi, and Asemnda. Interspersed within these are rivers and streams that form the catchment of the Amansure River, with coconut as the dominant cash crop. Some areas are waterlogged for part of the year and only grasses and sedges thrive to serve as grazing areas. The Krisan-Eikwe Road forms a border to the south of the existing and proposed GPP Trains.

# GAS PROCESSING PLANT (GPP) ENCLAVE LAYOUT (ATUABO)



Source: GNLGC, pers. comm.

Figure 2 General Layout of Atuabo Gas Enclave



Plate 3 Offices of GNGLC at A.B. Bokazo



(a)



(b)

Plate 4 Offshore Gas Pipeline Route to GPP Train 1

### **3.2 Land Acquisition**

The Government of Ghana (GoG) acquired the entire GPP Enclave, covering an approximate area of 398 ha (983 acres), by an Executive Instrument, E.I. 51, 2014. The GPP Enclave has within it the existing and operational GPP1 whereas the proposed GPP2 will also be situated within the GPP enclave, adjacent to GPP1 westward (see Plate 5). Both Atuabo and Anokyi communities have laid claim to the ownership of the GPP Enclave land which has culminated into an ongoing court case to determine the rightful ownership of the entire GPP enclave thus, the land litigation process has protracted leading to the non-payment of compensations by GNGLC. GNCG is prepared to work with the traditional authorities of both Atuabo and Anokyi to resolve the land litigation issue and pay the appropriate compensations.

Although land compensation for the GPP Enclave is pending, GNGLC has paid crop compensation to all Project Affected Persons (PAPs) whose farms were within the GPP Enclave at the time of the acquisition.

The closest communities to the GPP Enclave are Atuabo which is approx. 400meters from the western edge of the GPP Enclave, Anokyi which is approx. 600m from the south-eastern edge of the GPP Enclave whereas Asemda is approx. 50m from the north-western edge of the GPP Enclave.

### **3.3 Project Overview**

GNGLC proposes to establish an additional gas processing train in a second phase at its existing plant site at Atuabo. The new GPP Train 2 will process dense phase gas from the Jubilee field (up to 100 MMSCFD) and TEN fields (up to 50 MMSCFD) using the same offshore gas supply and sales gas pipelines as the existing 150 MMSCFD-capacity GPP Train 1 (GNGLC, 2019b). In addition, the new train will be capable of processing up to 50 MMSCFD of dense phase gas from new fields (Aker) currently under investigation. Thus, the combined gas treatment capacity at Atuabo will be 350 MMSCFD on completion of Train 2. The existing offshore gas supply pipeline (12-inch diameter and 58 km long) and onshore sales gas pipelines from Atuabo to Takoradi (20-inch diameter and 110 km) and from Esiam to Prestea have enough capacity to adequately cater for the additional operations of GPP Train 2.

### ***3.3.1. Design Inlet Gas Composition and Cases***

The minimum inlet gas rate to Train 2 shall be 60 MMSCFD (70,792 Sm<sup>3</sup>/h) which corresponds to 30% of the design. Lower flow rates shall be directed to Train 1.

#### ***i. Bulk Composition***

Train 2 will receive the same inlet gas as Train 1 via a common 12” offshore pipeline from the Jubilee and Tweneboa-Enyenra-Ntomme (TEN) fields –plus a new stream from new fields via a new pipeline. The Jubilee and individual TEN inlet gas design compositions (mol/%) are presented in Table 6 and are associated gas from oil production.

Untitled Map  
Write a description for your map.

- Legend
- GPP Enclave
  - GPP Train 2 Area
  - GPP2 Project Site
  - Swamp



Google Earth  
Image © 2023 Maxar Technologies  
Image © 2023 TerraMetrics  
Image © 2023 CNES / Airbus

Plate 5 GPP Enclave - Extent of Acquired GNGLC Land

Table 6 Field Export Gas Compositions (mol%)

Component	Tag	Jubilee (5)	Tweneboa (3)	Enyenra (2)	Ntomme (1)	TEN (4)
Hydrogen	H <sub>2</sub>	0.000	0.000	0.000	0.000	0.000
Hydrogen Sulphide	H <sub>2</sub> S	0.000	0.000	0.000	0.000	0.000
Carbon Dioxide	CO <sub>2</sub>	1.442	0.910	1.018	0.730	0.886
Nitrogen	N <sub>2</sub>	0.241	0.370	0.215	0.350	0.312
Methane	C1	78.054	83.080	84.085	89.850	85.672
Ethane	C2	8.943	5.300	6.048	4.090	5.146
Propane	C3	7.241	5.380	5.013	3.180	4.524
i-Butane	iC4	0.892	0.910	0.627	0.360	0.632
n-Butane	nC4	2.188	1.950	1.497	0.830	1.426
i-Pentane	iC5	0.453	0.550	0.314	0.170	0.345
n-Pentane	nC5	0.400	0.500	0.330	0.160	0.330
Hexanes	C6	0.073	0.370	0.296	0.100	0.255
Benzene		0.001	0.010	0.014	0.000	0.008
Cyclo-hexane		0.015	0.230	0.000	0.060	0.097
Heptanes	C7	0.026	0.170	0.282	0.050	0.167
Me-Cyclo-hexane		0.005	0.070	0.000	0.020	0.030
Toluene		0.002	0.020	0.013	0.000	0.011
Octanes	C8	0.013	0.100	0.130	0.020	0.083
Ethyl-benzene		0.001	0.010	0.005	0.000	0.005
Meta/Para-xylene		0.001	0.000	0.008	0.000	0.003
Ortho-xylene		0.002	0.000	0.002	0.000	0.014
Nonanes	C9	0.005	0.040	0.061	0.010	0.030
Decanes	C10	0.002	0.020	0.029	0.010	0.016
C11+	C11+	0.001	0.010	0.013	0.010	0.008
<b>Total</b>		<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>
Molecular Weight	MW	21.65	21.20	20.60	18.70	20.15

Source: GNGLC (2019d)

**Notes:**

1. Core Lab RFLA 20120257 Separator Gases - Main Flow Period Cylinder Number A01854;
2. EXPRO GHA1020 Sample Number 1.14, Cylinder Number; 16863-IB / Produced Gas @ 1,100 psia and 214 F (close conditions to A01854 at 688 psia 135 F);
3. Tweneboa-1\_composition data (20151015) Sample Number 1.05 Cylinder Number; 15991-IB / Cryogenic Gas @ 3,500 psia and 61F (leaner condition than actual);
4. Equal molar fractions of Tweneboa, Enyenra and Ntomme;
5. To have a more plausible description of heavy hydrocarbons fraction for Train 2 FEED purposes, a number of heavy hydrocarbon compounds (heavier than n-hexane) have been introduced in the jubilee raw gas composition, in the same ratio as is stated in the TEN gas composition and resulting in a total quantity as n-hexane (0.073% molar).

The proportion of Tweneboa, Enyenra and Ntomme in the TEN gas is not specified and it is assumed that they will be present in equal molar fractions.

Gas composition from the new field (Aker) is presented in Table 7 and represents associated gas from oil production.

Table 7 Field Export Gas Compositions (mol%) – AKER Field

Component	Tag	AKER Field <sup>1</sup>
Water	H <sub>2</sub> O	0.0015
Hydrogen	H <sub>2</sub>	0.000
Hydrogen Sulphide	H <sub>2</sub> S	0.000
Carbon Dioxide	CO <sub>2</sub>	0.723
Nitrogen	N <sub>2</sub>	0.366
Methane	C1	70.830
Ethane	C2	9.928
Propane	C3	12.010
i-Butane	iC4	1.358
n-Butane	nC4	3.515
i-Pentane	iC5	0.538
n-Pentane	nC5	0.439
Hexanes	C6	0.142
Benzene		0.0025
Cyclo-hexane		0.0310
Heptanes	C7	0.0529
Me-Cyclo-hexane		0.0100
Toluene		0.0035
Octanes	C8	0.0263
Ethyl-benzene		0.0016
Meta/Para-xylene		0.0010
Ortho-xylene		0.0044
Nonanes	C9	0.0095
Decanes	C10	0.0050
C11+	C11+	0.0025
<b>Total</b>		<b>100</b>
Molecular Weight	MW	23.88

Source: GNGLC (2019d)

1. To have a more credible description of heavy hydrocarbons fraction (heavier than n-hexane) for Train 2 FEED purposes, pseudocomponents, NBP246 and NBP46, have been distributed among the same heavy compounds present in the TEN gas composition, in the same ratio.

## *ii. Design Cases*

Train 2 will receive gas streams from three main fields, it shall be capable to operate with any blend of the three streams. Nevertheless, the following design cases shall be considered to investigate the plant performance and operating conditions:

1. Case 1A: 200 MMSCFD (235,973 Sm<sup>3</sup>/h) – 100 MMSCFD from Jubilee, 50 MMSCFD from TEN, 50 MMSCFD from new fields; maximum inlet flow rate, maximum LPG recovery (propane chiller and turboexpander in operation);
2. Case 1B: 200 MMSCFD (235,973 Sm<sup>3</sup>/h) – 100 MMSCFD from Jubilee, 50 MMSCFD from TEN, 50 MMSCFD from new fields; maximum inlet flow rate, reduced LPG recovery (propane chiller and turboexpander out of operation);
3. Case 2A: 150 MMSCFD (176,980 Sm<sup>3</sup>/h) - 100 MMSCFD from Jubilee, 50 MMSCFD from TEN; Maximum LPG recovery;
4. Case 2B: 150 MMSCFD (176,980 Sm<sup>3</sup>/h) - 100 MMSCFD from Jubilee, 50 MMSCFD from TEN; reduced LPG recovery (propane chiller and turboexpander out of operation);
5. Case 3A: 150 MMSCFD (176,980 Sm<sup>3</sup>/h) – 100% AKER composition; Maximum LPG recovery;
6. Case 4: 60 MMSCFD – 100% Jubilee composition; Propane Chiller in operation, turboexpander out of operation (Joule Thomsom Valve (JTV) working).

Cases 1A & 1B are the Design case as feed inlet flow rate and will provide the sizing basis for most of the equipment controlled by vapour throughput. These cases will investigate the plant performance either in the case of maximum LPG recovery or maximum sale gas production (reduced LPG recovery).

Cases 2A & 2B will provide the expected performance for the current feed characteristics. These cases will investigate the plant performance either in case of maximum LPG recovery or maximum Sale gas production (reduced LPG recovery).

Case 3A represents the future configuration if the Jubilee+TEN feed is absent or is treated by Train 1. It is the design case for most of the equipment controlled by LPG/condensate throughput.

Case 4 represents the turndown case for the plant; the turboexpander is assumed to be out of service due to the very low loading (below 50% capacity).

### ***iii. Contaminants***

The design water content of the inlet gas is specified in the contract as a maximum of 10 lb/MMSCFD and is expected to be less than 2 lb/MMSCFD.

The Train 1 site survey found the presence of water in the inlet separator. Train 2 will be designed considering the water content in the inlet gas as per the contract; however, the dehydration system will be designed taking into consideration that the received gas, coming from Inlet Separator, will be saturated in water vapour.

Considering the provisional raw gas composition presented to Ghana Gas by Kosmos, no contaminants (i.e. H<sub>2</sub>S or Mercury) are expected, however tie-ins and plot space shall be considered for future Train 2 inlet gas treatment by using fixed bed technology for:

- Trace H<sub>2</sub>S concentration removal, typically < 16.5 ppm mol which corresponds to the NACE MR0175/ISO15156 limit for the offshore pipeline for the maximum operating pressure, to meet sales gas and LPG specifications.
- The presence of mercury to meet product specifications or protect equipment from failure or contamination.

The Front End Engineering Design (FEED) would also consider:

- The maximum acceptable mercaptans and carbonyl sulphide concentrations possible in the inlet gas to meet the Train 2 product specifications.
- Whether tie-ins and plot space should be considered for LPG treatment in case mercaptans and COS concentrations are above these values in the future.

The inlet gas from Jubilee/TEN contains mono ethylene glycol for hydrate inhibition, which is drained from the inlet separator of Train 1. No presence of corrosion inhibitors or other chemicals has been detected. Mono ethylene glycol is also injected in Train 1 facilities, for hydrate inhibition, and drained from the water pot, nevertheless, traces of MEG are present in LPG and condensate from Train 1.

### ***iv. Gas Processing***

The natural gas liquids (NGLs) extracted from the dense phase raw gas will be fractionated into propane (C<sub>3</sub>), butane (C<sub>4</sub>), pentane (C<sub>5</sub>) and stabilized condensate (C<sub>5</sub>+) components.

The lean gas containing methane (C1) and ethane (C2) will be tied-in with the lean gas export from Train 1 and delivered into the onshore export pipeline to the existing Aboadze and Prestea power generation enclaves. The separated pure components C3 and C4 will be stored in their new respective storage spheres to be constructed as part of the GPP 2 project and may be further blended as per internal market demand. The blending of pure C3 and C4s will be carried out using a dedicated LPG sphere at Train 1. On spec LPG will then be exported to the LPG loading gantry or a jetty. Excess propane shall be exported to the new jetty. The potential of exporting both pure C3 and C4s to the new jetty exists but is not considered under the current scope.

The remaining C4+ components will be further fractionated to obtain a pentane/isopentane mixture (C5) and a stabilized condensate (C5+). Due to its low market value, the C5 mixture stream will be used preferably as fuel within the GPP Train 2 facilities, mainly for heaters. The stabilized condensate (C5+) will be sent to storage containers and then dispatched to the existing condensate loading station at existing GPP Train1 facilities.

In addition to providing lean gas to the power generation export pipeline, one of the main objective of the new GPP Train 2 is to maximize C3 and C4 recovery from the raw gas feed (GNGLC, 2019d). The light ends in the condensate will be removed with the aid of a depentanizer column before finally sending the stabilized condensate to the relevant storage tanks.

A new compression system located about 2.5 km east of the plant will compress lean gas from Train 1 and Train 2 to the Aboadze and Prestea power generation enclaves. Compared to the existing early phase Train 1 plant the Train 2 plant will have:

- Higher recovery of LPG components using a turboexpander and the associated feed gas treatment requirements.
- LPG fractionation facilities (depropanizer and debutanizer columns) to allow separate propane and butane products.
- Pentane product in liquid phase.

A JT valve is required to be installed, in parallel with the turboexpander, to maintain the inlet gas treatment capacity, even if with a lower recovery factor, in case of the turboexpander is out of service or in case of very low turndown or during start-up.

The Train 2 treatment facilities will be independent of the existing Train 1 treatment facilities but opportunities for integration will be explored and Train 1 lessons learnt will be incorporated into the design. Due to the expected high C3 and C4 production from the new Train 2, dispatching by truck is not reasonably possible, therefore all the pure propane, pure butane and blended LPG from Train 2 will be dispatched via tanker ship and a jetty.

Fresh water for use on site, including potable use, will be provided from boreholes to be installed by the project. Electricity will be obtained by gas-powered generators on site.

### **3.4 Key Project Components**

The new Train 2 plant will be composed of the following main process units (GNGLC, 2019b, GNGLC, 2019d):

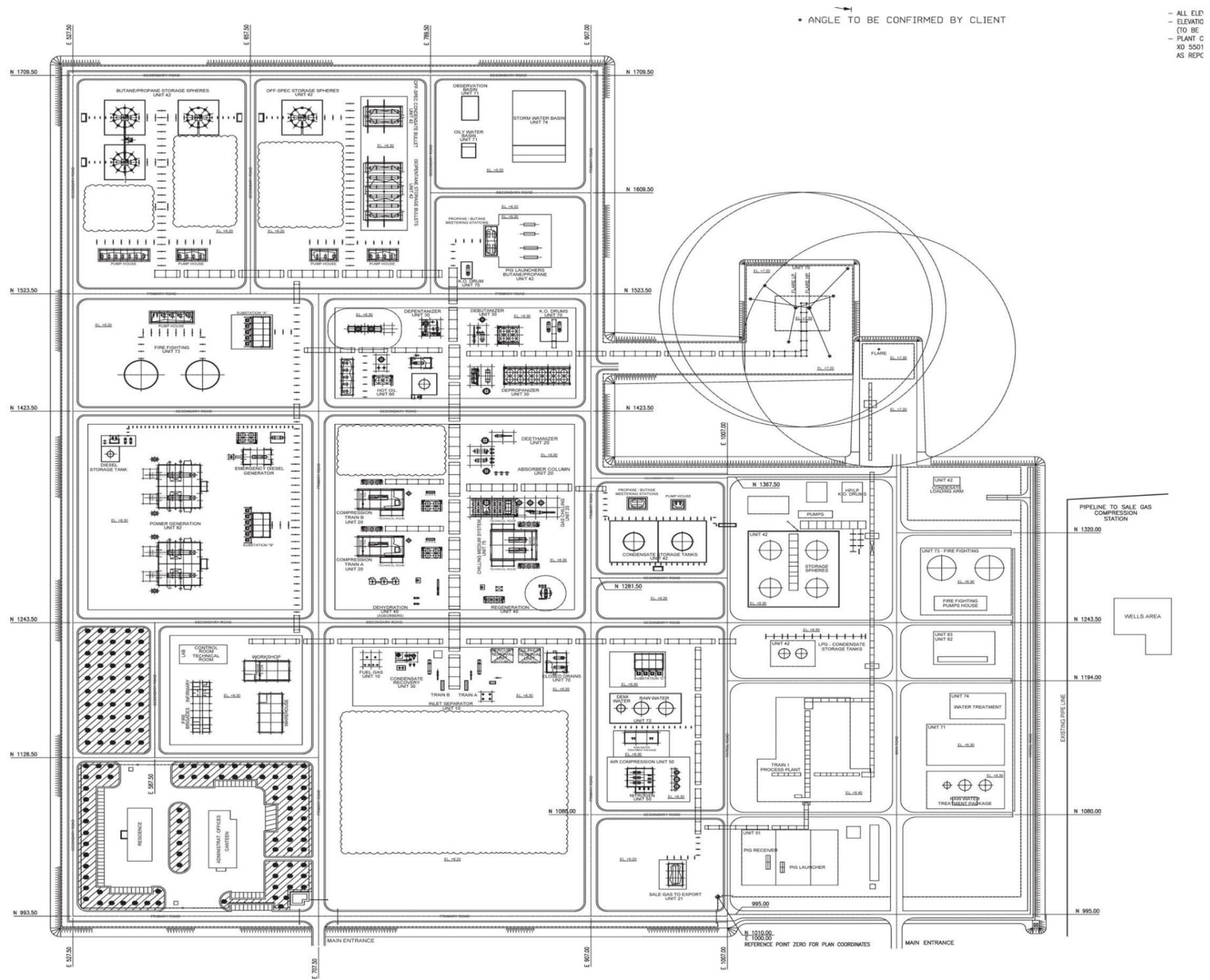
- Unit 10 - Inlet Separation and Fuel Gas System;
- Unit 20 – Chilling, Deethanization & Recompression;
- Unit 30 - Fractionation;
- Unit 40 - Dehydration;
- Unit 42 – Products storage and delivery.

Figure 3 provides a diagrammatic representation of the layout (GNGLC, 2018).

#### ***3.4.1 Inlet Separation and Fuel Gas System***

The Raw Gas from the GPP Train 2 inlet manifold is divided between two equivalent let-down pressure and phase separation trains, working in parallel and each sized for 50% of the design capacity. Each train consists of:

- Inlet Gas Preheaters.
- A common Slug Preheater and Hydrocarbon Slug Filters.
- Inlet Separators.



**GAS PROCESSING PLANT  
GPP2**

**GAS PROCESSING PLANT  
GPP1**

Source: GNGLC, pers. comm.

Figure 3 GPP 1 and 2 Layout

The purpose of this unit is to let down the pressure of the gas using a Joule Thomson (JT) valve and separate any liquid that can form due to the pressure and temperature reduction. The raw gas feed to each train is under a dedicated flow rate control; a pressure controller on the inlet manifold operates in cascade mode with the two flow controllers to keep the inlet pressure constant. A Distributed Control System (DCS) selector is provided for selecting one of 3 provided cascade controls.

To avoid hydrate formation problems due to expansion and consequent temperature reduction across the JT valve, the raw gas is first heated to about 20°C above the estimated hydrate formation temperature, in the shell & tube type exchanger using a Hot Medium tube-side circulation. Hot Medium circulation is controlled under temperature control of the raw gas from the exchanger.

The inlet separator is a horizontal three-phase gas/liquid/liquid separator, operating at about 70 barg and 25 °C. The raw gas is routed to a dehydration unit. The liquid hydrocarbon phase flows out of the separator under level control and is fed to another separator, operating at lower pressure, where light hydrocarbon flashes and heavier compounds are fed to the condensate recovery unit. The water phase is collected in a boot and discharged under level control to the wastewater treatment system, via the water flash drum.

### ***3.4.2 Gas Dehydration***

The wet raw gas from the inlet separators must be dried before being fed to the low-temperature LPG recovery section. This is achieved by using a molecular sieve-based dehydration package to remove water to less than 1 ppm. Valved connections are provided on the raw gas line before entry into the dehydration unit for gas treatment packages for gas that would contain hydrogen sulphide as well as mercury and heavy metals in the future.

The wet raw gas is first heated up to about 30 °C (about 5 °C above the relevant dew point) in the Shell & tube type exchanger. The heating is made, under temperature control, by hot medium circulation through the exchanger tube-side. Then the raw gas is passed through the knockout drum where any entrainment is separated.

The design of the dehydration package is based on a multi-bed molecular sieve arrangement with two beds in operation at about 69 barg and one bed offline in regeneration or stand-by.

The active beds work in parallel. Wet raw gas flows through the beds in downflow and water is adsorbed on the molecular sieves; dry gas exiting from the bottom of the beds is then filtered to remove any fines and then routed to the low-temperature LPG recovery section. Dry gas water content is continuously monitored by an in-line analyser.

The bed regeneration is carried out by a small percentage (10% to 20%) of the dried gas taken downstream of the dryers. The regeneration gas circulation is guaranteed by a flow control valve installed on the main wet gas line which generates a proper pressure drop. The regeneration stream is heated up to 300 °C, under temperature control, by a direct fire heater. Hot regeneration gas passes through the bed in upflow (counter flow with respect to the adsorption phase) and water desorbs. The regeneration phase is carried out at about the same operating pressure as the adsorption phase, to avoid the flaring of a huge amount of process gas due to the depressurizing and pressurizing cycle.

Regenerated gas is then cooled in an air cooler where most of the water condenses and is separated. The gas is then recycled to the in-line bed's inlet, jointly with the main raw gas stream. Separated water is discharged under level control to the wastewater treatment system. The adsorption and regeneration phases are fully automatic, they are done and supervised by a dedicated programmable logic controller which communicates with the central Distributed Control System for data sharing. The regeneration gas flow rate is controlled by a dedicated flow controller.

### ***3.4.3 Gas Chilling & Deethanization***

The dry raw gas from the dehydration unit is sent to the low-temperature NGL Recovery unit to recover NGL from the dehydrated gas to produce added value liquid products for export. To provide more efficient NGL recovery than Train 1, a low-temperature propane chilling system and turboexpander technology are utilized. The system consists of:

- A chilling section with condensate recovery.
- A pressure let-down section (turboexpanders/JT valves) to further reduce temperature and promote NGL condensation.
- An absorption and deethanization section, where NGL recovery is maximized, and light compounds (C1 and C2) are removed.

The dry gas coming from the dehydration unit is pre-cooled through a heat exchanger that works to recover, as much as possible, refrigeration from the colder streams coming from downstream units. The exit temperature of the raw NGL to be fed to the deethanizer column is controlled to keep stable operating conditions in the column. Pre-cooled gas is then chilled to about -27 °C in the Propane Chilling Unit utilizing vaporizing liquid propane as a cooling medium at -33.8 °C and 0.4 barg pressure. The propane chiller increases the NGL recovery of the whole process, condensing more hydrocarbons in the dried gas.

The chilled gas stream from the chilling unit at about 64 barg and -27 °C enters the turboexpanders section where pressure is reduced to about 23 barg and, because of an isentropic expansion, the temperature reduces up to about -63 °C. Turboexpander technology allows partial energy recovery for further gas re-compression. The turboexpander section is designed as three parallel trains, each sized for 50% of the total capacity; the design is for two trains to be in operation and one on stand-by as a spare. Each train is composed of:

- Turboexpander and relevant booster compressor mounted on a common shaft.
- A low flow JT valve which operates jointly with the turboexpander.
- A full flow JT valve for total turboexpander by-pass.
- A High Integrity Pressure Protection System (HIPPS) unit to protect the downstream low-pressure section against overpressure.

This configuration has been considered the best solution to satisfy the following requirements: Provide spare capacity to ensure maximum NGL recovery and treated gas delivery pressure even in case of one train failure.

- Achieve the required turn-down capacity (20% of the design) minimizing internal recirculation and, as a consequence, energy costs.
- Facilitate start-up/shut down procedure and assure the maximum reliability of the system in case of process upsets.

The chilled gas from a second low-temperature separator is divided from a common manifold to the two turboexpander operating trains. The feed flow rate to a train is controlled by keeping a constant operating pressure at the turboexpander inlet. The common manifold is also provided with an independent pressure controller (PIC) which vents to flare any overpressure due to process upset, without affecting the normal operation of the trains. A common supervisory

system is provided to monitor and intervene to balance the load sharing between the trains or in case of a train malfunction and spare start-up. This system can communicate with the central DCS for data sharing. Operating pressure downstream the turboexpander is reduced at 23 barg. This value has proved to be a good compromise to achieve the maximum NGL recovery while still minimizing sale gas re-compression.

Streams from the turboexpander trains are collected to a common manifold and fed to an absorber together with the condensate stream. The absorption process allows for the improvement of NGL recovery in the stream from the column bottom. The liquid stream from the column bottom is fed under level control to the deethanizer column after routing through heat recovery.

The deethanizer is a 35 valve trays refluxed column with a TEMA BKU bottom reboiler using Hot Oil at 250 °C supply temperature as a heating medium. The deethanizer operates at 25 barg and a temperature range of 9 °C (top) and 25 °C (bottom). It fractionates the feed into a C1/C2 overhead stream, partially refluxed at the top section, and a C3+ recovered liquid fraction (NGL) with a residual 0.9% volume of C2+.

The gas from the turboexpanders is thus separated into:

- C1/C2 Sales Gas sent to re-compression.
- C3+ Liquid stream sent to fractionation.

#### ***3.4.4 Sales Gas Compression***

C1/C2 Sales gas from the top of the absorber in the deethanizer column of the deethanization section is sent, after heat recovery, to the compression system. This system consists of three parallel trains, two in operation and one on stand-by as spare; each train is composed of:

- A booster centrifugal compressor driven by the turboexpanders.
- A compressor Knock Out drum.
- A main centrifugal compressor.

From a common manifold, the sale gas at an initial pressure of 21.6 barg is divided between the two operating trains. The first stage of compression is made by the booster compressor driven by the turboexpander; the sale gas is compressed up to 25 barg and then passed through

the knockout drum. Any liquid from the knockout drum is discharged under level control in gap action. The second and final stage of compression is made by the main centrifugal compressor which is electric motor driven. The sale gas is compressed to the final pressure of 53.7 barg and then cooled at 45 °C by the air cooler. Sale gas cooling is made under temperature control.

The compressed gases from the two operating trains are joined in a common discharge manifold and routed, through a dedicated custody metering unit using ultrasonic flowmeter technology, toward the Train 2 battery limit to be tied into the existing sales gas line from Train 1 and then dispatched to the existing delivering facilities. The existing gas export pipeline has available additional capacity to also accept Train 2 gas. Provision has been made for a dedicated pressure controller on the inlet and outlet common manifolds of the compression system, to flare any overpressure due to process fluctuation without affecting the normal operation of the unit.

### ***3.4.5 NGL Fractionation***

The NGL fractionation section receives the deethanizer bottom stream to be split into the required final liquid products - pure C3, pure C4, C5/i-C5 blend and stabilized condensate C5+. The section is composed of the depropanizer, debutanizer, and depentanizer columns.

#### ***i. Depropanizer***

NGL from the deethanizer bottom is fed to a depropanizer column, the first part of the fractionation section. This column is a 43-valve trays reflux column with a TEMA BKU type bottom reboiler using hot oil at 250 °C supply temperature as a heating medium. The depropanizer operates at 17 barg and a temperature range of 52°C (top) and 116°C (bottom). On spec C3 is obtained from the top of the column while the remaining C3+ from the bottom contains a residual C3 of less than 0.7 % molar.

#### ***ii. Debutanizer***

C3+ stream from the depropanizer column bottom is fed to the debutanizer column which is a 35-valve trays reflux column with a TEMA BKU type bottom reboiler, using hot oil at 250 °C supply temperature as a heating medium. The debutanizer operates at about 6.0 barg and a temperature range of 62°C (top) and 117°C (bottom). On spec C4 is obtained from the top of

the column while the remaining C4+ from the bottom contains a residual C4 of less than 0.7 % molar.

### *iii. Depentanizer*

C4+ stream from the debutanizer bottom is fed to the depentanizer column which is a 13-tray reflux column with a TEMA BKU type bottom reboiler, using hot oil at 250 °C supply temperature as a heating medium. The debutanizer operates at about 3.0 barg and a temperature range of 82°C (top) and 120°C (bottom). C5 mixture is obtained from the top of the column while the stabilized condensate is obtained from the bottom. The column specification is the Reid vapour pressure of the stabilized condensate, while the C5 mix composition is a function of the GPP Train 2 inlet raw gas composition.

Overhead vapours from each of the three fractionation columns (the depropanizer, debutanizer and depentanizer) are condensed under temperature control by air coolers. The condensate is collected in horizontal overhead receivers the operating pressure of which is controlled by pressure controllers acting in split range on hot by-pass valves and on vent valves to flare. Part of the condensate from the overhead receiver is refluxed to the respective column, under flow rate control, by three pumps per column, two operating and one spare, and part delivered to storage. Each column performance (product purity) is guaranteed by controlling the temperature on the most sensitive tray and operating on the heat medium flow rate to the reboiler.

### **3.4.6 Liquid Hydrocarbon from Inlet Separator Treatment**

The liquid hydrocarbons from the inlet separators operating at about 70 barg, contain NGL and lighter compounds like C1 and C2 and have to be treated to remove light hydrocarbons and recover NGL in the fractionation section. Hydrocarbon condensate is drawn from the inlet separators under level control and collected to a flash drum. This is a horizontal three-phase Gas/Liquid/Liquid separator operating at 25.4 barg; the operating pressure in the separator is controlled to allow gas phase recovery to the sale gas compression system. Any water phase separated in the flash drum is collected to a boot and discharged under level control to the wastewater treatment.

The hydrocarbon phase is drawn-off from the separator under level control and pumped through the condensate dehydration package and then to the top of a second deethanizer

(condensate deethanizer) column. The dehydration package is designed as a multi-bed molecular sieve arrangement with one or more beds in operation and one bed offline in regeneration or on stand-by. Wet condensate gas flows through the beds in upflow and water is adsorbed on the molecular sieve; dry condensate exiting from the top of the beds is then filtered through one of two filtering units, one in operation and one in standby, to remove any fines and then routed toward the condensate deethanizer column.

For the bed regeneration, the same circuit provided for the gas dehydration package above (section 3.4.3) is used. As adsorption is conducted at about 25 barg in the liquid phase, while regeneration operates at about 70 barg in the gas phase, draining and pressurizing operations shall be designed for in the regeneration cycle. Regeneration is fully automatic, managed by a dedicated PLC which communicates with other dehydration and regeneration units PLC as well as with the central DCS for data sharing.

Dry condensate from the dehydration package is heated up in the deethanizer condenser where heat recovery is achieved by condensing the column overhead, then it is fed to the top of the column. This column is a 16-valve tray top reflux column that operates as a stripper of lean components from the hydrocarbon liquid. The column overhead stream is mainly C1/C2 and residual C3, which is partially condensed in the deethanizer condenser and then settled in the overhead drum. Vapours from this drum are joined to the vapours from that in the first deethanizer unit above (Section 3.4.6) and recovered in the sales gas stream at the Sales Gas compression Inlet Manifold.

The liquid from the overhead Drum is refluxed to the head of the column by one of two pumps, one operating and one spare; automatic start of the spare pump in case of low discharge pressure is foreseen to improve the system reliability.

The deethanizer column bottom reboiler is a TEMA BKU type heat exchanger using HOT OIL at 250 °C supply temperature as a heating medium. The column performance (residual light hydrocarbon concentration in the bottom) is controlled by operating on the heat medium flow rate to the reboiler.

The bottom liquid from the deethanizer column is NGL and is, therefore, recovered in the depropanizer column, at the beginning of the fractionation section. The liquid stream is drained off from the column bottom under level control, in cascade mode on flow control.

### ***3.4.7 Products Storage and Delivery***

In addition to the existing product storage, which will be dedicated to the Train 1 products, all the liquid produced from Train 2 will be stored separately (GNGLC, 2019d). The storage capacity for the new GPP Train 2 facilities has been defined considering the following (GNGLC, 2019b & d):

- Propane and Butane will be mainly delivered to new dedicated spherical storage tanks and sent to the existing Train 1 multi-loading gantry into trucks by bulk off taker(s).
- Stabilized condensate will be shipped by truck via the truck loading arms at Train 1.
- Pentane will mainly be used within the plant as fuel.

The required minimum storage capacity at the site for Train 2 is as follows:

- Storage capacity of Propane and Butane equivalent to 2 production days. In addition, a minimum of three pressurized storage facilities (spheres) are envisaged for off-spec products (propane/butane/blended LPG), which correspond to more than 1 day of production (C3+C4).
- Storage capacity of Stabilized Condensate equivalent to 14 production days and two off-spec condensate vessels, equivalent to 1 production day.
- Storage capacity of Pentane equivalent to at least two production days.

#### ***i. C3 & C4 Storage***

C3 and C4 storage consist of fully pressurized spheres at ambient temperature as per existing Train 1 storage. Following the same philosophy of Train 1 storage, spheres are designed for 17.7 barg pressure. Sphere volume is defined considering the required hold-up capacity, 80% max filling ratio and mechanical restrictions.

Following the above criteria, a total of six (6) spheres are provided for C3 and C4 on-spec storage. Each storage sphere is protected against overpressure using a Pressure Relief Device sized for external fire, and a blow-down valve for emergency depressurization. Moreover, a

water rings deluge system is provided for each sphere to cool down the content in case of external fire in a neighbouring area.

Spheres in operation with the same product are then connected by a balance line to reduce flaring during product handling.

The 6 pressurized storage spheres are totally equivalent and available for both products. Based on Train 2 production capacity, 4 spheres are usually available for C3 and 2 spheres for C4 storage. During normal operation, the minimum hold-up of products is in the storage area, leaving most of the storage capacity available to accept production during any delivery system failure, without shutting down the plant.

Each sphere outlet is connected to two main common headers, one dedicated to C3 and one dedicated to C4 delivery. The following sets of pumps are provided:

- Two pumps (one in operation and one spare) – provided to transfer C3 between two spheres and to transfer C3 to the Train 1 storage.
- Two pumps (one in operation and one spare) – provided to transfer C4 between two spheres and to transfer C3 to the Train 1 storage.
- Three pumps (one in operation for C3, one in operation for C4, and one common spare) – provided to deliver C3 and C4 to the bottling station storage.
- Four pumps (Two in operation for C3, one in operation for C4, and one common spare) – provided to deliver C3 and C4 to the jetty storage.

Automatic On/Off valves, operated by the DCS Operator, are provided to align storage and pumps to the right service. An automatic cross-check system will be provided at DCS to inhibit wrong valve opening/closure (to be defined during the next engineering steps). On each delivery line, at Train 2 battery limit, a flow controller and totalizer are provided.

## ***ii. C5 Storage***

C5/i-C5 blend coming from the depentanizer column overhead, using 2 pumps is stored in 6 mounded vessels, blanketed with nitrogen, and connected with a common balance line to avoid flaring during product handling. Storages outlet lines are connected to a common header to feed 2 pumps (one in operation and one spare) provided for distribution to the users within Train 2 plant battery limit. Pentane mixture is mainly used as a fuel within the Train 2 facilities.

Distribution is made in the liquid phase from the storage. A vaporization and fuel control system will be provided at users within the Vendor scope.

### *iii. Condensate Storage*

The stabilized condensate from the depentanizer column bottom is stored in 2 atmospheric stabilized condensate storage tanks, floating roof type from which the condensate is dispatched to the existing loading arms at Train 1 by the 2 pumps, one in operation and one spare.

### *iv. Off-spec Storage*

The following off-spec product storages are also provided:

- Three storage spheres for C3 and C4 off-spec storage. The off-spec C3 and C4 production will be re-treated in the depropanizer and debutanizer columns, respectively, under flow control, using 3 pumps, one in operation for C3, one for C4 and one common spare;
- 2 storage mounded bullets for condensate off-spec storage. The off-spec condensate production will be re-treated in the depentanizer column, under flow control, using 2 pumps, one in operation and one spare.

## **3.5 Auxiliary Components**

The main auxiliary components are:

- Wastewater and stormwater management and drainage.
- Firewater system.
- Solid waste management.
- Venting and Flaring.

### **3.5.1 Wastewater Management**

#### ***i. Oily Water***

Oily water from the equipment areas will be collected and delivered to the Train 1 DAF/CPI separator where the oil will be removed from the water. Recovered oil will be sent to a slop oil storage tank, and the water will be sent to effluent treatment. The Train 1 oily water package is adequate to treat oily water from Train 2.

### ***ii. Sanitary Sewage***

Sanitary wastewater from the plant building sources will flow via an underground sewer system to Sanitary Lift Stations. The sanitary wastewater will be pumped to a Bio-Treatment Package where the wastewater will undergo biological oxidation, clarification, and chlorination. Treated effluent will be sent to the combined outfall.

### ***iii. Stormwater Management***

Process areas will be curbed to capture contaminated surface run-off. This water will be processed through an Oil Separator before being released. The uncontaminated surface run-off will be discharged directly to the combined outfall.

### ***3.5.2 Firewater System***

The overall intent for the firewater systems is to provide full onsite firefighting capabilities. New firewater facilities and a distribution ring will be provided for Train 2; the firewater pumps will be diesel-driven, whilst the jockey pumps will be electric-driven. The new fire water system of Train 2 will be integrated with Train 1's fire water system.

### ***3.5.3 Solid Waste Management***

According to the Environmental Policy of Ghana Gas, the Company seeks to achieve among others, conserving natural resources, and reducing the environmental impacts on waste generation and emissions to air, water, and land through strategies focusing on reducing, reusing, recycling, and safe disposal of waste (GNGLC 2021b). Solid waste management at GPP Train 2 will be the same as it is currently for Train 1, which is based on six best management practices of Waste Avoidance, Reduction, Reuse, Recycling, Treatment, and Disposal.

Solid waste generated from the operations of Train 2 will consist mainly of general waste (disposable packs, cans, and glassware); metal pieces; organic material, polythene and plasticware; and oily rags. These will be segregated into labelled colour-coded bins as follows (GNGLC, 2021a):

- General Waste            Black Bin with Yellow Lid
- Metals                     Aluminium Skip
- Organic                    Green Bin

- Polythene/Plastics      Blue Bin
- Oily Rags                      Black Bin

General waste generated will be collected, transported, and disposed of by a licensed waste management company. Out of this general waste, generated, waste plastics will be segregated, for some community members to collect and sell to recycling companies.

Other solid waste (hazardous and non-hazardous) such as; scrap metals, glass, used tyres, waste wood, oily rags, and used filter elements; will be segregated and temporarily stored on-site. In accordance with the Public Procurement Act 2016 (Act 194), licensed waste management companies will be engaged to recycle/reuse/treat/dispose permanently offsite in line with the Hazardous, Electronic, and other Waste Control and Management Act, 2016 (Act 917) and the Ghana Gas Environmental Policy.

#### ***3.5.4 Venting and Flaring***

A separate system will be used to collect the liquid relief and blowdowns. These systems deliver the liquid stream directly to the flare knockout drums. The heavier liquid from a knockout drum will be diverted to a slop tank. There will be one flare system at GPP Train 2.

The flare will consider the offshore pipeline/inlet gas facility choke valve and turboexpander/JT valve interfaces. The use of H.I.P.P.S. has been considered to limit the flare capacity at a value lower than the total nominal capacity of Train 2. Train 2 will include an emergency depressurization system to depressurize pressure equipment in an emergency.

#### ***3.5.5 Gaseous Emissions***

The GPP Train 2 emissions include:

- Total Particulate Matter (TPM).
- Fine and coarse Particulate Matter (PM<sub>2.5</sub> and PM<sub>10</sub>).
- Carbon monoxide (CO).
- Carbon dioxide (CO<sub>2</sub>)
- Nitrogen oxides (NO<sub>x</sub>)
- Volatile organic compounds (VOCs).

- Methane (CH<sub>4</sub>).

### 3.6 Utilities

#### 3.6.1 Fuel Gas System

Fuel Gas is used within the GPP Train 2 facilities at two pressure levels as follows:

- Medium pressure (MP, 30 barg), mainly used for power generation.
- Low pressure (LP, 7 barg) to be used for:
  - Flare vent purging and pilots.
  - Equipment Blanketing.
  - Direct fire heaters.

Fuel gas is an essential service as it is used for power generation. The following sources of fuel gas have been considered for the GPP Train 2:

- Sales gas from Train 2 Export manifold as MP main fuel gas source.
- Sales gas from Train 2 Compression Inlet manifold as LP main fuel gas source.
- Sales gas from Train 1 Export manifold as start-up/backup source (Medium and Low pressure);
- Raw gas from Train 2 new inlet manifold as start-up source.

During start-up, when sales gas from GPP Train 2 is not available yet, inlet raw gas (100% AKER) is assumed as available. Consumption rates of fuel gas at start-up are shown in Table 8.

Table 8 Fuel Gas Consumption at Start-up

User	Consumption <sup>1</sup> (kg/h)
Power Generation (1 Turbogas)	5,941
Blanketing	Nil
Flare purge	27
Gas Dryers regeneration (heating phase)	672
Hot Medium heating (50% maximum demand)	2,918
<b>TOTAL</b>	<b>9,558</b>

Source: GNGLC (2019c)

1. All values are preliminary and shall be verified after equipment Vendor selection, in the next engineering phase.

An additional 20% overdesign shall be provided for system design.

During normal operations, Train 2 sales gas is available as fuel gas. Table 9 indicates the fuel gas consumption during normal operations.

Table 9 Fuel Gas Consumption during Normal Operations

User	Consumption <sup>1</sup> (kg/h)
Power Generation (3+1 Turbogas) (MP)	17,823
<b>TOTAL (MP)</b>	<b>17,823</b>
Blanketing (LP)	56
Flare purge (LP)	27
Gas Dryers regeneration (heating phase) (LP)	672
Hot Medium heating (LP)	5,836
<b>TOTAL (LP)<sup>2</sup></b>	<b>6,591</b>

Source: GNGLC (2019c)

1. All values are preliminary and shall be verified after equipment Vendor selection, in the next engineering phase.
2. LP fuels gas can be drawn from Compressors K-2002 A/B/C suction manifold

An additional 20% overdesign shall be provided for the design of both systems.

#### ***i. Medium Pressure Fuel Gas***

Medium pressure (MP) fuel gas is normally drawn off by the sales gas outlet manifold at 52 barg; the stream is routed to the MP fuel gas scrubber. The scrubber works at 30 barg under pressure control, if the pressure decreases the controller will open the inlet valve, drawing more sales gas from the manifold. As this service is essential for the plant, a spare control valve is provided in parallel with the main one.

Medium pressure fuel gas can also be drawn off by the Train 1 sales gas manifold as a backup source; as this gas is richer in heavy components compared to the Train 2 sales gas, it is heated up using electrical heaters to avoid too low temperature after pressure let down. An independent pressure controller, set at a lower pressure value than the main one, will open the control valve on the Train 1 sales gas line in case of low pressure in the MP fuel gas scrubber. Sales gas from Train 1 can be used also in Train 2 start-up if Train 1 is already running.

In the case of a black start-up, with both Train 1 and Train 2 stopped, raw gas from the Train 2 inlet pipeline can be used. As this gas is in high-pressure, high-density phase, and rich in heavy compounds, it must be heated in the provided electrical heaters before being flushed, under pressure control, to the scrubber. During start-up, medium-pressure fuel gas is also used to obtain low-pressure fuel gas by means of a further pressure reduction. Gas heating in the electrical heaters is made under temperature control at a set value suitable to be at least 15 °C above the hydrate formation temperature at the lower pressure (7 barg). MP fuel gas distribution pressure is monitored, and in case of very low pressure, raw gas inlet to the Train 2 facilities is stopped and the plant is shut down. Any condensate in the MP fuel gas scrubber is discharged under level control, in gap action, to the hydrocarbon closed drain system.

#### ***ii. Low-Pressure Fuel Gas***

Low-pressure fuel gas is normally drawn off by the sales gas compression inlet manifold at about 21 barg; the stream is routed to the LP fuel gas scrubber. The scrubber works at 7 barg under pressure control; if the pressure decreases the controller will open the inlet valve drawing more sale gas from the manifold.

A backup source is also provided from the MP fuel gas system. An independent pressure controller, set at a lower value, will automatically draw off MP fuel gas from the distribution header (out of the MP fuel gas scrubber) in case of low pressure in the LP fuel gas scrubber. This backup line is also used during Train 2 start-up/ shut down and in all the cases when sale gas from Train 2 is not available. LP fuel gas distribution pressure is monitored, and in case of very low pressure, raw gas inlet to the Train 2 facilities is stopped and the plant is shut down. Any condensate in the LP fuel gas scrubber is discharged under level control, in gap action, to the hydrocarbon closed drain system.

#### ***3.6.2 Hot Medium***

Hot medium fluid is Petro-Therm, the same fluid already used at the existing Train 1. Hot medium users, relevant supply flow rate and duty for the maximum demand (Run case: 1A) are listed in Table 10.

Table 10 Hot Medium Users, Relevant Supply Flow Rate and Duty for the Maximum Demand (Run case: 1A)

User	T <sub>in</sub> (°C)	T <sub>out</sub> (°C)	Flowrate <sup>1</sup> [kg/h]	Design Duty <sup>1</sup> [MW]
E-1001 A	250	150	74,870	5.19
E-1001 B	250	150	74,870	5.19
E-1002	250	150	697	0.05
E-2005	250	180	309,616	15.33
E-3001	250	180	290,038	14.38
E-3002	250	180	124,705	6.18
E-3003	250	180	39,121	1.94
E-3004	250	180	36,225	1.79
E-4001	250	180	24,095	1.67
<b>TOTAL</b>			<b>974,237</b>	<b>51.72</b>

Source: GNGLC (2019c)

1. Process overdiesign included

An additional 20% overdiesign shall be provided for system design.

### 3.6.3 Chilling Medium

Chilling medium (propane) is used only in the final chiller E-2002. The design case is run 3A, duty=8.63 MW. Peak flow rate: 95495 kg/h through the exchanger, at -34 °C. An additional 20% overdiesign shall be provided for system design.

### 3.6.4 Methanol Injection

The hydrate formation temperature of natural gas at the inlet of the plant is 22°C (GNGLC, 2019d). However, there is the possibility that there will be certain operating conditions that could result in low gas temperatures, and therefore, can cause the formation of hydrates, even in the absence of free water. If not removed or treated, these hydrates can cause high pressure drops through piping and equipment, blockage, and eventually a plant shutdown. Methanol will be available through a dedicated distribution header to inhibit or dissolve hydrates that can periodically form in gas pipelines and equipment such as heat exchangers and drums. Methanol will typically be injected in the following cases:

- When the hydrate formation has already caused partial blockage, as evidenced by increased pressure drop across certain items of equipment.
- When it can reasonably be expected that an action will lead to hydrate formation.

The minimum continuous methanol flow rate to avoid hydrate formation is 20 kg/h. Additionally, a shock instantaneous flow rate of 100 kg/h, is also considered for a certain time to remove hydrates in case of upset. Storage capacity is defined as 2 days at a continuous flow rate of 960 kg/h.

The methanol injection system will consist of Methanol Unloading Pumps, Methanol Storage Vessel, Methanol Injection Pumps, and a distribution header. The injection pumps will be run only when required. The required methanol injection rate will vary according to the scale of the hydrate formation in the plant and the second injection pump can be started to provide additional capacity if required.

### 3.6.5 Instrument and Utility Air System

The compressed air system will supply clean air for instruments, pneumatic tools and other utility needs. Air dryers will be provided to supply dry air (-40°C dew point). Plant Air is provided in a supply header separated from Instrument Air. An instrument air buffer vessel will be provided to ensure 15 minutes of capacity at instrument air maximum demand between maximum and minimum operating pressure. The maximum clean air demands for instrument and utility systems are indicated in Table 11.

Table 11 Maximum Clear Air Demand

User	Maximum Flow Rate (Nm <sup>3</sup> /h)	Notes
Local Utility Station	90	3 Utility stations in operation
Power generation	132	3 Gas turbines in operation
Instrument Air	972	200% estimated valves consumption
Nitrogen generation	716	Air/N <sub>2</sub> ratio = 2.7 (97% N <sub>2</sub> )
Air Dryer regeneration	422	25% total dry air
TOTAL	2,332	

Source: GNGLC (2019c)

### 3.6.6 Nitrogen System

Nitrogen gas is mainly used as flushing gas in compressors and turbine seals. Nitrogen gas is also used to purge equipment on start-up and shut down, to maintain inert atmospheres in

sections of process services (nitrogen blanketing), and to purge miscellaneous analytical equipment. A new Nitrogen System unit will be installed to meet the nitrogen requirements during plant commissioning, start-up and extended shutdown.

A nitrogen buffer vessel will be provided to ensure 30 minutes of capacity at design seals flushing flow rate, between maximum and minimum operating pressure, to ensure a safe compressor and turbine shutdown even if in emergency conditions. Table 12 shows the maximum nitrogen demand for Train 2.

Table 12 Maximum Nitrogen Demand

User	Maximum Flow Rate (Nm <sup>3</sup> /h)	Notes
Compressor seal flushing	170	2 comp. running + 1 comp. start-up
Flare purge	-	Nil during normal run
Blanketing	35	
Utility station	60	2 per 30 Nm <sup>3</sup> /h each
TOTAL	265	

Source: GNGLC (2019c)

### 3.6.7 Service/Utility Water System and Plant Water

Service Water, Utility Water, and Plant Water are already present in Plant and the existing utility systems of Train 1 will be integrated with the new Train 2.

Raw water is collected from two existing wells and stored in two dedicated storage tanks. The water is used as fire water and service water. A de-mineralization package is already present, and the de-mineralized water is stored in a dedicated storage tank. A potable water system is not provided in the plant.

The existing water services/utilities shall be analysed and upgraded to the requirement of Train 2. The existing facilities will be refurbished to achieve new requirements, or a completely new system will be provided if necessary.

### **3.6.8 Power Supply**

#### ***Power Generation System***

Gas engine generators are present and are the primary source of power supply for Train 1. Train 2 power generation shall include 30% spare capacity; it will be connected to the national grid with a bidirectional capability to:

- Allow emergency power import.
- Enable future export of excess power.

#### ***Essential Power Generation (Diesel Generator)***

A diesel-driven generator will provide essential power during outages of the main power generators and for black-start requirements. Diesel fuel is supplied to the facility in tanker trucks and is offloaded to the Diesel Storage Tanks. Diesel fuel is supplied to the Firewater Pump diesel driver and diesel driver emergency generator day tanks. In addition, it may be used to provide diesel fuel for plant vehicles. Diesel storage capacity will be defined considering 3 days running for an emergency generator. Diesel consumption estimate is as follows:

- Emergency power generator: 1,200 kg/h.
- Diesel firefighting pumps: 300 kg/h (max 4 pumps running).

## **3.7 Project Execution Phases**

The gas processing project will be implemented in the pre-construction, construction, operations, and decommissioning & closure phases.

### ***3.7.1 Pre-construction Phase***

Pre-construction activities typically include technical surveys for siting the gas plant and its components, feasibility studies, project design, and acquisition of required permits and approvals. The required land area for the project was already acquired during the development of Train 1. Technical surveys including geophysical surveys and feasibility studies, market demand analysis (GNGLC, 2019d), and project designs have been completed. However, permits and approvals (such as environmental permit, construction permit, and groundwater abstraction licence) are yet to be obtained.

### ***3.7.2 Construction Phase***

Key activities in this phase include the construction of access roads, site preparations (earthworks and temporary facilities), infrastructure development (e.g., site drainage network, health and safety unit, tank farms for storage of LNG, NLG, LPG, and stabilized condensate, gas processing units and auxiliary units such as wastewater treatment units and installation of gas-powered generators).

### ***3.7.3 Operations Phase***

Operational activities will consist of processing up to 200 MMSCFD of dense phase gas per year into various quantities of propane (C3), butane (C4), pentane (C5) and stabilized condensate (C5+) fractions. The activities in this phase will also consist of running the plant in an environmentally friendly manner, ensuring good synergy between the plant, neighbouring communities, and the environment. It will also involve gaseous emissions control, and liquid and solid waste management.

### ***3.7.4 Decommissioning and Closure Phase***

The closure activities of the gas plant at the end of an operational period entail following procedures in the rehabilitation and decommissioning plan developed for the site. During this phase, the plant will cease functioning and all structures, plant units, machinery, and equipment will be dismantled. In addition, all destroyed vegetative areas will be restored with native vegetation.

## **3.8 Health, Safety and Security Management**

The Engineering Procurement Construction (EPC) Contractor to be appointed by GNGLC and the Consortium will be required to adapt the standalone Environmental and Social Management Plan (ESMP) prepared for the GPP2 project into a Construction Environmental and Social Management Plan (CESMP) which will contain associated policies, plans and procedures in consideration of occupational and community health and safety (H&S) hazards related to construction in line with Gas Processing Plants Safety Regulations and GIIP. The management system and procedures will generally align with ISO45001, the US OSHA or similar internationally recognized H&S standards and guidance.

The contractor's management system will include good international practice hazard identification and risk assessment protocols which consider the project scope and site context to develop a project-specific Hazard Register. Authority, roles and responsibilities and accountability will be defined, including but not limited to the following key requirements:

- i. The responsibility of all persons to stop any unsafe activity immediately.
- ii. Overall senior 'top' management leadership and accountability for safety.
- iii. The accountability of line management and supervisors (team leaders, foremen, department heads etc) to address safety matters on the ground – moving away from a common perception that this is the role of Safety Officers or Safety Supervisors only.
- iv. Emphasizing the oversight and compliance/improvement aspect of construction H&S supervision roles.
- v. Stipulating clear requirements and responsibilities for subcontractors to adhere to the same requirements.

Procedures will be developed for general safety requirements (including emergency response, communication and workforce participation, incident and observations reporting and tracking, leading/lagging indicators, and performance evaluation etc) and typical and reasonably foreseeable hazards and risks associated with the gas processing plant construction and commissioning scope (including excavations, lifting, hot works, confined space, pressure testing etc).

Security management providers will be screened by the EPC contractor and evidence of due diligence will be provided to GNGLC prior to deployment to demonstrate the competence and pre-deployment training of security personnel to consider key requirements of IFC PS4 around human rights, use of force, proportional response etc. A security management procedure will be developed by the EPC contractor and /or security provider to define associated roles, responsibilities, and authority in line with applicable IFC PS4 and associated guidance.

Competence of safety management personnel and safety training including for line management and supervisory roles will be confirmed and agreed with GNGLC prior to site mobilization of the EPC contractor and all works subcontractors. Contractor and subcontractor onboarding process will be used. Refresher training of all contractors and works subcontractor

supervisory staff is a mandatory requirement and content and format will be subject to GNGLC approval in advance.

### **3.9 Resource Efficiency**

Efficient water uses for both construction and operational phases is very essential to the sustainability of the project. Water use for the construction phase will mostly be for concrete formation and hydrotesting. Other construction uses will include potable supply for installation workers and equipment wash water. Operational requirements may include to make up water for gas temperature regulator chillers which will be provided by the existing water supply at GPP1. Currently, GNGLC uses approx. 3,300 m<sup>3</sup> of water per annum to run the GPP1 and since the proposed GPP2 is twice the capacity of GPP1 more water will be used. Nonetheless, GNGLC will ensure that efficient and effective ways are deployed to manage water use during the operational phase of GPP2. In terms of energy use, GNGLC currently generates electricity with some of the NG processed at GPP1 thus same approach will be deployed for GPP2.

Overall, given the scope of the gas processing project, the primary resource efficiency measures with respect to IFC PS3 will be the use of good practice construction methods for management and reuse of excavated materials and minimization of waste. In addition, all construction aggregates and associated materials will be sourced from sustainable, licensed providers including quarries and timber suppliers. Operational resource efficiency associated with the use of gas is addressed through the design measures of GPP2.

### **3.10 Labour and Supply Chain Requirements**

#### ***3.10.1 Labor Requirements***

Local and expatriate manpower will be involved in the GPP2 construction and operation activities. Supply of materials, goods and services will also apply at all the project phases of the GPP2 project. During the construction phase, there will be in the order of 100-200 staff for the construction of the GPP, with employment opportunities for the local labour force.

As part of the temporary works, the EPC Contractor will provide portable office site accommodation for his own and sub-Contractors staff, site office accommodation for the Engineer / Owner's construction management personnel, toilet and kitchen facilities, graded parking areas and canteen facilities. All these facilities will be located within the proposed site

area. All office site accommodation will conform with the IFC/EBRD Guidance Note on Workers Accommodation Processes and Standards (2009).

Estimated total staffing levels for the operational phase for GPP2 is estimated at 200-300 people generally working shift work.

### ***3.10.2 Labour Standards and Performance Monitoring***

GNGLC's labour compliance monitoring requirements for the construction phase will be defined in the EPC contract. The EPC contractor will be required to implement a human resources (HR) handbook or similar including HR policy, worker code of conduct, labour grievance mechanism and back-to-back commitments with GNGLC's HR policies including child and forced labour, collective bargaining, freedom from discrimination or retaliation and preferential recruitment policy for skilled and unskilled workers who were born and raised in the host communities.

To meet the requirements of IFC PS2, the EPC contractor will be required to implement a comprehensive labour monitoring program which shall be confirmed and approved by GNGLC prior to notice to proceed. The program should consider all key labour risks including but not limited to safe working conditions, signed contracts and confirmation that terms and workers' rights have been explained, working hours/overtime/rest periods and leave tracking against legal limits and use of fatigue assessments, timely payment of salary and contributions, confirmation of adequate site welfare facilities, demonstrable labour grievance mechanism, use of random worker labour monitoring surveys and worker representative meetings, and provision of documented information (contracts, timesheets, payslip samples, grievance register).

These requirements apply to the EPC contractor directly appointed staff as well as contract workers and subcontractors and workers. The EPC contractor will ensure that labour compliance and monitoring requirements are cascaded to all significant works subcontractors via contractual agreements for subcontracted services/works. The subcontractor's awareness and understanding of these requirements (and other GNGLC and project E&S requirements) will be demonstrated through a subcontractor onboarding process prior to contract execution, which will involve confirmation from subcontractor's management and HR teams that it can provide the required information and is aware.

GNGLC's construction management team and/or lenders (or lenders' technical advisors) will undertake verification monitoring surveys and audits as required to determine the efficacy of the labour monitoring system.

Failure to implement an effective construction labour monitoring system will be considered a breach of the EPC contract with associated sanctions as defined in the contract.

### ***3.10.3 Worker Accommodation and Worker Influx***

Worker camps to be provided for migrant labour for the construction of GPP2 will conform with the IFC/EBRD Guidance Note on Workers Accommodation Processes and Standards (2009). All the training and awareness programs necessary for the workers will be carried out in accordance with the requirements in the ESMP.

### ***3.10.4 Supply Chain***

Supply chain risks for the construction phase will be managed through the EPC Contractor's procurement process, contractor/subcontractor onboarding requirements and labour monitoring process described above.

Based on the IFC PS1 definition of primary suppliers, requirement prohibiting child and forced labour components (PS2) will be addressed from GNGLC's policy down through procurement to labour monitoring. Given the scope of works and materials for the GPP construction activities, no suppliers are expected to trigger the PS6 elements around significant damage to biodiversity and sensitive ecosystems.

However, Section 3.9 (resource efficiency) includes measures requiring the use of licensed and/or certified suppliers for the respective services. Operational risks will be managed through GNGLC's existing supplier procurement E&S screening procedure which forms part of the Environmental and Social Management System (ESMS).

## CHAPTER 4. CONSIDERATION OF ALTERNATIVES

In the initiation of the development of the gas processing plant, GNGLC evaluated options regarding siting of the gas processing plant, preference for natural gas use, technology for the natural gas processing as well as the no-action option. This chapter gives further insight into some elements of alternatives based on experiences from the operation of GPP Train 1. These include the siting of Train 2, the possibility of resettlement of nearby communities or relocation of Train 2, need for expansion and process technology.

### 4.1 Siting of the Gas Processing Plant Train 2

The land on which GPP Train 1 is located in Atuabo was acquired by a Ghana Government Executive Instrument (E.I. 51) in 2014. GPP Train 2 is to be constructed on the same piece of land next to the present location of Train 1. The Atuabo enclave was selected from amongst a total of five locations based on the following criteria (GNGLC, 2013):

- Proximity to the Jubilee field.
- Availability of land to allow for future expansion and serve as relief land.
- Sparseness of population to minimise resettlement.
- Minimisation of cross-border issues.
- Constructability (minimum clearing and levelling of land).

Three of the above factors were in favour of Atuabo, which allowed it to be selected. These were minimisation of cross-border environmental issues, constructability, and sparseness of population. However, as indicated in Section 5.3.2 below, available data from the EDA (Ellembelle District Assembly, 2017b) show that there was a sharp rise in the population of the three communities fringing the GPP Train 1 (Atuabo, Asemnda, and Anokyi) between 2010 and 2018. This sharp rise could be due to the commencement of the operations of the GPP and the influx of people looking for jobs and opportunities associated with the operations of the GPP. Apart from the sharp rise between 2010 and 2018, the population in the three communities has seen a steady rise since 2018.

Currently, Asemnda is located 0.5 km from the edge of the plot of land earmarked for Train 2. This issue emerged as a key concern during the consultation of stakeholders in July 2021. Indeed, concerns for human safety because of the proximity of the proposed Train 2 to the

communities ranked third highest with the same ranking as the need for increased employment of local youth and use of local content. Although the present location of Train 1 does not have as much land to serve as a relief compared to other areas considered (GNGLC, 2013), an option that may be considered concerning the location of Train 2 is the inclusion in the design the creation of a vegetative buffer zone between the Asemnda community and the site for Train 2. Furthermore, acceptance of the location of Train 2 within the communities will improve if the court dispute about the land ownership between Atuabo and Anokyi is resolved and GNGLC pays compensation to the rightful community owners. These additional options could forestall the possibility of resettlement of any of the communities or relocation of Train 2 with its attendant problems of acquiring new land and potential additional environmental impacts.

#### **4.2 Resettlement of Nearby Communities or Relocation of GPP Train 2**

As indicated in Section 4.1 above, the favourable indicators for the selection of Atuabo for the construction of Train 1 were minimisation of cross-border environmental issues, constructability, and sparseness of population to minimise resettlement. Thus, the present location of Train 1, comparatively, does not have as much land for extensive expansion activities. Based on this and according to its Community Affairs Corporate Social Responsibility Policy (GNGLC 2018), the GPP Train 2 was carefully planned to avoid the need for resettlement.

It was observed during the scoping exercise that although concerns were raised about the closeness of the proposed site for Train 2 to the communities and the resulting safety issues, the issue of resettlement of the people of the A3 communities did not come out strongly.

There are no specific guidelines or standards on how close land-based oil and gas processing facilities, including gas processing plants, can be to residential areas in Ghana. Internationally also, there are no clearly acceptable standards and setback limits range from 400 m to 2 km depending on local conditions. For example, a recent study (Lewis *et al.*, 2018) recommends that setbacks from the boundary of a facility should not be less than 0.25 of a mile, about 400 metres. Again, local conditions need to be considered.

Although safety is the most paramount factor, and it is not the communities involved which should have the final decision on whether they should be relocated or not, their main concerns

were more to do with compensation for loss of land and crops, job security, signing of an MoU, improvement in drainage, and provision of emergency assembly points. This is in addition to the proposal above to include in the zoning of the project area, a vegetative buffer area between the Asemnda community and the site for Train 2. Furthermore, rearrangement of components of the GPP can ensure that those closest to the nearby communities are the least dangerous.

GNGLC's policy also states that, in the unlikely event that resettlement may be required, an independent valuation institution will be contracted to provide estimates on a replacement cost basis, and in addition, a resettlement programme will be instituted. This will include the formation of a special committee, whose members will be from within the community and will be trained on how to effectively monitor any new settlement per the rules and procedures of Ghanaian regulations.

The option of relocation of Train 2 will result in major negative impacts, the key ones of which will be project delays and resulting negative economic impacts, considering the high demand for GNGLC's products. The search for a new location may take several years and have costly financial implications concerning land acquisition and payment of different types of compensation as well as linking the existing Train 1 to the new Train 2. Other difficulties include possible new or unanticipated environmental and social impacts and the inability to link efficiently with existing partners.

However, based on economic and physical displacement according to the IFC PS 5, there wouldn't be the need to resettle the closest community (Asemnda) to the proposed GPP2. A Resettlement Scoping was conducted during the additional stakeholder engagement between October 9<sup>th</sup> to 23<sup>rd</sup>, 2023 and it emerged that the GPP enclave land acquired by the GoG, E.I. 51, 2014 had only farms at certain portions and GNGLC paid crop compensation to the farm owners who were not landowners. Moreso, due to the location of the GPP enclave land, both Atuabo and Anokyi communities have laid claim to the land, and this has resulted in land dispute which is being settled in court. GNGLC is committed to paying for the land once there is resolution and the land dispute is settled.

In addition to the Resettlement Scoping, Quantitative Risk Assessment (QRA) and Fire and Explosion Risk Assessment (FERA) were conducted to quantify and assess the fire and explosion risks of the proposed GPP2. The outcome of both studies indicates that Location

Specific Individual Risk (LSIR) depicting the geographical distribution of risk puts Asemda at the least risk level in the event of fire and explosion at GPP2. Specifically, the modelled fire and explosion risk ascertained that there is one chance in 1,000,000 of being killed per year at Asemda if there should be fire and explosion at GPP2 (see Section 7.4.2).

### **4.3 The Need for Expansion**

The GPP Train 1 was planned to take into consideration the possibility of future expansion as indicated by the criteria used for site selection. After eight years of operation and based on current socio-economic trends in the gas and oil sector, GNGLC intends to expand its activities in Phase 2 with the construction and operation of GPP Train 2. As indicated in Section 1.3 above, there is ample justification for the expansion. For example, Ghana has discovered more oil and gas reserves in the recent past (ERM, 2014). Thus, apart from the Jubilee field, GNGLC currently receives dense gas feed from the TEN fields and more sources are expected to be available in the future (GNGLC, 2021a). In addition, as Ghana's economy continues to expand and diversify, there is rising demand for GNGLC's products. These products will facilitate the anticipated expansion of industrial activities such as the Ghana Government's Petroleum Hub (Daily Graphic, 2019) and the proposed Petronia City (<https://youtu.be/xsGt8GrfxEw>) in Takoradi. They will also directly support the achievement of the goals of Ghana's energy policy (Ministry of Energy, 2010) while creating many direct and indirect jobs.

### **4.4 Process Technology**

The GPP Train 2 will use new and improved technology to increase efficiency and diversify its end products. It will process 100 MMSCFD of dense phase gas from the Jubilee field and 50 MMSCFD from the TEN fields. It will also be able to process up to 50 MMSCFD of dense phase gas from new fields that are being developed (GNGLC, 2021b); Dense gas with NGL will be treated and fractionated into propane (C3), butane (C4), pentane (C5), and stabilized condensate (C5+) components.

In addition to providing lean gas for power generation, one of the main objectives of GPP Train 2 is to maximize C3 and C4 recovery from the raw gas feed (GNGLC, 2019d). The light ends in the condensate will be removed with the aid of a depentanizer column. Thus, compared to Train 1, the new process technology will enable Train 2 to have:

- Higher recovery of LPG components using a turboexpander and the associated feed gas treatment requirements.
- LPG fractionation facilities (depropanizer and debutanizer columns) to allow separate propane and butane products.
- Pentane product in liquid phase.

Due to the expected high C3 and C4 production from the new Train 2, these products will be dispatched by tanker ship instead bulk road vehicles.

Ghana Gas intends to discontinue flaring the iso-pentane from Train 2 by resolving all setbacks in engaging an off-taker to utilize the iso-pentane for power generation, after the withdrawal of the initial investor (Genser Energy Ghana Limited). Flaring of gas at Train 2 will basically be restricted to normal operational flaring.

#### **4.5 No-Action Alternative**

For this report, the No-Action alternative means that the GNGLC will not go ahead with the construction and operations of GPP Train 2. In this alternative, no direct socio-economic advantages are anticipated. The key potential disadvantages associated with this alternative include:

- Loss of the opportunity for the development of the Ghanaian economy, especially the ability to satisfy the increasing demand for lean gas and other products.
- Loss of employment opportunities.
- Loss of opportunities to support development projects in the Ellembelle District Assembly.
- Underutilisation of gas processing units and facilities provided under Train 1;
- Increased cost in the operations of the Aboadze Thermal plant, Tema Oil Refinery and other industries which rely on gas supply.
- Increased flaring of associated and un-associated gas from the oil fields with serious implications for marine life, public health and livelihoods.
- Excessive re-injection of the gas into wells to avoid flaring, which may lead to high pressures and consequent failure of the oil wells.

Thus, the no-action option is not favourable and will not be considered any further in this report.

## CHAPTER 5      BASELINE INFORMATION

The extension of the existing Gas Processing Plant (GPP) in a second phase, through the construction and operation of a second train, on a plot of land next to the existing Train1, at Atuabo will have impacts on the project area and its environs. Indeed, since they will be situated in the same location, the impacts of Train 2 will add to the impacts of Train 1, which has already been in operation since 2014. It is therefore necessary to describe the current existing natural environmental and socio-economic conditions of the area before the beginning of the proposed expansion to allow for future comparison. This involves description and analyses of baseline data and information on the project location in the Ellembelle District of the Western Region, parts of which cover the coastal zone and other wetlands. Data and information have been sourced from available publications and through discussions with various stakeholders, in addition to studies undertaken during field visits from 04 to 10 July 2021 and 03 to 08 April 2022.

### **5.1 Project Area of Influence**

The area of influence (AoI) is understood as “such area where significant environmental impacts caused by project performance are evident on biophysical and socio-economic components”. The area of influence and /or geographical extent for the GPP2 construction and operation will vary depending various variables including topography, size, hydrology, cumulative and transboundary effects and can be determined to cover the spatial (area) and temporal (time) scale. The spatial scale defines the area where the biophysical and socio-economic impacts are likely to occur. The temporal scale of the project includes all activities from pre-construction, construction, operation, and decommissioning of the GPP2 Project. Additionally, the area of influence can be determined based on the direct impacts or indirect impacts on the biophysical components and socio-economic components to be affected by the project footprint. The following considerations have been made to define the AoI of the Project. Generally, the area of influence will include:

- Areas in which site clearing, earth movement, and physical alteration of natural features will take place.
- Areas within the dispersion of emissions to air, noise and vibration and water during the construction and operation phases.

- Areas from which project employees will be drawn, and from which supplies will be procured as well as communities or people whose means of livelihood may be affected by any aspect of the project directly or indirectly. These areas will form part of the socio-economic area of influence.
- Associated facilities, which are facilities that are not funded as part of the project and that would not have been constructed or expanded if the project did not exist and without the project would not be viable.
- Cumulative impacts that result from incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification processed is conducted.
- Transboundary effects, such as pollution of air, or use or pollution of international waterways.

## **5.2 Physical Environment**

### **5.2.1 Topography, Geology and Soils**

#### ***i. Topography***

Topographically, the project area is generally low in altitude as for most of Southern Ghana (Figure 4). The land rises from the sea level to below 137 m to the north in an undulating manner. The Ghanaian coastal zone may be divided into three geomorphologic zones: the West, Central, and East Coasts (Ly, 1980). The West Coast, along which the project area is located, covers 95 km of stable shoreline, and extends from Ghana's border with Côte d'Ivoire to Axim. It is basically fine sand with gentle beaches backed by coastal lagoons.

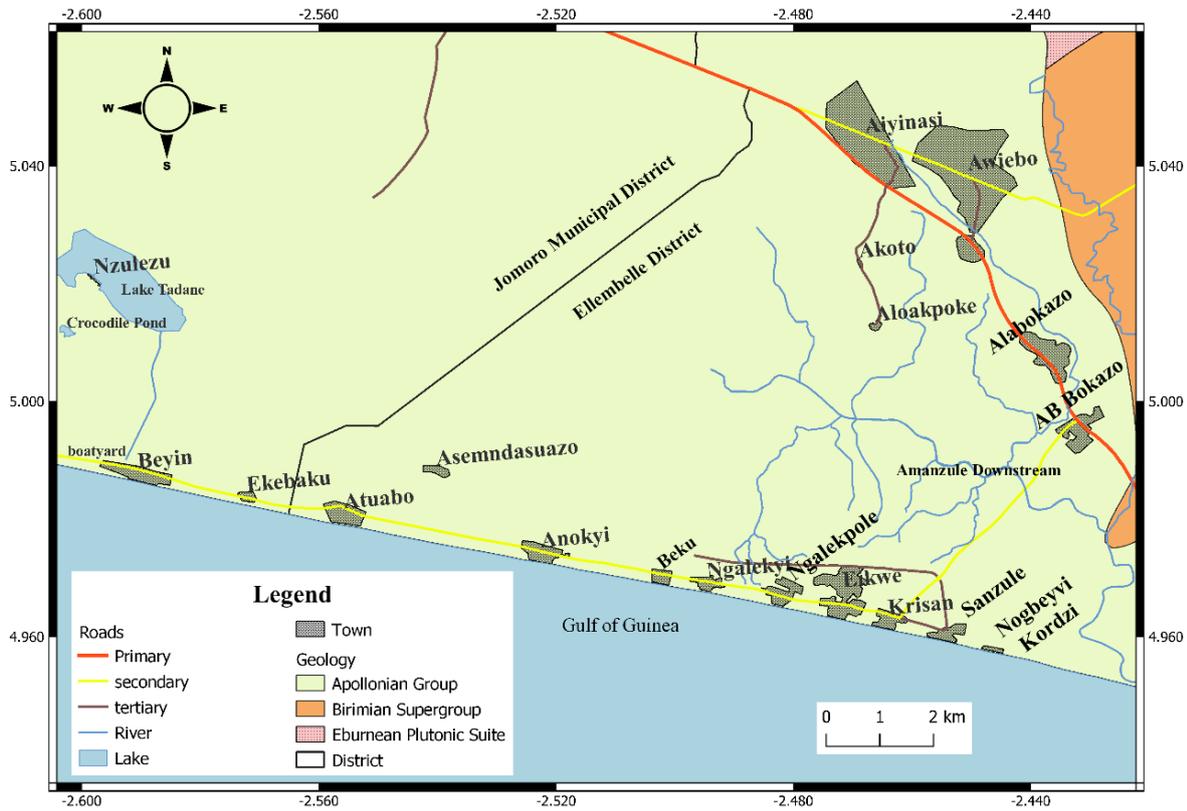


Source: <https://www.google.com/topographicmapofsouthernghana>

Figure 4 Topographical Map of Southern Ghana

## ii. Geology

The main onshore rocks underlying the project area comprise limestone, marl, and mudstone with intercalated or alternating sand-beds with minor Cenozoic clastic sediments. This group of sediments are geologically grouped as the ‘Apollonian System’. The age of the Apollonian Group is from Cretaceous to Eocene. The rocks overlie the Precambrian metamorphosed Birimian System of schist, phyllite and greywackes. At depth, the sands and clays are more compact and pass into sandstones and shales (Atta Peters *et al.*, 2004). Nodules of pyrite or muscovite are very common in the clays and shales. Muscovite has been reported to be common in some of the sandy beds. A map showing the geology of the project area is shown in Figure 5 below.



Source: EESL, 2022a

Figure 5 Geological Map of the Project Area

### iii Soils

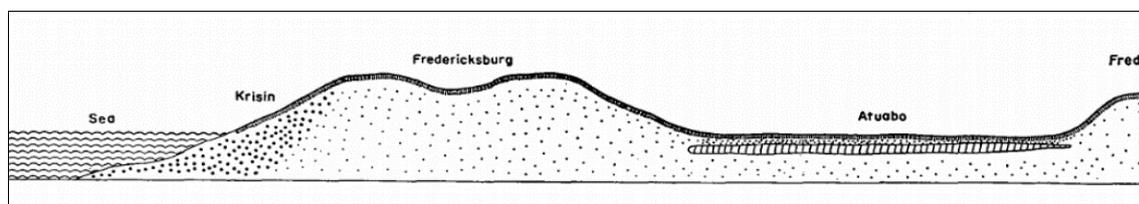
The soils of the proposed project site belong to the Fredericksburg Association, which predominantly comprises the Krisin series, Fredericksburg Series, Princess Series, Assini Series, Atuabo Series and Esiana Series. The approximate distribution of the soil series within the coastal sand soils of the project area is presented in Table 13.

Table 13 Distribution of Soil Series within the Coastal Sand Soils of the Project Area Coastal Sand Soils: Key to Series

Description of Soil Series	Approximate Parentage of Association (%)	Area in Square km (Miles)
<i>Under Forest, Thicket, Cultivation or Forb Regrowth:</i>		
With shell fragments in the profile		
(i) Pale yellow beach sand – Krisin Series	2	5.18 (2)
Without shell fragments		
(ii) Brown medium sand – Fredericksburg Series	90	212.38 (82)
(iii) Grey or white sand, brown sand below – Princess Series	2	5.18 (2)
(iv) Grey to white sand throughout – Assini Series	0.5 (1/2)	1.29 (0.5)
<i>Supporting grass and sedges only:-</i>		
(v) Fine white sand over massive brown organic pan – Atuabo Series	5	10.36 (4)
(vi) Grey to white loam or light clay – Esiama Series	0.5 (1/2)	1.29 (0.5)
<b>Total</b>	<b>100</b>	<b>235.68 (91)</b>

Source: GoG, 1959

The association occupies the whole of the recent sands area (Figure 6) and covers 236 square kilometres (91 square miles). The Fredericksburg series alone accounts for about 90 per cent of the association, and this is the normal series on which the extensive coconut plantations of the area are found. The remaining minor series of the association includes some pedologically interesting groundwater podsoils, some of which support only grass and sedges, but these soils are not extensive and of little agricultural value (GoG, 1959).



Source: GoG, 1959

Figure 6 Fredericksburg Association

### ***Fredericksburg Series***

The Fredericksburg series is a deep brown sandy soil which forms the most extensive series in the association, covering about 90 per cent of the area. A greyish brown humous sandy loam topsoil overlies a subsoil consisting of a considerable depth of uniform medium brown loose sand, loamy sand, or sandy loam. Rain is rapidly absorbed at the surface and internal drainage is rapid to excessive. There are also quantities of freshwater seeping seawards through the lower subsoil, and these are tapped by palms. The nutrient status of this soil is very low, and it is leached of most of the exchangeable bases. Fredericksburg series is very extensively planted with coconuts, to which it is suited by virtue of its depth and good drainage.

### ***Atuabo Series***

The usual soil of these poorly drained savanna areas is the Atuabo series, in which a very thin greyish brown, slightly humous, loamy fine sand topsoil overlies 61-122 cm (2-4 ft.) of pale, almost white, very fine sand. This in turn overlies a layer of dark brown massive organic pan, usually about 46 cm (18 in) thick. This series is waterlogged for part of the year but dries out at others. Only grasses and sedges survive on such sites. All attempts to grow crops, including coconuts, in this series have generally failed (Ahn, 1959).

## **5.2.2 Climate**

The climatological evaluation of the proposed site for the GPP Train 2 was based on data obtained from Axim, a synoptic station of the Ghana Meteorological Agency. The climatic information included monthly values of rainfall, temperature (maximum and minimum), relative humidity, wind speed, and direction and sunshine for the period 2010 to 2020. The proposed site lies in the extreme West of the coastline of Ghana and falls within the South–Western Equatorial Climatic Zone in Ghana.

### ***i. Rainfall***

The proposed area is located within the wettest region in Ghana and experiences bimodal rainfall in the year. The distribution of the rainfall is influenced by the warm moist South-West Monsoons that originate from the Gulf of Guinea and the Tropical Continental Air Mass (Harmattan) from the Sahara Desert. The movement of these air masses into the region is controlled by the oscillation of the Inter-Tropical Convergence Zone and this consequently determines the onset and the intensity of the rainfall.

Meteorological information collected from the Axim synoptic station for the past 11 years shows that there is rainfall throughout the year. However, the major rainy season sets in from March to July with the highest amount recorded in June. There is a brief break in rainfall in August. The minor rainy season sets in from early September to the middle of December when the dry Tropical Continental Air Mass (Harmattan) blowing from across the Sahara Desert through the Savannah belt in Ghana would have hit the coastal belt affecting the proposed area.

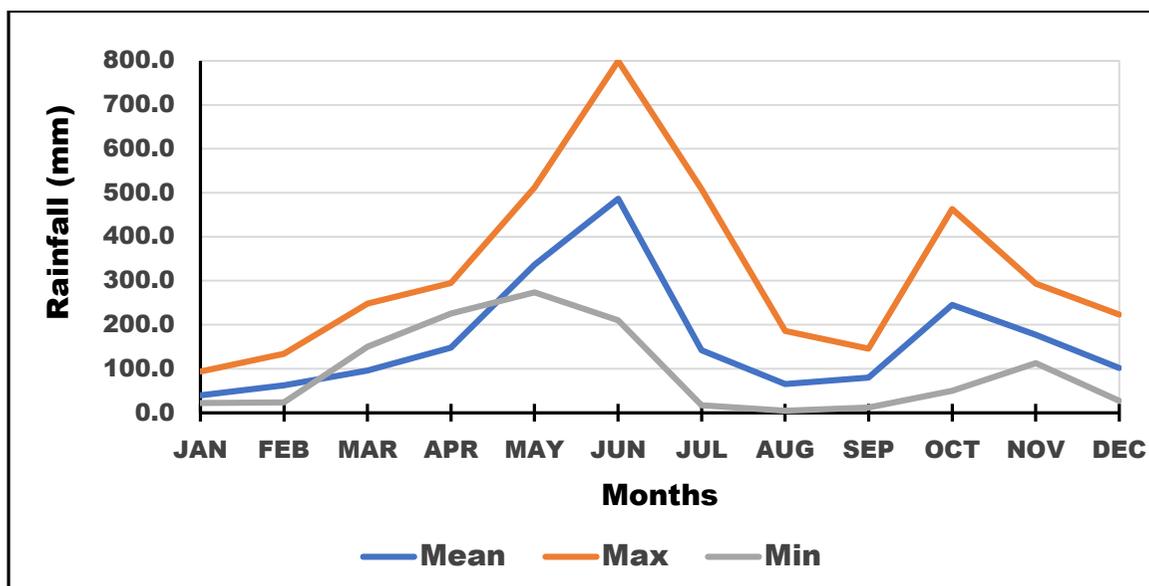
Statistical analyses of the 11 years' rainfall from the Axim synoptic station of the Ghana Meteorological Agency (GMet) are summarised in Table 14 and Figure 7. The table shows that out of the total amount of average annual rainfall of 1,980.9 mm; 1,210.1 mm representing 61.1% of the total average annual rainfall is recorded in the major rainy season. This explains why there are flash floods in the project area in the major rainy season that could result in high sheet erosion in areas with little or no vegetative cover. Figure 7 indicates the double rainy season experienced in the project area.

The break of the minor rains in December stretches to February when the dry and dusty winds from the Sahara Desert would have intensified with low amounts of cloud cover revealing high sunshine resulting in high air temperatures.

Table 14 Statistical Summaries of Monthly Rainfall (mm) at Axim

Item	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct	Nov.	Dec.	Jan-Dec		
													Sum of mean	Sum of mean	% of Jan-Dec
Mean	39.5	62.2	96	148.2	336.8	486.9	142.2	64.9	79.8	245.2	177.4	101.8	1,980.9	1,210.1	61.1
Max	94	134.1	248.4	295.1	512.1	799.8	508.5	186.2	145.3	462.9	293.7	223.4			
Min	22.1	23.8	149.8	225.4	273.6	210.2	16.8	4.8	11.8	49.8	112.6	27.2			

Source: GMet, 2010-2020



Source: GMet, 2010-2020

Figure 7 Statistics of Rainfall (mm) at Axim, 2010 – 2020

**ii. Temperature**

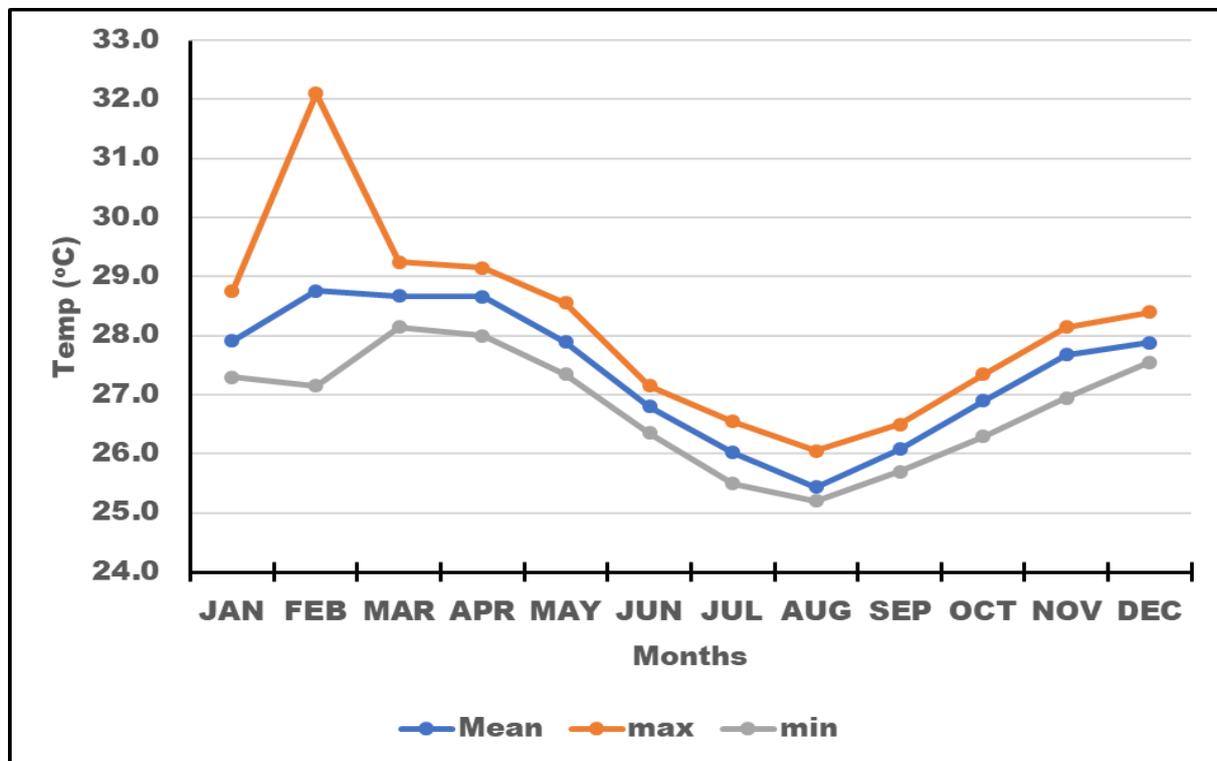
The mean daily temperature is the average of temperatures recorded for a continuous 24 - hour observation while the maximum or minimum temperature is the highest or lowest temperature recorded for a continuous observation for 24 hours.

Records from the Axim weather station for the past 11 years analysed and presented in Table 15 and Figure 8 indicate a trend of increasing temperature values from December through January from 27.9° C to the highest temperatures in February of 28.8° C. The lowest temperature value of 25.4° C is registered in August which coincides with the break of the major rainy season and the arrival of the cold moist South-West Monsoon originating from the Gulf of Guinea.

Table 15 Monthly Mean, Maximum, and Minimum Temperature (oC) at Axim (2010 – 2020)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	27.9	28.8	28.7	28.7	27.9	26.8	26.0	25.4	26.1	26.9	27.7	27.9
Max	28.8	32.1	29.3	29.2	28.6	27.2	26.6	26.1	26.5	27.4	28.2	28.4
Min	27.3	27.2	28.2	28.0	27.4	26.4	25.5	25.2	25.7	26.3	27.0	27.6

Source: GMet, 2010-2020



Source: GMet, 2010-2020

Figure 8 Monthly Mean, Maximum, and Minimum Temperature (°C) at Axim, 2010 - 2020

**iii. Relative Humidity**

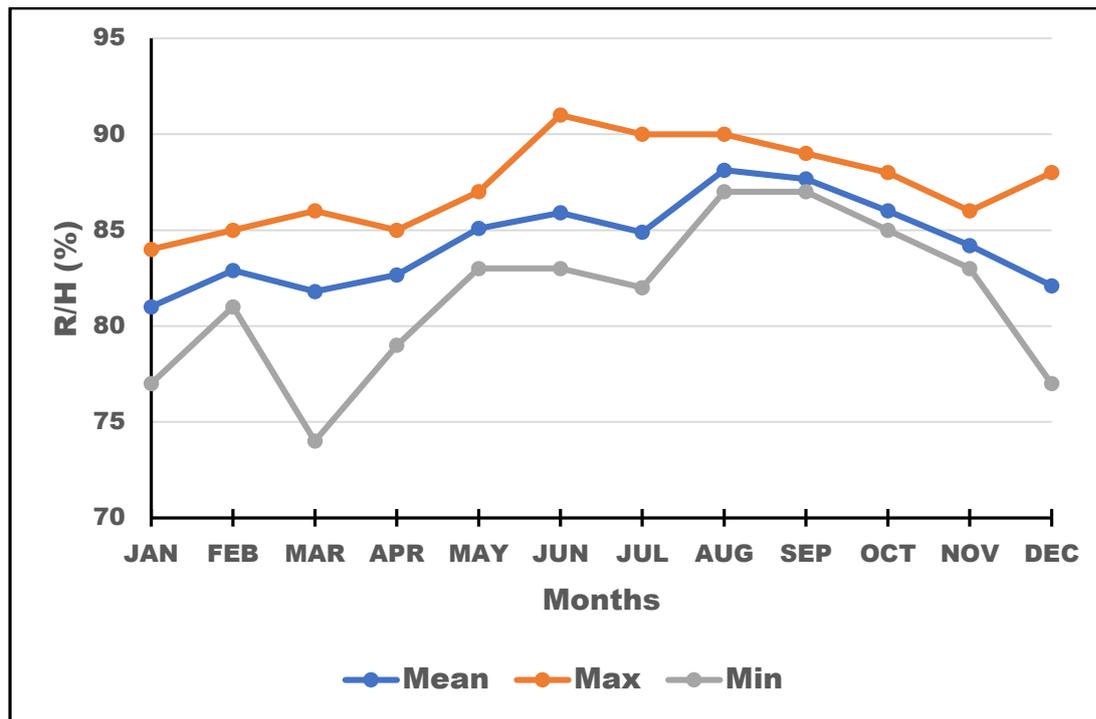
Air humidity is measured as “relative humidity”; and this reflects the amount of water in the surrounding atmosphere relative to the air temperature of the area. Table 16 shows the statistical summary of the 11 years’ relative humidity records from the Axim weather station while Figure 9 is the graphical presentation of the statistical summaries.

The values indicate that the proposed area is humid all year round with the average Relative Humidity ranging between 81% in January and 88% in August and September.

Table 16 Statistics of Relative Humidity (%) at Axim, 2010 – 2020

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	81	83	82	83	85	86	85	88	88	86	84	82
Max	84	85	86	85	87	91	90	90	89	88	86	88
Min	77	81	74	79	83	83	82	87	87	85	83	77

Source: GMet, 2010-2020



Source: GMet, 2010-2020

Figure 9 Monthly Mean, Maximum, and Minimum Relative Humidity (%) at Axim, 2010 - 2020

**iv. Wind Speed and Direction**

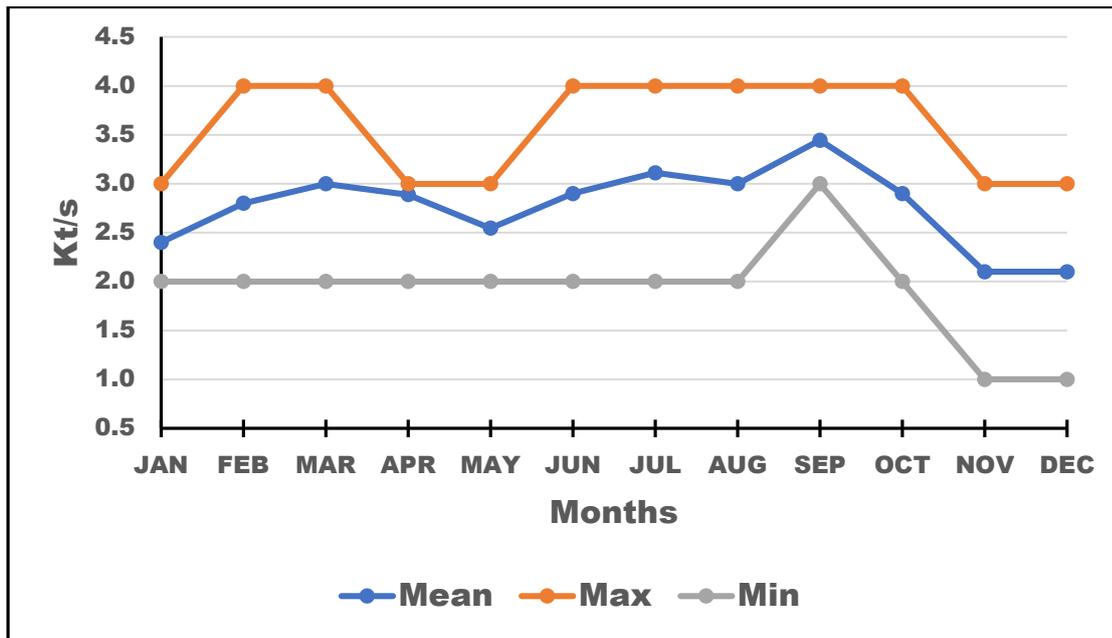
*Wind Speed*

The magnitude of wind in an area is represented by the speed and reflects the rate of wind flow in the atmosphere. From Table 17 and Figure 10, the wind flow in the proposed area is all year round with mean wind speed ranging from 2.1 kts occurring between November and December to 3.4 kts in September. The maximum wind speed is 4kts while the minimum wind speed is 1 kt.

Table 17 Statistics of Wind Speed (Kts) at Axim, 2010 – 2020

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	2.4	2.8	3.0	2.9	2.5	2.9	3.1	3.0	3.4	2.9	2.1	2.1
Max	3	4	4	3	3	4	4	4	4	4	3	3
Min	2	2	2	2	2	2	2	2	3	2	1	1

Source: GMet, 2010-2020



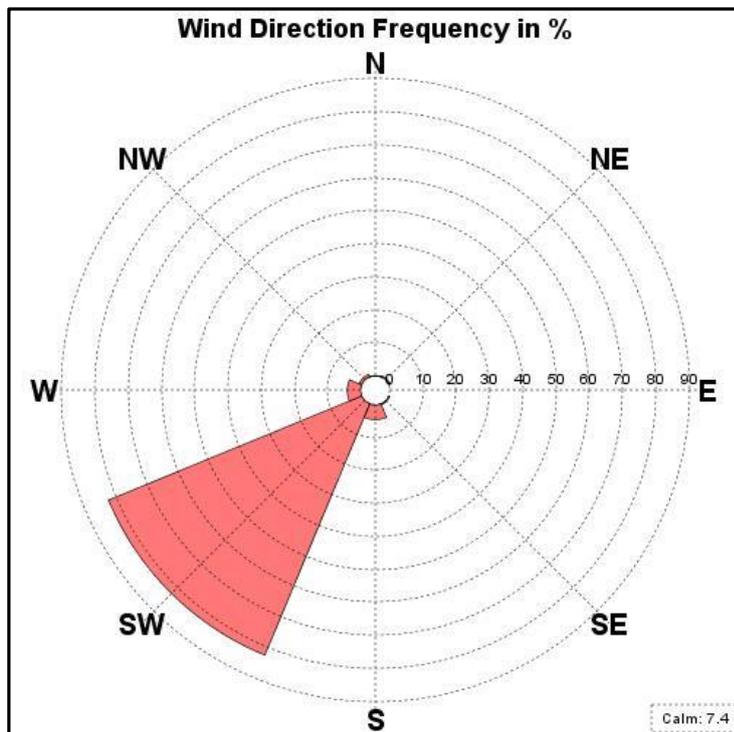
Source: GMet, 2010-2020

Figure 10 Monthly Mean, Maximum, and Minimum Wind Speeds (Kts) at Axim, 2010 - 2020

*Wind Direction*

The wind direction is the orientation of the wind vector and is determined from the origin of the wind flow. Wind speed and direction are important in determining both the direction and spatial extent to which emission fallouts occur. From Figure 11 showing the wind roses from

Axim weather station for the past 11 years, the wind direction in the proposed area is predominantly Southwest (SW) meaning the winds originate from the Gulf of Guinea.



Source: GMet, 2010-2020

Figure 11 Wind Roses for Axim, 2010 - 2020

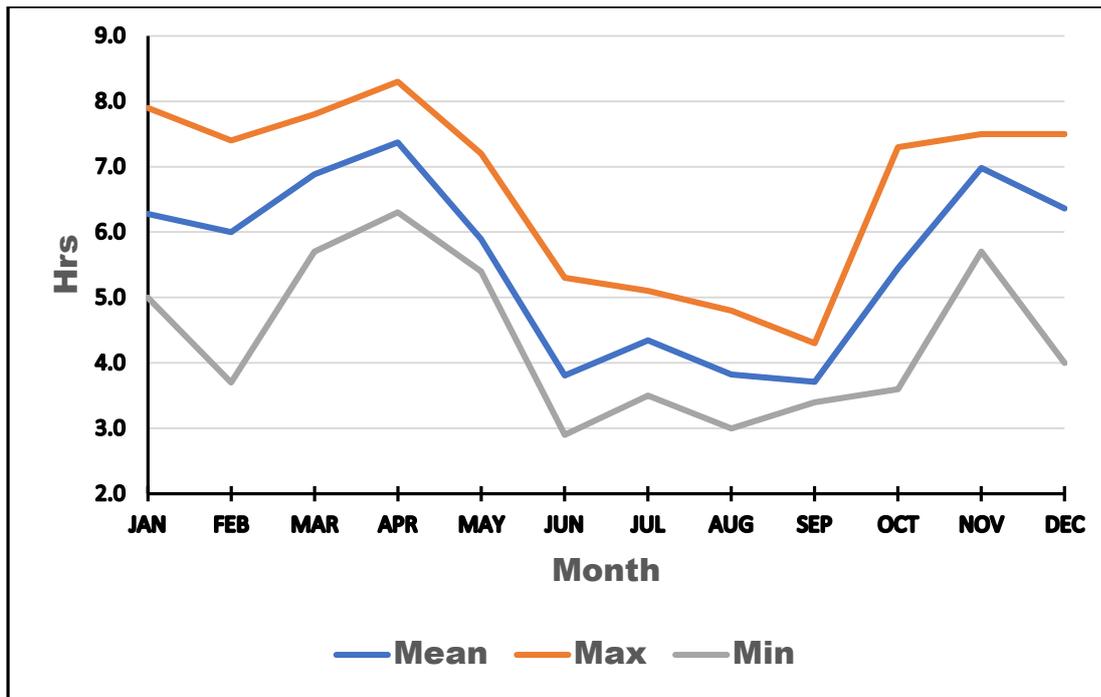
**v. Sunshine**

Available meteorological records from the Axim synoptic station for the past 11 years indicate that the proposed project area experiences bright sunshine throughout the year with annual mean hours of sunshine ranging between 3.7 hrs in September to 7.4 hrs in April as seen in Table 18 and Figure 12.

Table 18 Statistics of Sunshine duration (Hrs) at Axim Synoptic Station; 2010 – 2020

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	6.3	6.0	6.9	7.4	5.9	3.8	4.3	3.8	3.7	5.5	7.0	6.4
Max	7.9	7.4	7.8	8.3	7.2	5.3	5.1	4.8	4.3	7.3	7.5	7.5
Min	5.0	3.7	5.7	6.3	5.4	2.9	3.5	3.0	3.4	3.6	5.7	4.0

Source: GMet, 2010 -2020



Source: GMet, 2010 -2020

Figure 12 Monthly Mean, Maximum, and Minimum Bright Sunshine (Hrs) at Axim, 2010 - 2020

### 5.2.3 Air Quality

The objective of the study was to assess the air quality of the project area relative to standards in compliance with the Ghana Standards Authority (GSA)'s Environmental Quality Standard for Ambient Air Quality (GS 1236: 2019). It was also to identify the possible sources of emissions to help develop appropriate mitigation measures.

The scope of work involved:

i. Conducting a reconnaissance survey with a team from GNGLC's Community Relations Department to assess and select monitoring locations based on:

- Accessibility to unrestricted airflow to the sampling equipment.
- Wind direction.
- Representativeness of the location.

ii. Measuring the following fenceline and ambient air quality parameters at the selected stations over 24 hours:

- Total Suspended Particulate (TSP), Particulate Matter – PM<sub>2.5</sub> and PM<sub>10</sub>.

- Noxious Gases - Sulphur Oxide (SO<sub>2</sub>), Nitrogen Oxides (NO<sub>x</sub>), Carbon Monoxide (CO).

The selected locations are described in Table 19 below.

Table 19 Selected Sites for Ambient Air Quality and Noise Measurements

Site ID	Site Description	Coordinates
ML 1	Krisan - About 300 meters from the shore.	Latitude: 4.963655 N Longitude: 2.464503 W Altitude: 35 meters
ML 2	Anokyi - Along the Anokyi – Atuabo road.	Latitude: 4.974726 N Longitude: 2.522230 W Altitude: 35 meters
ML 3	Ekebaku - About 300 meters from the shore.	Latitude: 4.984180 N Longitude: 2.571112 W Altitude: 35 meters
ML 4	The proposed site for GPP Train 2 - About 380 meters from the flaring stack.	Latitude: 4.980135 N Longitude: 2.534289 W Altitude: 33 meters
ML 5	Asemnda - About 15 meters from the market.	Latitude: 4.988032 N Longitude: 2.539648 W Altitude: 37 meters
ML 6	Ngalekyi - In front of a residential area.	Latitude: 4.969297 N Longitude: 2.495652 W Altitude: 37 meters
ML 7	Atuabo - In front of the Methodist Church.	Latitude: 4.980542 N Longitude: 2.555390 W Altitude: 38 meters
ML 8	North of GPP Train 1. About 140 meters from Asemnda and 400 meters from the flare stack.	Latitude: 4.984408 N Longitude: 2.533746 W Altitude: 35 meters

Measurements were taken between 04 and 07 April 2022. The weather was mostly cloudy with the following characteristics: Temperature: 24-33° C; Wind speed: 9.0-16.3 km/h SW; Humidity: 75-88%; 1008-1014 mbar; Visibility: 5-10 km.

A Sensidyne Deluxe Nephelometer, also known as aerosol monitor, with an accuracy of recording dust concentrations ranging from 0.1 to 10,000  $\mu\text{g}/\text{m}^3$  was deployed in measuring TSP,  $\text{PM}_{2.5}$  and  $\text{PM}_{10}$ . The equipment was mounted at a height of 2 m on a tripod stand with a digital camera that enables an inbuilt photodetector sensor to measure light scattered by dust particles according to their concentrations (Plate 6). The noxious gases ( $\text{SO}_2$ ,  $\text{NO}_x$ , CO) were determined using a Portable Multi-Gas Analyzer alarm model SA-M203 with the gas sensors using the electrochemical principle with logging and analyzing times of six seconds and 1 hour respectively for all the three gases. The concentration of the gases was obtained using the relation:  $\text{mgm}^{-3}/\mu\text{gm}^{-3} = \text{ppm} \times \text{density}$ .



Plate 6 Equipment Deployed for Air Quality and Noise Level Measurements

The results of air quality measurements are presented in Table 20.

Table 20 Concentrations of Particulate Matter and Noxious Gases ( $\mu\text{g}/\text{m}^3$ )

Location	TSP	$\text{PM}_{10}$	$\text{PM}_{2.5}$	$\text{SO}_2$	$\text{NO}_x$	CO
Krisan	155.3	62.25	29.41	<0.05	<0.05	<0.05
Ngalekyi	98.27	50.81	24.04	<0.05	<0.05	<0.05
Anokyi	270.5	157.9	35.59	1.85	2.72	<0.05

Location	TSP	PM <sub>10</sub>	PM <sub>2.5</sub>	SO <sub>2</sub>	NO <sub>x</sub>	CO
Atuabo	217.9	74.81	33.98	0.15	0.62	<0.05
Asemnda	90.35	49.71	20.69	3.16	4.05	0.14
GPP Train 1 Site	87.56	48.36	21.60	0.23	1.01	<0.05
GPP Train 2 Site	92.07	51.45	19.12	5.19	9.83	0.57
Ekebaku	96.80	50.29	22.37	<0.05	<0.05	<0.05
<i>Averaging Time</i>	<i>24 hrs</i>	<i>24 hrs</i>	<i>24 hrs</i>	<i>1 hr</i>	<i>1 hr</i>	<i>15 mins</i>
<i>GSA Standard</i>						
<b>Fenceline</b>	<b>150</b>	<b>70</b>	<b>35</b>	<b>150</b>	<b>150</b>	<b>100</b>
<b>Ambient</b>	<b>150</b>	<b>70</b>	<b>35</b>	<b>520</b>	<b>250</b>	<b>-</b>
<b>WBG EHS/WHO Guideline</b>	<b>-</b>	<b>50</b>	<b>25</b>	<b>500</b>	<b>200</b>	<b>100</b>

For TSPs, concentrations higher than the GSA standard of 150 µg/m<sup>3</sup> (GSA, 2019) were observed at Krisan, Anokyi, and Atuabo with a range of 155.3 to 270.5 µg/m<sup>3</sup>. Anokyi and Atuabo also had PM<sub>10</sub> and PM<sub>2.5</sub> close to or higher than their respective GSA standards of 70 and 35 µg/m<sup>3</sup>. Overall, the highest concentrations of particulates occurred at Anokyi, which is located about 0.43 km south-west of GPP Train 1. These results cannot be compared with those obtained earlier by GNGLC’s monitoring activities because of the different averaging times used (GNGLC, 2021a).

For noxious gases, the pattern of occurrence of both SO<sub>2</sub> and NO<sub>x</sub> was: GPP Train 2 Site > Asemnda > Anokyi > GPP Train 1 Site. CO was not detected at the various locations except for traces at the site for GPP Train 2 and Asemnda. The concentrations of all the noxious gases were however below their respective GSA standards, the same as recorded by Ghana Gas from its monitoring activities (GNGLC, 2021a). As recommended by various stakeholders during the scoping exercise for the EIA (GNGLC, 2022), more studies are required on the modelling of emissions from the existing and proposed GPPs to ensure a clearer understanding of the dispersion, fate, and potential impacts of the emissions that influence air quality in the project area.

#### 5.2.4 Ambient Noise Levels

The objective of the study was to assess noise levels in various areas in the proposed project area in compliance with GSA’s Environmental Quality Standard for Ambient Noise (GS: 1222:

2018). It was also to identify the major sources of noise to develop appropriate mitigation measures.

The scope of work involved measuring ambient day and night noise levels at the same locations as used for air quality measurements (Table 19) using a Cirrus: 812B Integration Sound Level Meter with a data logging system (Plate 6). The noise levels were captured in decibels on the A scale which gives weight to the frequencies of sound to which the human ear is most sensitive and typically denoted by dB (A). The equipment was covered with a windshield and mounted on a stand to take readings of the ambient noise levels at the selected locations during the sampling periods (day and night). The maximum ( $L_{max}$ ), minimum ( $L_{min}$ ) as well as statistical values for  $L_{10}$ ,  $L_{90}$  noise levels were recorded over the same period (day and night) at each monitoring location (Table 19). The summarized Integrated Noise Level ( $L_{eq}$ ), results are presented in Table 21 and 22 below.

Table 21 Ambient Integrated Noise Level (dB(A) for Residential Area

Location	Noise Levels ( $L_{eq}$ )	
	Day (6 am-10 pm)	Night (10 pm)
Krisan	58.7	54.9
Ngalekyi	54.7	36.3
Anokyi	58.7	54.9
Atuabo	55.1	39.2
Asemnda	53.6	43.9
Ekabaku	52.8	45.3
<b>GSA Standard for Residential Area (Zone A)</b>	<b>55</b>	<b>48</b>
<b>WBG EHS/WHO Guideline</b>	<b>55</b>	<b>45</b>

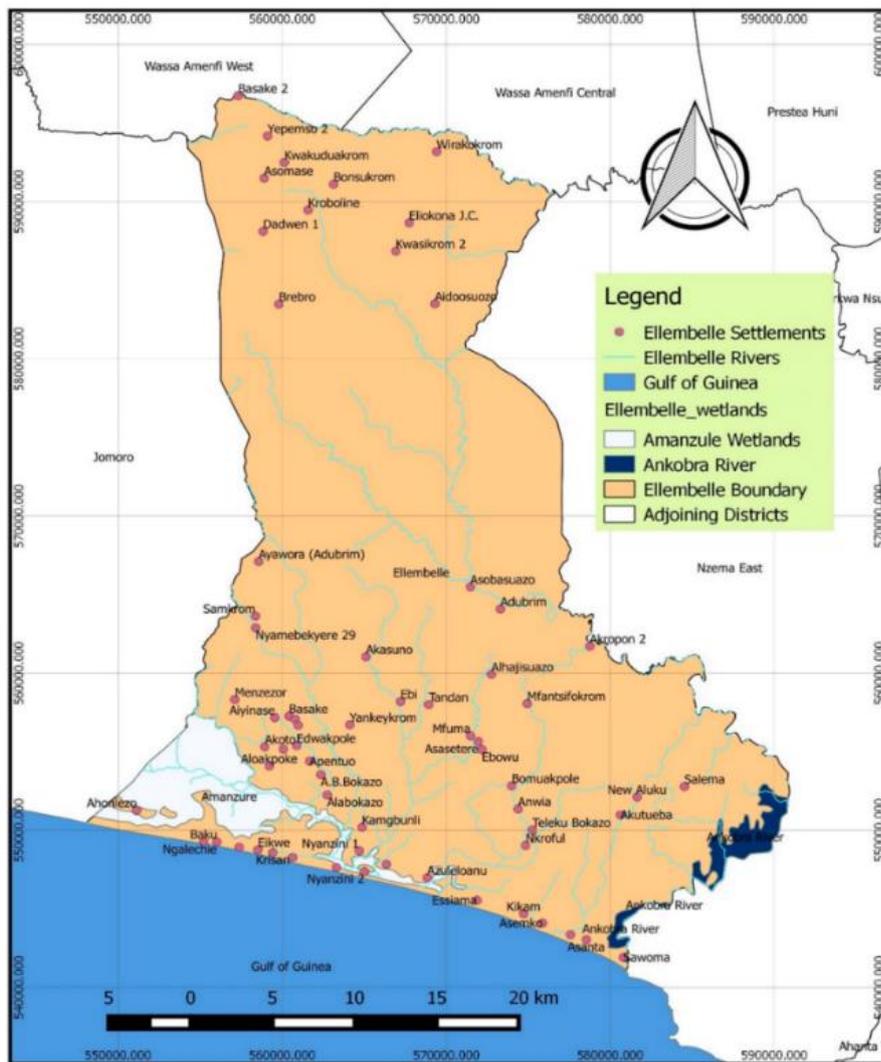
Table 22 Ambient Integrated Noise Level (dB(A) for Light Industrial Area

Location	Noise Levels ( $L_{eq}$ )	
	Day (6 am-10 pm)	Night (10 pm)
GPP Train 1 Site	64.6	56.1
GPP Train 2 Site	48.9	32.6
<b>GSA Standard Light Industrial (Zone C)</b>	<b>70</b>	<b>60</b>
<b>WBG EHS/WHO Guideline</b>	<b>70</b>	<b>70</b>

The sites for GPP Train 1 and Train 2 are considered within the category of a light industrial environment while the communities are considered residential. From Table 21, the results indicate that noise levels in most of the communities were slightly above or below the GSA standard and WBG EHS Guideline for residential areas during the day. This could be due to a combination of noise from wave action on the beaches, occasional traffic, and commercial activities. Noise levels at Krisan and Anokyi were also above the GSA day and night standards. Concerning the GPPs, noise levels recorded at both Train 1 and Train 2 were below the GSA standards for light industrial areas during the day and at night.

### ***5.2.5 Surface Hydrology***

The Ellebelle District is largely drained by the Southwestern Rivers System. The prominent river is the Ankobra with its major tributaries like the Ahama and Nwini Rivers. Others such as the Ankasa and Draw Rivers and their tributaries drain the northern parts and act as boundaries between Ellebelle and Wassa Amenfi West Districts. All streams and rivers flow throughout the year and exhibit a dendritic pattern that forms the Ankobra basin as shown in the drainage map of the Ellebelle District (Figure 13).



Source: Ellembelle District Assembly, 2017a

Figure 13 Drainage Map of Ellembelle District

The main river system at the GPP project site is the Amansuri. The tributaries of the Amansuri include Nyanzini, Franza, Amadenra, and Bozoke. The channel breadth of the river where samples were taken for previous hydrological studies is approximately 44.1m. This river originates from a network of streams that culminate in the Amansuri lagoon at Nzulezu and then travels towards the coast at Bakanta before entering the sea near Azulenloanu (see Figure 14). The Amansuri is gauged at a bridge crossing along the Alabokazo – Eikwe Road with the gauge measuring a depth of 32.26m at the time of the hydrological studies.

The table below provides the drainage features of the main tributaries in the Amansuri river system.

Table 23 Drainage Features of the Rivers in the GPP Project Area

Name of Stream	Length (km)	Area (km <sup>2</sup> )	Difference in Level {m (from source to mouth, a.m.s.l.)}	Slope
Amansuri	25.68	877.77	0.26	0.00001
Nyanzini	30.44	138.94	60.88	0.002
Franza	21.49	70.31	64.47	0.003

**Nyanzini River:** The Nyanzini River has a catchment area of about 138.94 km<sup>2</sup>. It travels about 30.44 km before it joins the Amansuri River. The Nyanzini has a slope of 0.002. The difference in level from source to mouth of stream is 60.88m a.m.s.l.

**Franza:** The Franza is a sub catchment within the Amansuri catchment. It originates from the Nkroful and the Bomokpole areas. The eastern section of the Amansuri Lagoon is served largely by discharges from the Franza which is also referred to as the Broma or Bonuma at its upper reaches. The Franza with a catchment area of about 70.31km<sup>2</sup> also has the Subele as a tributary draining Anwea and surrounding areas and traverses about 21.49 km before it empties into the Amansuri Lagoon. Its difference in level from source to mouth is 64.47 a.m.s.l. with a slope of 0.003.

Within the GPP Enclave, a tributary of the Amansuri river system drains into the swamp which the locals call Hooho (see Figure 14). Due to the blocking of a section of the Hooho stream, there are reports of occasional flooding of lands adjoining the Asemnda community particularly during the rainy season. GNGLC has reserved the swamp area as a vegetated buffer for the processing plants. As part of this EIA, a Flood Risk Assessment has been conducted to identify areas within and around the GPP Enclave that are prone to flooding and to develop strategies to mitigate the impact of floods (see Sections 7.4.1 and 8.4.1).

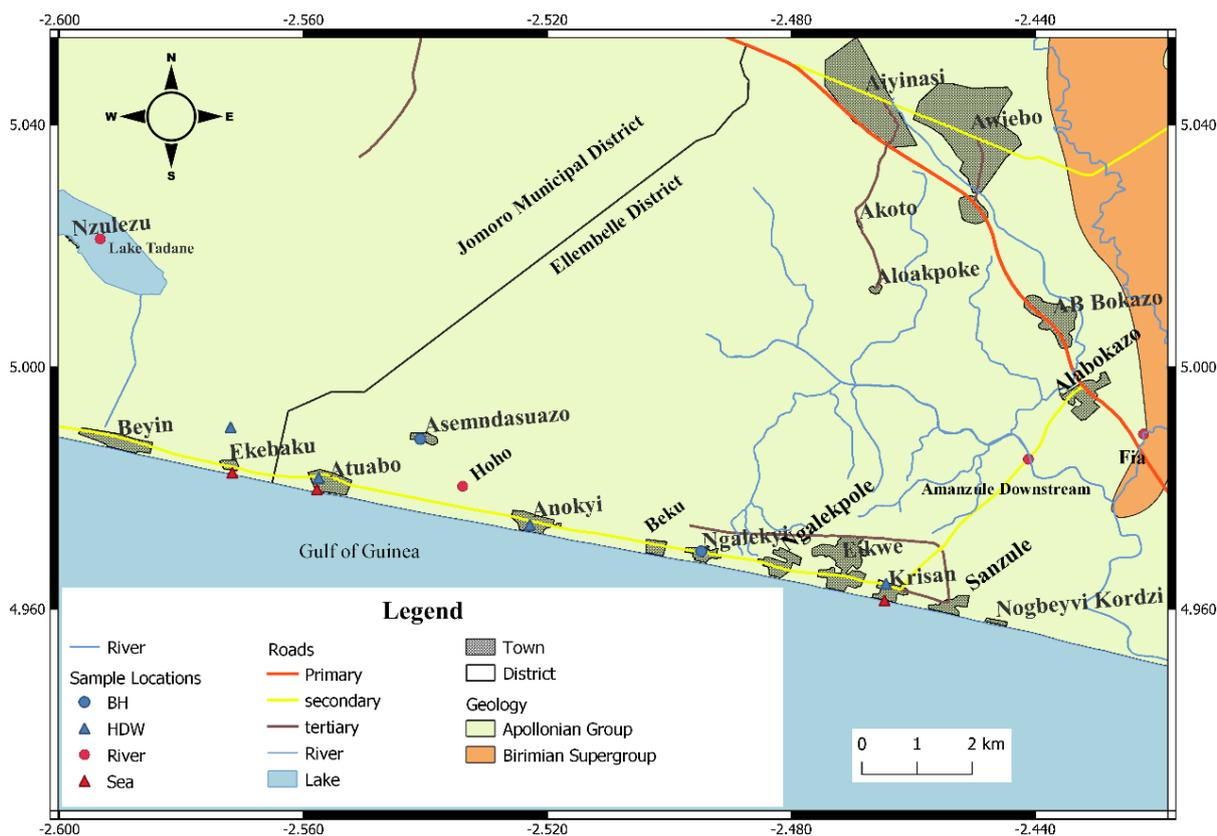


## ii. Surface Water Quality

This section presents baseline information on the physico-chemical characteristics of surface waters (rivers and streams) and seawater in the project area. Four (4) surface water samples and three (3) seawater samples from onshore areas were collected between 04 and 07 April 2022, which is the beginning of the wet season. They are presented in Table 24 below. The sampling locations are also indicated in Figure 15 below.

Table 24 Sampling Locations for Surface Waters

River/Stream	Location	Coordinates
Amanzure Upstream	Nzulezu	05° 01' 16" N 02° 35' 36" W
Amanzure Downstream	Krisan	04° 59' 05" N 02° 26' 28" W
Hooho	Proposed Site for Train 2	04° 58' 49" N 02° 32' 02" W
Fia	Kamgbuli	04° 59' 20" N 02° 25' 20" W
<b>Seawater</b>		
Beachfront	Krisan	04° 57' 41" N 02° 27' 53" W
Beachfront	Ekebaku	04° 58' 57" N 02° 34' 18" W
Beachfront	Atuabo	04° 58' 47" N 02° 33' 28" W



Source: EESL, 2022b

Figure 15 Map of Project Area Showing Water Sampling Locations

Samples were analysed at the CSIR Water Research Institute at 2<sup>nd</sup> CSIR Close in Accra. The methods used for the physico-chemical analyses of both surface and ground waters are summarised in Table 25. All field and laboratory determinations were according to the American Public Health Association (2012) Standard Methods for the Examination of Water and Wastewater, 22nd Edition. Also presented in the table are the equipment detection limits for the different parameters analysed.

Table 25 Methods and Detection Limits for Water Analyses

Parameters for Water Analysis	Reference for Method*	Detection Limits
pH	pH Meter	0.1 pH units
Turbidity (NTU)	HACH 2100P Turbidimeter	0.01NTU
TSS (mg/l)	Gravimetric	1.00 mg/l
Conductivity ( $\mu$ S/cm)	Cyberscan PC 510	
DO (mg/l)	DO Meter	0.2 mg/l
BOD (mg/l)	Dilution Method	0.5 mg/l
Chloride (mg/l)	Argentometric Method	

Parameters for Water Analysis	Reference for Method*	Detection Limits
Fluoride (mg/l)	Fluoride Meter	0.001 mg/l
Sulphate (mg/l)	Barium Chloride Method	1.0 mg/l
Nitrate (mg/l)	Hydrazine reduction	0.001 mg/l
Phosphate (mg/l)	Stannous Chloride	0.001mg/l
Ammonium (mg/l)	Direct Nesslerization Method	0.001mg/l
Calcium (mg/l)	EDTA Titrimetric	0.01 mg/l
Magnesium (mg/l)	EDTA-By Calculation	0.5 mg/l
Potassium (mg/l)	JENWAY Flame Photometer	0.1 mg/l
Sodium (mg/l)	JENWAY Flame Photometer	0.1 mg/l
Total Iron (mg/l)	AAS Graphite	<0.010
Manganese (mg/l)	AAS Graphite	<0.005

\* American Public Health Association (2012)

Tables 26 to 28 below present the characteristics of the surface waters of the project area as represented by key selected parameters. Further details are presented in Appendix 5-1.2. The results are compared with GSA Standards (2017) and World Health Organisation (WHO) guideline limits for drinking water and Ghana Raw Water Quality (GRWQ) Guidelines for Aquatic Ecosystem Protection (WRC, 2003). Where the relevant information is available, tabulated results are also presented alongside unpolluted natural background levels for tropical coastal waters (Livingstone, 1963; Burton and Liss, 1976; Jorgensen, 1979; Stumm and Morgan, 1981).

The pH values of the surface waters (Table 5-14) were slightly acidic, ranging from 5.50 in the downstream areas of the Amanzure to 6.65 in the Hooho Stream. The lower limit was below the GSA standard for drinking water of 6.0 to 9.0 and the Ghana Raw Water Quality (GRWQ) guideline range of 6.5 to 8.5 for freshwater aquatic ecosystems. The pH of natural waters is usually governed by the carbon dioxide/bicarbonate/carbonate equilibria due to such interactions as between suspended and sedimentary particles and the bioactivity of plants. Being close to the sea, the quality of the surface waters in the project area may vary with the influence of seawater intrusion and tidal spray, and input of freshwater from upstream areas. The pH of seawater from the onshore areas ranged from 7.99 to 8.10, close to the natural background range of 7.0 to 8.0.

Table 26 Physico-chemical Characteristics of Surface Waters\*

Location	pH	COND ( $\mu\text{S/cm}$ )	Turbidity (NTU)	TSS	Salinity (‰)	Fe
<i>River/Stream</i>						
Amanzure Upstream	6.25	34.6	9.06	<1.0	0.044	0.54
Amanzure Downstream	5.50	119	10.0	<1.0	0.082	0.93
Hooho	6.65	150	59.7	30	0.082	2.08
Fia	6.49	63.9	7.81	1.0	0.049	1.63
<i>Seawater</i>						
Krisan	8.10	57,600	6.68	1.0	28.17	0.27
Ekebaku	8.09	57,400	7.66	1.0	18.67	0.17
Atuabo	7.99	57,300	5.87	1.0	23.87	0.28
<b>WHO Guidelines</b>	<b>6.5-8.5</b>	-	<b>5.0</b>	-		<b>0.3</b>
<b>GSA Standards</b>	<b>6.5-8.5</b>	-	<b>5.0</b>	<b>0</b>		<b>0.3</b>
<b>Ghana Raw Water Quality Guidelines</b>	<b>6.5-8.5</b>	-	-	<b>100</b>	-	-
<b>Natural Background Levels</b>	<b>7-8</b>				<b>35</b>	-

\* All concentrations in mg/L except where otherwise stated

Conductivity (COND) is an expression of water's ability to conduct an electrical current. This property depends on the ionic strength of water and is therefore related to the nature of various dissolved substances and their actual and relative concentrations. Conductivity influences the occurrence and diversity of plants and animals. Because of their saline nature (salinity), estuarine and coastal waters have higher conductivities compared to freshwater, but changes may also indicate pollution. Thus, the conductivities and salinities of the surface waters increased from freshwater conditions in the rivers and streams (<0.1‰) to more saline conditions onshore (Table 26). Compared to the natural background level of 35‰, the salinities of onshore waters were low, probably due to the influx of freshwater from the upstream wetlands and increased land runoff during rainfall.

The turbidity values recorded for the rivers and streams were higher than the WHO guidelines and GSA standards for drinking water mainly because of the influence of land runoff arising from human activities. For example, the turbidity of the Hooho stream at 59.7 NTU, was more than ten times the GSA standard of 5 NTU. This was directly due to the occurrence of large

quantities of suspended solids. At the time of sampling, the Hooho was not flowing and had formed pools.

Concerning nutrients and the major ions in rivers and streams, the concentrations of nitrate (NO<sub>3</sub>-N) and ammonia (NH<sub>3</sub>-N) and all the cations (Ca, Mg, Na, K) and anions (Cl, SO<sub>4</sub>) were low compared to the WHO guidelines and GSA standards for drinking water and to the Ghana Raw Water Quality (GRWQ) Guidelines for Aquatic Ecosystem Protection. The respective levels in seawater were also low (Table 27).

Table 27 Nutrients and Major Ions in Surface Waters (mg/L)

Location	NO <sub>3</sub> -N	NH <sub>3</sub> -N	PO <sub>4</sub> -P	Ca	Mg	Cl	SO <sub>4</sub>	Na	K
<i>River/Stream</i>									
Amanzure Upstream	0.07	<0.001	0.15	3.68	0.48	7.52	<1.0	2.80	1.40
Amanzure Downstream	0.06	<0.001	0.10	4.15	6.80	28.6	6.66	12.3	0.80
Hooho	0.21	<0.001	0.23	5.45	6.70	28.9	19.9	13.6	7.50
Fia	0.12	<0.001	0.17	2.81	5.82	10.3	3.53	2.80	1.30
<i>Seawater</i>									
Krisan	0.07	<0.001	0.03	417	240	15,584	297	7,100	320
Ekebaku	0.09	<0.001	0.06	441	407	10,323	292	5,500	350
Atuabo	0.08	<0.001	0.09	420	272	13,202	392	6,800	318
<b>WHO Guidelines</b>	<b>10</b>	<b>1.5</b>	-	<b>200</b>	<b>150</b>	<b>250</b>	<b>250</b>	<b>200</b>	<b>30</b>
<b>GSA Standards</b>	<b>10</b>	<b>1.5</b>	-	<b>200</b>	<b>150</b>	<b>250</b>	<b>250</b>	<b>200</b>	<b>30</b>
<b>GRWQ Guidelines</b>	-	<b>0.007</b>	-	<b>100</b>	<b>100</b>	-	-	-	-
<b>Natural Background Levels</b>	<b>0.23</b>	<b>0.01</b>	<b>0.02</b>	<b>412</b>	<b>1,294</b>	<b>19,340</b>	<b>2,712</b>	<b>10,770</b>	<b>399</b>

On the other hand, the concentrations of phosphate (PO<sub>4</sub>-P) in all the surface waters, including seawater, were higher than their natural background values. The major sources of phosphates include land runoff containing domestic wastes and sewage.

Bacteriological analyses (Table 28) showed the presence of faecal coliforms and *E. coli* in all the surface waters, except for seawater at Atuabo. The others are therefore unfit, not only for direct human consumption but also for primary contact activities such as swimming. *E. coli* is an indicator of recent faecal pollution and therefore reveals the practice of open defaecation.

Table 28 Bacteriological Characteristics of Surface Waters\*

<b>Location</b>	<b>Total Coliform</b>	<b>Faecal Coliform</b>	<b><i>E. coli</i></b>
<b><i>River/Stream</i></b>			
Amanzure Upstream	279	14	2
Amanzure Downstream	379	1	0
Hooho	279	6	5
Fia	552	19	12
<b><i>Seawater</i></b>			
Krisan	186	10	5
Ekebaku	930	15	8
Atuabo	26	0	0
<b>WHO Guidelines – Primary Contact</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>WHO – Secondary Contact</b>	<b>10,000</b>	<b>5,000</b>	<b>-</b>
<b>GSA Standards</b>	<b>0</b>	<b>0</b>	<b>0</b>

\* Counts/100 ml

The above results on the physico-chemical characteristics of surface waters are considered preliminary and monitoring, therefore, needs to be continued to establish clear trends as done for groundwater.

### 5.2.6 Groundwater Hydrology

#### i. Groundwater Resources, Exploitation and Quality

The Tano hydrogeological basin is the closest to the project area. Due to its prolific nature, the hydrogeologic basin constitutes the major source of surface water and groundwater in the area for domestic, agricultural, and industrial purposes. Groundwater occurs in the weathered zones and in fractures or openings within the rocks (Agyekum, 2005). Due to the nature of the surficial marl and the intercalated sandy-clay formation, drilling through the overburden of the Tano hydrogeologic Basin is extremely difficult. However, drilling results in the area show that groundwater can be exploited from both the sandy beds and from deep fractures and fissures in the moderately weathered rocks.

The thickness of the overburden varies between 15 and 25 m. Even though the overburden yields large volumes of water, the underlying compact sandstone and Birimian rock systems are highly fractured with appreciably high yielding potential. In general, the groundwater potential of the Tano hydrogeologic basin is very high with borehole yields ranging from 100

to 400 lpm (i.e., 6-24 m<sup>3</sup>/hr). Borehole depths are generally shallow in the range of 22 to 50 m below ground level. The static water level in the area is generally high ranging from 1 m to 5 m.

## **ii. Conditions of Aquifers**

Within the Tano hydrogeological Basin, two major aquifer types generally develop. These are weathered and fractured rock aquifers, and they tend to act as confined or semi-confined (leaky) aquifers. The weathered aquifers consist of surficial soils, with a mix of slightly clayey material and weathered products. They lie between the bedrock and the intercalated sandy formation of the upper zone and act as a passage zone and a reservoir of water, which is drained by fractures and more permeable sections of the lesser weathered underlying rocks. They usually show variable yields, though in certain places they produce marginal yields.

The fractured aquifers contain water exclusively in joints or other highly fractured systems and the water-bearing zones are often associated with muscovite, pyrite, or marcasite minerals (Kesse, 1985). Due to the variable overburden thickness as well as the varying nature of the fracturing in the underlying rock system, the aquifers are highly anisotropic with permeability inhibited by less permeable or even less impermeable zones of hard rock or clayey weathering products. The transmissivity of aquifers, estimated from 24-hour pumping tests indicated a mean value of 30 m<sup>2</sup>/day and the specific capacity determined for the wells was 18 m<sup>3</sup>/d/m (Dapaah-Siakwan and Gyau-Boakye, 2000).

## **iii. Hydrogeology**

Recharge to the underlying aquifer system of the Tano hydrogeological basin area is mainly through direct and indirect infiltration of rainfall and the Tano and Ankobra rivers. Direct infiltration occurs through the weathered loose overburden formation and also through fractured and fault zones of the underlying rock. Indirect recharge occurs through percolation of rainfall to the water table following runoff and localization in joints, natural ponds in low-lying areas, and through preferential pathways and beds of some surface water courses. Similar to many crystalline rock areas, recharge to groundwater in the project area is controlled by factors such as the amount, frequency and intensity of rainfall, antecedent moisture condition of the soil profile, geology, soil properties, the depth to the water table and aquifer properties (Duah and Dapaah-Siakwan, 1998).

Other factors include vegetation, land use, topography, and landform. In line with these factors, recharge to groundwaters in the Tano hydrogeologic basin area is therefore highly variable both spatially and temporally and estimated to be slightly higher than 18% of the annual rainfall. The potential for direct recharge from surrounding streams could also be high since the potentiometric surface of the aquifer is below the surface water sources.

#### iv. Groundwater Quality

Six (6) groundwater samples were collected from four hand-dug wells and 2 boreholes (Table 29 in the same general area as the surface water samples (Figure 15).

Table 29 Sampling Locations for Groundwater

Groundwater	Location	Coordinates
<i>Hand Dug Well</i>		
	Krisan	04° 57' 51" N 02° 27' 52" W
	Anokyi	04° 58' 26" N 01 59' 26" W
	Ekebaku	04° 59' 24" N 02° 34' 19" W
	Atuabo	04° 58' 54" N 02° 33' 27" W
<i>Borehole</i>		
	Asemnda	04° 59' 17" N 02° 32' 27" W
	Ngalekyi	04° 58' 17" N 02° 24' 03" W

Tables 30 to 33 below present the characteristics of the groundwaters as represented by key selected parameters alongside WHO and Ghana EPA Standards. Further details are presented in Appendix 5-1.1. Just like the surface waters, the groundwaters were slightly acidic with a pH range of 5.37 to 7.02 (Table 30). However, unlike the surface waters, the groundwaters were less turbid with low concentrations of suspended solids except for the borehole at Asemnda.

Table 30 Physico-chemical Characteristics of Groundwater\*

Location	pH	COND ( $\mu\text{S}/\text{cm}$ )	Turbidity (NTU)	TSS	F
<b>Hand-Dug Well</b>					
Krisan	6.93	250	1,69	<1.0	<0.005
Anokyi	6.53	336	1.22	<1.0	0.05
Ekebaku	6.60	321	<1.0	<1.0	<0.001
Atuabo	7.02	238	8	<1.0	<0.005
<b>Borehole</b>					
Asemnda	5.70	240	66.2	12.0	<0.005
Ngalekyi	5.37	88.3	10.0	1.0	<0.005
<b>WHO Guidelines</b>	<b>6.5-8.5</b>	-	<b>5.0</b>	-	<b>1.5</b>
<b>GSA Standards</b>	<b>6.0-9.0</b>	<b>1,500</b>	<b>75</b>		<b>10</b>

\*All concentrations in mg/L except where otherwise stated.

The concentrations of nutrients (Table 31) and trace metals (Table 32) were low compared to the GSA standards and WHO guidelines. For example, ammonium was undetectable as well as copper, zinc, cadmium, and lead. The borehole at Asemnda however had a high concentration of iron, 6.5 mg/L compared to the GSA standard of 0.3 mg/L. This goes to explain the high turbidity of the waters of this borehole as the iron precipitates as hydrated ferric oxide.

Table 31 Nutrients and Major Ions in Groundwater (mg/L)

Location	NO <sub>3</sub> -N	NH <sub>3</sub> -N	PO <sub>4</sub> -P	Ca	Mg	Cl	SO <sub>4</sub>	Na	K
<b>Hand-Dug Well</b>									
Krisan	0.58	<0.001	0.16	31.4	9.49	24.9	19.4	5.3	1.4
Anokyi	2.36	<0.001	0.05	15.6	7.61	44.3	30.8	18.5	11.2
Ekebaku	1.96	<0.001	0.21	19.4	8.33	65.1	8.61	36.0	2.30
Atuabo	0.48	<0.001	0.15	31.1	6.04	24.9	3.99	15.3	2.40
<b>Borehole</b>									
Asemnda	0.10	<0.001	0.16	7.46	8.83	24.6	12.3	3.10	0.90
Ngalekyi	0.19	<0.001	0,22	1.76	6.56	20.5	<1.0	4.20	1.30
<b>WHO Guidelines</b>	<b>10</b>	<b>1.5</b>		<b>200</b>	<b>150</b>	<b>250</b>	<b>250</b>	<b>200</b>	<b>30</b>
<b>GSA Standards</b>	<b>50</b>		<b>2.0</b>				<b>250</b>		

\* All concentrations in mg/L except where otherwise stated

Table 32 Trace Metals in Groundwater (mg/L) \*

Location	Fe	Mn	Cu	Zn	Cd	Pb
<b>Hand-Dug Well</b>						
Krisan	0.04	0.01	<0.02	<0.005	<0.002	<0.005
Anokyi	0.08	0.01	<0.02	<0.005	<0.002	<0.005
Ekebaku	0.12	0.01	<0.02	0.01	<0.002	<0.005
Atuabo	0.34	0.02	0.03	0.06	<0.002	<0.005
<b>Borehole</b>						
Asemnda	6.55	0.02	<0.02	<0.005	<0.002	<0.005
Ngalekyi	0.50	0.02	<0.02	<0.005	<0.002	<0.005
<b>WHO Guidelines</b>	<b>0.3</b>	<b>0.4</b>	<b>2.0</b>	<b>2.0</b>	<b>0.01</b>	<b>0.001</b>
<b>GSA Standards</b>	<b>0.3</b>	<b>0.4</b>	<b>2.0</b>	<b>10</b>	<b>0.1</b>	<b>0.005</b>

\* All concentrations in mg/L except where otherwise stated

Bacteriological analyses (Table 33) showed the presence of faecal coliforms in five of the six locations, which makes them unfit for direct human consumption. The only exception was the borehole at Ngalekyi.

Table 33 Bacteriological\* Characteristics of Groundwater

Location	Total Coliform*	Faecal Coliform*	<i>E. coli</i> *
<b>Hand-Dug Well</b>			
Krisan	558	13	6
Anokyi	465	93	20
Ekebaku	837	22	10
Atuabo	651	11	5
<b>Borehole</b>			
Asemnda	35	17	13
Ngalekyi	186	0	0
<b>WHO Guidelines</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>GSA Standards</b>	<b>0</b>	<b>0</b>	<b>0</b>

\* Counts /100 ml

It is recommended that the Ellebelle District Assembly takes the necessary steps to increase public awareness of the need to protect boreholes in its jurisdiction from faecal contamination.

### ***5.2.7 Watershed Characteristics***

The proposed GPP Train 2 is located within a tributary of the Amansuri River. It has a catchment area of 8.5 sq.km computed at the drainage point located just upstream of the existing GPP1. Its watershed is largely covered with vegetation at the mountainous portion. It is composed mainly of coconut trees, bushes, and grass. The lower portion at the west side of GPP1 is generally a swampy area over a grassland with low level of drainage. Impervious surfaces are also noticeable at the towns of Atuabo and Asemnda including the area of the gas processing plant.

### ***5.2.8 Slope and Elevation***

The watershed elevation ranges from 4 to 27 meters with an average of 11 meters. It is characterized as a plain terrain with slopes ranging from 0 to 5% with an average of 0.18%.

The proposed GPP Train 2 is located on the low-lying area of the watershed which is a catch basin due to low drainage capacity and high surrounding elevations. The lowest elevation of the catch basin is around 4 meters amsl surrounded by natural terrain, roads and the existing GPP1.

The road and the existing GPP1 has elevations of 6 and 8 meters amsl, respectively, while the lowest elevation of the drainage point is approximately 5.2 meters amsl.

### ***5.2.9 Oceanographic Condition***

The hydrography of the study area, which is within the Gulf of Guinea, is influenced largely by subtropical gyres of the north and south Atlantic oceans. The major currents influencing the area include:

- i. the Canary current from the north which splits into the North Equatorial Current and a coastal current which feeds the Guinea Current, and
- ii. the Benguela Current which flows northwards and extends into the Gulf of Guinea as the South Equatorial Current.

The Guinea Current which is the main current in the study area flows eastwards throughout the year over its whole length and obtains velocities close to 100 cm/s. It is however subject to periodical and usually short-term reversals. The reversal of the Guinea current is probably because of the varying strengths of the Equatorial Current and the waters of Benguela origin.

The general dynamics of the ocean currents in the Gulf of Guinea depends on the large-scale oceanic climatic seasonal exchanges which occur in the oceans and the morphology of the shelf and the orientation of the coast.

The coastal surface currents are primarily propelled by the wind and are confined to a 10–40 meters thick layer. Breaking waves generate littoral drift, the primary propelling force of coastal circulation in this region. These littoral drifts, which generally move in an eastward direction, have flow rates of less than 1 m/s, but they are responsible for transporting large volumes of littoral sediments and also for rip currents, which are more localized in their action, but transport a significant number of sediments away from the coast.

The coastline is susceptible to south-southeast to south-southwest lengthy swells generated by fetches in the South Atlantic Ocean. The coast near the Project Area is subject to moderate wave intensity, with 11-16 second swells dominating. The average amplitude of waves in the region is 1 meter, but annual significant surges can occasionally reach 3.3 meters. However, waves reaching heights of 4.8-6 meters occur with a frequency of 10-20 years. The maximal wave period for swells is typically between 7 and 14 seconds. The orientation of swell waves is almost always south or south-southwest. Table 34 and Table 35 show the results of statistical analysis regarding wave height exceedance statistics and extreme value analysis are summarized, respectively.

Table 34 Offshore Wave Height Exceedance Statistics

Heights (m)	Exceedance (%)
<1.0	82.8
<1.5	23.0
<2.0	3.0
<2.5	0.1
3.0	0.0

Table 35 Extreme Offshore Waves

Return Period (yrs)	Extreme Heights (m)
10	3.0
20	3.2
50	3.4

Other wave climate observations include a long swell of distant origin and wavelengths ranging from 160 to 220 meters. This swell has a primary period of 12 seconds and an average height between 1 and 2 meters that is relatively consistent. Generally, the waves move from southwest to northeast.

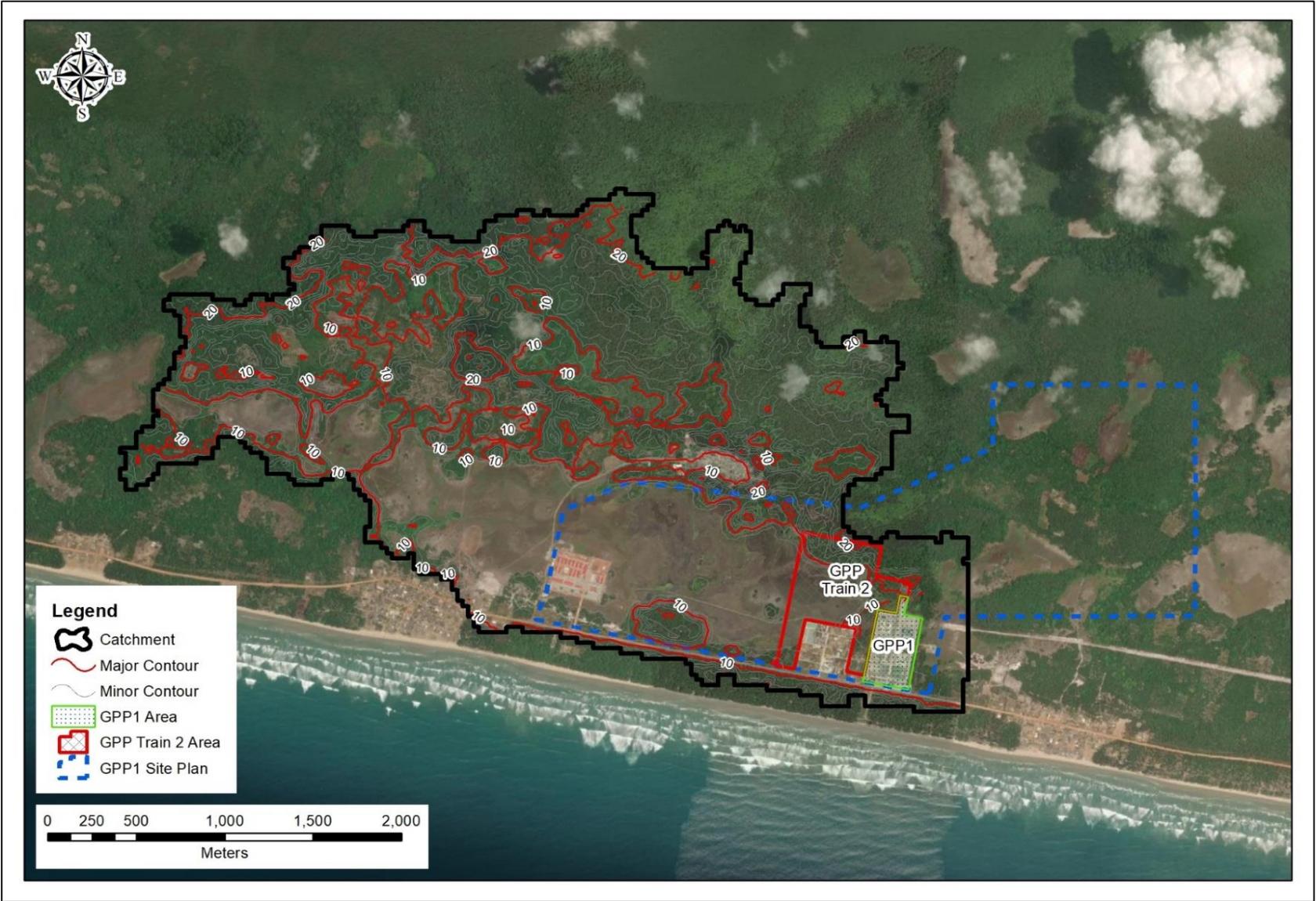


Figure 16 Watershed and Elevation Map

## 5.3. Biological Environment

### 5.3.1 Flora

The natural vegetation of the Ellembelle District is comprised of such typical tree species as the African Walnut, *Coula edulis*; *Cynometra ananta*; Akadan *Cola chlamydantha*, *Tenanfera Cola umbratilis*, Cherry Mahogany *Tieghemelia heckeli*; Nyankom *Heritira utilis*, *Placodiscus oblongifolia*, and *Pentadesmas butyracea* forming the principal timber species that can support the Timber Industry in the area. Other characteristic plants include the tree shrub *Soyauxia grandifolia*, the ferns *Trichomanes sp.*, *Agelaea sp.*, among others. In areas that are perennially flooded, the Raffia Palm *Raphia hookeri* and the herb *Cyrtosperma senegalense* are reported (MEST, 2002; Hall and Swaine, 1981; Hutchinson and Dalziel, 1972). Further south towards the coast, on lands that are seasonally flooded can be found short grassland such as *Panicum sp.*, *Setaria anceps*; *Hyparrhenia mutica* among others interspersed with various herbaceous and shrub species including *Tridax procumbens*; *Talinum traingulare*, *Centrosema sp.* and *Chlomolaena odorata*. On lands that are permanently flooded where there is mixing of fresh and saline waters the Red mangroves – *Rhizophora harisonii*; *Rhizophora mangle*; *Rhizophora racemose* – with their prop roots are commonly observed (de Graft- Johnson *et al.*, 2010). Along the length of the beaches of the district, coconut plantations are observed to form the major vegetation cover of the coastline.

The present vegetative cover of the proposed GPP Train 2 site does not reflect the natural vegetation type described above. The site is comprised of a mosaic of grassland and thicket interlocked with swamps of freshwater forests. The main species include Borassius Palm *Borassius aethiopium*; grass species of *Panicum*; *Setaria*; *Hyparrhenia* and *Anadelphia*. Strands of Oil Palm *Elaeis guineensis*, and *Calophyllum sp.*, are found included in pockets of forest thickets scattered at the site. Clearly, the site represents a regrowth of previous vegetation following clearing in recent time (Plate 8).



Plate 7 Sections of the Terrestrial Flora at Proposed Site for GPP Train 2



Plate 8 Floristic Composition of the GPP2 Project Site

### 5.3.2 Flora Species Conservation Status

Two methods are used to assess the flora of Ghana namely the IUCN Red List and the color-coded star rating developed by Hawthorne and Abu-Juam (1995). The latter is mainly used in forest setting. The IUCN Red List of threatened species is widely recognized as a comprehensive world-wide approach used to evaluate the conservation status of plant and animal species (IUCN, 2014). These threatened species or species of conservation concern include species which are classified (by the IUCN) as critically endangered, endangered, vulnerable, near threatened, least concerned, data deficient (if insufficient data exists to complete an assessment).

Table 36 Conservation Status of Flora Species on GPP2 Project Site

Scientific Name	Lifeform	Relative Abundance	IUCN Status
Borassius aethiopium	Tree	Frequent	Least Concern
Setaria Hyparrhenia	Grass	Frequent	Least Concern
Setaria Anadelphia	Grass	Frequent	Least Concern
Elaeis guineensis	Tree	Frequent	Least Concern
Nymphaea micrantha	Herb	Frequent	Least Concern
Calophyllum	Tree	Frequent	Least Concern

Table 37 Conservation Status of other Flora Species within the GPP Enclave

Scientific Name	Lifeform	Relative Abundance	IUCN Status
<i>Syzygium guineense</i>	Tree	Frequent	Least Concern
<i>Smeathmania pubescens</i>	Tree	Occasional	Endangered
<i>Baphia nitida</i>	Tree	Frequent	Least Concern
<i>Uvaria chamae</i>	Climber	Frequent	Least Concern
<i>Acridocarpus smeathmannii</i>	Climber	Frequent	Not Available
<i>Cnestis ferruginea</i>	Climber	Frequent	Not Available
<i>Flagellaria guineensis</i>	Climber	Frequent	Not Available

### 5.3.3 Fauna

Faunal studies indicate that several species known to occur in the district are of both national and international conservation concern (Anon, 1986). These include primates, birds, tortoises and pangolins, reptiles including snakes, monitor lizards, and crocodiles. These animals enjoy various levels of protection under international and national wildlife laws. Thus, activities that will impact negatively on the survival and welfare of these animals need to be executed with due consideration for environmental concerns.

As a result of the previous anthropogenic activities around the proposed site (construction of Train I, roads to settlements, and clearing of sites), many of the original fauna of the proposed project site might have left the area. Thus, the fauna of the site reported included rodents and reptiles such as lizards and snakes and insects including crickets, cockroaches, mosquitoes, bees, and termites.

Adjoining the existing GPP Train 1 and the proposed site Train 2 is a flooded swamp that is reported to have served as a fishing ground for the inhabitants of the nearby Asemnda community. Aquatic fauna reported by inhabitants included Tilapia fishes such as *Sarotherodon melanotheron*, *Tilapia zillii*, *Oreochromis niloticus*, *Parachanna obscura*, and the African catfish *Clarias sp.* Inhabitants also reported the stream to be their deity however, the necessary rites and rituals have been performed to relocate before the construction of Train 1.

### 5.3.4 Ecosystem Services

An ecosystem is a dynamic complex of plant, animal, and micro-organism communities and their nonliving environment, interacting as a functional unit (Millennium Ecosystem Assessment, 2005). Ecosystems make up the environment around us and form habitats such as forests, rivers, lagoons, and farmlands. Ecosystem services are generally referred to as those goods (food, raw materials etc.) and services (flood and climate regulation, nutrient cycling, etc.) provided by ecosystems that benefit humans (Costanza *et al.*, 1997). Ecosystem Services thus, highlight the critical dependence of the environment’s provision of natural resources and ecosystems and the need to recognize and value these benefits.

The major ecosystem services that can be provided in this study are presented in Table 38. These include Provisioning such as land for farming and habitat for plants and animals; Regulating including storm protection, flood control, and drought recovery; Supporting such as nutrient recycling and air circulation as well as Cultural and Recreation. The various project catchment areas, based on their characteristics, also provide refuge for different types of organisms.

Table 38 Major Existing Ecosystem Services in Project Catchment Area

Ecosystem Service	Elements in Project Catchment Area
<b>Provisioning</b>	<ul style="list-style-type: none"> <li>i. Land for farming and production of animals, fish, fruit, and vegetables for human consumption.</li> <li>ii. Habitat for plants (trees, grasses) and wild animals (reptiles, birds, insects, micro-organisms).</li> <li>iii. The production of timber and/ or fodder.</li> <li>iv. Provision of water by watersheds and aquifers.</li> </ul>
<b>Regulating</b>	<ul style="list-style-type: none"> <li>i. Disturbance regulation: Storm protection, flood control, drought recovery, and other aspects of habitat response to environmental variability mainly controlled by vegetation structure.</li> <li>ii. Acting as a receptor for mainly domestic wastes generated in the communities.</li> </ul>
<b>Cultural</b>	Educational, aesthetic, artistic, spiritual, and/or scientific values
<b>Supporting</b>	i. Nutrient recycling - Nitrogen (N), phosphorus (P), and other elemental or nutrient cycles.

Ecosystem Service	Elements in Project Catchment Area
	ii. Air circulation – Carbon dioxide (CO <sub>2</sub> )/Oxygen (O <sub>2</sub> ) balance.
<b>Recreation</b>	Eco-tourism and other outdoor recreational activities
<b>Refugia</b>	
<b>Actual Project Site</b> Atuabo, Anokyi, Asenmda, Baku	Stream floodplain's reduction of predator pressure on prey species contributes to recruitment into the fishery of the Amanzule lake - lagoon-sea complex in the area.
<b>Immediate Project Environs (West of Actual Project site)</b> Ekebeku, Benyin, Nzulenzu communities	Trophic-dynamic regulations of populations in the Amanzule floodplains provide space and basis for predator control of prey species and reduction of herbivory by top predators.
<b>Immediate Project Environs (East of Project site)</b> Krishan, Eikwei, Sanzule communities	Estuaries and associated fringing vegetation constitute habitats for resident and transient populations of fish nurseries, habitats for migratory species, regional habitats for locally harvested species or overwintering grounds for other wildlife.
<b>Upper Catchment</b> Aiyinase, Ebuokrom, Alabokazo A. B. Bokazo	Upper reaches of the estuaries and associated fringing vegetation constitute habitats for resident and transient populations of fish nurseries, habitats for migratory species, regional habitats for locally harvested species or overwintering grounds for other wildlife.

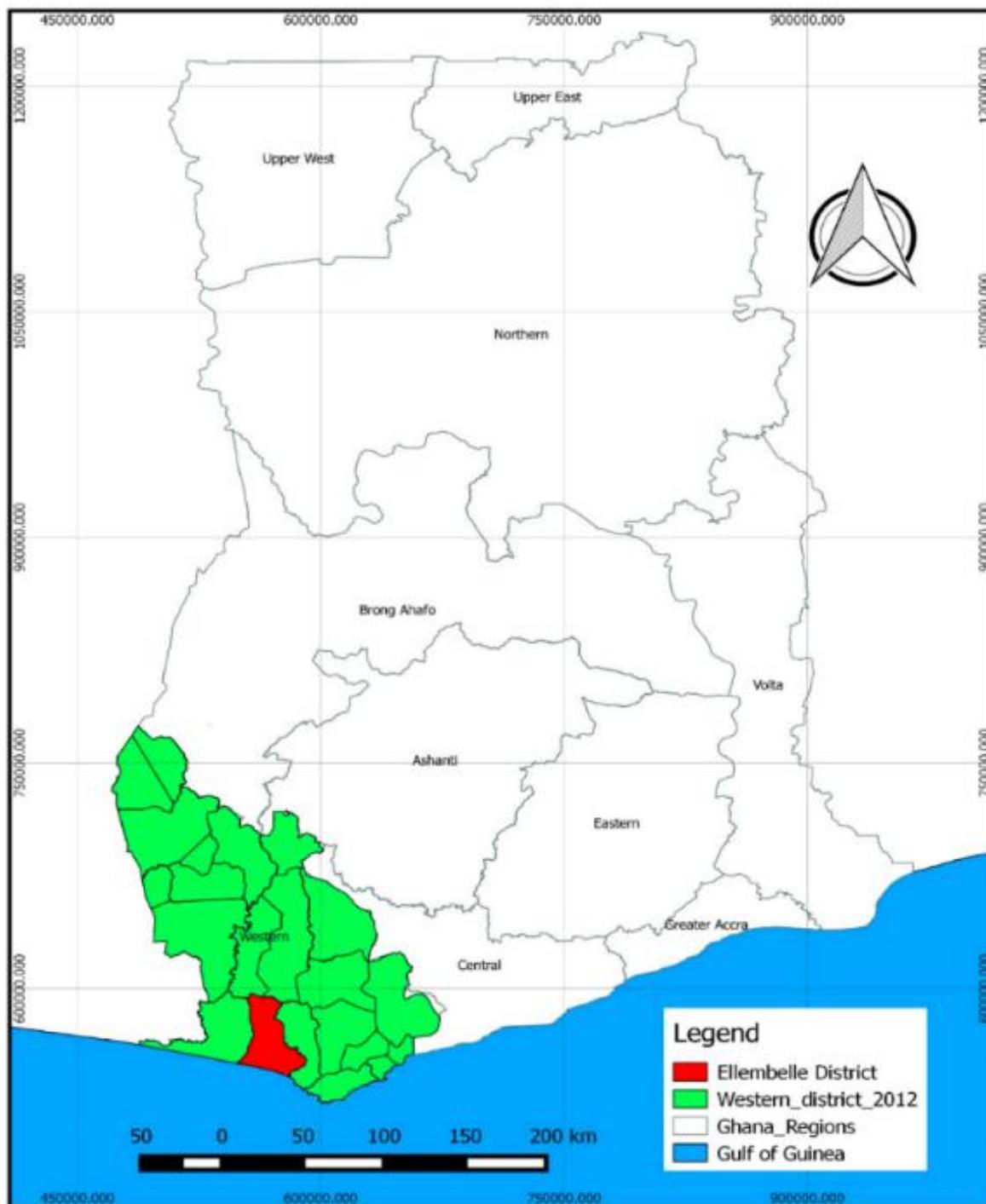
The capacity of the general project area to provide these services has been diminished through degradation over the years from anthropogenic activities. Therefore, the natural complexes are weakened and may be limited in terms of the potential for self-regeneration. The vegetation of the project site is devoid of its original flora and fauna as already indicated.

## 5.4 Socio-economic Environment

This section describes the socio-economic conditions of the Ellembelle District before the construction of the GPP Train 2. It covers the population composition, distribution, and growth rate; socioeconomic conditions of the district and the fringe communities of the GPP; the cultural and ethnic diversity and the presence and types of social services; and some cultural heritage of the areas.

#### ***5.4.1 Establishment, Physical Environment, and Administration***

Ghana National Gas Limited Company (GNGLC) has its Gas Processing Plant (GPP) and a proposed expansion of the GPP located in the Ellembelle District. The district is one of the 14 administrative MMDAs (Metropolitan, Municipal, and District Assemblies) in the Western Region of Ghana. It was carved out of the then Nzema East District, now Nzema East Municipal in December 2007 by Legislative Instrument (L.I.) 1918 and officially inaugurated in February 2008 (Ellembelle District Assembly, 2019). The district is located in the southern part of the Western Region of Ghana between longitudes  $2^{\circ} 05''$  W and  $2^{\circ} 35''$ W, and latitudes  $4^{\circ} 40''$ N and  $5^{\circ} 20''$ N covering a total land size of  $995.8 \text{ km}^2$  (GSS, 2014). It is a coastal district sharing boundaries with Jomoro Municipal to the West, Wassa Amenfi West Municipal to the North, Nzema East Municipal to the South-East, Tarkwa-Nsuaem Municipal to the East, and a 70 km stretch of sandy beach along the Atlantic Ocean to the south. The district capital is Nkroful, which is the birthplace of the first President of the Republic of Ghana, Osagyefo Dr. Kwame Nkrumah (Ellembelle District Assembly, (2019).



Source : (Ellembele District Assembly, 2017b)

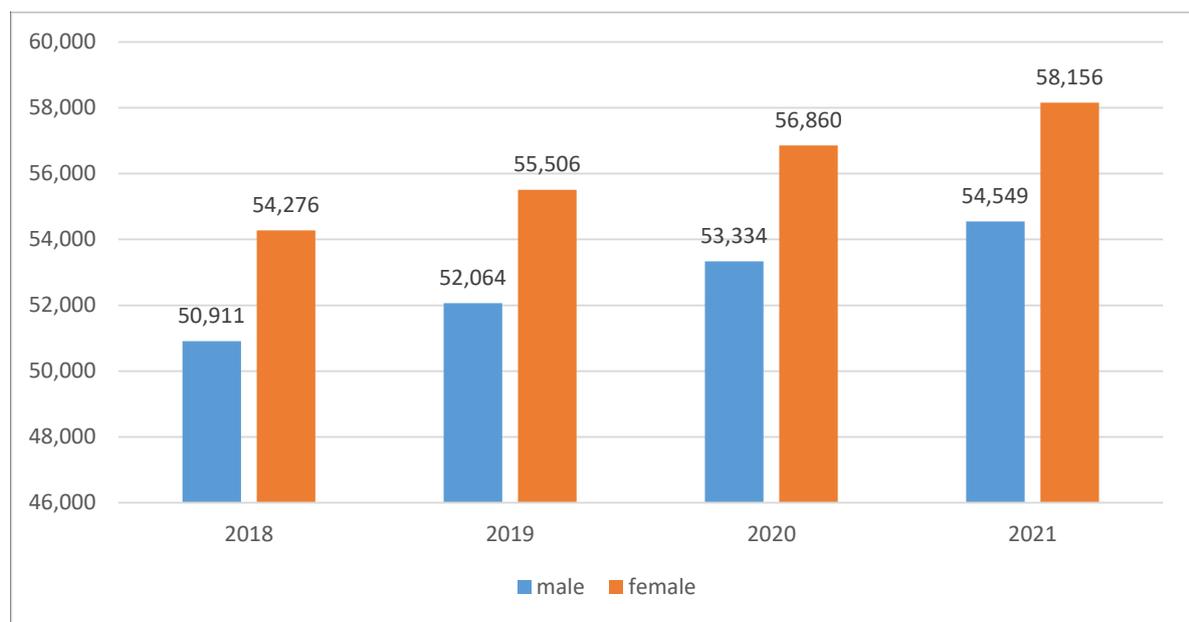
Figure 17 Ellembele District in the National Context

The Ellembele District is richly endowed with human and natural resources including mineral deposits (gold, kaolin, silica) oil and gas, fertile soils, rivers and streams, a good climate that supports a tropical rainforest with a variety of timber species, and cash crops (Ellembele District Assembly, 2017b). The soil in the district is mainly of the ferric acrisols and dysric fluvisols type. The ferric acrisols type constitutes about 98% of the entire land of the district

and supports the cultivation of a wide range of crops including cocoa, coffee, coconuts, oil palm, plantain, rubber, and cassava. Due to this characteristic, the district has a comparative advantage in agriculture, especially in the area of agro-processing and plantations. However, the heavy and prolonged rains associated with the semi-equatorial climate adversely affect cocoa harvests especially, the drying of the beans and aggravate the black pod diseases that attack cocoa. In addition, all the un-tarred roads become almost unmotorable during the rainy season. The effects of this on the economy of the district are obvious.

#### 5.4.2 Population Composition, Distribution, and Growth Rate

Available data from the Ellembele District Assembly (EDA) shows that the population of the district for 2021 is projected to be 112,705, comprising 52% female and 48% male. Figure 18 presents the gender distribution of the population between 2018 and 2021.



Source: Chart generated from data available at the EDA

Figure 18 Gender Distribution of Population (2018-2021)

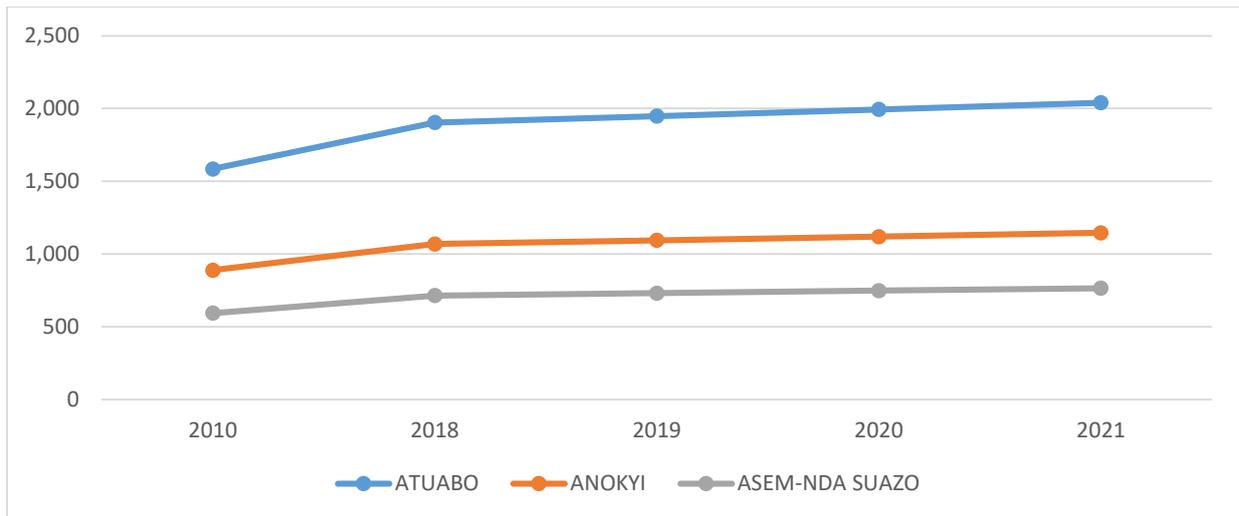
Although there are no recent data, the 2010 Population and Housing Census shows that the 0-4 age group constitutes the highest proportion of the population in the district followed by the age groups 5-9 and the 10-14 years. The 80-84 and 85 years and older age groups constitute the lowest proportion of the population (Table 39). Furthermore, the distribution by sex also reveals high proportions of the population in the younger age groups 0-4, 5-9 and 10-14 years with the older age groups reporting smaller proportions (GSS, 2014).

Table 39 Age Structure by Gender

Age Group	Sex				Sex ratio	Type of locality	
	Both Sexes		Male	Female		Urban	Rural
	Number	Percent					
All Ages	87,501	100.0	42,317	45,184	93.7	18,010	69,491
0 - 4	11,904	13.6	6,014	5,890	102.1	2,316	9,588
5 - 9	11,574	13.2	5,864	5,710	102.7	2,315	9,259
10 - 14	10,987	12.6	5,519	5,468	100.9	2,334	8,653
15 - 19	10,146	11.6	5,190	4,956	104.7	2,032	8,114
20 - 24	8,192	9.4	3,851	4,341	88.7	1,789	6,403
25 - 29	6,910	7.9	3,133	3,777	82.9	1,498	5,412
30 - 34	5,432	6.2	2,627	2,805	93.7	1,191	4,241
35 - 39	4,925	5.6	2,308	2,617	88.2	1,031	3,894
40 - 44	4,006	4.6	1,937	2,069	93.6	857	3,149
45 - 49	3,091	3.5	1,508	1,583	95.3	634	2,457
50 - 54	2,849	3.3	1,279	1,570	81.5	558	2,291
55 - 59	1,612	1.8	755	857	88.1	308	1,304
60 - 64	1,567	1.8	713	854	83.5	324	1,243
65 - 69	1,028	1.2	424	604	70.2	210	818
70 - 74	1,371	1.6	509	862	59	273	1,098
75 - 79	702	0.8	271	431	62.9	134	568
80 - 84	628	0.7	213	415	51.3	102	526
85 - 89	302	0.3	117	185	63.2	57	245
90 - 94	190	0.2	52	138	37.7	27	163
95 - 99	85	0.1	33	52	63.5	20	65
All Ages	87,501		42,317	45,184	93.7	18,010	69,491
0-14	34,465	39.4	17,397	17,068	101.9	6,965	27,500
15-64	48,730	55.7	23,301	25,429	91.6	10,222	38,508
65+	4,306	4.9	1,619	2,687	60.3	823	3,483
Age-dependency ratio	79.56		81.61	77.69		76.19	80.46

Source: GSS, 2014

The three communities immediately fringing the GPP Train project site, Atuabo, Asemnda (also known as Asemnda Suazo), and Anokyi, are generally referred to as the A3 Communities. Available data from the EDA showed that there was a sharp rise in the population of these communities between 2010 and 2018 (Figure 18). This sharp rise could be due to the commencement of the operations of the GPP Train 1 in 2014 which saw many workers of the GNGLC coming in from outside the area. Apart from the sharp rise between 2010 and 2018, the population in the A3 Communities has seen a steady rise since 2018 (Figure 19).



Source: Graph generated from data available at the EDA

Figure 19 Trends in Population of the A3 Communities (2010, 2018-2021)

### 5.4.3 Land Use

The land for both GPP Train 1 and Train 2, covering an approximate area of 398 ha (983 acres), has been acquired by an Executive Instrument, E.I. 51, 201). The piece of land is in the Ellebelle District in the Western Region (Figure 17).

Land use in the general project's area of influence is a mixture of residential, civic, and commercial activities. Along the major roads in the area including the N1 Highway, in towns and villages, and in between these locations can be observed rapid development of various socio-economic activities. These include residential houses, tourist hotels and recreational areas, fuel stations, clinics, and shops, as well as restaurants, schools and religious establishments. The N1 Highway from Esiamia to Ayinase passes in front of the GNGLC's Gas Complex offices at A. B. Bokazo. Other prominent landscapes on this section of the highway are the Aya Community Center and the Nzemaman Council offices. Interspersed within these landmarks are water bodies, notably Rivers Ebi and Fia that form the catchment of the Amansuri River and Amanzule Lake (Plate 9).



Plate 9 Amanzule Lake

The flat sandy beaches of the area support fishing by canoe and beach seine with fish landing sites. However, no fishing activities are allowed within the vicinity of GNGLC's offshore 30.5 cm (12-inch) diameter gas pipeline, which transports dense-phase gas from the FPSOs to the GPP Train 1. Crop farming is also a common activity with coconut, cassava, plantain, oil palm and vegetables dominating. Associated activities include palm wine tapping and the production of local drink referred to as akpeteshie. In addition, free-range grazing of domestic animals, mainly cattle, sheep, and pigs was observed.

The actual project area lies south of the N1 Highway on the coastal Krisan-Beyin Road (Plate 10). The major settlements along this road, from the east, are Krisan, Eikwe, Ngalekyi, Baku, Anokyi, Atuabo, Ekebaku, and Beyin. On the eastern outskirts of Atuabo lies the junction to Asemnda, which community is located 0.5 km north-west of the proposed site for Train 2.



Plate 10 Krisan-Beyin Road

Along this stretch of coastline occur various beach resorts such as French Beach at Ngalekyi, Maaha Beach Resort and Vision Hotel at Anokyi, Organic Beach at Atuabo, and Tenack Hotel at Beyin. Other land uses include the St. Martin des Porres Hospital at Eikwe, Makarios Church, and the site for construction of a Trauma Centre at Atuabo.

Vehicular traffic on the Krisan-Beyin Road was generally low, dominated mainly by local taxis and motorbikes. Bulk Road Vehicles travelling to and from GNGLC's facilities use a bypass north of this road and therefore do not pass through the settlements. Although there is no significant erosion of the flat sandy beaches here, sand wining activities were observed behind the flare stack, about 1 km from Asemnda. These activities, if extended to the beaches, may cause increased erosion in the future. Strewn along the beaches were seagrasses (*Sargassum*

*sp.*) that are deposited by the waves periodically (Plate 11). The pattern of occurrence of the seagrasses here is not clearly understood.



Plate 11 Seaweeds on Beach at Atuabo

The site for the proposed GPP Train 2 is bordered immediately to the east by the existing Train 1. The Anokyi community is located about 0.43 km to the east of Train 1. Further to the east, about 2.5 km from Train 1 is located the LPG truck loading gantry, which is connected to Train 1 by two sets of 20.3 cm (8-inch) pipelines and a 15.2 cm (6-inch) vapour return line. Along the Atuabo-Eikwe road, which forms a border to the south of the existing and proposed GPP Trains, grazing by domestic animals, mainly sheep, was observed within the coconut plantations that front the beaches.

The proposed site for the GPP Train 2 (Plate 12) is mainly a wetland area with pockets of shrub. The wetland area was created due to the construction of GPP Train 1 by blockage of the Hooho River, which originally flowed northwards into the Amanzule Lake. The area dries up in the dry season although with patches of wet area that serve as refugia for diverse flora and fauna. In the southernmost portion of the site, close to the Krisan-Beyin Road, is located GNGLC's storage area for various items including hazardous and non-hazardous wastes as well as unused vehicles.



Plate 12 Proposed Site for Train 2, with Cattle Grazing

#### ***5.4.4 Socio-Economic Conditions***

According to the EDA, over 65% of the economically active population is engaged in agriculture (including fishing) and agro-processing (Ellembelle District Assembly, 2017b). A larger portion of the land area of the district in the northern part has forest vegetation cover. Majority of the people in the northern belt of the district are mainly engaged in tree crop farming such as cocoa, coffee, rubber, and oil palm, in addition to cassava and plantain. The southern portion, however, is mainly coastline and therefore, a large proportion of the people along the coastal belt engage in fishing and coconut farming as the main sources of livelihood. The relief and drainage system of the district also favours the development of fish farming and the cultivation of rice, sugar cane and vegetables (Ellembelle District Assembly, 2017b).

#### ***Employment Status***

According to the Ghana Statistical Service (GSS, 2014), the distribution of the population 15 years and older by employment status and sex in the district shows that persons self-employed without employees represent the highest proportion of the employed population (69.0%). On this score, the percentage of females is significantly higher (77.5%) than that of males (59.7%). Following closely is the population with employee status (17.3%) with the male population (26.4%), higher than the females (8.9%). Table 40 presents the employment status of persons 15 years and older in the district.

Table 40 Population 15 Years and Older by Employment Status and Sex

Employment Status	Both sexes		Male		Female	
	Number	Percent	Number	Percent	Number	Percent
Total	29,567	100.0	14,153	100.0	15,414	100.0
Employee	5,104	17.3	3,730	26.4	1,374	8.9
Self-employed without employee(s)	20,407	69.0	8,456	59.7	11,951	77.5
Self-employed with employee(s)	919	3.1	550	3.9	369	2.4
Casual worker	822	2.8	643	4.5	179	1.2
Contributing family worker	1,459	4.9	386	2.7	1,073	7.0
Apprentice	636	2.2	275	1.9	361	2.3
Domestic employee (House help)	183	0.6	96	0.7	87	0.6
Other	37	0.1	17	0.1	20	0.1

Source: Source: GSS, 2014

### ***Ethnic Diversity and Cultural Heritage***

According to a report co-published by the Coastal Resources Center and Friends of the Nation, the Nzema constitute the largest ethnic group in the area with 80% of the population. The remaining are Fante (9%) Ewe (4%), Mole-Dagbani (4%) and Ga-Adangbe (3%). The report further notes that majority of the people are Christians (79%) followed by Muslims (8%), Traditionalists (3%), and others (10%) (Coastal Resources Center / Friends of the Nation, (2010). Traditional authority is very important in Ghana and therefore same applies in the Ellembelle District. The district has one Paramount Chief—the Eastern Nzema Traditional Council, which is seated at Atuabo and headed by Awulae Amihere Kpanyinli III. All the Traditional Councils in the three (3) districts of Nzema East, Ellembelle, and Jomoro constitute the Nzema Manle Council. The major language spoken in the district is Nzema with other dialects including Evalue and Gwira, Fante, and Twi also spoken (EDA, 2017b).

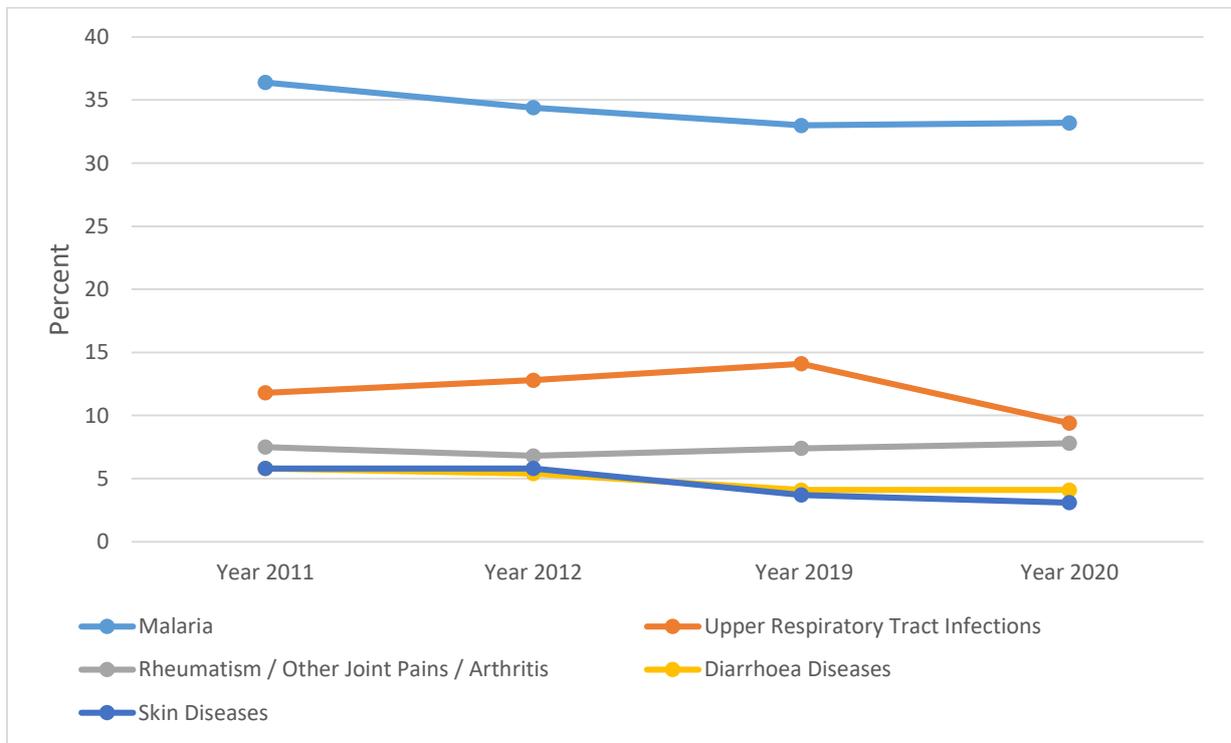
### ***Festivals***

Kundum is the traditional festival of the district, and it is celebrated in all the communities of the district between August and October each year. During the celebration of the festival, many people from far and near come to the district to observe and participate in festival activities (Ellembelle District Assembly, 2017b). Indeed, it has been noted that the Kundum festival is not an individual activity but a shared ritual that is integral to the culture of the people. The sense of community among the people appears to give space for communal values such as sharing, caring for others, interdependence, and social harmony (Etikpa, 2015)

### 5.4.5 Health Conditions

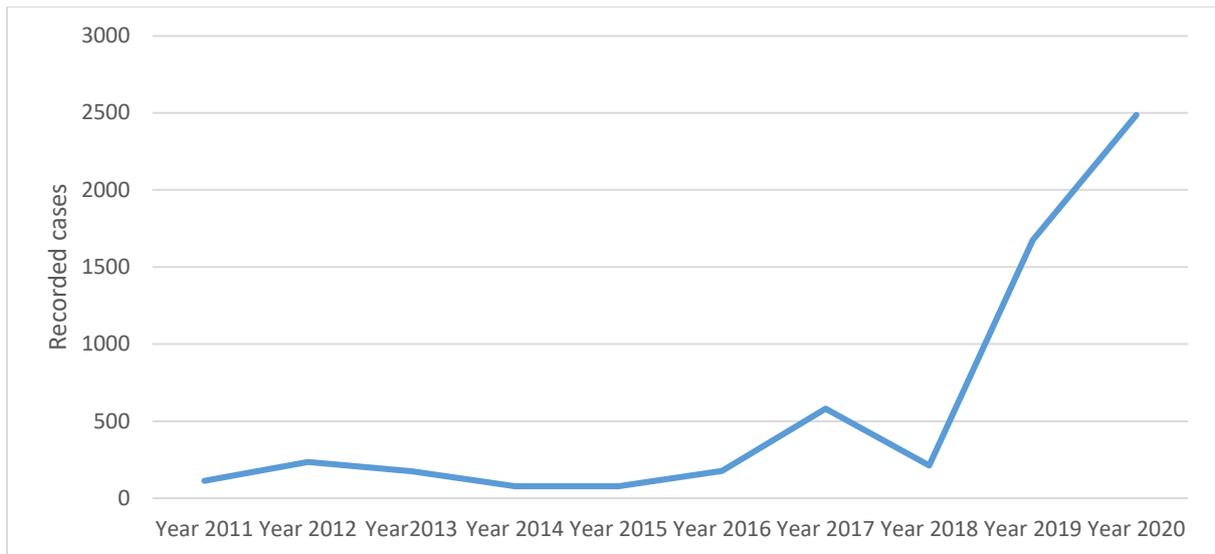
Available records show that the major health concern of the EDA since 2011 has been malaria. Figure 5-16 shows that although the incidence of malaria has been decreasing steadily since 2011, together with skin diseases, the same cannot be said about rheumatism which has seen a steady increase. Upper respiratory tract infections follow malaria, in terms of incidence in the district. It saw a steady increase but has been declining since 2020.

Alarming, though not reported in the district via outpatient records as a top-five OPD morbidity is the incidence of HIV/AIDS and related conditions. As Figure 20 shows, the incidence of HIV/AIDS saw an increase in the district in 2017 and then dipped in 2018. However, it shot from 212 cases in 2018 to 1675 cases in 2019, then continued to 2487 cases in 2020. This is very alarming. Indeed, the Ghana Aids Commission identified the EDA as the district with the highest incidence of HIV/AIDS in the Western Region in 2020. Meanwhile, the EDA in its Medium-Term Development Plan (2017-2021) ranked the Periodic shortages of HIV/AIDS commodities (ARV's, Test Kits, Condoms) and inadequate coverage of reproductive health and family planning services jointly as second in priority.



Source: Calculated from data available at the EDA

Figure 20 Top Five OPD Morbidity in Ellembele District



Source: Calculated from data available at the EDA

Figure 21 HIV/AIDS-Related Conditions in Ellembelle District

### 5.4.6 Cultural Resources

Cultural resources refer to tangible and intangible aspects of a community's heritage, traditions, history, and identity. These resources hold significant cultural, historical, or archaeological value and contribute to the understanding and preservation of a group's identity and legacy.

Cultural resources can encompass a wide range of elements, including:

- **Tangible Cultural Resources:** archaeological sites, historic buildings and structure, cultural landscapes, artifacts and objects, traditional knowledge, and practices.
- **Intangible Cultural Resources:** traditional music and dance, cultural rituals and festivals, traditional knowledge systems, oral traditions and storytelling, traditional crafts, and artistry.

Preserving and protecting cultural resources is essential for maintaining cultural diversity, fostering community identity, and understanding the shared history and heritage of different societies. These resources often require safeguarding measures to prevent their loss or degradation due to development, environmental changes, or other human activities. Assessment of the impact of GPP2 project on the cultural resources within the project's area of influence is provided in Section 7.4.6 of this report. The predominant cultural resources within the communities are provided in Table 41 below.

Table 41 List of Cultural Resources within GPP2 Project Communities

Communities	Cultural Resources	Cultural Resource Common to all the Communities
Ngalekyi	Cemetery, shrine and sacred stream	Kundum <sup>2</sup> Festival
Ngalekpole	Cemetery and shrine	
Sanzule	Cemetery, shrine and sacred forest	
Krisan	Cemetery	
Eikwe	Cemetery and shrine	
Baku	Cemetery	
Anokyi	Cemetery and shrine	
Atuabo	Cemetery and shrine	
Asemda	Cemetery	
Ekabaku	Cemetery	
Beyin	Cemetery, shrine, sacred stream (Kumakpole), Fort Apollonia and Nzulezu	

The Plates below depict some of the notable cultural resources visited during the additional stakeholder engagement field activities.

<sup>2</sup> The Kundum festival is a major Akan festival celebrated in the Western Region of Ghana by the Nzema people. It is both a harvest and religious festival which generally involves a lot of dancing, drumming, and feasting. It also involves the following stages: The first stage, Abisa siedu ehole serves as a preparation rite; the second Abisa gua zo erale serves as the public performance of festival and the final stage as a purification rite (Abisa azule nu edole). Each of these stages is marked with a libation rite (edeneyele), or the pouring of wine accompanied by invocations (nza eguale). (<https://culturalencyclopaedia.org/the-kundum-festival-in-ghana-ritual-interaction-with-the-nonhuman-among-the-akan>)

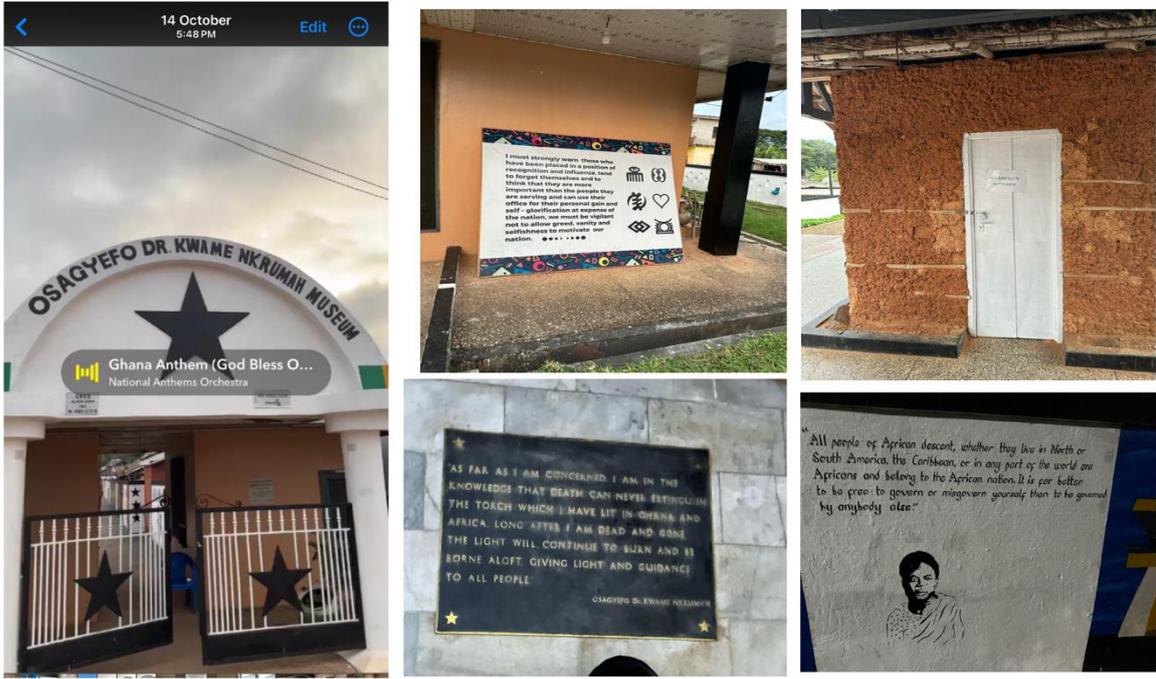


Plate 13 Nkroful – Kwame Nkrumah’s Birthplace



Plate 14 Fort Apollonia at Beyin



Plate 15 Nzulezu at Beyin

## **CHAPTER 6. PUBLIC PARTICIPATION AND STAKEHOLDER CONSULTATION**

### **6.1 Stakeholders Identified**

As already indicated in Chapter 1, Ghana's Environmental Assessment Regulations, 1999 (L.I. 1652), requires that an EIA begins with a scoping exercise the report of which shall set out the scope or extent of the EIA. The scoping report shall include a draft Terms of Reference (ToR), which shall indicate the essential issues to be addressed in the EIA. The draft scoping report will be approved by the EPA before the commencement of the actual EIA study. Therefore, at the beginning of the EIA process, the EESL team undertook a scoping exercise by holding consultations with various stakeholders to seek their concerns and appreciation of the project.

Between 04 and 10 July 2021 the EESL team consulted with various stakeholders in Atuabo and surrounding areas in the Ellembelle and Jomoro Districts in the Western Region. Other stakeholders – Ministry of Energy, EPA, NPA, VRA, WRC, and Energy Commission were also consulted in Accra after the field trip.

The key objectives of the scoping exercise, as indicated in Section 1.2 above, were to:

- Inform the public about the proposed expansion of the activities of GNGLC.
- Identify the main stakeholders and their concerns and appreciation of the project also taking into consideration their views on the operation of Train 1 since 2014.
- Define reasonable and practical alternatives to the project activities, where relevant.
- Identify the key environmental and social-economic issues and impacts to be addressed.
- Set requirements for the collection of baselines and other information.
- Establish the Terms of Reference for the EIA for approval by the EPA.

The discussions focused on the following issues, among others:

- Awareness of the public of the proposed project.
- Commitment by project proponent to pursue best environmental practices.
- Impacts of the operation of GPP Train 1.
- Location of the project with respect to nearby communities.

- Potential impacts on human health and socio-economic activities.

The consultations are summarized below.

***05 July 2021***

- Management Team of GNGLC at the Gas Complex.
- Ellebelle District Assembly, Nkroful.

***06 July 2021***

- CHPS Compound, Atuabo;
- Nzulezu Stilts Village Tourism Project, Beyin;
- EPA, Nkroful;
- GNGLC (Gas Processing Plant—GPP), Atuabo.

***07 July 2021***

- St. Martin de Porres Hospital, Eikwe;
- GNGLC (Site for GPP Train 2), Atuabo;
- District Health Directorate.
- Anokyi Community.

***08 July 2021***

- Asemnda Community.
- District Education Office.
- District Police Command.

***09 July 2021***

- District Fire Office.
- Debriefing with Management Team of GNGLC.

Attempts made by GNGLC for the EESL team to pay a courtesy call on the Paramount Chief of Nzema East to be followed by discussions with the Atuabo community failed because of the absence of the Paramount Chief on an emergency trip.

The lists of stakeholders consulted are attached as Appendix 6-1.1. Written responses received from NPA, Ministry of Energy, Energy Commission, and WRC are presented in Appendices 6-1.2 to 6-1.5 respectively.

## 6.2 Issues, Concerns and Appreciation of Stakeholders

The highlights of the issues, concerns, and appreciation of the stakeholders are presented in Table 42 below.

Table 42 Highlights of Discussions during Consultations

Stakeholder Consulted	Date	Main Issues Discussed/Arising
<p><b>1. Ghana National Gas Limited Company at Gas Complex, A. B. Bokazo</b></p>	<p>05/07/2021</p>	<ul style="list-style-type: none"> <li>• The communities to be consulted would bring up land issues but the land has been acquired (compulsory acquisition) [by government’s Executive Instrument]: <ul style="list-style-type: none"> <li>○ Compensation has been paid for land acquired from Takoradi to Atuabo;</li> <li>○ There are issues in some areas where multiple claimants have emerged for the same pieces of land. These have stalled the compensation process.</li> <li>○ There is an ongoing court case on the ownership of the land where the plant is sited.</li> </ul> </li> <li>• From the GNGLC perspective, issues that concern the communities include: <ul style="list-style-type: none"> <li>○ Safety of the communities concerning the proximity of the gas processing plant.</li> <li>○ Flooding—there have been reports of frequent flooding in the area since the construction of Train 1. Therefore, there is the need to design drains to evacuate the water that presently floods the communities as well as to ensure that there is no flooding when Train 2 is constructed.</li> <li>○ Livelihood impacts (in-land fishing);</li> <li>○ Emergency assembly points for the communities.</li> <li>○ Employment issues <ul style="list-style-type: none"> <li>▪ Need for a clear plan for employing from the A3 communities.</li> <li>▪ MoU concerning employment.</li> </ul> </li> </ul> </li> <li>• GNGLC has reports of their engagement with the communities and will share them with the consultant.</li> </ul>

Stakeholder Consulted	Date	Main Issues Discussed/Arising
		<ul style="list-style-type: none"> <li>• Arrangements are being made for the EESL team to pay a courtesy call on the Paramount Chief of Nzema Manle at Atuabo.</li> </ul>
 <p><b>Kick-off Meeting with Management of GNGLC</b></p>		
<p><b>2. Ellebelle District Assembly, Nkroful</b></p>	<p>05/07/2021</p>	<ul style="list-style-type: none"> <li>• Local people complain about the lack of employment opportunities for them. The excuse is that local people lack the requisite skills needed at the GPP. So, GNGLC may train local people such that over a period of time, they can have the expertise required.</li> <li>• Lack of local content leading to low patronage of local farm produce and goods by GNGLC and its contractors. It is understood that GNGLC has standards that producers must meet; however, if the local produce does not presently meet these standards, GNGLC can roll out interventions to build the capacities of the local producer to meet the required standards.</li> <li>• GNGLC should provide support to Kikam Technical Institute to train local people to render them employable.</li> <li>• GNGLC should collaborate more with the Assembly and its decentralised departments to plan and implement activities.</li> <li>• The Assembly can develop and provide a database of expertise in the district so that it could be consulted for employment.</li> <li>• Communities complain about heat and associate that with the gas flaring.</li> <li>• Increasing social vices in the major towns in the district:</li> </ul>

Stakeholder Consulted	Date	Main Issues Discussed/Arising
		<ul style="list-style-type: none"> <li>○ Influx of prostitutes.</li> <li>○ Increase in petty crime.</li> <li>● <i>Galamsey</i> is increasing in the district.</li> <li>● Need to increase the number of policemen in the district as well as provide housing for them.</li> <li>● The cost of rent in the district is exorbitant for public and civil servants. Housing projects (by GNGLC) in the district could bring down costs.</li> <li>● Need to upgrade health facilities to be able to handle future emergencies.</li> <li>● Handling of compensation during the construction of Train 1 was not the best. Some people have still not been compensated.</li> <li>● There is increasing encroachment on the Right of Way (RoW) of GNGLC pipelines. The Assembly suggests that GNGLC should construct a feeder road parallel to the pipeline to serve as a clear boundary to the gas pipeline.</li> <li>● There is a need for GNGLC to increase public awareness of its operations.</li> <li>● GNGLC has supported the Assembly to manage the COVID-19 pandemic; it has also supported the development of roads, education and health facilities in addition to paying taxes.</li> </ul>
<p><b>3. CHPS Compound, Atuabo</b></p>	<p>06/07/2021</p>	<ul style="list-style-type: none"> <li>● Common ailments are not different from district-wide reports of cases; so, malaria is number 1, but respiratory tract infections are on the ascendancy. Specialised studies are needed to find out if that is related to the siting of GNGLC's Train 1. Although there has been an influx of migrants following the operations of Train 1, there has not been a rise in cases of Sexually Transmitted Diseases (STDs).</li> <li>● Since the CHPS deals mostly with the prevention, GNGLC may support with transportation (motorbikes to the communities around, a public address system, and public education materials. Detention rooms for treatment are also needed since it is the first port of call.</li> <li>● Inland (freshwater) fishing is no more possible for the people.</li> <li>● No alternative livelihood options have been provided to the communities. Options can include: <ul style="list-style-type: none"> <li>○ Rearing small ruminants.</li> <li>○ Poultry.</li> <li>○ Piggery.</li> <li>○ Distilling and packaging of alcohol.</li> </ul> </li> <li>● Increased flooding in the Asemnda community.</li> <li>● Need to design a better drainage system for the area to avert more flooding.</li> </ul>

Stakeholder Consulted	Date	Main Issues Discussed/Arising
		<ul style="list-style-type: none"> <li>• Need to fulfil the promise to provide a footpath (route) between Asemnda and Anokyi since the old one was in the area now occupied by Train 1.</li> </ul>
<div style="display: flex; justify-content: space-around;">   </div> <p><b>Meeting with CHPS Staff, Atuabo</b></p>		
<p><b>4. Nzulezu Stilts Village Tourism Project, Benyin</b></p>	<p>06/07/2021</p>	<ul style="list-style-type: none"> <li>• There are about 160 bird species in the area, including: <ul style="list-style-type: none"> <li>○ Pigmy goose.</li> <li>○ Lily trotters.</li> <li>○ White-faced street duck.</li> </ul> </li> <li>• There are 4 species of sea turtles: <ul style="list-style-type: none"> <li>○ Leatherback turtle;</li> <li>○ Green turtle.</li> <li>○ Olive turtle.</li> <li>○ Hawksbill turtle.</li> </ul> </li> <li>• Mammals include: <ul style="list-style-type: none"> <li>○ Whales.</li> <li>○ Dolphins (Bottlenose);</li> <li>○ Otters.</li> <li>○ Crocodiles.</li> </ul> </li> <li>• Important economic trees: <ul style="list-style-type: none"> <li>○ Denya wood.</li> <li>○ Coconut.</li> <li>○ Raffia.</li> <li>○ Onyina;</li> <li>○ Palm.</li> </ul> </li> </ul>

Stakeholder Consulted	Date	Main Issues Discussed/Arising
		<p>The raffias are being negatively affected, apparently due to the operation of Train 1. They used to be harvested in Nzulezu to distil alcohol, but now the raffias are not growing as they should; stunted growth and yellowing of leaves. The Onyina tree is also suffering-it is dying.</p> <ul style="list-style-type: none"> <li>• There is a need for specialist studies.</li> </ul>
<p><b>5. EPA, Nkroful</b></p>	<p>06/07/2021</p>	<ul style="list-style-type: none"> <li>• Cumulative impacts of the two trains, especially on-air quality should be assessed using different scenarios such as full capacity of one train and half capacity of the other.</li> <li>• Flaring is necessary now for the safety of the plant. In Section 8.4.1 is presented an analysis of the alternative options for the use of iso-pentane from Trains 1 and 2.</li> <li>• EPA does not independently monitor or verify the environmental quality data received from GNGLC.</li> <li>• GNGLC to use permitted companies in sourcing of materials – sand/laterite/quarrying to ensure compliance along the value chain.</li> <li>• There is a need for GNGLC to increase engagement of the public in its activities such as haulage of materials.</li> <li>• The location of the plants is too close to the community of Asemnda, about 500 m and therefore in the event of an explosion, the community would be severely affected.</li> <li>• There are no EPA guidelines on siting of gas processing plants concerning communities/public places.</li> <li>• GNGLC should involve the communities in safety drills.</li> <li>• Management of high expectations, especially jobs for local youth.</li> <li>• GNGLC acquired the land by Executive Instrument (E.I.) 51 in 2014.</li> <li>• ENI has done a good job with respect to meeting community needs: <ul style="list-style-type: none"> <li>○ They paid compensation.</li> <li>○ Provided (alternative) livelihood options to the youth.</li> <li>○ Provided food items to the communities.</li> </ul> </li> </ul>

Stakeholder Consulted	Date	Main Issues Discussed/Arising
		
<p><b>Meeting with Staff of EPA, Nkroful</b></p>		
<p><b>6. GNGLC Gas Processing Plant, Atuabo</b></p>	<p>06/07/2021</p>	<ul style="list-style-type: none"> <li>• There is a lack of understanding within the communities, about the way gas flaring works and therefore they attribute several issues/problems to gas flaring at the GPP. For instance, about 2 to 3 years ago, the rainfall pattern changed—less rainfall—and they blamed that on gas flaring at the GPP. But this year, the rains seem to have come back to the levels experienced about 2012/2013.</li> <li>• The GPP management is worried about potential encroachment on the facility. Because the facility stores large quantities of flammable materials and with the coming of Train 2, more of such materials would be stored.</li> <li>• The contractor for the construction of Train 2 has not yet been selected so sources of building materials are unknown.</li> <li>• After the meeting, the team went on a tour of the GPP—Train 1.</li> </ul>
<p><b>7. St. Martin de Porres Hospital, Eikwe</b></p>	<p>07/07/2021</p>	<ul style="list-style-type: none"> <li>• The top ten out-patient cases are: <ol style="list-style-type: none"> <li>1. Malaria.</li> <li>2. Gynaecological.</li> <li>3. Joint pains-rheumatism.</li> <li>4. Urinary Tract Infections.</li> <li>5. Anaemia.</li> </ol> </li> </ul>

Stakeholder Consulted	Date	Main Issues Discussed/Arising
		<ol style="list-style-type: none"> <li>6. Asthma.</li> <li>7. Hypertension.</li> <li>8. Diarrhoea.</li> <li>9. Pneumonia.</li> <li>10. HIV and other related diseases.</li> </ol> <ul style="list-style-type: none"> <li>• The top ten in-patient diseases are: <ul style="list-style-type: none"> <li>○ Malaria.</li> <li>○ Hypertension.</li> <li>○ Abortion.</li> <li>○ Anaemia.</li> <li>○ Hernia.</li> <li>○ Gastrointestinal diseases.</li> <li>○ Cellulitis.</li> <li>○ Diabetes.</li> <li>○ Local accidents.</li> <li>○ Pregnancy and others.</li> </ul> </li> <li>• Road accidents are currently on the rise. The number of accidents doubled between 2019 and 2020 with most of them involving motorcycles. Most of the riders do so without helmets. There were few accidents involving oil and gas vehicles.</li> <li>• The incidence of HIV/Aids and STDs is on the rise in the area, per records. Also, hepatitis B appears to be prevalent in the area.</li> <li>• A few years ago, the Atuabo Public Health Committee was formed to study trends in public health to determine if they are associated with the oil and gas industry in the area.</li> <li>• There is a cordial relationship between the hospital and GNGLC (especially its HSE Department). Indeed, the hospital has participated in simulation exercises with GNGLC in the past. The staff of GNGLC patronise the hospital too. The hospital is however not aware of plans to establish Train 2.</li> <li>• There has been some support from the GNPC Foundation and ENI to expand the hospital.</li> <li>• The hospital has informed GNGLC about the need to expand its accident and emergency unit.</li> <li>• The hospital also needs accommodation for staff and backed by social services to enable the staff to stay continuously.</li> </ul>

Stakeholder Consulted	Date	Main Issues Discussed/Arising
 <p><b>Meeting with Staff of St. Martin de Porres Hospital, Eikwe</b></p>		
<p><b>8. GNGLC (Site for GPP Train 2), Atuabo</b></p>	<p>07/07/2021</p>	<ul style="list-style-type: none"> <li>• The Consultant visited the proposed site for the GPP expansion (Train 2). The site was flooded and waterlogged at the time.</li> </ul>
 <p><b>Visit to Site for GPP Train 2</b></p>		
<p><b>9. District Health Directorate</b></p>	<p>07/07/2021</p>	<ul style="list-style-type: none"> <li>• The District Health Directorate is represented on the GNGLC Public Health Committee and thus collaborates with oil and gas and mining companies in the district.</li> <li>• The district will need more health staff given the rate of growth of the district and the coming into being of Train 2.</li> </ul>

Stakeholder Consulted	Date	Main Issues Discussed/Arising
		<ul style="list-style-type: none"> <li>• The GNGLC trauma centre will be an upgrade of the Eikwe St. Martin de Porres Hospital.</li> <li>• There is a need to take a holistic view of healthcare provision in the district. It is important to provide adequate utilities and amenities that will attract and retain health workers and other workers in general to the district.</li> </ul>



**Meeting with District Health Directorate, Nkroful**

<p><b>10. Anokyi Community</b></p>	<p>07/07/2021</p>	<p>Three groups were formed (Youth, Women, and Elders) that met separately to discuss their concerns and then elect representatives to present them. Four men spoke for the Youth, five women for the Women group and six men for the Elders group.</p> <p>Youth Group:</p> <ul style="list-style-type: none"> <li>• During the construction of Train 1, the Anokyi football park was lost. The promise by GNGLC to provide a new field is yet to be fulfilled.</li> <li>• The present location of Train 1 and the proposed site for Train 2 should not have been where they are now. The initial site provided was at Sanedea, which is further away from the community.</li> </ul>
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Stakeholder Consulted	Date	Main Issues Discussed/Arising
		<ul style="list-style-type: none"> <li>• GNGLC has taken so much land that it is not using, yet the people do not have land to farm; their water sources have been affected and they cannot do inland fishing.</li> <li>• The youth are not employed in GNGLC as they were promised before the construction of Train 1. So, before the construction of Train 2, they would like to sign MoUs with GNGLC in respect of their obligations.</li> <li>• Since the 3A communities (Anokyi, Asemnda and Atuabo) are closest to the GPPs, the associated risks are highest and therefore they ought to benefit most (in terms of employment);</li> <li>• GNGLC should restore the footpath to Anokyi lost during the construction of Train 1;</li> <li>• Unfair sharing of benefits where the Anokyi community is disadvantaged as against other communities.</li> <li>• Workers of GPP do not live in the communities. They live elsewhere, which shows that the operations of the GPP are dangerous, e.g., flaring and heat.</li> <li>• Increasing occurrence of refuse in fishing nets since GNGLC began operations.</li> <li>• Non-stop cycle of poverty – no schooling; no employment; loss of livelihoods.</li> <li>• There is a need for peaceful co-existence.</li> </ul> <p>Women Group</p> <ul style="list-style-type: none"> <li>• There are no livelihood options for women. A monthly stipend, as is done by the Government of Ghana through the Livelihood Empowerment Against Poverty programme will be welcome. Also, provision of subsidised LPG for domestic use.</li> <li>• Catering contracts are not given to people in the community because they are supposed to lack the capacity and capabilities.</li> <li>• Discomfort about gas flaring and resulting heat too close to the community.</li> <li>• Unfulfilled promises concerning Train 1 include: <ul style="list-style-type: none"> <li>○ Children being employed at the GPP.</li> <li>○ Provision of scholarships to local students.</li> <li>○ Construction of a hospital.</li> </ul> </li> <li>• Train 2 should only come on if an MoU was signed with the community.</li> <li>• There is the need for peaceful co-existence.</li> </ul>

Stakeholder Consulted	Date	Main Issues Discussed/Arising
		<ul style="list-style-type: none"> <li>• GNGLC should learn from ENI concerning support to the communities.</li> </ul> <p>Elders Group</p> <ul style="list-style-type: none"> <li>• Train 1 was supposed to be located at Sanadea, 1.5 km away. So, Train 2 would have been located there too. But since that was not done, the community presently faces many negative impacts.</li> <li>• Palm and coconut trees are dying, and groundnut, tiger nut, and ginger farming has died out.</li> <li>• ENI has provided alternative livelihood options to communities in its operational area such as support for the rearing of small ruminants. The same can be done by GNGLC in its catchment communities.</li> <li>• Construction of Train one prevented the community from fishing in the Ehooho (river). GNGLC should help set up aquaculture systems as a source of livelihood.</li> <li>• The community looks like part of an industrial area with two existing flares and another flare to be added from Train 2 that will result in more heat in the area.</li> <li>• When the compressor of the GPP trips, it makes so much noise and can last for 3 days.</li> <li>• Rainwater in the community has been affected by the operation of the GPP. It is now coloured and cannot be used domestically. Skin rashes are also increasing.</li> <li>• Complaints have been made to the EPA, who has visited the community but indicated that there was nothing wrong with the air quality.</li> <li>• GNGLC paid for the premium of National Health Insurance of community members, but GNGLC has not helped to renew the subscription.</li> <li>• Compensations have not been fully paid for the acquisition of the land. Even some people are yet to receive compensation for the destruction of their crops.</li> <li>• Fishermen were asked not to go to sea for two weeks, but the promised compensation never came.</li> <li>• GNGLC should construct an emergency assembly point for the community and involve them in disaster management and evacuation drills.</li> </ul>

Stakeholder Consulted	Date	Main Issues Discussed/Arising
		<ul style="list-style-type: none"> <li>• Currently, GNGLC has employed cleaners, even from Jomoro (another district) and not from Ellembelle, which is closer to the GPP, with all the attendant risks.</li> <li>• For Train 2, the 3A communities will sign an MoU with GNGLC before construction and operation.</li> <li>• As part of MoU, there should be an annual quota for providing local employment, including national service and internships; The football field should be replaced.</li> <li>• GNGLC should also set up a system such that when the construction phase of Train 2 is completed, the drivers could be absorbed. This was promised during the construction of Train 1 but was not fulfilled.</li> <li>• The situation is not improving; the communities are getting poorer and poorer since the start of operations of the GPP.</li> <li>• There is a need for peaceful co-existence.</li> </ul> <p>Chief of Anokyi</p> <ul style="list-style-type: none"> <li>• Possibility of people of Anokyi losing their lands soon. If so, the community should be made clearly aware of available options.</li> <li>• For Train 1, GNGLC was welcomed with open arms but there have been many unfulfilled promises.</li> <li>• Concerns raised by the community have largely gone unanswered.</li> </ul>



Stakeholder Consulted	Date	Main Issues Discussed/Arising
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**Meeting with Anokyi Community**



**Meeting with Anokyi Community**

<p><b>11. Asemnda Community</b></p>	<p>08/072021</p>	<p>The elders insisted that before the meeting, the consultant should visit the proposed site for Train 2. At the site, community members complained that the cleared site was too close to their community, Asemnda. Indeed, it took 4 minutes to walk from the cemetery at the edge of the town to the proposed site for Train 2.</p> <p>During the site visit, the elders asserted that there was no need to meet with the consultant since all their concerns had already been made known to GNGLC, which is yet to respond. However, after further discussions, it was agreed that the meeting should come on.</p> <p>Three groups were formed (Youth, Women, and Elders), which met separately and then elected representatives to articulate their views. Four men spoke for the Youth, four women for the Women group, and five men for the Elders group.</p> <p><b>Youth Group</b></p> <ul style="list-style-type: none"> <li>• Various concerns have been raised by the community of Asemnda over land and compensation issues arising from the construction of Train 1. GNGLC has neither responded to nor resolved these issues.</li> <li>• The youth do not agree to the construction of Train 2 because of the many unfulfilled promises concerning Train 1.</li> <li>• For example, no one in the community was informed when the land was cleared for Train 1 and no compensation was paid.</li> </ul>
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Stakeholder Consulted	Date	Main Issues Discussed/Arising
		<ul style="list-style-type: none"> <li>• The same appears to be for the construction of Train 2 with crops and fish traps being destroyed during the clearing of the proposed site although no EIA study had been conducted.</li> <li>• Therefore, before Train 2 construction starts, GNGLC should pay compensation for the crops and traps destroyed. Some were paid compensation for their land; however, the valuation was not right and therefore the compensation was inadequate.</li> <li>• During the construction of Train 1, the footpath to the Anokyi community was blocked. The only means to Anokyi now is via the main road which takes about one hour by foot. GNGLC should construct a new walkway to Anokyi as promised.</li> <li>• Flooding has increased in the community since the construction of Train 1 due to blockage of the flow of two rivers (Ehoohoo and Ebolani). So, GNGLC should construct drains to evacuate the floodwaters into the sea.</li> <li>• The proposed site for Train 2 is too close to the community. It is only about four minutes of casual walk from the community boundary.</li> <li>• Community people are not being employed at the GPP because they are supposed not to have the capacity; yet no one from among the A3 communities has been trained to build their capacity to work in the GPP.</li> <li>• There are no scholarship opportunities for the youth of the town. Same with internships. There should be a quota for the communities.</li> <li>• Two receptionists were employed by GNGLC, one each from Anokyi and Atuabo, but none from Asemnda. That is an example of unfair treatment to the community that is closest to risks associated with the GPP.</li> <li>• People from the community employed to cut grass by GNGLC can go for about 4 months without salaries being paid unlike other staff.</li> <li>• It seems that community liaison assistants are not able to communicate the local concerns to the GNGLC because they fear for their jobs. Also, rarely do the community liaison assistants inform communities about vacancies at the GNGLC to enable residents to apply.</li> <li>• There is the need to sign an MoU with GNGLC before the construction of Train 2.</li> <li>• GNGLC should construct an assembly point for the community for emergencies.</li> <li>• The youth organised a press conference and presented a petition to the GNGLC in June 2020 (Appendix 6-2.1) about their concerns. In addition,</li> </ul>

Stakeholder Consulted	Date	Main Issues Discussed/Arising
		<p>many petitions including those from the Eastern Nzema Traditional Council have gone unanswered.</p> <p>Women Group</p> <ul style="list-style-type: none"> <li>• We support the call by the youth that the construction of Train 2 should be aborted, because: <ul style="list-style-type: none"> <li>○ Train 1 is too close to Asemnda;</li> <li>○ Train 1 is causing the release of a lot of heat even in the wet season.</li> <li>○ Flaring has many negative impacts including sleeplessness. Thus, the cumulative impacts of Train 2 will worsen the situation;</li> <li>○ There were no consultations during the clearing of land for the GPPs.</li> <li>○ There was no compensation for crops and land taken.</li> <li>○ The original site for the GPPs was supposed to be at Sanadea, not close to the community.</li> <li>○ Train 2 should be located at Sanadea. GNGLC should not consider only the financial cost but also the environmental and social costs.</li> </ul> </li> <li>• The youth are not employed by GNGLC, which claims they are unskilled.</li> <li>• GNGLC should support the community with a service station where LPG can be procured for domestic use.</li> <li>• Need for peaceful co-existence.</li> </ul> <p>Elders Group</p> <ul style="list-style-type: none"> <li>• GNGLC does not consult the communities in a lot of ways. For example, there was no consultation before clearing the land for Train 2.</li> <li>• There have been many unfulfilled promises including employment for local youth.</li> <li>• Although the sources of livelihood have been destroyed (farming and freshwater fisheries), GNGLC has not provided the community with alternative livelihood options.</li> <li>• GNGLC should emulate the efforts of ENI.</li> <li>• In 1964, there was a major downpour that saw other nearby communities flooded, including even Atuabo. That downpour did not cause floods in Asemnda. The siting of Train 1 has interfered with the flow of rivers from</li> </ul>

Stakeholder Consulted	Date	Main Issues Discussed/Arising
		<p>Beyin to Amanzule resulting in an increased incidence of floods in Asemnda. GNGLC should construct drains to mitigate the situation.</p> <ul style="list-style-type: none"> <li>• There is fear that the community will be evacuated at some point because it is at risk of destruction from both fire and water. This will bring great difficulties judging from the high prices of land, among others.</li> <li>• GNGLC should construct an assembly point for the community for emergencies.</li> <li>• GNGLC has taken the community for granted for too long. Families had to borrow money to prepare documents that showed ownership of the land. While the interests on the loans are accruing, GNGLC is yet to pay compensation to those involved.</li> <li>• There is a need for peaceful co-existence.</li> </ul>



**Border of Site for GPP Train 2 and Asemnda with Train 1 in Background**

Stakeholder Consulted	Date	Main Issues Discussed/Arising
 <p><b>Meeting with Asemnda Community</b></p>		
<p><b>12. District Education Office</b></p>	<p>08/07/2021</p>	<ul style="list-style-type: none"> <li>• The office is aware of the support that GNGLC is giving to educational development in the nearby communities. Specifically, the office is aware of support for: <ul style="list-style-type: none"> <li>○ Anokyi (1 teachers’ bungalow block).</li> <li>○ Asemnda (1 nursery and 1 teachers’ bungalow block).</li> </ul> </li> <li>• Educational facilities are not enough in the district given the growing population and economic development of the district due to oil and gas opportunities.</li> <li>• There is no coordination among the companies and the district education office for planning.</li> <li>• The district education office lacks office space, stores to keep items, and equipment.</li> <li>• Enrolment in the schools is sufficient but the results are generally poor because some communities are cut off whenever it rains, and their schools are very underdeveloped and understaffed.</li> <li>• General deficit in educational infrastructure, especially classroom furniture and toilet facilities.</li> <li>• Companies (e.g., Adamus, GNPC, Aker) are running their own scholarship schemes without recourse to the office.</li> </ul>

Stakeholder Consulted	Date	Main Issues Discussed/Arising
		<ul style="list-style-type: none"> <li>School sports and cultural events have taken a back burner in recent times due to a lack of funding.</li> </ul>
		
<p><b>Meeting with District Education Officer, Nkroful</b></p>		
<p><b>13. District Police Command</b></p>	<p>08/07/2021</p>	<ul style="list-style-type: none"> <li>The district police command is understaffed and since the district is growing with exuberant economic activities, it is important to increase the numbers. Moreover, a bigger number of the police force will be important to protect facilities at GNGLC, a national asset.</li> <li>The command is also faced with inadequate logistics for operations.</li> <li>There is collaboration between the division and GNGLC, but it is the army that is giving protection to GPP although the presence of the police is required to provide civil protection.</li> <li>Crime rate is low, mainly minor offences such as assault and petty stealing.</li> <li>Road accidents are on the rise and mostly involve motorcycles.</li> <li>The police have conducted several swoops of dens for use of illicit drugs. The common drugs abused in the area include tramadol and cannabis.</li> </ul>

Stakeholder Consulted	Date	Main Issues Discussed/Arising
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**Meeting with District Police Commander, Esiam**

<p><b>14. District Fire Office</b></p>	<p>09/07/2021</p>	<ul style="list-style-type: none"> <li>• The Fire Station was established after the establishment of GNGLC. So, there is a station at the GPP dedicated solely to it.</li> <li>• The regional fire office directs affairs at the GPP. So, the district office is not aware of the proposed expansion of the GPP to include Train 2. The district office could make no comments since it had yet to see the drawings of the project.</li> <li>• The fire tender at the district office was out of service and so it must rely on Axim station should there be a fire outbreak that requires the station's attention.</li> <li>• One of the main observed challenges is the recurrence of bushfires around the GPP site. The office has suggested to GNGLC to create fire belts to help control the fires.</li> <li>• The district fire office would need help organising regular medical check-ups for their staff, especially after firefighting.</li> <li>• The district office also needs help with transportation to enable them to go around and sensitise people about preventing fires;</li> <li>• There has not been water in Nkroful for three months, and the water pressure in Esiam is low. So, in the event of a fire, even if their fire tender were working, there would be no water to attend to the fire. The office thus needs help to construct a borehole to provide water.</li> </ul>
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Stakeholder Consulted	Date	Main Issues Discussed/Arising
		
<p><b>Meeting with Staff of Ghana Fire Service, Nkroful</b></p>		
<p><b>15. Debriefing Meeting with GNGLC</b></p>	<p>09/07/2021</p>	<p>The consultant presented a summary of the consultations held with the stakeholders and other activities undertaken at the meeting.</p>
<p><b>16. EPA, Accra</b></p>	<p>26/07/2021</p>	<ul style="list-style-type: none"> <li>• The EIA should consider the activities of Train 1 and Train 2 together and discuss the cumulative impacts on the environment.</li> <li>• The study should also consider community engagement as to whether there will be significant socio-economic impacts from the GPPs.</li> <li>• The crucial issues to be considered in the pre-construction phase should include: <ul style="list-style-type: none"> <li>○ Emission modelling for the combined effects of the GPPs taking the existing emission issues of Train 1 as the baseline.</li> <li>○ Quantitative Risk Assessment on possible explosions.</li> </ul> </li> </ul>

### 6.3 Summary of Project Concerns and Appreciation

Below is presented a summary of the concerns and appreciation for the proposed construction and operation of the Train 2 of the GPP. The concerns are presented based on their ranking

according to how many times they were raised or came up for discussion during the consultations: A low ranking however does not mean that a particular concern is not important. Most often, this may be because the concern is of local interest. Thus, mitigation measures have been prescribed for all the concerns.

### **Concerns**

The need for Ghana Gas to strengthen communication and increase public awareness on the project ranked the highest as it was raised twenty (20) times by various stakeholders (Table 6-2). Requests for more support from GNGLC to improve facilities in both local communities and public institutions concerned with health, education and security ranked the second highest (16). The need for increased employment of local youth and use of local content was the third highest (14) with the same ranking as concerns for human safety because of the proximity of the proposed Train 2 to the communities of Asemnda and Anokyi.

Table 43 Summary Ranking of Concerns

<b>Rank</b>	<b>Concern/Issue</b>	<b>Total</b>
1	Communication and awareness creation	20
2	Request for more support from GNGLC – hospital, schools, police, communities	16
3	Local employment / content	14
3	Proximity of GPPs and safety	14
4	Land and compensation issues	11
5	Loss of livelihoods	10
6	Flaring, heat, and other impacts	9
7	Agreement / Memorandum of Understanding	7
7	Flooding and drainage	7
8	Youth training/capacity building	6
9	Emergency Assembly Points and involvement of communities in safety drills	5
9	Peaceful co-existence	5
10	Cumulative impacts of Trains 1 and 2	4
10	Specialist studies	4
11	Acquisition of permits and approvals	3
11	Use of permitted companies	3
12	Football Park at Anokyi	2
12	General security	2
12	Encroachment of RoW and GPP	2
12	Restoration of the footpath to Anokyi	2
12	Increasing cost of living	2

12	Increasing social vices	2
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Other high-ranking concerns included land and compensation issues (11), loss of livelihoods (10), gas flaring and its perceived impacts (9), and the need for an Agreement or Memorandum of Understanding (MoU) with the 3 communities (Atuabo, Asemnda and Anokyi) before activities associated with Train 2 begin (7). In addition, the possibility of increased flooding (7) in the communities, especially Asemnda and the need for an adequate drainage system as well as the construction of emergency assembly points (5) were issues of major concern. Of note are the need for GNGLC to conduct specific specialised studies (4) and for the Consultant to take into consideration the cumulative impacts of both GPPs in the EIA study (4). For example, it has been proposed that GNGLC conducts specialised studies on emission modelling of the GPPs and quantitative risk assessment of possible explosions as well on the cumulative impacts of the two trains, especially on-air quality using different scenarios.

Other concerns, although of low ranking, are considered equally important because they are specific local issues. These include the replacement of the football park at Anokyi, restoration of the footpath between Anokyi and Asemnda and encroachment of the RoW of GNGLC's pipelines. Many of these concerns can be tackled as part of preparatory activities before actual construction of Train 2 starts.

### ***Appreciation***

In general, and despite the various concerns raised, all the institutions consulted commended GNGLC for its activities as a national strategic asset. Specifically, the Ellembelle District Assembly noted that GNGLC has supported it to manage the COVID-19 pandemic and has also supported the development of roads, education, and health facilities in addition to paying taxes. The Saint Martin de Porres Hospital at Eikwe indicated that it has a cordial relationship with GNGLC (especially its HSE Department) and the hospital has participated in simulation exercises with GNGLC in the past. The District Education Office is aware of the support that GNGLC is giving to educational development in the nearby communities as exemplified by Plate 16.



Plate 16 Example of GNGLC Support to Education

From the above appreciation and ranking of concerns, it may be deduced that although GNGLC is held in good esteem by public and private institutions in its operational catchment, it must improve its relationships with the local communities. It is noted that the Minister of Energy, speaking at the most recent inauguration of the GNGLC Board on 21 July 2021, charged the board to among others, work to improve the company's community relations, particularly in its operative areas, <https://www.graphic.com.gh/general-news/board-chair-of-ghana-gas.html>.

#### **6.4 Additional Stakeholder Engagement**

In addition to the stakeholder engagement carried out during the scoping phase of the EIA process, additional stakeholder engagement was conducted following the review of the draft EIA by the EPA and gap assessment of the draft EIA in accordance with the requirements of

the IFC Performance Standards, the industry standard sustainability framework implemented by International Financial Institutions (IFI) to private sector development, and applicable to the GPP2 Project.

#### ***6.4.1 Additional Stakeholder Engagement Objectives***

The additional stakeholder engagement process gave stakeholders an opportunity to gain understanding of the Project, comment on the proposed Project and helped the EIA Gap Assessment Team to gather local information about the project area, identify key issues, and consider alternative ways of achieving the Project objectives as well as gather information to carry out the additional specialist studies. The key objectives of the engagement activities that were held during the EIA Gap Assessment were:

- Identify the most effective tools and methods to disseminate Project information, and to ensure regular, accessible, transparent, and appropriate consultation.
- Inform relevant stakeholders on the EIA process and all aspects of the Project.
- Identify and highlight key environmental and social issues relating to the Project.
- Notify stakeholders on all issues and concerns that may emerge.
- Lay the foundation for future stakeholder engagement throughout the Project's lifespan.
- Ensure all engagement practices meet requirements set out in local and international standards for good practices.
- Gather information to carry out the additional specialist studies pursuant to the review of the draft EIA document.

#### ***6.4.2 Additional Stakeholder Identification Process***

The following key principles were considered in the identification and engagement process in accordance with the IFC Performance Standard:

- Undertake engagement in a culturally appropriate manner.
- Engagement must be free from interference, intimidation, and manipulation.
- All interest and affected groups especially the vulnerable are engaged.

The engagement activities included the following:

- Stakeholder mapping
- Providing notifications to key stakeholders.
- Holding consultation meetings with stakeholders at the institutional and traditional authority levels.

An effective stakeholder engagement process required the identification of stakeholders to enable understanding of their needs related to the proposed Project. The IFC Handbook on

Stakeholder Engagement (2007) defines stakeholders as “persons or groups who are directly or indirectly affected by a project, as well as those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively.” In-line with the principles of IFC PS1, identified stakeholders were categorized into the following major groups:

- Project Affected People/Community: persons, groups and other entities within the Project Area that are directly influenced (actually or potentially, positively, or adversely) by the Project and/or have been identified as most susceptible to change associated with the Project, and who need to be closely engaged in identifying impacts and their significance, as well as in decision-making on mitigation and management measures.
- Non-community stakeholders/Interested Parties: people who may be able to influence decisions on the Project or have an interest in the Project.
- Vulnerable groups: persons who may be disproportionately impacted or further disadvantaged by the Project relative to other groups due to their vulnerable status.

The stakeholder mapping exercise was also undertaken based on the experience of the ESA Gap Assessment Team from similar EIAs in Ghana and in collaboration with the Community Relations Department of GNGLC.

#### ***6.4.3 Additional Stakeholder Consultation Methodology***

After the stakeholders were identified, stakeholder notification was initiated and facilitated through notification letters by the Community Liaison Department of GNGLC. The list of stakeholders identified and engaged is provided in Table 44 below whereas photos of the engagement activities are provided in Appendix E.

Table 44 Stakeholder Engagement List and Schedule

No.	Stakeholder Group	Meeting Location	Proposed Meeting Dates	Proposed Meeting Time
1.	Ghana National Gas Limited Company (GNGLC)	Gas Office Complex at A. B. Bokazo	October 9, 2023	10am
		Gas Processing Plant at Atuabo	October 9, 2023	2pm
2.	Ellembelle District Assembly	Nkroful	October 10, 2023	10am
3.	Environmental Protection Agency (EPA)	Nkroful	October 10, 2023	2pm
		Head Office Accra	October 23, 2023	10am
4.	Ellembelle District Fire Office	Nkroful	October 10, 2023	11am

No.	Stakeholder Group	Meeting Location	Proposed Meeting Dates	Proposed Meeting Time
	Ngalekyi Opinion Leaders, Residents and Vulnerable Group	Ngalekyi	October 10, 2023	8am
	Ngalekpole Opinion Leaders, Residents and Vulnerable Group	Ngalekpole	October 10, 2023	8am
5.	Sanzule Opinion Leaders, Residents and Vulnerable Group	Sanzule	October 11, 2023	9am
6.	Krisan Opinion Leaders, Residents and Vulnerable Group	Krisan	October 11, 2023	2pm
7.	Eikwe Opinion Leaders, Residents and Vulnerable Group	Eikwe	October 11, 2023	3pm
10.	Baku Opinion Leaders and Vulnerable Group	Baku	October 13, 2023	2pm
11.	Anokyi Opinion Leaders, Residents and Vulnerable Groups	Anokyi	October 15, 2023	2pm
	Atuabo Opinion Leaders, Residents and Vulnerable Groups	Atuabo	October 15, 2023	3:30pm
12.	Asemnda Opinion Leaders, Residents and Vulnerable Groups <sup>3</sup>	Asemnda	October 15, 2023	5:30pm
14.	Ekabaku Opinion Leaders, Residents and Vulnerable Groups	Ekabaku	October 17, 2023	2pm
15.	Beyin Opinion Leaders, Residents and Vulnerable Groups	Beyin	October 18, 2023	10am
16.	Maha Beach Resort	Facility Premises	October 18, 2023	2pm
17.	Quantum, Anokyi LGP Facility	Facility Premises	October 19, 2023	10am

<sup>3</sup> Meeting was truncated due to displeasure and dissatisfaction from the Leaders of Asemnda about GNGLC's Corporate Social Responsibilities (CSR) towards them. Details of the issues are provided in Table 45 of this document.

Table 45 Summary of Stakeholder Issues resulting from Additional Consultations

Issue Group	Summary of Issues Raised	Recommended Solution	Stakeholder Category
Resettlement and Land Compensation.	<p>The land for both GPP Train 1 and Train 2, covering an approximate area of 398 ha (983 acres), has been acquired by the government’s Executive Instrument, E.I. 51, 2014 (Appendix 3-2.1).</p> <p>Compensation has not been paid for the land due to multiple claimants who have emerged for the same piece of land, particularly Atuabo and Anokyi communities.</p>	<p>It was noted during the additional stakeholder engagement that there is an ongoing court case to determine the rightful ownership of the entire GPP land however, the land litigation process has protracted. Management of GNGLC would work together with the traditional authorities of both Atuabo and Anokyi to resolve the land litigation issue and pay the appropriate compensations.</p>	Atuabo and Anokyi
	<p>The potential fire and explosion risk of the GPP1 and GPP2 should be the basis for relocation and resettlement of the Asemnda Community.</p>	<p>On the basis of economic and physical displacement according to the IFC PS 5, there wouldn’t be the need to resettle Asemnda Community according to the Resettlement Scoping done for GPP2 to assess whether there is the need for resettlement.</p> <p>In addition to the Resettlement Scoping, Quantitative Risk Assessment (QRA) and Fire and Explosion Risk Assessment (FERA) were conducted to quantify and assess the fire and explosion risks of the proposed GPP2. The outcome of both studies indicates that Location Specific Individual Risk (LSIR) depicting the geographical distribution of risk puts Asemnda at the least risk level in the event of fire and explosion at GPP2. Specifically, the modelled fire and explosion</p>	Asemnda

Issue Group	Summary of Issues Raised	Recommended Solution	Stakeholder Category
		risk ascertained that there is one chance in 1,000,000 of being killed per year at Asemnda if there should be fire and explosion at GPP2	
Inadequate Community Relations, Sensitization and Communication.	Despite the pending land compensation payment, it was noted that GNGLC paid compensation for the crops on the land acquired for both the GPP project site and GNGLC's pipeline, but this information seems not to be disseminated adequately.	It is recommended that compensation payment for crops should be put on notices in the communities and if possible, the names of the beneficiaries added to the information. This information should also be given to the Ellembelle District Assembly for them to also publish on their notices.	Atuabo, Anokyi, Asemnda and all other communities with beneficiaries.
	The communities are unaware of the grievance redress mechanism (GRM) of GNGLC.	It is recommended that GNGLC displays its GRM on notices in all the project affected and interested communities in both English and Nzema.	All communities engaged
	Although the CSR of GNGLC within the project affected and interested communities in Ellembelle District are reported to be inadequate, the ones carried out in these communities seem not to be notable.	<p>GNGLC would display its CSR projects within the project affected and interested communities in Ellembelle District on notices with pictures and adequate project information.</p> <ul style="list-style-type: none"> <li>▪ For example, information on GNGLC's annual scholarship program would be effectively disseminated in the communities.</li> <li>▪ The application process would be clearly communicated to the people.</li> <li>▪ The number of past and existing beneficiaries from the Scholarship Program in each community would be put on notices in each community.</li> </ul>	Ellembelle District Assembly

Issue Group	Summary of Issues Raised	Recommended Solution	Stakeholder Category
<p>Inadequate Corporate Social Responsibility (CSR) towards the communities, especially the A3 communities (Atuabo, Anokyi and Asemda).</p>	<p>The following were some of the issues raised by the communities regarding the inadequate CSR by GNGLC:</p> <ul style="list-style-type: none"> <li>▪ GNGLC does not honor the invitation to attend and support the Kundum Festivals in the project affected and interested communities apart from Atuabo and Beyin which have paramountcies. By this GNGLC does not regard the other communities thus their inputs into planning of GPP2 should not be solicited.</li> <li>▪ GNGLC should emulate Eni Ghana in terms of CSR activities in the Ellebelle District.</li> </ul>	<p>The current CSR policy of GNGLC allows for the company to support the paramountcies in the district.</p>	<p>Sanzule, Eikwe</p>
	<ul style="list-style-type: none"> <li>▪ The local content of GNGLC in terms job opportunities for the people (Nzemas) from the project affected and interested communities is not adequate.</li> </ul>	<ul style="list-style-type: none"> <li>▪ The EIA Gap Assessment team reckon than GNGLC has employed locals in various capacities at GPP1 thus, GNGLC would display the number of locals employed from the project affected and interested communities on notices in order to appropriately disseminate this information. The local content employment quotas should be properly communicated to the communities.</li> </ul>	<p>All communities engaged</p>

Issue Group	Summary of Issues Raised	Recommended Solution	Stakeholder Category
		<ul style="list-style-type: none"> <li>▪ The Labor Management Plan for GPP2 construction would include provisions for monitoring third party contractor recruitments so that the adequate number of locals are recruited to work during the construction phase and the appropriate wages paid to them.</li>   <li>▪ GNGLC would consider granting National Service and Industrial Attachment opportunities to the locals. The Community Relations Department can work with the leaders of the communities to come up quotas for this opportunity.</li> </ul>	
	GNGLC should consider providing basic amenities such as schools, health posts, potable drinking water for the communities around the GPP project site as part of its CSR.	Consideration would be given to these requests by GNGLC.	All communities engaged
Flood Risk	Occasional flooding at Atuabo and Asemnda.	<p>A Flood Risk Assessment (FRA) has been conducted as part of the EIA Gap Assessment to assess the flooding situation.</p> <p>According to the FRA studies, the drainage point just north of the existing GPP1 has a minimal discharge capacity with attenuation of 80 to 90% of the</p>	Atuabo

Issue Group	Summary of Issues Raised	Recommended Solution	Stakeholder Category
		<p>incoming flow. The flow difference results to the water stored at the west side of GPP area leaving it inundated and swampy for an extended period.</p> <p>The maximum inundation depth ranges from 2.13 to 2.42 meters, reaching an elevation of 5.89 meters amsl for the most extreme flood event. This elevation is lower than the floor elevation of GPP1 with an average elevation of 8.0 meters. This is also lower than the elevation of the town of Asemnda at the north-western side, thus, no flooding condition is expected.</p> <p>However, it was observed that some areas in the town of Anokyi are susceptible to flood with minor depths of 0.0 – 0.50 meters for the most extreme flood events. It is important to note that this scenario is not caused or intensified by the GPP facilities.</p> <p>Nonetheless, the proposed GPP Train 2 area will impede the natural flow of water which will cause the inundation level at the west side of the GPP2 project site to rise even higher. This will then affect the GPP1 and expand the inundation area without proper drainage. The stored water will seep through soil and</p>	

Issue Group	Summary of Issues Raised	Recommended Solution	Stakeholder Category
		<p>embankments which can trigger other problems such as soil consolidation, erosion, piping phenomenon among others.</p> <p>To prevent this scenario, a drainage culvert has been proposed across the existing road opposite GPP2. The discharge will be diverted to the coastal side, instead of the town of Anokyi. This will effectively eliminate the flooding specifically at the community area. This will also discharge the storage at the west side to prevent other potential major disasters that can occur.</p>	
<p>Fire and Explosion Risk Emergency Response</p>	<p>What is the Emergency Response Plan for Fire and Explosion Risk for GPP1 and GPP2?</p> <p>GNGLC should communicate its ERP to all stakeholders around GPP1 particularly Maha Beach Resort.</p> <p>The outcome of the QRA and FERA for GPP2 should be adequately disseminated to all interested parties around GPP project site.</p> <p>GNGLC should replace its faulty fire tender.</p>	<p>GNGLC would collaborate with the communities and business entities around the GPP project site to sensitize them on its ERP for Fire and Explosion Risk.</p>	<p>Maha Beach Resort</p>

Issue Group	Summary of Issues Raised	Recommended Solution	Stakeholder Category
Flare Stack Induced Heat	<p>The flaring of Gas at the Flare Stack at GPP1 is the cause of excessive heat in all the communities engaged, thus construction of GPP2 would only worsen the current heat situation and make the communities uninhabitable.</p> <p>This was a common concern shared by all the communities engaged.</p>	<p>It is evident that climate change has led to extreme weather events and in the last few years high rainfall and temperatures have occurred. Thus, GNGLC would work on its community relations and engagements to disabuse the perception of the communities on GPP1 being the cause of the high temperatures by doing the following:</p> <ul style="list-style-type: none"> <li>▪ Conduct continuous ambient temperature monitoring for at least 14days at GPP1 and the communities particularly at the A3 communities (Atuabo, Anokyi and Asemda).</li> <li>▪ Assist the communities to engage third party contractors to also conduct continuous ambient temperature monitoring for at least 14days at the communities particularly at the A3 communities.</li> <li>▪ The temperature results should be compared to ascertain the veracity of the claim that GPP1 flare stack is the cause of the high temperature and heat at the communities.</li> <li>▪ Furthermore, GNGLC could use some communities outside of the catchment of GPP along the coast as controls and conduct the continuous ambient temperature monitoring to compare the monitoring results and ascertain the</li> </ul>	Ellembelle District Assembly and all the communities engaged, particularly the A3 communities.

Issue Group	Summary of Issues Raised	Recommended Solution	Stakeholder Category
		<p>veracity of the claim that GPP1 flare stack is the cause of the high temperature and heat.</p> <ul style="list-style-type: none"> <li>▪ Whatever the outcome of the continuous ambient temperature monitoring, GNGLC would increase its community engagement and sensitization.</li> <li>▪ GNGLC would continue its nature-based solutions (NBS) and increase carbon reduction initiatives such as tree planting at the Ankasa Conservation Forest.</li> </ul>	
Negative Impact of GPP1 Operations on Community Livelihoods (Fishing and Farming).	All the communities engaged blamed their low fish catch and low crop yield on the GPP1 operations.	<p>GNGLC would consider the following as part of its CSR:</p> <ul style="list-style-type: none"> <li>▪ Provision of alternative livelihood programs such as aquaculture, pig farming etc.</li> <li>▪ Provision of fertilizers to farmers.</li> <li>▪ Provision of climate resilient seeds to smallholder farmers.</li> </ul>	All communities engaged
Occupational Safety Risk to Staff of GNGLC at the GPP1 site.	Due to the lingering issues and the displeasure of the residents particularly the youth in the project affected and interested communities, the staff of GNGLC at GPP1 could be at risk of being physically assaulted.	<ul style="list-style-type: none"> <li>▪ GNGLC would take precautions and ensure the safety of its staff at GPP1.</li> <li>▪ The lingering issues would be resolved promptly.</li> <li>▪ There would be continuous community engagement and sensitization by the Community Relations Department to diffuse all tensions.</li> </ul>	All communities engaged
Dereliction of Duty	In order to make room for the development of GPP1, GNGLC took over the Anokyi community park,	GNGLC would endeavor to work as soon as possible with the leaders of Anokyi to develop the community	Anokyi

Issue Group	Summary of Issues Raised	Recommended Solution	Stakeholder Category
	<p>promising to provide another park for the locals. But because GNGLC broke this pledge, the local leaders are furious.</p> <p>The Chief of Anokyi provided the Plan of the Land earmarked for developing the new community park but there was no action from GNGLC after the land was surveyed.</p>	<p>park for them before the construction of GPP2 in order avert any future community agitation.</p>	
Cumulative Impacts	<p>The existing impacts from GPP1 operations, if not mitigated adequately could affect GPP2 construction and operation.</p>	<p>GNGLC would endeavor to resolve the lingering issues within the communities in order to ensure the successful implementation of GPP2.</p>	<p>Ellembelle District Assembly</p>
Collaboration Opportunity	<p>Inadequate waste management within the Ellembelle District due to the influx of labor to major companies, including GNGLC, in the district. This problem could provide the opportunity for GNGLC and Eni Ghana to engineer and develop a landfill site in the district for appropriate management of waste.</p> <p>GNGLC is collaborating with Quantum to execute some CSR projects in the communities, but it seems the communities are unaware.</p>	<p>GNGLC may consider this suggestion.</p> <p>The CSR projects jointly implemented by GNGLC and Quantum would be clearly communicated to the communities and information displayed on notices in the communities.</p>	<p>Ellembelle District Assembly – The District Chief Executive.</p> <p>Quantum, Anokyi LGP Facility</p>
Truncated Engagement	<p>Due to the displeasure of the residents of Asemda particularly the youth about GNGLC’s perceived inadequate CSR, they did not want to engage</p>	<p>GNGLC would endeavor to resolve the issues with Asemda to ensure the successful implementation of GPP2.</p>	<p>Asemda</p>

Issue Group	Summary of Issues Raised	Recommended Solution	Stakeholder Category
	representatives of GNGLC thus the ESIA Gap Analysis additional stakeholder engagement with them was truncated abruptly.		
Alignment of Studies to produce fit for purpose EIA.	The findings and recommendations of the QRA, FERA & FRA should be linked to the impacts and mitigation measures of the final ESIA report to be submitted to the agency.	The EIA Gap Assessment team has taken note of this comment and has addressed it.	EPA

## **CHAPTER 7      IDENTIFICATION AND EVALUATION OF POTENTIAL IMPACTS**

### **7.1      Overview**

The key objectives of an EIA are to predict the impacts, resulting from a proposed development project or activity, on the environmental (physical and biological) and socio-economic components of the project area and to recommend mitigation measures to minimize, eliminate, or offset the negative impacts and enhance the positive ones. This chapter presents the identification and evaluation of the potential impacts of the proposed construction and operation of the GPP Train 2 at Atuabo in the Ellebelle District of the Western Region. It is based on the EPA Environmental Assessment Regulations, 1999 (L.I. 1652).

### **7.2      Impact Assessment Methods**

The method for the assessment involved matching the various activities under the different phases of the proposed GPP Train 2 project with the environmental and socio-economic components associated with the project area. Subsequently, the potential impacts were identified and evaluated based on legal and regulatory requirements, the magnitude of the impacts, risk posed by impacts, public perception, and the importance of the affected environmental and socio-economic components. The methods are illustrated in Figure 22 below.

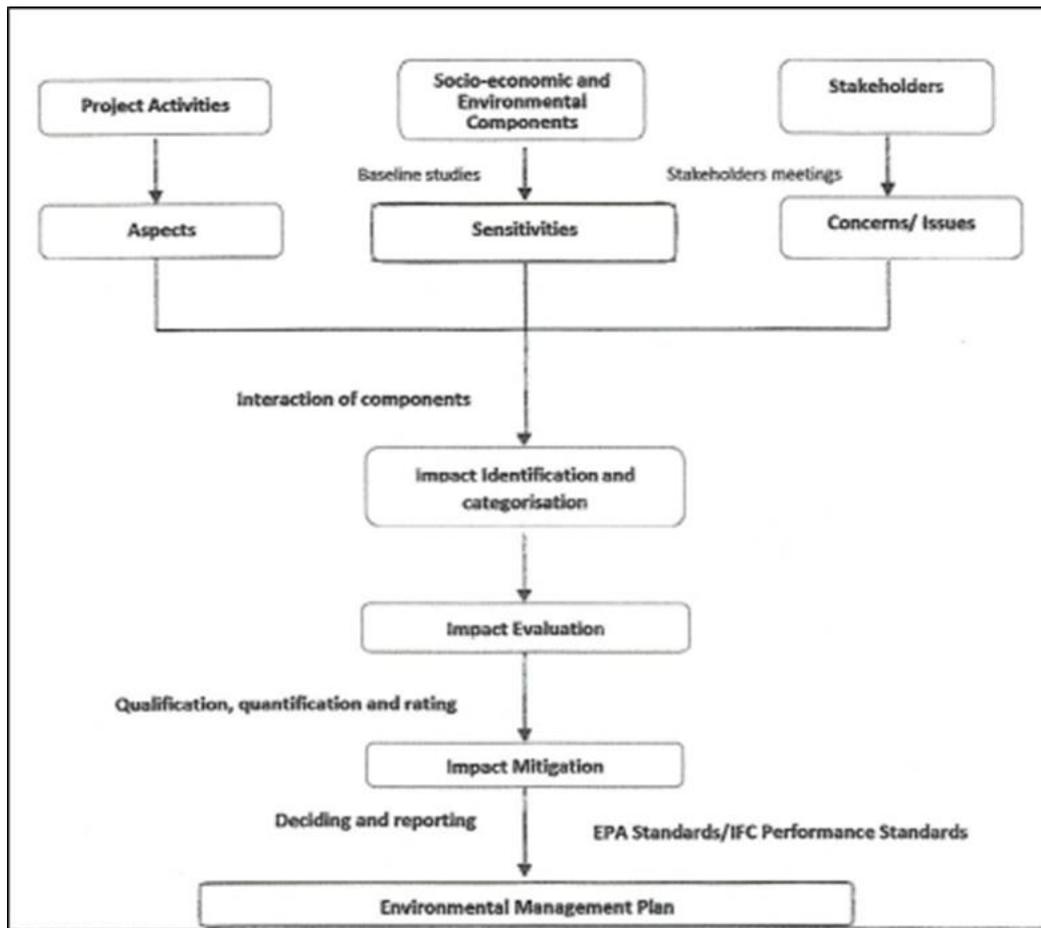


Figure 22 Flow Diagram of Impact Assessment Process

The criteria for the impact assessment are based on both the physical characteristics of an impact (e.g., magnitude, areal extent, duration, frequency, likelihood, and reversibility) and the context-specific value characteristics or importance (e.g., ecological, social, cultural, public health, and economic values) that adhere to the affected environmental and socio-economic component in the area of a project. Regulatory standards and the results of stakeholder consultation are usually essential factors in defining value characteristics (IAIA, 2016).

### 7.2.1 Overview of Identification of Impacts

The first step in identifying impacts associated with a proposed project is the development of interaction matrices, which show the relationships or interactions between the planned project activities and the environmental and socio-economic components of the project area. These interactions constitute the potential impacts of the project. The various activities that would be carried out in the different phases of the project may have positive or negative impacts on the environmental and socio-economic components.

Examples of environmental and socio-economic components are:

- *Environmental (Physical)* - air and noise, soils, drainage, surface water, and groundwater.
- *Environmental (Biological)* - flora and fauna.
- *Socio-economic* – stakeholders, employment or recruitment, local/regional/national economy, occupational and public health and safety hazards, land use, and regulatory requirements.

An overview of the major activities for the different phases - pre-construction, construction, operations, and decommissioning & closure – of the GPP Train 2 project is presented below.

***i. Pre-Construction phase:***

This phase shall involve activities including settlement of compensation issues, feasibility and specialist studies, technical surveys, update of project design, stakeholder consultations, recruitment, acquisition of relevant permits and approvals, and compliance with related regulations.

***ii. Construction phase***

Key activities in this phase include recruitment, construction of access roads, site preparation (earthworks and temporary facilities), and development of the main gas processing and auxiliary infrastructure, waste disposal, and compliance with relevant regulations.

***iv. Operations phase:*** This is usually ‘long term’, involving activities from post-construction to pre-decommissioning. It commences once the GPP Train 2 has been commissioned for use. The activities in the phase will consist of processing up to 200 MMSCFD of dense phase gas per year into various quantities of propane (C3), butane (C4), pentane (C5) and stabilized condensate (C5+) fractions. Other activities cover operating the plant in an environmentally friendly manner, ensuring good synergy between the plant, neighbouring communities, and the environment. Furthermore, the activities shall include recruitment, transportation and storage of raw and intermediate materials and finished products, resource use (water, fuel and electricity), management of wastewater, solid waste, and gaseous emissions, as well as corporate social responsibility.

v. *Decommissioning and closure phase*: This phase begins once the use of the GPP Train 2 is discontinued, or the project life span has come to an end. Activities shall include the dismantling of components, management of movable and unmovable assets, and land reclamation.

### 7.2.2 *Overview of Characterisation of Impacts*

According to the requirements of the Ghana Environmental Assessment Regulations, 1999 (L.I. 1652), the GPP Train 2 project is categorised under Schedule 2, undertakings for which Environmental Impact Assessment (EIA) is mandatory. The proposed project has the potential to impact the physical, biological, and socioeconomic environments within the area of influence of the project. Depending on the component, the area of influence of the project may be local, regional, or national.

The potential impacts identified have been described in terms of their nature, which includes the type of impacts, their physical characteristics, and their significance. The impact type indicates the relationship of the impact to a project activity or activities (in terms of cause and effect). The terms employed to describe the type of impacts are:

- i. *Direct* - impacts that result from a direct interaction between a project activity and an environmental or socio-economic component (e.g., between the occupation of a plot of land and the habitats which are affected).
- ii. *Indirect* - impacts that follow on from the direct interactions between a project activity and an environmental or socio-economic component as a result of subsequent interactions within the component (e.g., viability of a species population resulting from loss of part of habitat as a result of a project activity occupying a plot of land).
- iii. *Induced* - impacts that result from other activities (which are not part of the project) that happen because of the project.
- iv. *Cumulative* - impacts that arise because of an impact and effect from a project activity interacting with those from another activity to create an additional impact and effect. This is further expanded in Section 7.2.3 below.

The physical characteristics of an impact may be described by its *duration, areal extent, scale, frequency, likelihood, reversibility, and magnitude as follows*:

- i. *Duration* - connotes the time period over which an environmental or socio-economic component is affected; temporary (< 3 years), short term (>3< 5 years), long term (>5<15 years), and permanent (> 15 years);
- ii. *Areal Extent* - the reach of the impact, that is, the physical distance an impact will extend to (on-site, local, regional, national, and transboundary or international).
- iii. *Scale* - describes the quantitative measure of the impact such as the size of the area damaged or impacted, and the fraction of a resource that is lost or affected) or the professional viewpoint on the measure of impact.
- iv. *Frequency* - the measure of the constancy or periodicity of the impact.
- v. *Likelihood* - pertains to unplanned events determined either qualitatively or quantitatively based on experience and/or evidence that such an outcome has previously occurred.

### **7.2.3 Overview of Evaluation of Impacts**

The process of evaluation of the identified potential impacts to determine their significance was based on professional judgment and use of additional criteria - legal, the importance of the environmental or socio-economic component to be impacted, the risk posed by the impact, and public perception. These are further explained below:

#### ***i. Legal and Regulatory Requirements***

Here, the proposed project activities that have potential impacts were considered with respect to legal and regulatory requirements identified in Chapter 2 of this report as follows:

- Low Rating (1): No legal or regulatory requirement for undertaking activity.
- Medium Rating (2): Legal or regulatory requirement exists for undertaking activity.
- High Rating (3): A permit is required prior to undertaking activity.

#### ***ii. Importance of Environmental and Socio-economic Components***

The importance or value of an environmental or socio-economic component in respect of an identified potential impact was ranked as high (3), medium (2) or low (1) based on the component's attributes and usefulness to society.

### iii. Risk Posed by Potential Impacts

The criteria used to categorise the risk posed by the potential impacts of a proposed project address both the consequence and probability or likelihood of occurrence (SRK Consulting, 2011). The consequence criterion considers the severity of the impact (1-3), duration (1-3), and spatial scope (1-3). The likelihood of occurrence is classified as unlikely (1), likely (2), and definite (3). The impact consequence was defined using the impact magnitude /severity, scope, and duration to rate the consequence as high (3), medium (2), and low (1). The two criteria were combined as shown in the matrix below (Table 46) to evaluate the risks posed by the potential impacts into the following ratings:

- Low Risk (1): No further mitigation may be required.
- Medium Risk (2): Impact can be mitigated with additional controls and modifications.
- High Risk (3): Impact requires avoidance or major controls/mitigation.

Table 46 Matrix for Risk Determination

Impact Characteristics	Definition	Score	Criteria
<b>Severity / Magnitude</b>	Major	3	Substantial deterioration or harm to receptors; receiving environment has an inherent value to stakeholders; receptors or impacts are of conservation importance; or identified threshold often exceeded.
	Moderate	2	Moderate/measurable deterioration or harm to receptors; receiving environment moderately sensitive; or identified threshold occasionally exceeded.
	Minor	1	Minor deterioration (nuisance) or harm to receptors; change to receiving environment not measurable; or identified threshold never exceeded.
<b>Spatial Scope</b>	Site or local	1	Site-specific or confined to the immediate project area
	Regional	2	May be defined in various ways, e.g., cadastral, catchment, topographic.
	National / International	3	Nationally or beyond.
<b>Duration</b>	Short term	1	<3 years
	Medium term	2	>3<5 years
	Long term	3	>5<15 years
	Permanent	4	>15 years
<b>Risk based on consequence and likelihood</b>			
			<b>Consequence</b>

			Low (1)	Medium (2)	High (3)
<b>Probability</b>	Unlikely	1	1	2	3
	Likely	2	2	4	6
	Definite	3	3	6	9

**Legend for Risk Level**

	Low	1
	Medium	2
	High	3

#### ***iv. Public Perception***

Public perception was based mainly on the concerns and appreciation of stakeholders consulted during the initial scoping exercise. It was also based on experiences and lessons learnt from the operations of GPP Train 1 since 2014. As detailed in Table 42 above, the major concerns and appreciation were:

#### ***Concerns***

Communication and awareness creation

- i. Request for more support from GNGLC – hospital, schools, police, communities
- ii. Local employment / content
- iii. Proximity of GPPs and safety
- iv. Land and compensation issues
- v. Loss of livelihoods
- vi. Flaring, heat, and other impacts
- vii. Agreement / Memorandum of Understanding
- viii. Flooding and drainage
- ix. Youth training/capacity building
- x. Emergency Assembly Points and involvement of communities in safety drills
- xi. Peaceful co-existence
- xii. Cumulative impacts of Trains 1 and 2
- xiii. Specialist studies
- xx. Acquisition of permits and approvals
- xxi. Use of permitted companies
- xxii. Football Park at Anokyi

- xxiii. General security
- xxiv. Encroachment of RoW and GPP
- xxv. Restoration of the footpath to Anokyi
- xxvi. Increasing cost of living.
- xxvii. Increasing social vices.

It must however be pointed out here that concerns that may appear of low ranking, are equally important because they are specific local issues. These include the replacement of the football park at Anokyi, restoration of the footpath between Anokyi and Asemnda and encroachment of the RoW of GNGLC's pipelines.

### ***Appreciation***

- i. Support to Ellebelle District Assembly.
- ii. Coordination of activities with Saint Martin de Porres Hospital at Eikwe
- iii. Support to the development of education.
- iv. Contribution to Ghana's industrialisation process.

### ***v. Significance of Identified Impacts***

The significances of the identified potential impacts, based on the above criteria, were ranked for the different phases of the project as a basis for selecting those negative impacts that require mitigation measures as follows:

- ***0-4: Minor or Low Significance*** - Minor deterioration, nuisance, or harm to environmental and socio-economic components; or identified threshold never exceeded. Mitigation is not required for impact.
- ***5-8: Moderate Significance*** – Moderate or measurable deterioration or harm to environmental and socio-economic components; receiving environment moderately sensitive; or identified threshold occasionally exceeded. Mitigation required for impact.
- ***9-12: Major or High Significance*** - Substantial deterioration or harm to environmental and socio-economic components; receiving environment has an inherent value to stakeholders; receiving environment of conservation importance; or identified threshold often exceeded. Mitigation is required for impact.

## ***vi. Cumulative Impacts***

Cumulative impacts may be defined as changes to an environmental or socio-economic component caused by the combined impact of past, present, and future human activities and natural processes. They are the result of multiple activities whose individual direct impacts may be relatively minor but in combination with other impacts result in significant effects. The multiple impacts of different activities may have an additive, synergistic or antagonistic effect on one another and with natural processes (Clark, 1994). Some activities known to have significant impacts on the environment and contribute highly to cumulative effects are resource development, energy production and consumption, and land use changes. In this study, cumulative impacts were assessed by adding the known or existing impacts from the operation of GPP Train 1 and the potential impacts from the construction and operation of Train 2.

For example, GPP Train 1 has been in existence since 2014 and its operations include flaring of mainly iso-pentane. Currently, the EPA allows GNGLC to flare for safety reasons because it lacks the infrastructure to store the excess gas <https://www.myjoyonline.com/epa-justifies-decision-to-allow-ghana-gas-company-to-flare-gas/>. GPP Train 1 may also emit other fugitive gases including methane. Although current air quality monitoring results (GNGLC, 2021a) indicate that emissions are below the GSA standards, it is likely that the addition of GPP Train 2, which has 33% more of the capacity of Train 1 will result in total emissions leading to ambient levels above the stipulated standards. Another example is flooding and degradation of aquatic ecosystems resulting from the construction of GPP Train 1. Since GPP Train 2 will occupy a bigger area, cumulative impacts could occur.

## **7.3 Identification of Potential Impacts**

### ***7.3.1 Pre-construction Phase***

#### ***i. Potential Impacts***

As indicated in Section 7.2.2 above, the major activities in this phase shall involve:

- Acquisition of relevant permits and approvals and compliance with related regulations.
- Recruitment.
- Technical surveys and update of project design.
- Feasibility and specialist studies.
- Settling of land compensation issues.

- Signing of agreement with the A3 communities.
- Establishment of emergency assembly points for the A3 communities.
- Creation of awareness at local and national levels.

In Table 47 is presented a matrix showing the possible interactions between the activities in the pre-construction phase and the environmental and socio-economic components.

Table 47 Matrix of Pre-construction Phase Activities and Environmental and Socio-economic Components

Environment and Socio-economic Components	Acquisition of Permits & Approvals	Recruitment	Technical Surveys & Design	Feasibility & Specialist Studies	Settlement of Compensation Issues	Stakeholder Consultations*
<i>Socio-economic</i>						
Employment						
Local Economy						
OPHS**						
Land Use						
Regulatory Requirements						
Relevant Stakeholders						

\* Consultations: Awareness Creation; Signing of Agreements, Establishment of Assembly Points, etc.

\*\* OPHS: Occupational and Public Health and Safety

**Legend:**

	Activity does not interact with environmental or socio-economic component
	Activity interacts positively with environmental or socio-economic component
	Activity interacts negatively with environmental or socio-economic component

None of the project activities in this phase will interact with the physical and biological environments. Concerning the socio-economic component as indicated in Table 7-2, the most negatively affected sub-components in this phase will be regulatory requirements and consultation with the relevant stakeholders.

With respect to project activities, compensation issues and stakeholder consultations have the potential to generate the most negative interactions. Technical surveys may also generate some negative interactions in the form of occupational and public health and safety hazards. On the

other hand, some project activities, notably recruitment and payment of compensation for land, will generate positive interactions affecting employment and the local economy.

## *ii. Significance of Impacts*

Based on the above interactions (Table 47) the overall significances of potential impacts in the pre-construction phase are presented in Table 48 below.

Table 48 Significance of Impacts – Pre-construction Phase

<b>Pre-Construction Phase Activities</b>	<b>Potential Impacts</b>	<b>Legal/Regulatory</b>	<b>Importance</b>	<b>Risk</b>	<b>Public Perception</b>	<b>Significance</b>
Acquisition of Permits and Approvals	Inability to start a project without relevant permits and approvals;	3	3	1	3	<b>10</b>
Recruitment	Employment opportunities arising from the recruitment of workers;	1	3	1	3	<b>8</b>
	Impacts of COVID-19 pandemic;	3	3	3	2	<b>11</b>
Technical Surveys and Design	Business opportunities for local experts and contractors;	2	1	1	2	<b>6</b>
	Risk of accidents leading to injury or loss of assets;	1	2	2	1	<b>6</b>
Feasibility and specialist studies	Business opportunities for local experts and contractors;	1	3	2	2	<b>8</b>
	Improvement in knowledge and understanding of the impacts of Trains 1 and 2 and the possibility of providing effective mitigation measures;	3	3	3	3	<b>12</b>
Settlement of issues on compensation	Improvement in the local economy;	3	3	3	3	<b>12</b>
	Social conflict and delays in the start of project activities;	3	3	3	3	<b>12</b>
Stakeholder Consultations	Social conflict and delays in the start of project activities;	3	3	3	3	<b>12</b>

From the above, negative potential impacts of major significance (9-12) will be associated with the acquisition of permits and approvals and compliance with regulations, the COVID-19 pandemic, settlement of compensation issues, and the need for stakeholder consultations. The conduct of specialist studies has brought significant positive impacts while potential positive impacts of moderate significance will arise from recruitment of workers and experts to conduct technical and feasibility studies. Further details are provided below taking into consideration conditions at the existing GPP Train 1.

### *iii. Specific Positive Impacts on Socio-economic Component*

#### *Employment and Improvement in Economy*

In the pre-construction phase (Table 48), potential positive impacts will arise from employment opportunities for skilled and unskilled workers as well as business opportunities that would lead to improvement in the local economy. For example, to undertake technical surveys and consultations for the project, experts and consultants will be engaged by GNGLC. However, these potential positive impacts will be of relatively short duration in this phase and are rated as moderately significant (Table 48). On the other hand, prompt payment of fair compensation will lead, among others, to community satisfaction and improvement in the local economy both of which will be of high significance. The results of specialist studies conducted will also be of high positive significance in improving knowledge and understanding of the cumulative and other impacts of GPP Trains 1 and 2 that would lead to more effective mitigation measures, especially concerning emissions.

#### *Specialist Studies*

During the scoping exercise, concerns were raised about the perceived impacts of the operation of GPP Train 1. These included the generation of heat from flaring, sleeplessness, stunting and loss of vegetation, flooding, and respiratory tract infections. To provide answers to some of these concerns, specialist studies have been conducted as recommended by various stakeholders, particularly the EPA (see Section 7.4). These will lead to improvement in knowledge and understanding of the cumulative impacts of Trains 1 and 2 allowing for effective mitigation measures.

#### ***iv. Specific Negative Impacts on Socio-economic Component***

##### ***Occupational and Public Health and Safety***

During the pre-construction phase, the activities of accessing and inspecting the proposed project site as well as technical surveys of the area could result in accidents that may affect the health and safety of those involved. For example, the exposure of technical teams carrying out surveys and environmental studies to injury is likely. Such potential negative impacts, although of short duration during this phase are rated as *moderately significant because of the occupational and public health values of the impacts and mitigation measures are necessary.*

As already pointed out in Section 5.3 of this report, the COVID-19 pandemic has become a leading health issue in Ghana since March 2020. Infections and deaths have been recorded in the country including the Western Region where the proposed project is located. The pandemic is still ongoing and can therefore have negative impacts during the pre-construction and other phases of the GPP Train 2 project. The impacts could be direct or indirect and the duration could be short or long-term while the likelihood is high. *The potential impacts of COVID-19 are rated as of major significance.*

##### ***Regulatory Requirements***

Of importance in the pre-construction phase is the possibility that the project activities may not start as scheduled due to the inability of Ghana Gas to apply for and obtain the relevant permits and approvals. Regulatory requirements need to be followed and respected during all activities in this phase and in all the other phases of the GPP Train 2 project, otherwise, this could even affect the investment schedule of the project.

Regulatory requirements will, among others, be required to satisfy various legal and regulatory frameworks covering technical surveys and design ( Energy Commission Act, 1997 (Act 541), payment of compensation (Lands Commission Act, 2008, (Act 767), and acquisition of permits such as the Ghana National Fire Service Act, 1997 (Act 537), Fire Precaution (Premises) Regulations, 2003 (L.I. 1724), Water Resources Commission Act, 1996 (Act 522), Water Use Regulations, 2001 (L.I. 1692), and recruitment (Labour Act, 2003 (Act 651).

Information available on the operations of Train 1 (GNGLC, 2019e) shows that Ghana Gas generally operated within regulatory requirements and is expected to continue to do the same

in the pre-construction phase of GPP Train 2. For example, the Ghana National Fire Service is stationed on the premises of the GPP at Atuabo and Ghana Gas was granted a Water Use Permit by the WRC for the operations of Train 1.

Despite the above, the potential adverse impacts of disregarding regulatory requirements are direct and national in extent and rated of major significance.

### ***Settlement of Compensation Issues***

It is stated from Section 3.2 above that the land for both GPP Train 1 and Train 2 has been acquired by the government's Executive Instrument, E.I. 51, 2014. However, both Atuabo and Anokyi communities have laid claim to the ownership of the GPP Enclave land which has culminated into an ongoing court case to determine the rightful ownership of the entire GPP enclave thus, the land litigation process has protracted leading to the non-payment of compensations by GNGLC. GNGLC is prepared to work with the traditional authorities of both Atuabo and Anokyi to resolve the land litigation issue and pay the appropriate compensations. Although land compensation for the GPP Enclave is pending, GNGLC has paid crop compensation to all Project Affected Persons (PAPs) whose farms were within the GPP Enclave at the time of the acquisition. Nonetheless, the protracted land dispute could lead to community agitations thereby having *potential negative impact which is of major significance*.

### ***Consultation with Relevant Stakeholders***

Consultations with the relevant stakeholders are required for the following, among others:

- General awareness creation on the details of the project.
- Payment of compensation to those who have lost their lands.
- Signing of an MoU with the A3 communities as indicated in their concerns on employment and other local issues.
- Provision of emergency assembly points for the A3 communities.

Again, it is noted that GNGLC, through its Community Relations Department, has been consulting with many stakeholders on the existing GPP Train 1 and the proposed GPP Train 2 (GNGLC, 2018; 2021a). However, there is still the need to conduct more consultations with the relevant local and administrative stakeholders to avoid conflicts and delays in the project schedule. For example, at the local level, fears have been expressed about the perceived impacts

of the operation of GPP Train 1. These include the generation of heat from flaring, sleeplessness, stunting and loss of vegetation, flooding, and respiratory tract infections. To provide answers to some of these concerns, specialist studies have been conducted as recommended by various stakeholders, particularly the EPA (see Section 7.4). Inadequate dissemination of information on the proposed project, as well as measures to safeguard the interests of the local communities, could result in project delays. Just as for the issues on compensation, this could be expressed in terms of attacks on the workers, public demonstrations, and violent behavior. *These perceived potential negative impacts are rated as highly significant.*

### **7.3.2 Construction Phase**

#### ***i. Potential Impacts***

The construction phase includes such activities as:

- Acquisition of permits and approvals.
- Recruitment.
- Site preparation and zoning.
- Construction of access roads and drainage facilities.
- Development of main and ancillary infrastructure.
- Water use and disposal.
- Solid waste disposal.
- Gas and dust emissions.

Table 49 presents a matrix showing the possible interactions between the activities in the construction phase and the various components. All the components (physical, biological, and socio-economic) will be affected by the activities in this phase. Activities that will generate the most negative interactions are site preparation, construction of access roads and development of the main and ancillary infrastructure. Positive interactions will result from the recruitment of workers and associated improvement mainly in the local economy.

Table 49 Matrix of Construction Phase Activities and Environmental and Socio-economic Components

Environmental and Socio-economic Component	Acquisition of Permits and Approvals	Recruitment	Site Preparation and Zoning	Construction of Access Roads and Drainage	Development of Main and Ancillary Infrastructure	Water Use / Disposal	Solid Waste Disposal	Gas and Dust Emissions
<i>Physical</i>								
Air Quality <sup>1</sup>								
Noise and Vibration <sup>1</sup>								
Drainage <sup>1</sup>								
Erosion								
Soils								
Surface Water <sup>1</sup>								
Groundwater								
<i>Biological</i>								
Flora								
Fauna								
Ecosystem Services <sup>1</sup>								
<i>Socio-economic</i>								
Employment								
Local Economy								
National Economy								
OHS* <sup>1</sup>								
PHS** <sup>1</sup>								

Local Traffic								
Land Use								
Regulatory Requirements								
Relevant Stakeholders								

1: Possible Cumulative Negative Impacts \*OHS: Occupational Health and Safety; \*\*PHS: Public Health and Safety.

**Legend:**

	<b>Activity does not interact with environmental or socio-economic component</b>
	<b>Activity interacts positively with environmental or socio-economic component</b>
	<b>Activity interacts negatively with environmental or socio-economic component</b>

**ii. Significance of Impacts**

Table 50 below presents the significance of potential impacts during the construction phase.

Table 50 Significance of Impacts – Construction Phase

<b>Construction Phase Activities</b>	<b>Potential Impacts</b>	<b>Legal/Regulatory</b>	<b>Importance</b>	<b>Risk</b>	<b>Public Perception</b>	<b>Significance</b>
Acquisition of Permits and Approvals	Inability to start construction without relevant permits and approvals;	3	3	3	3	<b>12</b>
Recruitment	Employment opportunities resulting in improvement in the local economy and community relations;	3	3	3	3	<b>12</b>
	Impacts of COVID-19 pandemic;	3	3	3	2	<b>11</b>
i. Site Preparation and Zoning ii. Construction of Access, Drainage iii. Development of Main and Ancillary Infrastructure	Increased noise and vibration;	3	3	2	3	<b>11</b>
	Blockage of natural drainage and flooding;	3	3	3	3	<b>12</b>
	Increased soil erosion;	2	3	3	1	<b>9</b>
	Loss of flora and degradation of faunal habitats and ecosystem services;	2	2	2	2	<b>8</b>
	Risk of accidents leading to injury or loss of assets;	3	3	2	2	<b>10</b>
	The influx of migrant workers leading to increased demand for services as well as public health and social problems;	3	3	3	2	<b>11</b>
	Increased vehicular traffic with associated incidence of accidents and injuries;	3	3	3	2	<b>11</b>
Water Use / Disposal	Excessive use of water resources	3	3	3	1	<b>10</b>
	Improper disposal of liquid wastes causing water pollution and occupational and public health problems;	3	3	3	3	<b>12</b>
Solid Waste Disposal	Improper disposal of solid wastes causing water pollution and occupational and public health problems;	3	3	2	2	<b>10</b>

<b>Construction Phase Activities</b>	<b>Potential Impacts</b>	<b>Legal/Regulatory</b>	<b>Importance</b>	<b>Risk</b>	<b>Public Perception</b>	<b>Significance</b>
Gas and Dust Emissions	Gas and dust emissions reducing air quality and causing occupational and public health problems.	3	3	3	3	<b>12</b>

As already indicated in the matrix above (Table 50), the activities in the construction phase will affect all the environmental and socio-economic components. Additionally, Table 50 indicates that all the potential positive and negative impacts will be highly significant (9-12) except for the loss of flora and fauna at the Train 2 project site. Further details are provided below.

### *iii. Specific Positive Impacts on Socio-economic Component*

#### *Employment and Improvement in Economy*

In the construction phase, positive impacts will be associated with only the socio-economic component in the form of employment opportunities for skilled and unskilled workers as well as with business opportunities that would lead to improvement in the local economy. As revealed in the scoping exercise, the issues of employment and the use of local content are very important to the people in the project’s area of influence. Thus, these positive impacts will be of high significance and lead to improvement in relations between the local communities and GNGLC (Table 50).

#### *iv. Specific Negative Impacts*

The GPP Train 2 is to be situated on the west side of the existing GPP Train 1. The Atuabo community is located on the shoreline, about 1.5 km south –west of Train 2 while the Asemnda community lies 0.5 km north-west of the proposed site for Train 2. The Anokyi community is located about 2 km to the east of Train 2. Thus, in terms of direct negative impacts from construction activities, although all the 3 communities are adjudged to be very close to the site,

Asemnda and Atuabo may be more affected by such impacts as increased noise and decreased air quality. It must also be stressed that other communities that lie on the Krisan-Beyin Road such as Ngalekyi, Baku, and Ekebaku can be equally stressed by the expansion activities.

#### **a. Physical Environment**

##### ***Air Quality***

During site preparation and construction works by the Contractor, local air quality will be impacted by the emission of air pollutants from the engines of vehicles, construction and road machinery as well as from diesel-fired power plants which will result in increases in the local concentrations of hydrocarbon combustion products, including carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), oxides of nitrogen (NO<sub>x</sub>), sulphur dioxide (SO<sub>2</sub>), lead compounds, and soot/particulate matter. Dust will also be generated from the movement of construction vehicles, machinery, and during earthworks from exposed surfaces and waste dumps, which will also negatively affect air quality.

These air pollutants may cause headaches, dizziness, nausea, and convulsions (Fuller, 2018; Manisalidis *et al.*, 2020). In the construction phase, short-term effects are temporary and range from simple discomfort, such as irritation of the eyes, nose, skin, throat, wheezing, coughing and chest tightness, and breathing difficulties, to more serious effects, such as asthma, pneumonia, bronchitis, and lung and heart problems. Short-term exposure to air pollution can also cause headaches, nausea, and dizziness. These problems can be aggravated by extended long-term exposure to air pollutants from Train 1, which is harmful to the neurological, reproductive, and respiratory systems and causes cancer and even, death.

Ambient air quality as monitored in 2020 at Train 1 and in the A3 communities (GNGLC, 2021a) showed that all parameters were below their respective national fenceline standards (GSA, 2019a) and WBG General EHS/WHO Guideline for industrial areas. However, during the construction of GPP train 2 while Train 1 is in operation, the likelihood of additive cumulative negative impacts on air quality is high and the standards may be exceeded. *Thus, the spatial scope and duration of airborne particulates, point source dust, non-point source dust, and gaseous emissions during the construction phase are rated to be highly significant.*

### ***Noise and Vibration***

There will be a range of noise and vibration sources during construction including:

- Drilling of additional wells.
- Use of heavy construction equipment.
- Use of power generators.
- Piling activities associated with the construction of pile-supported structures for the gas plant and auxiliary facilities.

Other activities that will contribute to increased noise levels during the construction phase include vehicular and truck movements, site preparation, and construction of roads and GPP infrastructure. With 2020 daytime ambient noise levels at Train 1 and the A3 Communities ranging from 53.95 to 79.37 dBA and 44.26 to 58.6 dBA (GNGLC, 2021a) respectively, noise and vibration generated from construction activities coupled with those from Train 1 activities are likely to go beyond the GSA standards and WBG General EHS/WHO Guideline of 70 dBA for light industrial areas and 55 dBA for residential areas (GSA, 2018) for long periods. The impacts may lead to negative occupational and public health and safety hazards including discomfort and loss of hearing.

*The impacts from noise and vibration will be direct, temporary but moderate in scale. However, just as for air quality, cumulative impacts will arise because of the operations of Train 1 whose noise impacts sometimes become a source of concern for nearby communities. The impacts are thus rated highly significant.*

### ***Drainage (Flooding)***

Exposed surfaces from land clearing and excavations will generate loose sediment which could potentially be carried by surface runoff into the existing natural drains and lead to their siltation and reduction in carrying capacity. In addition, construction activities could further destroy the existing natural drainage of the project site that was blocked by the construction of GPP Train 1. Thus, flooding could occur at the project site and the nearby A3 communities.

It was reported during the scoping exercise that there has been frequent flooding in the A3 communities since the construction of GPP Train 1 because the swampy areas within the GPP Enclave could be overflowed with tributaries (Ehoohoo and Ebolani) of the Amansuri.

The possibility of increased flooding in the communities thus ranked high among the concerns raised by stakeholders on the proposed Train 2 project. *Therefore, the potential impacts are cumulative and considered highly significant.* The flood risk of the entire GPP enclave and the nearby A3 communities is provided in Section 7.4.1.

### ***Soils and Erosion***

Construction activities can adversely impact the landscape, soils, and geological environment within the construction area. Impacts are associated with significant volumes of earthmoving operations, soil compaction, and the creation of new land relief forms. Many activities in this phase (Table 7-4) such as land clearing and site preparation will expose bare soil to erosion. The use of heavy machinery and equipment will also result in soil compaction thereby negatively impacting its structure and permeability while leaks of oil and diesel fuel from the use of heavy equipment are likely to contaminate the soils. In addition, the potential for increased flooding in the area during construction could also lead to increased erosion and sediment transport. *The potential negative impacts as assessed (Table 7-5), are of high significance in this phase.*

### ***Surface Water and Groundwater Quality***

Activities during the construction phase such as recruitment of personnel and construction of infrastructure will be associated with a corresponding increase in quantities of solid and liquid wastes to be generated in temporary offices, work camps, and maintenance workshops. Specifically, the construction activities will result in the generation of wastewater, stormwater, and ‘hydrotest water’ generated during hydraulic pressure testing of pipelines, storage tanks or other equipment. Solid wastes will include wood, scrap metal, glass pieces, and food remnants. Liquid and solid wastes, if not properly managed, will negatively affect the waters of the Amansuri River catchment and associated groundwater whose quality characteristics, as reported in this study, are generally satisfactory except for bacterial contamination.

*For surface waters, especially during the wet season when erosion of exposed surfaces and sediment transport by runoff could increase, the impacts would be direct and severe. The impacts on surface waters will also be cumulative, considering the lack of flow of the streams at the project site arising from the construction of Train 1. For groundwater, although the impacts may be indirect, its shallow nature in the project area means that the impacts will also be of high significance.*

## **b. Biological Environment**

### ***Flora***

The present vegetative cover of the site for GPP Train 2, as described in Section 5.3, comprises a mosaic of grassland and thicket interlocked with swamps of trees that represents a regrowth of previous vegetation following clearing in recent time. In the construction phase, especially during land clearing and site preparation, the already degraded flora at the project site will be lost. This loss of habitat will directly affect the occurrence of fauna in the project area. Also, during this phase, accidental spills of lubricants and fuel, depending on the quantities, may lead to further losses of vegetation. *Due to the short time duration of this phase, the potential impacts are considered moderately significant.*

### ***Fauna***

In addition to those activities that will have potential negative impacts on the flora and the habitats of the fauna of the project site, other activities such as vehicular movement and associated noise and vibration and waste disposal will have negative impacts on the existence of reported birds and land-dwelling fauna such as reptiles and insects in and around the project site. *The potential impacts are considered moderately significant.*

### ***Ecosystem Services***

In the construction phase, the loss of flora and fauna as described above will also result in losses in ecosystem services, particularly the catchment's capacity to regulate disturbances such as storm protection, drought recovery, and other aspects of ecosystem response to environmental variability controlled by vegetation structure that could lead to flooding of the general project area, among other disasters. While other services such as the provision of land for construction and acting as a receptor for solid wastes can be provided by other areas in the Ellembelle District, the loss of flood control services could lead to flooding of the project area in the wet season and subsequent negative impacts on people and businesses. *The potential impacts are considered moderately significant.*

### **c. Socio-economic Component**

#### ***Occupational Health and Safety***

All the construction activities, except the acquisition of permits and approvals, will have potential negative impacts on occupational health and safety (Table 7-4). Activities such as site preparation and construction of roads and infrastructure could result in accidents that may affect the health and safety of those involved. Workers will be exposed to risks of injuries from the operation of machinery, possible fires and explosions, inhalation of dust and fumes, and accidents from falling objects, among others. Improper handling of wastes and hazardous materials as well as inadequate sanitary facilities will also constitute health threats to workers.

Airborne particulates are of particular concern because they are well known to be associated with classical widespread occupational lung diseases such as pneumoconiosis, as well as systemic intoxications such as lead poisoning, especially at higher levels of exposure. But, in the modern era, there is also increasing interest in other dust-related diseases, such as cancer, asthma, allergic alveolitis, and irritation, as well as a whole range of non-respiratory illnesses, which may occur at much lower exposure levels (Fuller, 2018; Manisalidis *et al.*, 2020). Wherever the particulates are deposited, either in the head or the lung, they have the potential to cause harm either locally or subsequently elsewhere in the body.

The ongoing COVID-19 pandemic can also have negative impacts during the construction phase. The recruitment of additional workers and influx of job seekers to both the project site and 3A communities will result in cumulative impacts the likelihood of which is high. *The potential impacts on occupational health and safety are thus rated as of high significance.*

#### ***Public Health and Safety***

Just as for occupational health and safety, dust, noxious gases, and noise from various construction activities as indicated above pose health risks for the public, particularly in the local communities. Improper disposal of both solid and liquid wastes as well as unsecured excavations, will also have adverse impacts on public health and safety. Furthermore, exposed surfaces and improperly covered trenches may result in the stagnation of water and increased breeding of mosquitoes and other insects associated with water-borne diseases. Another potential negative impact is the influx of people to the project area during the construction period, which may lead to increased demand for services such as water and sanitation as well

as promote anti-social behaviour. Coupled with the possibility of increased COVID-19 infections, *these impacts are assessed as cumulative and highly significant.*

### ***Local Traffic and Land Use***

There is a road from the roundabout at A.B. Bokazo to the LPG loading gantry near Anokyi that joins the main coastal Krisan-Beyin Road at Baku. This road therefore bypasses the local coastal communities between Krisan-and Baku. (Ref figure). The Baku-Beyin Road stretch of this coastal road borders the southern edge of the site for GPP Train 1 and the proposed Train 2 and, with the bypass, are expected to be the major route of delivery of materials during the construction phase. Although vehicular traffic on this road is currently not heavy, increased traffic will occur during the mobilization of equipment and transportation of construction materials to the project site. Other direct impacts will come from the exposure of the public to increased noise, dust, and gaseous emissions. Any unattended breakdown of vehicles on this road could also increase the risk of accidents. *The combined negative impacts are considered highly significant.*

### ***Regulatory Requirements***

Just as for the pre-construction phase, regulatory requirements will be required during the construction phase to avoid delays or suspension of activities. Apart from requirements related to the environment (Environmental Assessment Regulations, 1999 L.I. 1652) and the petroleum sector (National Petroleum Act, 2005 (Act 691), other laws and regulations will be relevant for such activities as construction (Local Government Act, 1993 (Act 462); Building Code, GS 1207), employment (Labour Act 651, 2003), fire prevention (Ghana National Fire Services Act, 1997 (Act 537), waste management of hazardous materials (Hazardous and Electronic Waste Control, and Management Act, 2016 (Act 917), as well as water use (Water Use Regulations, 2001 (L.I. 1692). Failure or untimely action by GNGLC and its contractors to satisfy the above regulatory requirements may lead to delays in the project schedule. As in the pre-construction phase, the adverse impacts of disregarding regulatory requirements are direct and national in extent. *The potential impact is of high significance.*

### ***Relevant Stakeholders***

During the construction phase, the inability of GNGLC and its contractors to sufficiently consult with the relevant administrative stakeholders and local communities may lead to social conflicts and delays in construction schedules. Consultations initiated by GNGLC in the pre-

construction phase need to be extended in the construction phase, especially on recruitment and use of local content. Representatives of the local communities at GNGLC should increase the briefing of their communities on available opportunities. *These potential negative impacts are rated as highly significant.*

### **7.3.3 Operations Phase**

#### ***i. Potential Impacts***

As described in Section 3.3 of this report, the new GPP Train 2 will process dense phase gas from the Jubilee field (up to 100 MMSCFD) and TEN fields (up to 50 MMSCFD) into various quantities of propane (C3), butane (C4), pentane (C5) and stabilized condensate (C5+) fractions using the same offshore gas supply and sales gas pipelines as the existing 150 MMSCFD-capacity GPP Train 1 (GNGLC, 2019b). In addition, the new GPP will be capable of processing up to 50 MMSCFD of dense phase gas from new fields currently under investigation. Thus, the combined gas treatment capacity at Atuabo will be 350 MMSCFD on completion of Train 2, which is three times the current capacity.

The activities in this phase will also consist of ensuring good synergy between the plant, neighbouring communities and the environment and may be summarised as follows:

- Acquisition of permits and approvals.
- Recruitment.
- Handling and storage of raw materials and finished products.
- Resource use.
- Wastewater management.
- Solid Waste management
- Flaring.
- Corporate social responsibility activities.

In Table 51 is presented a matrix showing the possible interactions between the activities in the operations phase and the various components. All the components (physical, biological, and socio-economic) will be affected by the activities in this phase. Activities that will generate the most negative interactions are handling and storage of raw materials and finished products, solid waste management, and flaring. Positive interactions will result from the recruitment of workers and improvement in the economy as well as from GNGLC's Corporate Social Responsibility (CSR) activities.

Table 51 Matrix of Operations Phase Activities and Environmental and Socio-economic Components

Environmental and Socio-economic Components	Acquisition of Permits and Approvals	Recruitment	Resource Use	Handling and Storage of Raw and Finished Products	Wastewater Management	Solid Waste Management	Flaring	CSR Activities
<b>Physical</b>								
Air Quality <sup>1</sup>								
Noise <sup>1</sup>								
Soils <sup>1</sup>								
Surface Water <sup>1</sup>								
Groundwater <sup>1</sup>								
<b>Biological</b>								
Flora								
Fauna								
Ecosystem Services								
<b>Socio-economic</b>								
Employment								
Local Economy								
National Economy								
OHS* <sup>1</sup>								
PHS** <sup>1</sup>								
Regulatory Requirement								
Relevant Stakeholders								

1: Possible Cumulative Negative Impacts; \*OHS: Occupational Health and Safety; \*\*PHS: Public Health and Safety.

**Legend:**

	<b>Activity does not interact with environmental or socio-economic component</b>
	<b>Activity interacts positively with environmental or socio-economic component</b>
	<b>Activity interacts negatively with environmental or socio-economic component</b>

**ii. Significance of Impacts**

The overall significances of potential impacts during the operations phase are presented in Table 52 below. All the potential negative impacts will be of major significance and will require mitigation measures. Further details are provided below.

Table 52 Significance of Impacts – Operations Phase

<b>Operations Activities</b>	<b>Potential Impacts</b>	<b>Legal/Regulatory</b>	<b>Importance</b>	<b>Risk</b>	<b>Perception</b>	<b>Significance</b>
Acquisition of Permits and Approvals	Inability to operate smoothly without relevant permits and approvals;	3	3	3	3	<b>12</b>
Recruitment	Employment opportunities resulting in improvement in local and national economies;	3	3	2	3	<b>11</b>
	Impacts of COVID-19 pandemic;	3	3	3	2	<b>11</b>
Resource Use (Electricity, Water, Fuel, etc.)	Increased demand for resources for combined GPP Trains 1 and 2 operations;	3	3	2	1	<b>9</b>
	Increased occupational and public health and safety risks, e.g., from noise and air emissions;	3	3	3	2	<b>11</b>
Handling and Storage of Raw Materials and Finished Products	Soil, surface water and groundwater pollution;	3	3	3	3	<b>12</b>
Solid and Liquid Waste Management	Soil, surface water and groundwater pollution and increased occupational and public health risks;	3	3	3	2	<b>11</b>
	Business opportunities for local entrepreneurs;	3	3	2	3	<b>11</b>
Flaring	Increased occupational and public health risks; air pollution at the ground level and in the atmosphere;	3	3	3	3	<b>12</b>

Operations Activities	Potential Impacts	Legal/Regulatory	Importance	Risk	Perception	Significance
CSR Activities	Improved community relationships and improvement in local and national economies.	2	3	3	3	11

**iii. Specific Positive Impacts on Socio-Economic Component**

Just as for the pre-construction and the construction phases, positive impacts will be associated with only the socio-economic component as described below.

**Improvement in Economy**

In the operations phase, there will be improvement in the national economy because of the operations of the two GPPs and the sale of their final products. Petroleum-based technologies have transformed the global and national economies, providing mobility unimaginable to previous generations. The rise of the automobile, the manufacture and distribution of affordable consumer products, mass access to air travel, and advances in healthcare leading to doubling the average life expectancy are just a few of the many benefits obtained from the development of the oil and gas sector. In the United States, for example, the American Petroleum Institute (API) estimated that in 2019 the oil and natural gas industry, through its operations and capital investment, had widespread economic impact on all sectors of the economy, accounting for 7.9% of total GDP (API, 2021).

In Ghana, it is reported that the country generated over US\$ 6.5 billion in oil and gas revenue in 10 years, from 2011 to 2020 (<https://www.ghanaweb.com/Ghana-generated-over-US-6-5-billion-in-oil-revenue-in-10-years-PIAC-report-1361428>). Out of the amount, the Ghana National Petroleum Corporation received \$2,012.16 billion, representing about 30.72 percent, Annual Budget Funding Amount had \$ 2,557.12 billion (39.04 percent), the Ghana Heritage Fund had \$0.587 billion (8.97 percent), while the Ghana Stabilisation Fund received \$1,393.18 billion (21.27 percent). These impacts are expected to be long-lasting because of future opportunities for more

development of the oil and gas sector. Experts in the oil sector for example have predicted more oil exploration in Ghana in the next few years, as oil production output is expected to pick up supported by higher oil prices (<https://www.ghanaweb.com/Analysts-predict-more-oil-exploration-Ghana-1392076>). Ghana also hopes to continue using more gas in the future as it transitions towards renewable sources (<https://www.ghanaweb.com/Gas-is-best-option-until-renewable-energy-transition-Ghana-Gas-CEO-1387927>). According to the NPA, the GPP Train 2 when constructed and operated will contribute to Ghana's industrialisation process. The positive impacts on the national economy are thus considered highly significant.

### ***Employment***

The potential positive impacts will also include employment opportunities for skilled and unskilled workers, as well as business opportunities for waste management and other companies that would lead to improvement in the local economy. As revealed in the scoping exercise, the issues of employment and the use of local content are very important to the people in the project's area of influence. Thus, these positive impacts will be of high significance and lead to improvement in relations between the local communities and GNGLC (Table 52).

### ***Relevant Stakeholders***

GNGLC has a Community Affairs, Corporate Social Responsibility (CSR) Policy with objectives that include (GNGLC, 2018):

- Creating an enabling social environment for project implementation.
- Establishing good working relationships with the affected communities in an atmosphere of genuine trust and mutual understanding.
- Sensitizing and promoting peace in the communities through education and advocacy programs.

Ghana Gas also has a Waste Management Plan (GNGLC, 2021a) that allows private companies to participate in waste collection, treatment, and disposal.

In 2020 Ghana Gas successfully executed various CSR activities, examples (Plate 17) of which are presented below (GNGLC, 2021a):

- Renovation of Half Assini Senior High School dormitory for girls.
- Renovation of a 3-bedroom house for the Marine Police Station at Aiyinasi;
- Support to the District Health Directorates and A3 Communities to control the COVID-19 pandemic.
- Donation of waste bins to schools in the communities of the project area.
- Training of Queen Mothers of Eastern Nzema Traditional Council in bead making.
- Support to the Anokyi Community in the rehabilitation of its community durbar grounds.
- Construction of Astro turf Park at Sekondi;
- Provision of One Million Ghana Cedis to each of the sixteen regions in Ghana to support a total of 121 projects towards achieving the Sustainable Development Goals 3 (good health and well-being), 4 (quality education), and 6 (clean water and sanitation).



Plate 17 Nursery School and House for Teachers at Asemnda

In 2021, Ghana Gas continued its CSR activities including supporting sporting activities (<https://www.myjoyonline.com/ghana-gas-supports-boxing/>) and in 2022, supporting the victims of the Apiate explosion (<https://www.ghanaweb.com/GhanaHomePage/NewsArchive/Apiate-explosion-Ghana-Gas-gives-victims-GHC2-million-1452712>). With the additional income from Train 2 operations, it is expected that GNGLC will continue to use its CSR initiatives to achieve enhanced socio-economic well-being, improved health and educational, and training opportunities. This cumulative positive impact is considered highly significant because of its long-lasting and national nature.

*iv. Specific Negative Impacts*

**a. Physical Environment**

*Air Quality*

Gas production processes release large quantities of waste gases, especially carbon dioxide and methane, at every stage of the supply chain. A generalised representation of major sources of emissions from GPPs is shown in Figures 23 and 24 (Natural Gas STAR, 2017).

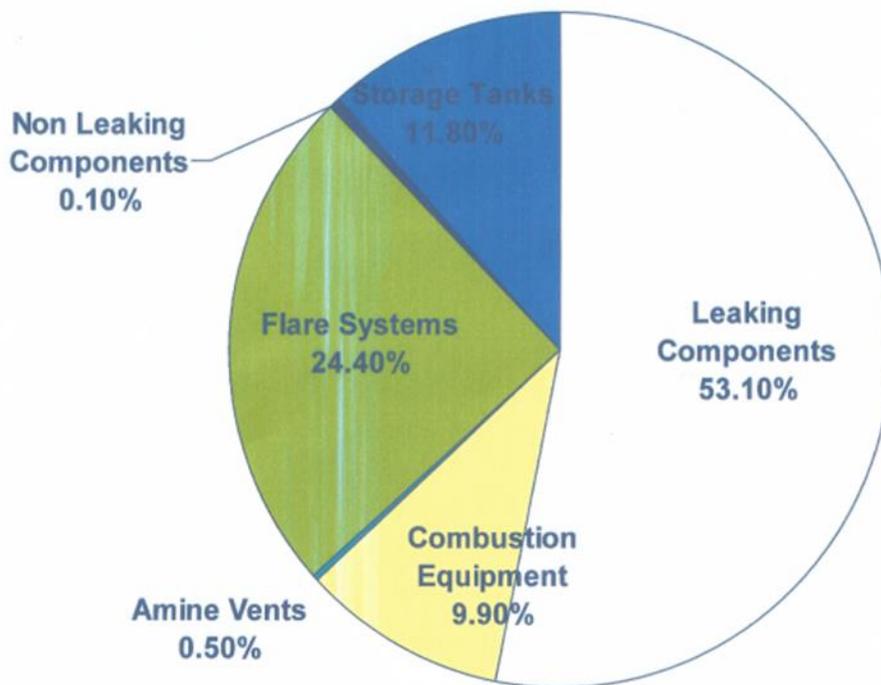
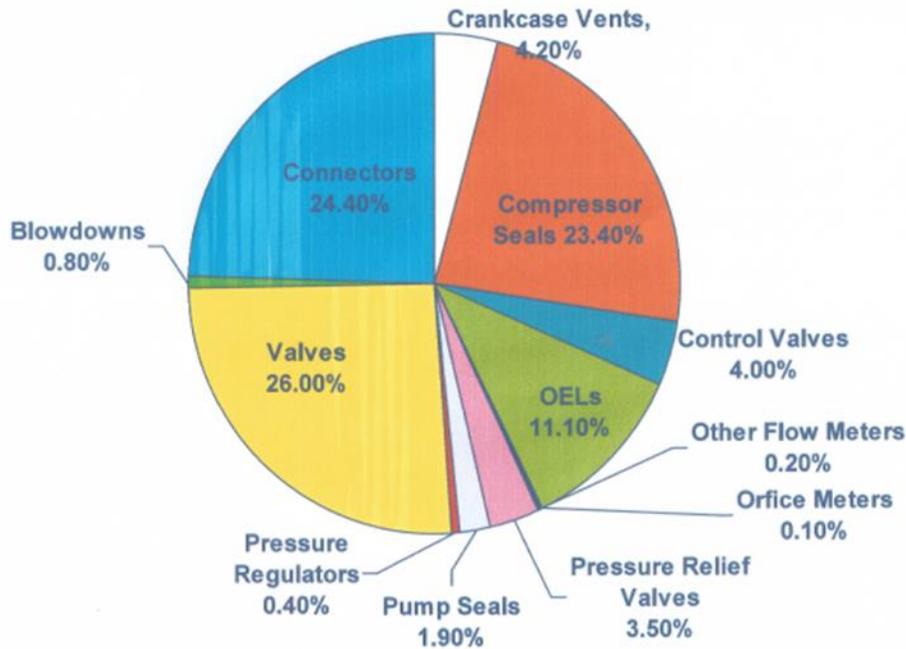


Figure 23 Percentage Distribution of Gaseous Emissions from Source Type



Source: Natural Gas STAR, 2017

Figure 24 Percentage Distribution of Gaseous Emissions from Equipment Type

In the operations phase of the GPP Train 2 and just as for Train 1, the primary sources of air emissions will be from fugitive gases and flaring (GNGLC, 2019e). Fugitive emissions will occur from leaks in tubing and piping, valves, connections, pump and compressor seals, tanks for storing gases, and loading operations.

There will be one flare system at GPP Train 2. Flaring, which is an important operational and safety measure, also occurs because of burning off flammable gas released by pressure relief valves during unplanned over pressuring of plant equipment, start-ups, and shutdowns.

Another important source of emissions will be the combustion of fuel for electricity and flaring (Natural Gas Star, 2017). As detailed in Chapter 3 on Project Description above, fuel gas will be used within the GPP Train 2 facilities at two pressures: medium pressure (30 barg) mainly for power generation and low pressure (7 barg) for flare vent purging, equipment blanketing and for direct fire heaters. The sources of fuel gas will be sales gas from Trains 1 and 2 and raw gas from Train 2. Gas engine generators will be the primary source of power supply. A diesel-driven

generator will provide essential power during outages of the main power generators and for black-start requirements. Diesel will also be used as fuel for plant vehicles.

From the above, the various components of air emissions from GPP Train 2, which will be like those from Train 1, may be summarised as follows:

- Total Particulate Matter.
- Fine and coarse Particulate Matter (PM<sub>2.5</sub> and PM<sub>10</sub>).
- Carbon monoxide (CO).
- Carbon dioxide (CO<sub>2</sub>)
- Nitrogen oxides (NO<sub>x</sub>)
- Volatile organic compounds (VOCs).
- Methane (CH<sub>4</sub>).

High levels of fine particulate matter and gaseous emissions in the atmosphere may cause increased occupational and public health problems including headaches, dizziness, nausea, and convulsions (Fuller, 2018; Manisalidis *et al.*, 2020), and initiate a variety of respiratory diseases such as bronchitis, emphysema, and cardiovascular diseases (UNEP and Climate and Clean Air Coalition, 2021).

All the above gaseous components of the emissions are greenhouse gases that contribute to climate change and global warming (IPCC, 2020). In addition, increased concentrations of atmospheric carbon dioxide are causing the oceans to become more acidic, threatening the viability of fisheries and marine ecosystems (Global Leadership for Climate Action, 2009). The other major gas, methane, is short-lived, with an atmospheric lifetime of roughly a decade and is a potent greenhouse gas tens of times more powerful than carbon dioxide at warming the atmosphere. Overall, it is second only to carbon dioxide in driving climate change. Methane also contributes to the formation of ground-level ozone, which causes approximately half a million premature deaths per year globally and harms ecosystems and crops by suppressing growth and diminishing production (UNEP and Climate and Clean Air Coalition, 2021).

Available information (GNGLC, 2019d; 2021a) however indicates that gas processing at Train 1 may pose a relatively low environmental risk, primarily because the raw gas has a simple and comparatively pure composition. It is also noted that waste gases produced from gas processing in GPP Train 1 are treated by pollution abatement equipment (scrubbers, filters, and knockout drums) before being sent to the flare stack for final disposal (GNGLC, 2019e; 2021a). In 2020, the EPA approved a request from GNGLC to increase the iso-pentane flared per day from 200 m<sup>3</sup> to 250 m<sup>3</sup>. The quantity of iso-pentane currently flared is thus within the approved 250 m<sup>3</sup>/day limit. While the EPA has justified the need for flaring (<https://www.myjoyonline.com/epa-justifies-decision-to-allow-ghana-gas-company-to-flare-gas/>), GNGLC has, at the same time, adopted measures to reduce flaring and venting. These include process optimization and the use of backup systems to achieve high plant reliability. Flaring is avoided as much as possible because natural gas is economically valuable and as much of it needs to be recovered during processing.

In addition to the above, consumption of diesel fuel during Train 1 operations has been generally low. For example, the consumption of diesel in 2020 averaged about 3,000 liters per month. The largest quantities of diesel consumed were in February (10,303 L) and March (10,950 L) due to extended use of the diesel generator during planned maintenance shutdown. Furthermore, the results of environmental quality monitoring of Train 1 operations (GNGLC, 2021a) indicate that all air quality parameters monitored at the GPP and in the communities in the project area were below the Ghana Standards Authority (GSA) maximum limits for fence line air pollutant (GSA, 2019a).

Based on the above, it could be deduced that the potential adverse impacts of air emissions would be low or moderate. However, the quantity of natural gas processed annually at Train 1 between 2016 and 2020 was in the range of 21,000 to 32,000 MMSCF, averaging 27,530 MMSCF (GNGLC, 2019e; 2021a). The utilisation capacity of Train 1 is 120 MMSCFD out of the total capacity of 150 MMSCFD. Assuming a full utilisation capacity for Train 1 of 120 MMSCFD for 30 days in 12 months, the expected annual quantity of natural gas processed will be 43,200 MMSCF. The quantity of 32,000 MMSCF of gas processed in 2020, or 88 MMSCFD, is therefore about 75% of the utilisation capacity of Train 1. Considering that the combined full capacity of both GPPs is 350 MMSCFD, and assuming a total utilisation capacity of 280 MMSCFD or 100,800

MMSCF annually, it can be deduced that about 3 times the amount of waste gases can be cumulatively generated in the future operations of the two GPPs.

Coupled with concerns and perceptions already raised about the effects of flaring on human and plant life, *the potential impacts of gaseous emissions are considered highly significant.*

### **Noise**

In a typical modern GPP, the major sources of noise include compressors, inlet air coolers, pumps, inlet separators, generators, flares, and workshops (Ramboll, 2019). Noise may also be generated by the movement of vehicles in and around the processing plant.

Evidence indicates that noise can have negative health impacts. For example, studies have concluded that modern oil and gas development can cause noise at levels that increase both short- and long-term health risks, including hearing loss, stress, sleep disturbance and deprivation, elevated blood pressure, and heart disease ([https://earthworks.org/issues/oil\\_and\\_gas\\_noise/](https://earthworks.org/issues/oil_and_gas_noise/)). Noise has also been documented to have negative physiological and reproductive effects on birds and other wildlife and interfere with their ability to communicate. It may even cause their temporary or permanent displacement from areas; if nests and dens are abandoned, populations could decline.

In addition to the immediate vicinity of the GPP Trains 1 and 2, the nearest noise-sensitive areas are the local communities including, Asemnda, Anokyi, and Atuabo, which are located between 0.4 and 1.5 km from Train 2. However, results from GNGLC's environmental monitoring of Train 1 operations in 2020 indicate that ambient noise levels at the plant site and in the A3 communities were within the permissible day-time standards for light industrial areas and residential areas respectively, throughout the year (GNGLC, 2021a). Occupational noise levels measured at such places as the Raw Gas Reception Area, Instrument Air Compressor Room, Heat Medium Area, Overhead Compressor Area, Flare Stack Area, and Generator Set Area were also below the permissible exposure limit, except for the Overhead Compressor Area, where control mechanisms were maintained to protect workers.

Since the GPP Train 2 will operate at two times the capacity of Train 1, it is expected that more noise will be generated from its operations within the same area. Added to the fact that the combined full capacity of the two GPPs will be 350 MMSCFD compared to the current 88 MMSCFD, the cumulative impacts at both the occupational and ambient levels could be even greater than the permissible standards. The impacts will also be of long duration, throughout the lives of the GPPs. *The potential negative impacts are therefore rated to be of major significance.*

### ***Soils***

In the operations phase, negative impacts on soils may arise from the use of resources such as chemicals and from handling and storage of raw and finished products, mainly through accidental spills. Negative impacts may also arise from wastewater and solid waste management.

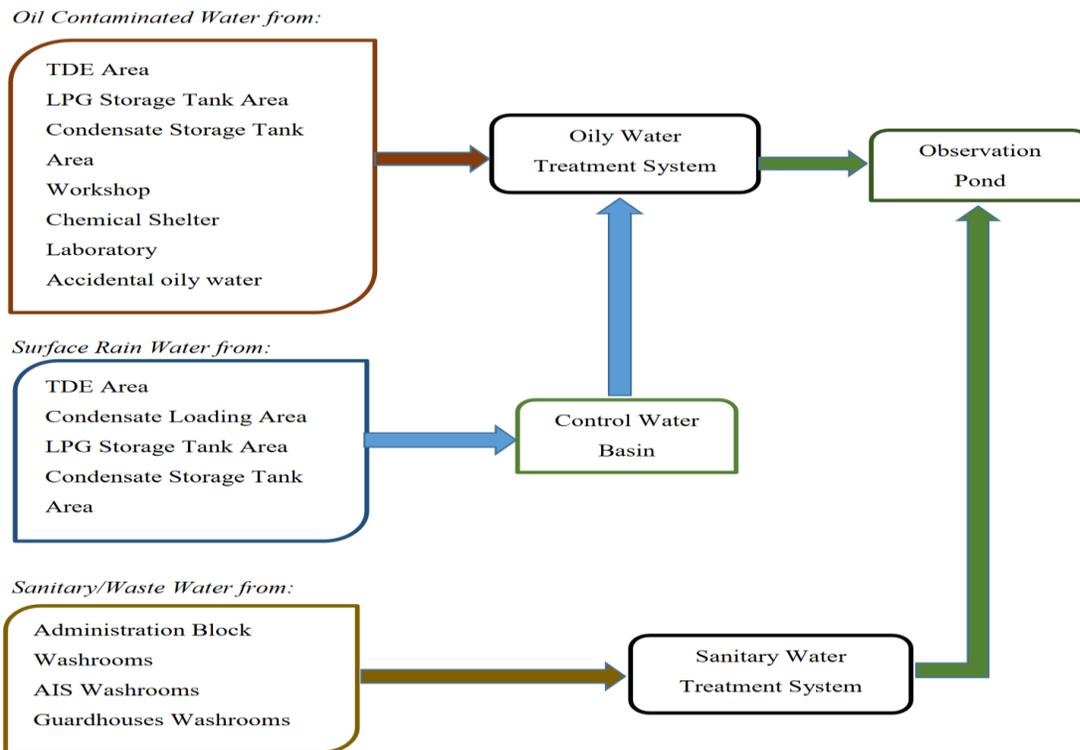
Experience from the operations of GPP Train 1 indicates that there have not been any major spills since operations began because of targeted preventive measures that are maintained (GNGLC, 2019e; 2021a). For example, bunds have been constructed around the storage tank areas to contain any spills from the tanks and obsolete and expired chemicals are returned to the supplier or stored under the hazardous waste shed on non-permeable surfaces. Waste oil is also stored in labelled containers under the hazardous waste shed. In addition, while liquid wastes are treated to permissible standards before discharge, chemicals, waste oil, and other hazardous solid wastes are transported offsite by accredited waste management companies for reuse, recycling, or treatment. More details are provided below in the sections on liquid and solid wastes.

*From the above, the potential negative impacts of operations of Train 2 on soils may be considered moderate. However, considering the expanded operational activities in the future, especially when both GPPs operate at their full capacities, the impacts will be cumulative and of long duration and thus are rated highly significant.*

### ***Wastewater Management***

According to an Environmentally Based Flow Chart of GPP Train 1 operations (Figure 25), the main types of wastewaters are (GNGLC, 2021a):

- i. Oil contaminated water from the main processing (TDE) area, condensate storage tank area, workshop, chemical shelter, and laboratory. This is sent to the Oily Water Treatment System.
- ii. Sewerage from the administration block, Atuabo Initial Station (AIS), guard houses, and Sinks 1 and 2, which is directed to the Sanitary Treatment System.
- iii. Surface rainwater from the TDE area, condensate loading area, LPG storage tank area AIS, and the LPG recovery train. This is sent to the Control Water Basin,



Source: GNGLC.

Figure 25 Environmentally Based Process Flow Chart

Treated effluents from the Oily Water Treatment System and the Sanitary Treatment System are sent to the Observation Pond for monitoring to meet effluent standard guidelines before discharge. Accumulated wastewater contained in the Observation Pond that does not meet effluent standard guidelines is dislodged by an accredited service provider and transported to the Sekondi Takoradi Municipal Assembly effluent treatment site at Sofokrom for further treatment before safe disposal. Other liquid wastes generated, such as waste methanol and glycol, for which Ghana Gas does not

have in-house treatment capability, are stored in labelled containers, and collected by licensed waste management companies for treatment and safe disposal. These and other environmental management actions have so far led to no spills at the GPP Train 1. In addition, results of physicochemical and biological quality monitoring undertaken by Ghana Gas in 2020 and from 2016 to 2018 have shown that the quality of groundwater and effluents was good as compared to their respective standards, except for phosphate in effluents.

During the operations phase of GPP Train 2, and as indicated in Section 3.5.1 of this report, arrangements like the above will be made for wastewater management. For example, the Train 1 Oily Water Treatment System will be adequate to treat oily water delivered from Train 2. Also, sanitary wastewater from Train 2 will flow via an underground sewer system to be pumped to a Bio-Treatment Package, the effluent from which will go to the existing Observation Pond.

However, with GPP Train 2 projected to operate at 25% more than the capacity of Train 1, more volumes of wastewater are expected to be released. Available information (GNGLC, 2019e; 2021a) indicate that the following quantities of hazardous waste were produced at Train 1 from 2016 to 2018 and in 2020 (Table 53).

Table 53 Volumes of Hazardous Waste Generated: 2016-2018; 2020 (L)

Description	2016	2017	2018	2020	Mean
Waste Engine Oil	4,330	4,550	3,490	3,328	3,925
Petro-therm Waste	50	0	1,650	22,000	5,925
Glycol Waste	4,350	2,450	6,350	4,920	4,518
Closed Drain	17,280	36,100	16,460	72,080	35,450
Waste Coolant	0	800	150	-	317

Source: Compiled from GNGLC, 2019e and 2021a

As indicated above, these wastes were generated from processing of natural gas of about 88 MMSCFD, 75% of the existing capacity of Train 1. Since the combined full annual capacity of both GPPs is 350 MMSCFD, and assuming a total utilisation capacity of 280 MMSCFD, it can be deduced that about 3 times the amount of current hazardous wastes can be cumulatively produced in the future operations phase. The increased quantities of wastewaters have the potential not only

to stress existing treatment facilities within the GPP and elsewhere but to cause increased risks to occupational and public health and safety. *The potential impacts of wastewater generation are cumulative and of long duration, during the operational lives of the GPPs. They are therefore rated as of major significance.*

### ***Solid Waste Management***

Solid waste management at GPP Train 2 will be the same as it is currently for Train 1. Solid wastes will consist mainly of general waste (disposable packs, cans, and glassware); metal pieces; organic material, polythene and plasticware; and oily rags generated from the plant site, offices, laboratory, vehicle and other machinery and equipment maintenance workshops. These will be segregated into labelled colour-coded bins as follows (GNGLC, 2019e; 2021a):

- General Waste            Black Bin with Yellow Lid
- Metals                    Aluminium Skip
- Organic                    Green Bin
- Polythene/Plastics      Blue Bin
- Oily Rags                 Black Bin

Out of these, waste plasticware will be segregated, for some community members to collect and sell to recycling companies. Other solid waste (hazardous and non-hazardous) such as scrap metals, glass, used tyres, waste wood, oily rags, and used filter elements will be segregated and temporarily stored on-site. In accordance with the Public Procurement Act 2016 (Act 194), licensed waste management companies will be engaged to recycle /reuse /treat / dispose permanently offsite in line with the Hazardous, Electronic, and other Waste Control and Management Act, 2016 (Act 917) and the Ghana Gas Environmental Policy.

Records indicate that the volume of solid waste generated over the years keeps decreasing. For example, a 47% decrease occurred between 2016 and 2018 (GNGLC, 2019e) because of continuing education and increasing awareness of good waste management practices. In 2020, the quantities of non-hazardous solid waste produced during operations (about 75% capacity) of GPP Train 1 and from the Gas Complex offices were 8.46 and 7.76 tones, respectively (GNGLC, 2021a). These quantities are expected to increase by about 3 times during operations of both GPPs

at full capacity, also augmented by increases in staff numbers at processing plants and offices. *The potential impacts of waste generation are negative and of major significance because waste generation will occur throughout the lives of the GPPs.*

## **b. Biological Environment**

### ***Flora***

There will be no land clearing during the operations phase and therefore loss of vegetation will be insignificant. However, what remains of the existing degraded vegetation will need to be augmented and maintained.

### ***Fauna***

In the operations phase, the negative impacts on fauna would be minimal because those that survived the land clearing activities in the construction phase would have moved to more habitable areas, away from the project site.

### ***Ecosystem Services***

The loss of green open spaces at the GPP Train 2 site during the construction phase, will result in the loss of ecosystem services concerning habitats for animals such as birds, insects, and micro-organisms. This will also negatively impact support services such as nutrient recycling and flood control. In addition, accidental spillages of raw and finished products will lead to further losses of ecosystem services in the form of reduced occurrence of plants and animals. *These negative impacts are considered moderately significant.*

## **c. Socio-economic Component**

### ***Occupational Health and Safety***

Negative potential impacts concerning occupational health and safety during operations of GPP Train 2 will be manifested through such hazards as poor ambient air quality from gaseous and particulate emissions, increased risk of fires and explosions as well as increased noise levels, exposure to hazardous chemicals, and waste generation. These potential impacts also include the

risk of Coronavirus infections, all of which can negatively affect workers and lead to loss of productivity. They are summarised below.

### ***Ambient Air Quality (Gaseous Emissions and Particulates)***

Air emissions during the operations phase shall be composed of particulate matter and gases such as carbon dioxide, carbon monoxide, methane, nitrogen oxides, and volatile organic compounds. Apart from emissions to the atmosphere, there is the potential for emissions at the ground level within the gas processing plant. As indicated above, at the peak of operations of both Trains 1 and 2, it is expected that emissions will be about three times the current quantities.

For workers of both GPPs, exposure to high levels of fine particulate matter and gaseous emissions in the atmosphere and at ground level over long periods may cause increased occupational health problems including headaches, dizziness, nausea, and convulsions (Fuller, 2018; Manisalidis *et al.*, 2020) and initiate a variety of respiratory diseases such as bronchitis, emphysema, and cardiovascular diseases, and even premature deaths (UNEP and Climate and Clean Air Coalition, 2021). *These potential impacts on occupational health and safety are assessed to be highly significant.*

### ***Fires and Explosions***

During the processing of natural gas, most of the raw materials, semi-finished products and final products are flammable and explosive liquids and gases. Gas releases may cause “jet fires” or give rise to a vapour cloud explosion, fireball, or flash fire, depending on the quantity of flammable material involved and the degree of confinement of the cloud. Flammable liquid spills may cause “pool fires.” Explosive hazards may also be associated with the accumulation of vapours in storage tanks. Under the pressurized conditions, in which gas processing is carried out, the occurrence of leaks, can also cause fires and explosions. Again, fluid media may generate static electricity during transportation, venting, leaking, pumping, or sampling and cause fires and explosions (IFC, 2016).

The potential for fires from GPP Train 2 is summarised in Table 54. Fires and or explosions resulting from ignition of flammable materials or gases can lead to loss of property as well as possible injury or fatalities to plant workers. Unlike other hazards such as air and water pollution,

fires and explosions can cause many fatalities in a short time. Added to the above are the same potential impacts from Train 1 and the fact that at full capacity the two GPPs will process 350 MMSCFD of natural gas compared to about 88 MMSCFD in 2020. Despite fire-prevention and management measures currently employed during Train 1 operations (GNGLC, 2019e), *the potential negative impacts on occupational health and safety during this phase, are assessed as of major significance and would require mitigation measures.* The fire and explosion risk assessment for the GPP2 project is summarized in Section 7.4.2.

Table 54 Potential for Fire/Explosion Hazards from Gas Processing Operations

<b>Operation / Process</b>	<b>Fire/Explosion Hazard</b>
<i>Heat Exchangers, Coolers, and Process Heaters</i>	There exists the chance of explosions when lighting fires in heater furnaces. If flammable product escapes from a heat exchanger or cooler due to a leak, fire could occur.
<i>Steam Generation</i>	The most potentially hazardous operation in steam generation is heater start up. A flammable mixture of gas and air can build up because of the loss of flame at one or more burners during light-off with the potential of fire and explosion.
<i>Pressure-Relief and Flare Systems</i>	The potential exists for fires if vapours and gases discharge where sources of ignition could be present.
<i>Electric Power</i>	Generators that are not properly classified and are located too close to process units may be a source of ignition should a spill or release occur.
<i>Gas and Air Compressors</i>	There is a potential for fire should a leak occur in gas compressors or if the compressors are located such that their suctions take in flammable vapours or corrosive gases.
<i>Truck Loading and Unloading</i>	The potential for fire exists where flammable vapours from spills or releases can reach a source of ignition.
<i>Pumps, Piping and Valves</i>	The potential for fire exists should hydrocarbon pumps, valves, or lines develop leaks that could allow vapours to reach sources of ignition.
<i>Tank Storage</i>	The potential for fire exists should hydrocarbon storage tanks be overfilled or develop leaks that allow vapours to escape and reach sources of ignition.
<i>Wastewater Treatment</i> (for process, runoff, prior to discharge or recycling.)	When waste coolant is contaminated by hydrocarbons, flammable vapours can be evaporated into the discharge air. If a source of ignition is present, or if lightning occurs, a fire may start.

Source: Adapted from OSHA (1999)

### **Noise**

The major sources of noise during the operations phase of Train 2 will be the overhead compressor area, glycol regeneration area, and the generator set area (GNGLC, 2019e). As indicated above, the possible negative health impacts on the workers include hearing loss, stress, sleep disturbance and deprivation, elevated blood pressure, and heart disease which may be short- or long-term. *Thus, during the operations of both GPP Trains 1 and 2 at full capacity, the cumulative negative impacts of noise on occupational health and safety will be highly significant.*

### **Hazardous Chemicals**

The major chemicals used in the processing of natural gas include methanol, demulsifying agent, monoethylene glycol, and petro-therm (GNGLC, 2019e), all of which are hazardous to human health and the environment. For example, ethanol is highly flammable and toxic. Direct ingestion can cause permanent blindness by destruction of the optic nerve, poisoning of the central nervous system, coma, and possibly death. These hazards are also true if methanol vapours are inhaled. [https://www.cdc.gov/niosh/ershdb/emergencyresponsecard\\_29750029.html](https://www.cdc.gov/niosh/ershdb/emergencyresponsecard_29750029.html). Ethylene glycol in the body breaks down into toxic compounds, which first affect the central nervous system then the heart, and finally the kidneys. Ingesting enough can cause death. Thus, improper handling and storage or accidental spills of these chemicals can pose health hazards to workers. Experience from the operations of Train 1 shows that Ghana Gas provides PPEs to workers during the handling and use of these chemicals. It also conducts training for the relevant staff on the use of the chemicals and stores obsolete chemicals in labelled containers for collection and disposal by accredited service providers. However, during the operations of both GPPs at their full capacities of 350 MMSCFD of natural gas compared to about 88 MMSCFD in 2020, much larger quantities of chemicals will be used. In 2020, the quantities of monoethylene glycol, petro-therm, and methanol used were 68,000 L: 25,625 L and 21,620 L, respectively. *Clearly, the potential negative impacts of hazardous chemicals are of major significance.*

### **Wastewater Management**

As explained above, the quantities of wastewater generated during the operations of Train 2 are expected to increase more than ten times compared to the current volumes. These have the potential not only to stress treatment facilities within Atuabo and elsewhere but also to cause increased risks

to occupational and public health and safety. Wastewaters typically contain a diverse array of materials including pathogens, chemicals, microplastics, and other inert materials. Discharges of untreated or poorly treated wastewaters into natural waters results in poor water quality, which directly impacts people, workers, or the public, who may rely on these sources as their main supply by further limiting their access to water (i.e., water availability) and increasing water-related health risks including cholera, typhoid, dysentery, and diarrhoea (UNESCO, 2019). Plastic micro particles in the aquatic environment can be absorbed by small organisms at the base of the food chain and can then bioconcentrate and reach very high concentrations in top predator species many of which are consumed by humans (UNEP, 2021).

*The potential impacts of wastewater generation on occupational health and safety are cumulative and of long duration, during the operational lives of the GPPs. They are therefore rated as of major significance.*

### ***Solid Waste Management***

Exemplified with the operations of GPP Train 1, hazardous solid wastes to be generated include oily rags, electronic waste, drums emptied of chemicals, and waste filter elements (GNGLC, 2019e). These are segregated and stored for collection by an accredited waste management company for recycling, treatment, or disposal offsite. The quantities of hazardous solid waste are however expected to increase significantly during operations of both GPPs at full capacity. Among others, hazardous solid wastes can be toxic, explosive, flammable, or infectious and may cause harm and injuries to workers and even fatalities. *The potential negative impacts of solid waste generation on occupational health and safety are long-term and cumulative and thus of major significance.*

### ***COVID-19 Pandemic***

In Ghana, from 3 January 2020 to 10 June 2022, there have been 161,841 confirmed cases of COVID-19 with 1,445 deaths. As of 29 May 2022, a total of 16,203,630 vaccine doses have been administered in the country (<https://covid19.who.int/region/afro/country/gh>). The Western Region ranks third behind the Greater Accra and Ashanti Regions with 8,339 confirmed cases and at least 8 confirmed deaths (<https://ghcovid19-statsghana.hub.arcgis.com/>). The pandemic is still ongoing

and can therefore have negative impacts during the operations phase of the GPP Train 2, which will operate at two times the capacity of the existing Train 1 and therefore will have more workers. Added to workers already employed at Train 1, the cumulative impacts will be direct or indirect and the duration could be short or long term while the likelihood is high. Ghana Gas is aware of the threats of the COVID-19 pandemic and has taken measures since the beginning of 2020 to train and equip its workers in preventing and controlling the infection (GNGLC, 2021a) and *will continue to take mitigative action against this highly significant potential impact during the operations of GPP Train 2.*

### ***Public Health and Safety***

Negative potential impacts concerning public health and safety during operations of GPP Train 2 will be manifested through such hazards as poor ambient air quality from gaseous and particulate emissions, increased risk of fires and explosions, increased noise levels, exposure to hazardous chemicals, and waste generation. They also include the risk of Corona virus infections. The most sensitive areas will be the communities on the Krisan-Beyin Road as summarised below.

### ***Ambient Air Quality (Gaseous Emissions and Particulates)***

The local communities such as Ngalekyi, Baku, and Ekebaku are located very close to the GPP Train 1 while Asemnda and Atuabo even closer to Train 2. The potential negative impacts of air emissions during the operations phase will be like those described for occupational health and safety above. These include increased health problems caused by prolonged exposure to fine particulates and noxious gases. These potential impacts are in addition to concerns on flaring raised by different stakeholders during the scoping exercise. *These potential impacts on public health and safety are assessed to be highly significant.*

### ***Fires and Explosions***

Just as for gaseous emissions and particulates, the potential impacts of fires and explosions will affect the nearby communities. They will also negatively affect vehicular movement on the Krisan-Beyin Road. Considering that these areas do not have control measures in place in anticipation of such events, *these potential impacts are of high significance.*

### **Noise**

As described for occupational health, the potential negative impacts of noise will be the same for public health and safety because of the close location of the nearby communities to the GPPs. *The impacts of noise and vibration are assessed as highly significant.*

### **Wastewater Management**

Just as for occupational health and safety, *the potential impacts of wastewater generation on public health and safety are cumulative and of long duration, during the operational lives of the GPPs. They are therefore rated as of major significance.*

### **Solid Waste Management**

The quantities of hazardous solid waste are expected to increase significantly during the operations of both GPPs at full capacity. Among others, hazardous solid wastes can be toxic, explosive, flammable, or infectious, and may cause harm and injuries and even fatalities. Apart from workers at the GPP sites, the same potential negative impacts can affect the public, especially people in nearby communities. *The potential negative impacts of solid waste generation on public health and safety are therefore long term and cumulative and are considered highly significant.*

### **COVID-19 Pandemic**

As indicated above, under Occupational Health and Safety, Ghana Gas is aware of the threats of the Covid-19 pandemic. It has taken steps not only to support its workers to protect themselves against the infection but also since the beginning of 2020 provided various forms of assistance to the local health authorities and communities to prevent and bring infections under control (GNGLC, 2021a). These include cash and material donations to the Nzema East Municipal, Ellembelle and Jomoro District Assemblies and the A3 Communities to control the COVID-19 pandemic. In the operations phase of Train 2, the influx of new workers and job seekers to the Ellembelle District and especially the A3 Communities will result in cumulative impacts the likelihood of which is high. *The potential impacts on public health and safety are thus rated as of high significance.*

### ***Regulatory Requirements***

Regulatory requirements need to be followed and respected during all phases of the project activities. In the operations phase of Train 2, the relevant regulatory requirement will include those for the petroleum sector (National Petroleum Act, 2005 (Act 691), Petroleum Local Content and Participation Regulations, (2013), employment (Labour Act 651, 2003), fire prevention (Ghana National Fire Services Act, 1997 (Act 537), and water use (Water Use Regulations, 2001 (L.I. 1692). Others are the Hazardous and Electronic Waste Control and Management Act, 2016 (Act 917) and the EPA Environmental Quality Standards for noise, air quality and effluent discharges. *As in the pre-construction and construction phases, the adverse impacts of disregarding regulatory requirements are assessed as of major significance..*

### ***7.3.4 Decommissioning and Closure Phase Impacts***

#### ***i. Potential Impacts***

The closure of GPP Train 2 at the end of its operational period will entail following procedures in a Rehabilitation and Decommissioning Plan to be developed. During this phase, Train 2 will cease to function and all structures, plant units, machinery, and equipment will be dismantled. GNGLC will carry out reclamation of the plant site to a stable and safe condition for appropriate use. For example, all destroyed vegetative areas will be restored with appropriate native vegetation.

The interactions between the decommissioning and closure phase activities and the environmental and socio-economic components are presented in Table 55. Most negative interactions will result from the dismantling of infrastructural components and waste management while the most positive interactions will come from land reclamation.

Table 55 Matrix of Decommissioning and Closure Phase Activities and Environmental and Socio-economic Components

Environmental and Socio-economic Components	Acquisition of Permits and Approvals	Recruitment	Dismantling of Components	Management of Movable Assets	Management of Unmovable Assets	Waste Management	Land Reclamation
<b>Physical</b>							
Air Quality							
Noise and Vibration							
Landscape/Drainage							
Soils and Erosion							
Surface Water							
Groundwater							
<b>Biological</b>							
Flora							
Fauna							
Ecosystem Services							
<b>Socio-economic</b>							
Employment							
Local Economy							
National Economy							
OHS*							
PHS**							
Land Use							
Regulatory Requirements							
Relevant Stakeholders							

\* OHS: Occupational Health and Safety

\*\* PHS: Public Health and Safety

**Legend:**

	<b>Activity does not interact with environmental or socio-economic component</b>
	<b>Activity interacts positively with environmental or socio-economic component</b>
	<b>Activity interacts negatively with environmental or socio-economic component</b>

**ii. Significance of Impacts**

Based on the identified interactions in Table 56 above, the overall significances of potential impacts during the decommissioning and closure phase are presented in Table 7-11 below. Apart from recruitment, which will have a moderately significant impact (8), all other impacts will be of major significance (11-12). More details are provided below.

Table 56 Significance of Impacts – Decommissioning and Closure Phase

<b>Operations Activities</b>	<b>Potential Impacts</b>	<b>Legal/Regulatory</b>	<b>Importance</b>	<b>Risk</b>	<b>Perception</b>	<b>Significance</b>
Acquisition of Permits and Approvals	Inability to start this phase without relevant permits and approvals	3	3	3	3	<b>12</b>
Recruitment	Employment opportunities resulting in improvement in the local economy;	3	1	1	3	<b>8</b>
Dismantling of Components	Increased erosion of soils	1	1	1	1	<b>4</b>
	Surface water and groundwater pollution;	3	3	3	2	<b>11</b>
	Occupational and public health and safety risks, e.g., from noise and emissions;	3	3	3	2	<b>11</b>
	Loss of business opportunities dependent on Train 2 operations;	2	3	3	3	<b>11</b>
Management of Movable Assets	Business opportunities for local entrepreneurs;	3	3	3	3	<b>12</b>
Management of Unmovable Assets	Business opportunities for local administrators and entrepreneurs;	3	3	3	2	<b>11</b>
Waste Management	Business opportunities for local entrepreneurs;	3	3	3	3	<b>12</b>
	Soil, surface water and groundwater pollution;	3	3	3	2	<b>11</b>

Operations Activities	Potential Impacts	Legal/Regulatory	Importance	Risk	Perception	Significance
	Occupational and public health risks;	3	3	3	3	12
Land Reclamation	Improved biodiversity;	3	3	3	3	12
	Occupational and public health risks;	3	3	3	3	12

**iii. Specific Positive Impacts**

In the decommissioning and closure phase, positive impacts will be associated with the biological environment and the socio-economic component.

**a. Biological Environment**

**Flora**

Rehabilitation of the location of GPP Train 2, when fully completed, will be beneficial for recovery and increase in diversity of plants. This restoration will enable the site to be used for various purposes depending on the objectives of the traditional and administrative authorities. The potential positive impacts, which may be of short or long duration, will be local but of major significance.

**Fauna**

The recovery of plant diversity after rehabilitation of the project area will also be directly beneficial for faunal diversity. This is a potential positive impact that will be highly significant.

**Ecosystem Services**

Just as for floral and faunal diversity, ecosystem services will improve with the decommissioning and closure of GPP Train 2 followed by land rehabilitation. Since ecosystem services, directly and

indirectly, support human wellbeing, the potential positive impacts are considered of major significance.

## **b. Socio-economic Component**

### ***Employment and State of Economy***

Every phase of the GPP Train 2 project will have potential positive impacts on employment including the decommissioning and closure phase. During this phase of the project, there will be positive impacts from employment opportunities for skilled and unskilled workers to dismantle the components and reclaim the land. There will also be opportunities for local entrepreneurs as well as the administrative and traditional authorities who would be involved in the management of both movable and unmovable assets which would lead to improvement in the local economy. However, these potential positive impacts will be of relatively short duration in this phase and are rated as moderately significant (Table 7-10). The magnitude of these impacts will also be reduced because of the job losses that would arise from the closure of the GPP.

### ***Relevant Stakeholders***

Engagement by Ghana Gas of the relevant stakeholders during the decommissioning and closure phase will bring potential positive impacts, especially during the disposal of movable and unmovable assets. Concerning the latter, movable assets such as furniture and pipes may be sold to EPA-certified collectors to enhance their businesses and therefore, the local economy. Immovable assets may be disposed of in consultation with the traditional and government administrators.

## ***iv. Specific Negative Impacts***

### **a. Physical Environment**

#### ***Air Quality***

During the decommissioning and closure phase, gaseous emissions will occur mainly from vehicular movements and operations of machinery used for dismantling the components of the gas

processing plant and other auxiliary structures. Also, these activities will result in dust emissions that will affect air quality. Deterioration of air quality will pose health problems to workers as described for other phases of the project above. *These impacts, although of relatively short duration, are considered highly significant because of their likelihood of affecting human health.*

### **Noise**

Noise and vibrations will occur from both vehicular movements and operations of machinery used for dismantling structures. Apart from the workers, these will also negatively affect the nearby Communities and workplaces. *These impacts, although of relatively short duration, are considered highly significant because of their likelihood of affecting human health.*

### **Soils and Erosion**

Land clearing and excavation will not occur in this phase to cause soil loss. However, improper maintenance of the drainage system developed for Train 2, especially during the dismantling of components, could cause flooding and result in erosion of land areas. *The negative impacts will be project-site specific and of short duration and thus rated as being of minor significance.*

### **Surface Water and Groundwater Quality**

Pollution of surface water and groundwater from storm runoff, oil, and other waste spillages from vehicles and machinery used for dismantling structures could occur in this phase. *The potential negative impacts are assessed as highly significant.*

### **Waste Management**

Various types of wastes will be generated during the dismantling of components and management of movable assets. The inability of the contractor to properly manage especially the hazardous waste could pose serious problems as already discussed for other phases above. *The potential negative impacts will affect human health and are therefore rated as of major significance.*

## **b. Socio-economic Component**

### ***Employment and State of Economy***

During this phase, although there will be some moderate economic gains for contractors involved in dismantling and transportation of components of the GPP, there will be even more significant losses of jobs and business opportunities that depend on the operations of Train 2. The impacts will affect both the national and local economies.

### ***Occupational and Public Health and Safety***

Increased dust emissions are expected during the dismantling of the components of GPP Train 2. Gaseous emissions are also expected from the movement of vehicles to and from the project site. Furthermore, possible fire outbreaks and explosions arising from improper handling of fuel or chemicals on site or leakages from equipment and vehicles may also pose hazards to the workers and the public. Accidents may also occur from the transfer of dismantled components from the project site. These are all likely to result in negative impacts on the health of workers and the public. *The potential negative impacts are of short duration but because they will affect human health are assessed to be of major significance.*

### ***Regulatory Requirements***

During the decommissioning and closure phase, regulatory requirements that must be taken into account include those for employment (Labour Act 651, 2003), fire prevention (Ghana National Fire Services Act, 1997 (Act 537), Hazardous and Electronic Waste Control and Management Act, 2016 (Act917) and the GSA Standards for noise, air quality and effluent discharges. *Just as for the other phases, the negative impacts of disregarding regulatory requirements are highly significant.*

## **7.4 Specialist Studies**

Pursuant to the concerns and issues raised during the scoping exercise, review of the draft EIA by the EPA and gap assessment of the EIA processes specialist studies were conducted to ensure the overall project sustainability and acceptability in accordance with the requirements of the IFC Performance Standards, the industry standard sustainability framework implemented by International Financial Institutions (IFI) to private sector development, and applicable to the GPP2

Project and Good International Industry Practice (GIIP). The specialist studies are summarized below whereas the full documents are provided as Appendixes to this report.

#### ***7.4.1 Flood Risk Assessment***

The flood risk assessment was carried out to assess the flood risk to the proposed GPP2 from all sources of flooding, including coastal, groundwater, fluvial and pluvial flooding. Flood risk assessments are essential for ensuring the safety and continuity of operations at gas processing plants to minimize the environmental and safety risks associated with flooding. They are crucial for informed decision-making on plant and facility design, disaster and emergency preparedness and planning, and regulatory compliance. As part of the flood risk assessment, flood inundation simulation was conducted covering the towns of Atuabo, Asemnda and Anokyi using HEC-RAS. The current condition shows the drainage point just north of the existing GPP1 has a minimal discharge capacity with attenuation of 80 to 90% of the incoming flow. The flow difference results to the water stored at the west side of GPP area leaving it inundated and swampy for an extended period.

The existing GPP1 was assessed not to be affected by flooding. However, it was observed that some areas in the Anokyi community are susceptible to flood with minor depths of 0.0 – 0.50 meters for the most extreme flood events. It is important to note that this scenario is not caused or intensified by the GPP facilities.

Furthermore, the proposed GPP Train 2 area clearly impedes the natural flow of water which will cause the inundation level at the western section of the proposed GPP2 project site, albeit within the GPP Enclave, to rise even higher. This will then affect GPP1 and expand the inundation area without proper drainage, thus impact assessed as significant without any mitigation measures.

The flood susceptibility condition without GPP Train 2 is provided in Plates 18 to 20 whereas the flood susceptibility condition with GPP Train 2 in place and recommended mitigation measure implemented in provided in Section 8.4.1 (Plate 30 & 34).

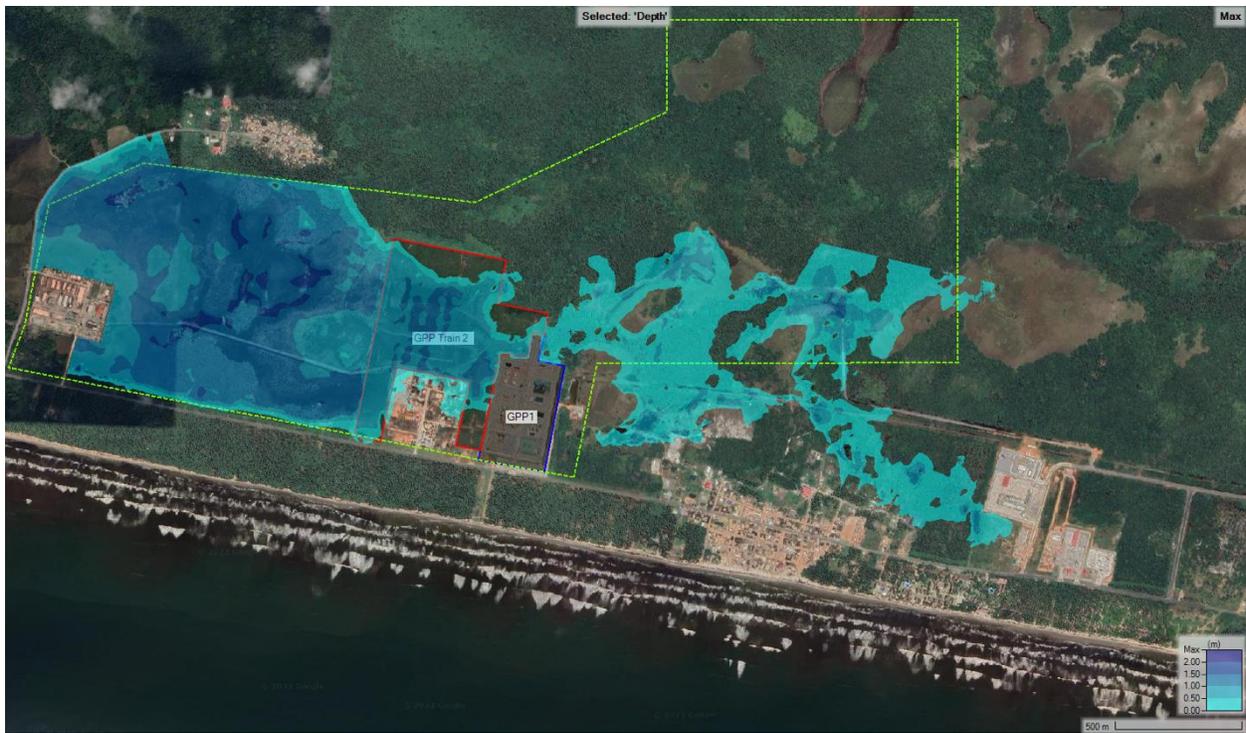


Plate 18 Flood Susceptibility Map for Current Condition (Without GPP Train 2) (5-yr Return Period)

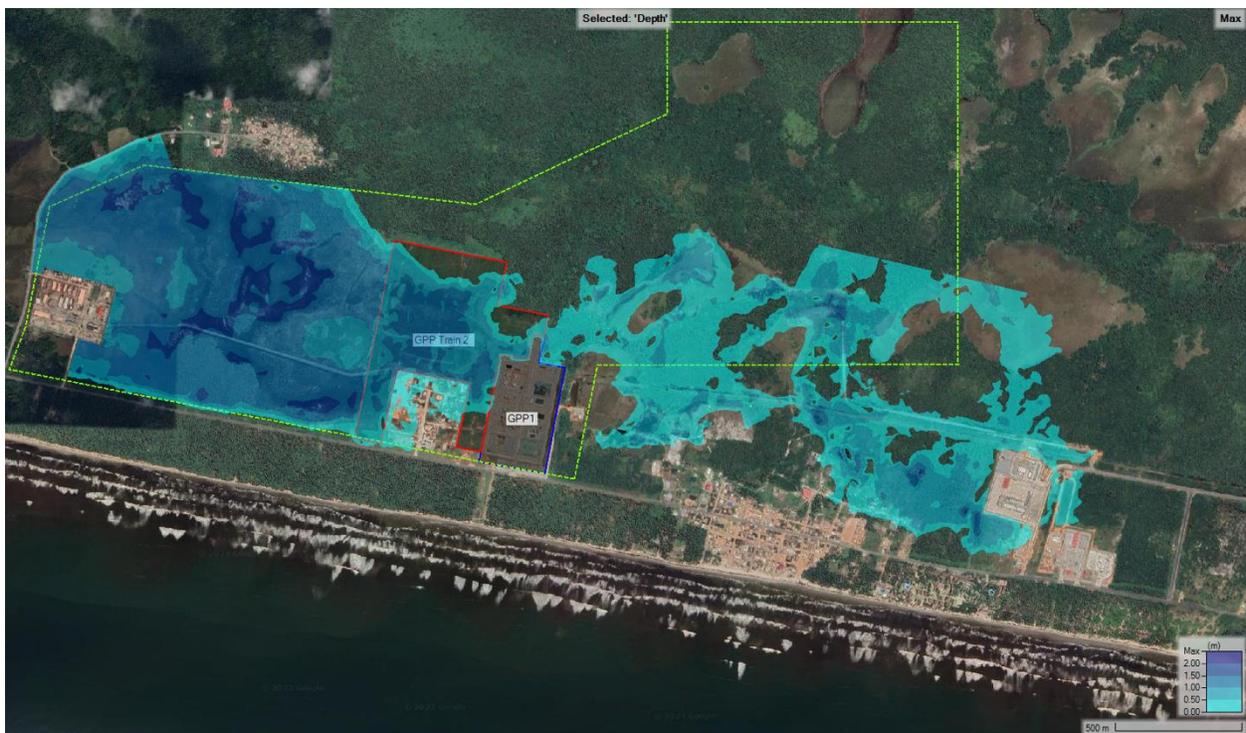


Plate 19 Flood Susceptibility Map for Current Condition (Without GPP Train 2) (10-yr Return Period)

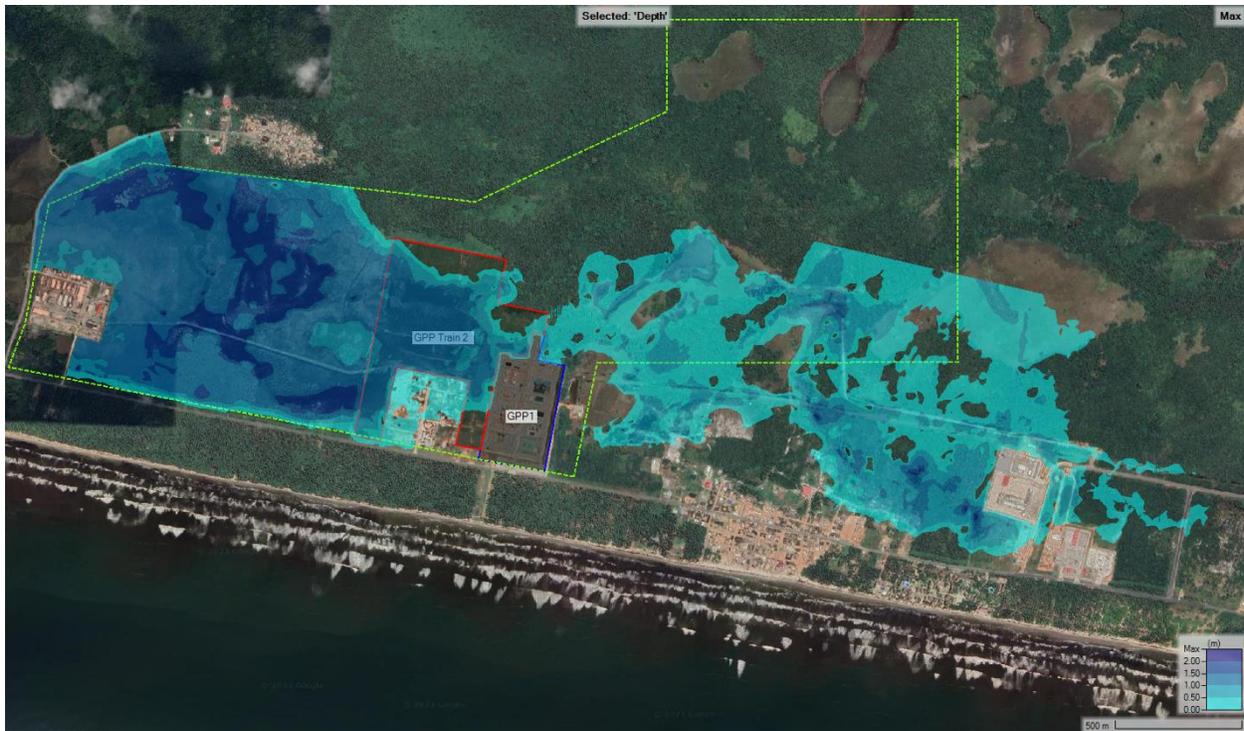


Plate 20 Flood Susceptibility Map for Current Condition (Without GPP Train 2) (25-yr Return Period)

#### ***7.4.2 Quantitative Risk Assessment and Fire and Explosion Risk Assessment***

As part of the specialist studies to ensure the sustainability of the GPP2 project and safeguard occupational and public health and safety in accordance with the IFC Performance Standard 3 &4, both Quantitative Risk Assessment (QRA) and Fire and Explosion Risk Assessment (FERA) were carried out to identify all relevant hazards and potential accident scenarios to be associated with GPP2, calculate and model the risk level in terms of location specific individual risks within the GPP2 and its immediate vicinity.

The outcome of both studies indicates that Location Specific Individual Risk (LSIR) depicting the geographical distribution of risk puts the most severe risks and hazards at only the GPP2 and GPP1 projects sites. The means that in terms of occupational health and safety, the fire and explosion risks at GPP2 is highly significant with one chance in 10 to one chance in 10,000 of being killed per year with jet fire, pool fire and flash fire (see Plates 21 to 24).

On the other hand, the modelled LSIR puts Asemnda at the least risk level in the event of fire and explosion at GPP2. Specifically, the modelled fire and explosion risk ascertained that there is one

chance in 1,000,000 to one chance in 10,000,000 of being killed per year at Asemda if there should be fire and explosion at GPP2. This also means that there is no chance of being killed at Anokyi and Atuabo. Thus, in terms of public health and safety, the fire and explosion risks of GPP2 to the A3 communities (Asemda, Atuabo and Anokyi) is low with minor significance (see Plate 25 & 26).



Plate 21 LSIR Contour for– Jet Fire 12.5kW/m2

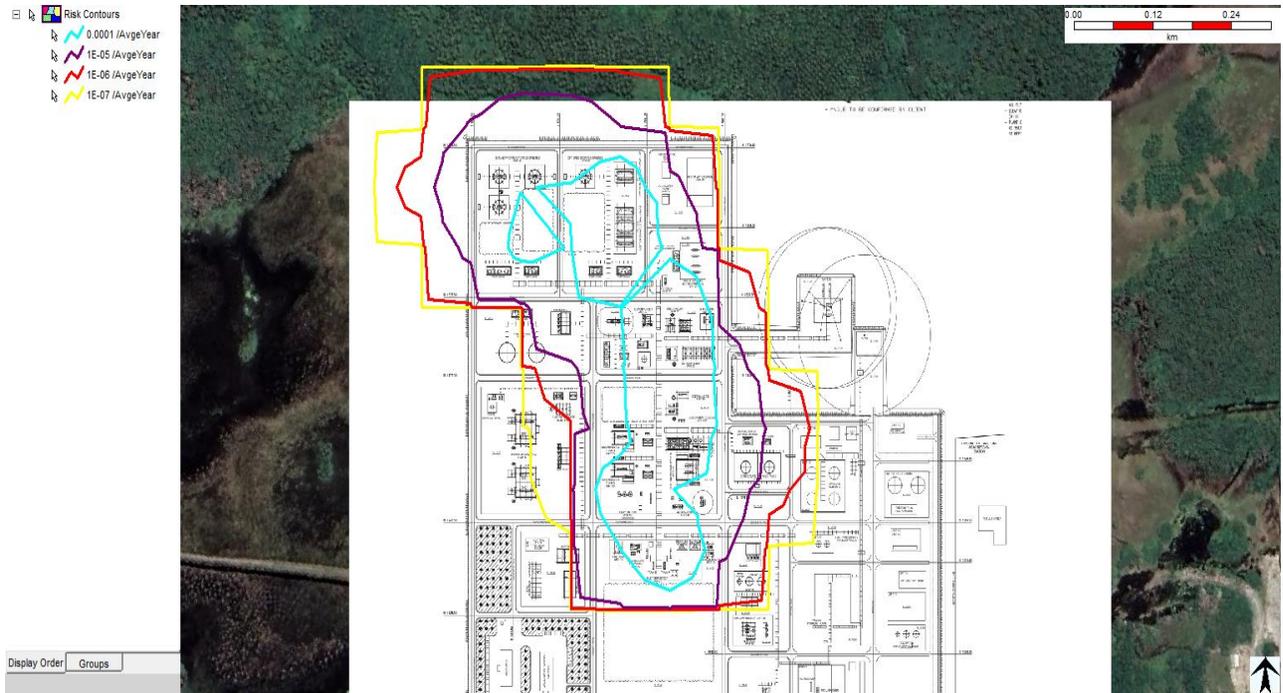


Plate 22 LSIR Contour for– Jet Fire 37.5kW/m2

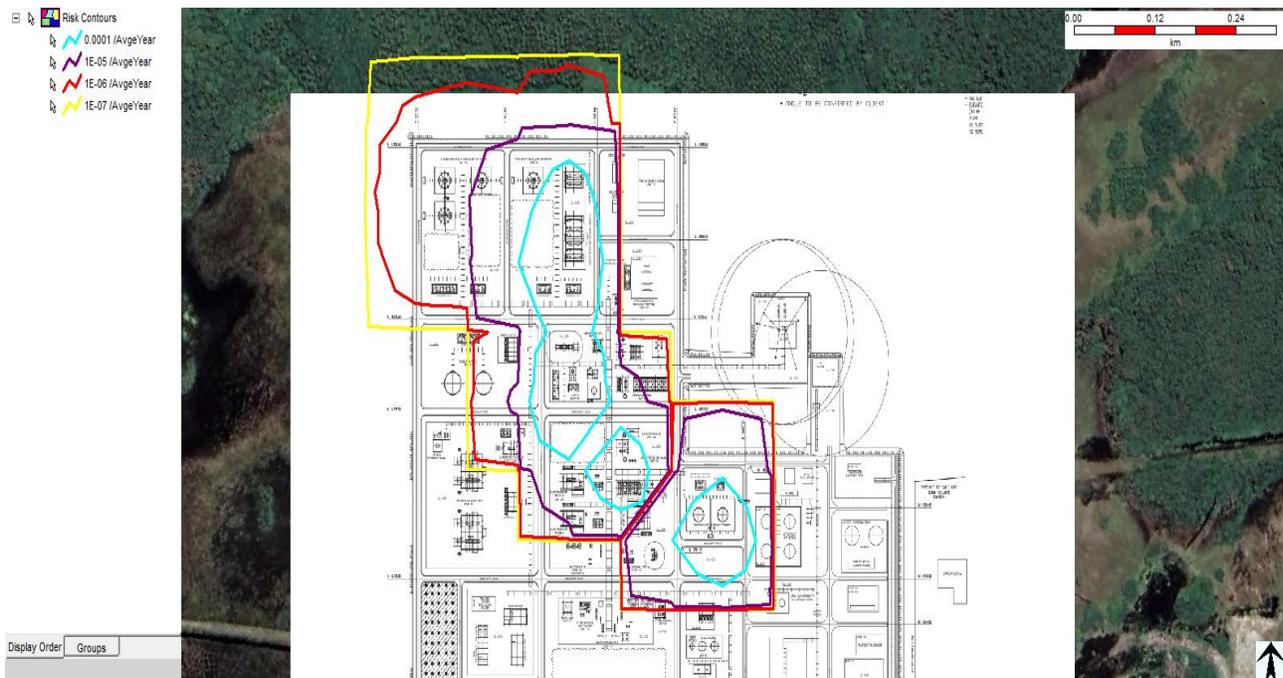


Plate 23 LSIR Contour – Pool Fire 12.5kW/m2



Plate 24 LSIR Contour – Pool Fire 3.75kW/m2

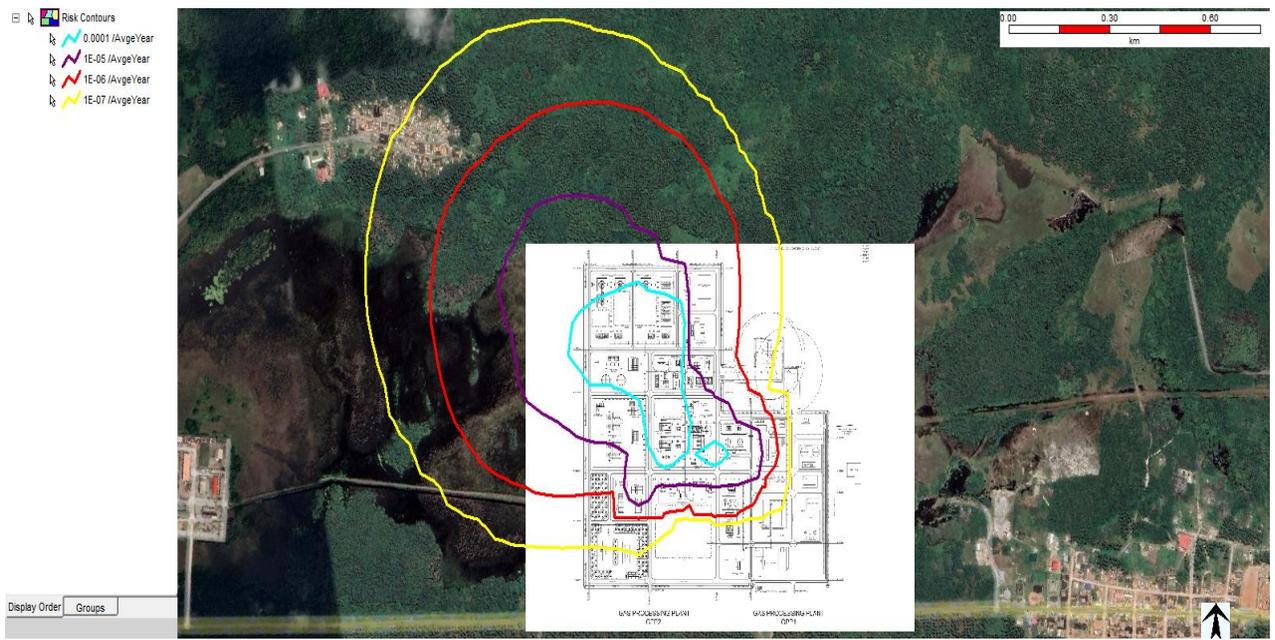


Plate 25 LSIR Contour– Flash Fire



Plate 26 Overall Outdoor LSIR Contour

### 7.4.3 Climate Change Risk Assessment

The Task Force on Climate-related Financial Disclosures (TCFD) recommends that risks and opportunities that climate change and the global energy transition present to the oil and gas business is huge thus they should be identified through an integrated risk management process. Pursuant to this, energy transition is expected to change the environment in which GPP2 will be operated. The impact of these changes will depend on the speed, depth, and geographic distribution of the energy transition, all of which remain uncertain. The evaluation of potential risks as they pertain to GPP2 operation are provided in Table 7-12, using the Carbon Disclosure Project's (CDP) categorization of risk types, risk drivers and potential financial impacts as required in its 2020 Climate Change Questionnaire for oil and gas companies. In line with TCFD and CDP recommendations, potential risks are divided into:

- Physical risks stemming from the physical impacts of climate change. This can be divided into two types: acute risks from increased severity of extreme weather events such as storms and floods and increased incidence of wild-fires and other climate-related emergencies and chronic risks from changes in precipitation patterns, extreme variability in weather, rising mean temperatures, rising sea levels and increased incidence and intensity of droughts.

- Transition risks stemming from the world's transition to a lower carbon economy. These are generally considered under four headings suggested by the TCFD: Policy and Legal, Technology, Market and Reputation.

The Physical and Transition risks identified, the assessment of their impacts on GPP2 operations, and the recommended actions to take to mitigate these risks, are summarised in the Climate Risk Table below.

Table 57 GPP2 Climate Risk Table

Risk		Risk Driver	Impact on GPP2 Operations	Timeframe		
Physical	Chronic	Sea-level rise, drought and variable rainfall patterns.	Direct impact on GPP2 operations could be loss of houses at the adjacent coastal communities, loss of GPP2 & GPP1 infrastructure due to sea level rise induced coastal flooding, loss of farmlands and productivity due to drought. This could lead to conflicts over land and food security in turn leading to increased militancy and agitation against the GPP operations.	Short Term	Medium Term	Long Term
	Acute	Flooding from heavy rainfall.	Unmotorable roads, storm drain damage, destruction to community livelihoods and accessibility, indirect burden to increase CSR budget allocation and spending to provide relief items.	Short Term	Medium Term	Long Term
Transition	Market	Increased uncertainty and volatility for gas prices.	Significantly lower gas prices could negatively impact revenues, profits & cash flow. Significantly higher prices could also negatively impact the Ghanaian economy and make gas processing business less competitive because prices will be exorbitant for consumers.	Short Term	Medium Term	Long Term
		Reduced demand for gas.	Limiting global warming to 1.5°C or 2°C requires global demand for gas to decline sharply. This could affect the Consortium's ability to sell products thus increasing uncertainty around the strategy for domestic gas business.	Short Term	Medium Term	Long Term

Risk		Risk Driver	Impact on GPP2 Operations	Timeframe		
		Increased costs of raw materials.	Climate change is likely to have a growing impact on trade patterns; the energy transition will have a significant impact on demand for specific metals, other commodities, and products. These impacts may translate into higher prices for steel, chemicals and other materials that will be used in GPP2 business.	Short Term	Medium Term	Long Term
		Repricing and stranding of assets.	If stakeholders expect that oil & gas demand will fall in line with global decarbonisation goals, there could be a negative impact on the valuation of GPP2 assets and share price and raise fears of the longer-term gas processing becoming stranded.	Short Term	Medium Term	Long Term
		Cost of capital.	The cost of capital may increase if investors perceive the climate-related financial, reputational or other risks of investing in the GPP business are growing or if GPP2 operations is viewed negatively relative to other peers in the industry.	Short Term	Medium Term	Long Term
	Policy and Legal	Carbon pricing mechanisms.	Currently there is no regulatory emissions pricing, taxation, or emissions trading schemes in Ghana, and it is expected that it is likely to be some time before global carbon pricing becomes a practical reality. Even if GPP2 will not directly be impacted by carbon pricing mechanisms, it is noteworthy that such costs could be passed down through the supply chain and result in increased operational costs over time.	Short Term	Medium Term	Long Term
Increased regulation		Increasing concern around the impact of climate change and efforts to meet the Paris Agreement could lead to more	Short Term	Medium Term	Long Term	

Risk		Risk Driver	Impact on GPP2 Operations	Timeframe		
		and reporting requirements.	international agreements and regulatory measures seeking to curb global GHG emissions, which could in turn lead to new mandates on or regulation of GPP2 business potentially increasing costs or affecting demand.			
		Growing of legal cases being brought against fossil fuel companies.	Increased scientific and judicial understanding of the link between GHG emissions and physical climate impacts and a growing body of regulation raises the risks of fossil fuel companies being sued in the courts. For instance, the operations of GPP1 are already being blamed by the local communities as the sole cause of extreme heat and temperature within the local communities.	Short Term	Medium Term	Long Term
	Technology	Substitution of gas with low-carbon forms of energy.	Further rapid development of renewable energy technologies, including for batteries and other forms of energy storage, together with falling prices could drive renewables to become an ever-larger share of the global energy mix and impact on demand for gas.	Short Term	Medium Term	Long Term
		Cost of GHG emissions & technology.	Adopting technology to reduce emissions, particularly flaring, will have implications for capital and operating expenditure	Short Term	Medium Term	Long Term

Risk		Risk Driver	Impact on GPP2 Operations	Timeframe		
	Reputation	Increased stakeholder concern or negative stakeholder feedback	Increasing concerns around the potential impacts of climate change mean that companies that do not address the issue risk being perceived negatively by investors, becoming divestment targets, or suffering increased cost of capital.	Short Term	Medium Term	Long Term

#### ***7.4.4 Habitat Quality and Impact Assessment***

Paragraph 20 of the IFC Performance Standard 6 makes specific reference for biodiversity mitigation strategy in protected and international recognized areas, particularly as the GPP enclave is within the Amansuri wetland catchment area, which is noted for the occurrence of international important biodiversity species making it an internationally recognized area.

Guidance Note (GN2) of IFC PS 6 recognizes that sustainable development cannot be achieved if either biodiversity or ecosystem services are lost or degraded by development efforts. IFC PS6 further provides the criteria and requirements for habitats categorization; natural habitat (Paragraphs 13 and 14), modified habitats (Paragraphs 11 and 12) and critical habitats (Paragraph 16 and 17). Paragraph 9 of the IFC PS 6 defined Habitat as a terrestrial, freshwater, or marine geographical unit or airway that supports assemblages of living organisms and their interactions with the non-living environment.

Per the assessment of the biodiversity screening, there is no critical habitat within the GPP2 project site although the unique black peat wetland (regarded as Critical Habitat) is in proximity to the GPP enclave. Thus, the existing habitats within the GPP2 project site and its enclave fall with the category of Natural and Modified habitats per the IFC PS 6 guidelines in paragraphs 13 and 14 and 11 to 12 respectively.

#### **Biodiversity Impact Assessment Criteria**

The key primary ecological concern of the GPP enclave may stem from:

- Changes in the provision of ecosystem services because of loss of species and/or natural habitats.
- Habitat loss and degradation, (e.g., earthworks, vegetation clearing, pollution, air emissions). For example, possible pollution of the swamp that support biodiversity.
- Habitat fragmentation — ecosystems and their species need a certain amount of interconnectivity for processes to continue; breaking a natural area into smaller pieces, means that eventually species could disappear and certain functions could be lost; e.g., adverse impact on the water quality and flow regimes of the streams within the wetland

catchment could potentially impact adversely on vegetation and associated fauna, also avifauna species could be deprived of valuable food items, habitats and breeding grounds.

- Loss of species, e.g. the plants and animals endemic to a particular habitat will not be able to survive if that habitat is destroyed or altered by the development.
- Changes in natural environmental processes, such as reduced river flow, discharge of brine into nearshore/coastal environment, coastal sediment transport, which can have long-term impact on habitats and species.

**Biodiversity Impact Assessment**

It is evident that any activity or development in a natural area will impact on the surrounding environment in either a positive or negative way. Thus, the purpose of the biodiversity screening amongst others was to determine and assess the major potential impacts associated with the GPP2 construction and operation on the ecological environment and biodiversity, and to determine mitigation requirements post construction.

The significant impacts of the GPP2 construction and operation on habitat and biodiversity (flora and fauna) is provided in Tables 58. Based on the current information, the most pertinent and significant potential impacts (negative) associated with the GPP2 on indigenous fauna and flora would span from medium to low but with the activation of the appropriate mitigation measures in line with the IFC PS6 requirement, most negative impacts are expected to be low to negligible.

Table 58 Biodiversity Impact Significance of GPP2 Development

Negative Impact	Source of Impact	Impact Significance (without mitigation measure)
Habitat fragmentation	GPP2 construction could cause fragmentation of habitats or loss of natural habitats	Medium
Recurring disturbance to fauna utilizing the area	Operational noise from GPP2	Medium
Destruction of food sources for fauna	Clearing of vegetation and land preparation activities for construction	Medium

Negative Impact	Source of Impact	Impact Significance (without mitigation measure)
Swamp <sup>4</sup> wetland destruction	Swamp wetland habitat destruction for construction	<b>Medium</b>

The main impact of the GPP2 project on the vegetation and plant species will occur during the construction phase of the project. Site clearance activities and earthworks during the construction phase will result in fragmentation and the removal of flora species. The loss of vegetation will be permanent within the GPP2 project site thus impact on biodiversity is expected to be medium but with the implementation of the mitigation priority measures, the impact will be low. Again, similar plant species and more are in the wider GPP enclave which will not be impacted; thus, food resources and ecosystem services may not be completely destroyed making the overall adverse impact low. The swamp wetland, which is a natural habitat, with 18ha representing 18.69% of the total swamp land cover within the GPP enclave will be removed but this would be compensated for in accordance with the NNL strategy to be developed by GNGLC as per the requirements of IFC PS6 (see Plate 27). Consequently, adverse impact will be potentially low.

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<sup>4</sup> The total area of the swamp wetland within the GPP enclave is 96.3ha.



Plate 27 Swamp Wetland withing GPP Enclave vs GPP2 Project Site

#### ***7.4.5 Human Rights and Fragile Context Risk and Impact Assessment***

Human Rights and Fragile Context Risk and Impact Assessment was carried out to provide a comprehensive assessment of human rights considerations and fragile context risks likely to be associated with the construction and operation of the GPP2. The analysis evaluates potential impacts on local communities, workers, and the environment, aiming to mitigate adverse effects and uphold human rights standards throughout the project's lifecycle, in accordance with the United Nations Guiding Principles on Business and Human Rights and ILO Declaration on Fundamental Principles and Rights at Work. The human rights and fragile context risks and impacts assessment is provided in Table 59 below.

Table 59 Human Right and Fragile Context Risks and Impact Assessment

Human Right and Fragile Context Issue	Description	Impact Significance
The right to an adequate standard of living.	The right to an adequate standard of living is one of the most salient human rights issues for the Consortium/GNGLC to consider. This right includes several components, namely adequate food, clothing, housing, water, and the continuous improvement of living conditions. This right can be impacted by the construction and operation of the GPP2 project. The allure and need to work for an oil and gas company and climate change induced low crop yield and low fish catch could dissuade the residents from engaging in their traditional livelihoods.	<b>Moderate</b>
The right to work.	The right to work entails the right of everyone to have the opportunity to make a living by work which they freely choose or accept. The influx of migrant workers during construction could threaten the residents by making accommodation within the communities too expensive. From the interaction with the residents and the vulnerable groups, the heightened expectation of the residents to work for GNGLC on the GPP projects and the inability of GNGLC to provide work opportunities for all could impact the right to work of the resident particularly those who may have the required skill sets.	<b>Moderate</b>
The right to freedom of association.	The right to freedom of association with others includes the right to form and join all types of associations, including political parties and trade unions. Currently, management of GNGLC allows all its employees to be part of a petroleum workers union where the union can negotiate or mediate on behalf of its members. It is believed that same arrangement will apply to GPP2 operation.	<b>Negligible</b>
Right to education.	The right to education for everyone aims to guarantee the right of all children to free and compulsory primary education and progressive provision of secondary and	<b>Moderate</b>

Human Right and Fragile Context Issue	Description	Impact Significance
	<p>higher education. Currently, secondary education is free in Ghana however, the right to basic education in the communities around the project is threatened due to deplorable basic education facilities in communities such as Baku, Ekabaku, Ngalekyi and Ngalekpole. Although GNGLC has provided some basic education facilities in Atuabo, Anokyi and Asemnda.</p>	
<p>Right to water and sanitation.</p>	<p>The right to water and sanitation includes the right to safe and clean drinking water as well as physical and affordable access to sanitation. GPP2 construction and operation may not have direct impact on the this right however, the inability of GNGLC to provide adequate and potable drinking water for the communities as part of its CSR constitute indirect negative impact particularly on the vulnerable groups who cannot afford bottle and sachet water.</p> <p>For example, GNGLC carried out water quality assessment on the ground water sources in Atuabo and found out that there were high levels of faecal coliform but did not go further to treat the water or provide alternative sources for the people as part of its CSR.</p>	<p><b>Moderate</b></p>
<p>The right to liberty and security of persons.</p>	<p>The right to liberty and security of the person includes the right to be free from unlawful or arbitrary arrest or detention of any kind and the ability to be free from injury to the body and the mind, or bodily and mental integrity. There is a very close connection between potential impacts on the right to liberty and security, and the quality of the GNGLC’s community engagement and sensitization process as well as its CSR projects. If people are unsatisfied with the GNGLC’s processes regarding community engagement and sensitization process as well as its CSR projects, there is a greater likelihood of unrest and protests, which in turn increase the chances of impacts on their right to liberty and security. Currently, the</p>	<p><b>Moderate</b></p>

Human Right and Fragile Context Issue	Description	Impact Significance
	<p>people in the A3 communities (Atuabo, Anokyi and Asemnda) are not enthused about GNGLC’s community engagement and sensitization process as well as its CSR projects. This was the reason the Asemnda engagement was truncated, and the peoples threatened protest if their concerns are not addressed.</p>	
<p>The right to life and the right to health.</p>	<p>The right to life encompasses a right to have one’s life protected by law and the right not to be deprived of life arbitrarily or unlawfully and the right to health includes the right to the highest attainable standard of physical and mental health. GNGLC upholds the safety of its staff on site and the safety of the public where it operates. However, it was noted during the additional stakeholder engagement that the Fire Tender at GPP1 was faulty and could not be deployed on time when there was fire incident at Maha Beach Resort is close by. If this situation had happened at GPP1, that would have been disastrous and catastrophic, thus posing threat to human life and health.</p>	<p><b>Moderate</b></p>
<p>Conflict sensitivity and community tensions.</p>	<p>The land dispute over the rightful owners of the GPP enclave by the Atuabo and Anokyi communities could be escalated and turn into full blown conflict which will in turn affect the construction and operation of the GPP2 project. If the land dispute is not resolved amicably and compensation paid to the rightful owners.</p> <p>Secondly, In order to make room for the development of GPP1, GNGLC took over the Anokyi community park, promising to provide another park for the locals. But because GNGLC broke this pledge, the local leaders are furious.</p> <p>The Chief of Anokyi provided the Plan of the Land earmarked for developing the new community park but there was no action from GNGLC after the land was surveyed.</p>	<p><b>Moderate</b></p>

Human Right and Fragile Context Issue	Description	Impact Significance
Perceived negative environmental impact from GPP1 operations.	<p>The residents in the communities particularly, the A3 communities claim that the flaring of Gas at the Flare Stack at GPP1 is the cause of excessive heat in all the communities engaged, thus construction of GPP2 would only worsen the current heat situation and make the communities uninhabitable.</p> <p>This was a common concern shared by all the communities engaged.</p>	<b>Moderate</b>

**7.4.6 Cultural Resources and Vulnerable Group Impact Assessment**

The cultural resources and vulnerable group impact assessment was carried out to assess the potential risk and impacts of the GPP2 project cultural resources and vulnerable groups within the project area in accordance with the IFC PS 7 and 8. It was assessed that the GPP2 project will have both positive and negative impacts on the project area. Tables 60 and 61 provide the overview of both the positive and negative impact significance of the GPP2 project on the project area.

Table 60 GPP2 Positive Impact Assessment on Cultural Resources

Impact	Cultural Resource	Description	Impact Significance
Revenue Generation, historical appreciation, boosting local tourism, indirect employment of local tour guides.	Kwame Nkrumah’s Birthplace at Nkroful	This is a historical and culturally significant place in the Ellemabelle District. It is located at Nkroful, the district capital, which is approximately 32km away from the GPP2 project site. According to the Ellemabelle District Assembly, due to the historical significance of Kwame Nkrumah, Ghana’s first president, almost all visitors to the district visit this cultural resource. It is envisaged that, migrant workers (both Ghanaians and non-Ghanaians) to be	<b>Moderate</b>

Impact	Cultural Resource	Description	Impact Significance
		engaged during GPP2 construction and operation would be inclined to visit this cultural resource.	
	Fort Apollonia at Beyin	The fort is a UNESCO World Heritage Site which holds significant historical and cultural value due to its colonial and Nzema history. It is envisaged that, migrant workers (both Ghanaians and non-Ghanaians) to be engaged during GPP2 construction and operation would be inclined to visit this cultural resource.	<b>Moderate</b>
	Nzulezu	This cultural resource is a historical and culturally significant place, which is also a UNESCO World Heritage Site. It is a spectacular scenery of the 400-year-old stilt propped water settlement of Nzulezu, built on Lake Tadane in the Western Region, stands out as a magnificent interplay between man and his environment. It is envisaged that, migrant workers (both Ghanaians and non-Ghanaians) to be engaged during GPP2 construction and operation would be inclined to visit this cultural resource.	<b>Moderate</b>
Resource mobilization	Kundum Festival	It was noted during the stakeholder engagement and field visit that GNGLC makes an annual cash donation to Atuabo and Beyin (the two paramount areas within the project's area of influence). This donation enhances the communal resources mobilization of these communities.	<b>Moderate</b>

Table 61 Negative Impact Assessment on Vulnerable Cultural Resources

Impact	Vulnerable Group/Cultural Resource	Description	Impact Significance
Economic and physical displacement	Women's group, small scale farmers and fisherfolks.	The GPP2 construction will not lead to economic or physical displacement of the vulnerable groups. Crop compensations were paid by GNGLC at the time of the land acquisition.	Negligible
Health and safety risks	Women's group, small scale farmers and fisherfolks.	Increased exposure to hazardous materials, fire and explosion risk, air pollution, noise, and potential accidents that can threaten the health and safety these groups, especially those living in proximity to the construction site (Atuabo, Anokyi and Asemda)	Moderate
Disruption to ecosystem services	Women's group, small scale farmers and fisherfolks.	Pollution, habitat destruction, and alterations to ecosystems services that can negatively impact these groups access to clean water, food sources, and local wildlife habitats. Since the acquisition of the GPP enclave (398 ha), which situates the GPP1 and GPP2 project sites, these vulnerable groups are restricted from entering these areas to safeguard the GPP.	Moderate
Restricted access to resources and services	Women's group, small scale farmers and fisherfolks.	Limited access to basic services like water, healthcare, education, and infrastructure that could be further compromised during construction, affecting vulnerable groups disproportionately. The GPP2 construction and operation will not limit access to these basic services.	Negligible
	School children and youth group.	Limited access to basic recreational facility (community park at Anokyi). To make room for the development of GPP1,	Major

Impact	Vulnerable Group/Cultural Resource	Description	Impact Significance
		GNGLC took over the Anokyi community park, promising to provide another park for the locals but the alternative park was never provided.	
Inadequate Corporate Social Responsibility (CSR)	Women's group, small scale farmers and fisherfolks.	It was noted during the stakeholder engagement that GNGLC's CSR towards the communities, especially the A3 communities (Atuabo, Anokyi and Asemnda) is inadequate. The social interventions of the CSR projects of GNGLC are not adequate to solve the issues of the vulnerable groups.	<b>Moderate</b>
Cumulative Impacts	Women's group, small scale farmers and fisherfolks.	Climate change has exacerbated the climatic conditions of the project communities leading to low crop yield and low fish catch. This impact could worsen if GNGLC does not put together interventions to assist these vulnerable groups.	<b>Major</b>
Desecration of cultural resources	Cemetery, shrine, sacred stream, and sacred groves	None of these cultural resources were found on the GPP2 project site thus no impact is envisaged however, should there be any chance finds during the construction of GPP2 a Chance Finds Procedure should be followed.	<b>Negligible</b>
Social and cultural disruption and inadequate resource mobilization	Kundum Festival	It was noted during the stakeholder engagement that GNGLC does not honor the invitation to attend and support the Kundum Festivals in the project affected and interested communities apart from Atuabo and Beyin which have paramountcies. This decision by GNGLC is in line with the company's existing CSR policy.	<b>Major</b>

Impact	Vulnerable Group/Cultural Resource	Description	Impact Significance
		The other communities feel disregarded.	

**7.4.7 Supply Chain Risks and Impacts**

GPP2 construction and operations could involve some supply chain risks and impacts across different stages of the project. These risks and impacts can affect various aspects, including procurement, logistics, labour, and environmental considerations. The following were assessed for the GPP2 project:

- **Supply Chain Disruptions:** Supply chain disruptions can have significant implications for the GPP2 construction and operation, affecting various aspects of the project in the areas of project timeline, cost overruns, resource allocation and planning, quality and safety concerns, operational continuity, regulatory compliance, local economy, and employment. Thus, the impact significance of supply chain disruptions on the GPP2 project is assessed as Moderate.
- **Ethical Sourcing:** While ethical sourcing for the GPP2 construction and operation holds some benefits, there could be some potential negative impacts to be associated with implementing stringent ethical standards and these are increased cost, limited local supplier capacity, construction and operational delays and lack of standardization. Thus, the impact significance of ethical sourcing on the GPP2 project is assessed as Moderate.
- **Skilled Labour Shortages:** GPP2 construction and operation would leverage on the expertise used to construct and operate GPP1 thus skilled labour shortages are not envisaged. Thus, the impact significance of skilled labour shortage on the GPP2 project is assessed as Minor.
- **Worker Welfare and Safety:** Worker welfare and safety will be a crucial aspect of the GPP2 construction and operation and there could be some negative impacts associated with inadequacies in addressing worker welfare and safety concerns if the following (workplace accidents and health risks, legal and regulatory noncompliance, and community backlash) are not addressed should they occur. Thus, the impact significance of worker welfare and safety on the GPP2 project is assessed as Moderate.

- **Logistical and Transportation Challenges:** This could significantly impact the construction and operation of GPP2 should there be supply chain disruptions, higher transportation costs due to poor road conditions or more expensive shipping methods. Thus, the impact significance of logistical and transportation challenges on the GPP2 project is assessed as Moderate.
- **Local Economic Development Challenges:** This could be due to inadequate local content and procurement although the Local Content and Local Participation Regulations 2013, (L.I 2204) in the petroleum sector has been established to, among other goals, encourage the maximization of value creation and employment opportunities by utilizing local skills, products, services, and financing within Ghana's petroleum industry value chain, aiming to retain these resources within the country. Ghana's oil and gas sector is still developing thus these challenges could emerge, as a result, the impact significance of local economic development challenges on the GPP2 project is assessed as Moderate.

## 7.5 Cumulative Impacts Assessment

Cumulative impacts are impacts that result from incremental changes caused by other past, present or reasonably foreseeable projects and /or actions together with those of the proposed project. The types of cumulative impacts relevant to the Project are:

- **Accumulative:** the overall effect of the same or different types of impacts at the same location (e.g., due to combined impact of the current GPP1 operation in the area).
- **Interactive:** where two different types of impacts, which by themselves may not be significant, react with each other to create a new significant impact.
- **Additive:** where impacts from a primary activity are added to impacts from other major projects in the vicinity of the Project which are already occurring, planned or may happen in the foreseeable future.

The cumulative effects of the project are considered at two geographical levels: national and local level. At the national level, the project has been assessed in conjunction with other activities that could benefit from the GPP construction and operation or that could have a negative interaction within the project.

The impact at the national level is largely positive and of high significance. Key among the impacts at the national level is the provision of reliable low-cost electricity, provision of enough gas to power thermal plants thereby boosting of the generation capacity of the country. Other impacts include job creation, local expertise development, stimulation of economic growth and direct capital investment.

At the local level the project interaction will be mainly with GPP1. Since GPP2 is proposed to be situated adjacent to GPP1, westward, all forms of interaction will be with the operations of GPP1 particularly during the operation phase. In addition, the project will interact with the LPG loading facility of Quantum Terminals at Anokyi.

No other planned projects which could potentially result in cumulative impacts have been identified at the time of writing.

Potential local level cumulative impacts are likely to be restricted to construction-related air emissions, dust, noise, surface water, waste and traffic which could cause the magnitude of these impacts to be raised above the level defined earlier in this report. Secondly, operational related impacts could be air emissions, negative public perceptions about GPP 1&2 operations and unmet CSR expectations. However, the mitigation and management actions to be put in place by this project and implemented by GNGLC will render the significance of the local level cumulative impacts Moderate.

## **7.6 Transboundary Effects Assessment**

The potential transboundary effects of the GPP2 construction and operation have been assessed under some key environmental and social considerations and they are:

### ***7.6.1 Environmental Consideration***

For biodiversity, the proposed GPP2 construction, operation and decommissioning is not predicted to result in a significant transboundary effect in relation to biodiversity. The rationale for this conclusion is that given the considerable distance (43km) from the proposed GPP2 site to Ivory Coast there is no potential for any direct or indirect effects on ecological receptors in Ivory Coast

as a result of the GPP2 construction and operation. The impact of the project on biodiversity is low and will be localized, only within the project's immediate vicinity.

For air emissions and climate, no transboundary effects are anticipated during construction, operation, and decommissioning of GPP2 with the exception of transportation related Scope 1,2 &3 emissions. Since major components of the GPP2 will be manufactured outside Ghana and transported into the country, some negative transboundary impacts on air quality and climate due to greenhouse gas emissions are anticipated. Also, the transportation of migrant labour particularly foreign expertise during the construction of GPP2 is anticipated to generate some negative transboundary impacts on air quality and climate due to Scope 3 greenhouse gas emissions.

In terms of transboundary effects on land, soil, and geology, the proposed GPP2 construction and operation has no potential effect on the land, soil, and geology environment of Ivory Coast or any of Ghana's neighbours since the proposed construction works will be kept within the proposed development site boundary (GPP Enclave).

With reference to hydrology and hydrogeology, all forms of potential impact on surface and groundwater will be localized no transboundary effects due to the construction, operation, and decommissioning of GPP2 is anticipated.

### ***7.6.2 Social Consideration***

Transboundary effects on population, public health, land use, cultural resources, labour, economy, and other social factors is expected to be non-existent. All forms of potential impact on socio-economic and cultural factors will be localized during the construction, operation, and decommissioning of GPP2.

## **CHAPTER 8      MITIGATION OF POTENTIAL IMPACTS**

### **8.1 Introduction**

From the identification and evaluation of potential impacts as described in Chapter 7 above, this chapter on Mitigation of Potential Impacts proposes actions to be instituted by Ghana National Gas Limited Company to mitigate the moderate and high significant potential negative impacts on the environmental and socio-economic components in the various phases of the GPP Train 2 project. According to the Ghana Environmental Assessment Regulations, 1999 (L.I. 1652) Regulation 30, on *Interpretations*, “Mitigation” means, the elimination, reduction, or control of the adverse effects of an undertaking and includes restitution for any damage to the environment caused by such effects through replacement, restoration, compensation, or any other means.

It is noted that GPP Train 1 has been in existence since 2014 and has operated without any major disaster (GNGLC, 2019e; 2021a). Since Train 2 is an extension of Train 1 and is located in the same area, mitigation measures that have been used successfully for Train 1 have also been proposed for the operations of Train 2. In addition, Ghana Gas shall take into consideration proposals and recommendations from various stakeholders such as EPA, NPA, Ministry of Energy, and WRC in all the phases of the GPP Train 2 project.

### **8.2 Mitigation Measures for the Project Phases**

#### ***8.2.1 Pre-construction Phase***

As indicated in Table 48 in the previous chapter, there will be no potential negative impacts on the physical and biological environments in the pre-construction phase of the project. Negative potential impacts of major significance (Rank 9-12) will be associated with the socio-economic component concerning occupational and public health and safety, acquisition of permits and approvals and compliance with regulations, the ongoing COVID-19 pandemic, settlement of compensation issues, and the need for stakeholder consultations (Table 48). The following mitigation actions are proposed:

## *i. Socio-economic Component*

### ***Occupational and Public Health and Safety***

During the pre-construction phase, activities such as site inspections and technical surveys could result in accidents that may affect the health and safety of those involved. Also, the ongoing COVID-19 pandemic can have negative impacts of major significance on personnel involved in pre-construction activities and indirectly on the public.

To ensure the health and safety of personnel undertaking high-risk activities, the HSE Department of GNGLC shall, according to its revised Requirements and Procedures for Contractors (GNGLC, 2020), continue to require selected licenced Contractors to submit job risk assessments and method statements, that include general safety and emergency response plans for their staff. The statements from the Contractors shall also include COVID-19 Management Plans for their staff involved.

The HSE Department shall insist on the observance of all recommended protocols by teams during field inspections and surveys as well as during consultations. For the public, Ghana Gas shall continue to provide support to the local health and administrative authorities as part of its corporate social responsibility activities (GNGLC, 2018).

To improve the safety of nearby communities, GNGLC shall also consider the possibility of rearranging various components of the proposed GPP Train 2 to locate the most dangerous ones furthest away from residential areas such as Asemnda.

### ***Regulatory Requirements***

GNGLC, aware of the need to operate within regulatory requirements shall in the pre-construction phase:

- Be guided by all the relevant government policies such as the National Energy Policy and the Local Content Policy of the Oil and Gas Sector.
- Satisfy all the relevant regulatory frameworks such as for planning and design of the GPP (Environmental Assessment Regulations, 1999 (L.I. 1652) and the National Petroleum Act, 2005 (Act 691).

- Apply for and obtain all the relevant permits including the Water Use Regulations, 2001 (L.I. 1692).
- Ensure local content and local participation, concerning the employment of workers and general procurement according to the Petroleum (Exploration and Production) Act, 2016 (Act 919), Petroleum (Local Content and Local Participation) Regulations, 2013 (L. I. 2204), the Labour Act, 2003 (Act 651), and Labour Regulations, 2007 (L.I. 1833).

### ***Settlement of Compensation Issues***

It has been noted that, despite previous consultations with the communities in the project area, the inability of Ghana Gas to settle compensation issues during the pre-construction phase for GPP Train 2 may lead to local unrest and possible project delays. Ghana Gas shall, therefore, within the context of its Community Affairs Corporate Social Responsibility Policy and Practice, liaise with the Land Valuation Division of the Lands Commission to ensure that all associated court matters are settled, and fair compensation is paid within a reasonable period. This view is also shared by other key stakeholders such as the Ministry of Energy (Appendix 6-1.3) and WRC (Appendix 6-1.5).

### ***Consultation with Relevant Stakeholders***

As already indicated, consultations with the relevant stakeholders are required for the following, among others:

- General awareness creation on the details of the proposed project.
- Payment of compensation to either Atuabo or Anokyi.
- Signing of an agreement with the A3 communities as indicated in their concerns on employment and other local issues.
- Responding to other concerns raised during the scoping exercise including employment quotas, provision of emergency assembly points for the A3 communities, restoration of the footpath between Asemnda and Anokyi, and replacement of the football pitch at Anokyi.

Ghana Gas shall therefore strengthen its general collaboration with the relevant District and Metropolitan Assemblies and their decentralised departments to increase awareness of the project and to plan and implement activities prioritised by the Assemblies. Also, based on its Community

Affairs Corporate Social Responsibility Policy and Practice, and as recommended by other stakeholders, it shall continue consultations with the relevant stakeholders to:

- Sign a Memorandum of Understanding with the A3 communities.
- Provide emergency assembly points for the A3 communities.
- Restore the footpath between Asemnda and Anokyi.
- Replace the football pitch at Anokyi.

In all phases of the project, Ghana Gas shall positively consider the concern of giving priority to local skilled and unskilled workers as part of its Corporate Social Responsibility programme.

Also, to help understand the real and perceived potential impacts of the operations of GPP Train 1 and its combined operations with Train 2, the following specialised studies have been carried out as recommended by various stakeholders, particularly the EPA.

- Quantitative Risk Assessment of GPP2.
- Fire and Explosion Risk Assessment of GPP2.
- Flood Risk Assessment to mitigate potential flooding within the GPP Enclave.

Furthermore, Ghana Gas shall support the Atuabo Public Health Committee to continue with its studies on the trends in public health, including the occurrence of respiratory tract infections to determine if they are associated with the oil and gas industry in the area.

### **8.2.2 Construction Phase**

The activities in the construction phase of the project will affect all the environmental and socio-economic components (Table 49). Activities that will generate the most negative interactions are site preparation, construction of access roads, and development of the main and ancillary infrastructure. Also, except for the loss of flora and fauna at the Train 2 project site, all the potential negative impacts will be highly significant (9-12) because of the closeness of several local communities to the project site (Table 50). Mitigation measures are proposed below.

#### ***i. Physical Environment***

According to GNGLC's revised Requirements and Procedures for Contractors (GNGLC, 2020), all Contractors are required to '*strictly comply with the Ghana Gas Occupational Health and*

*Safety and Environmental policies and shall take all reasonable steps to ensure good Health and Safety of all persons likely to be affected by the contracted scope of work and shall endeavour to avoid harm to the environment by the execution of the contract'. Contractors are also expected to carry out all works in accordance with the relevant statutory legislation.*

Thus, during the construction phase, the HSE Department of GNGLC shall continue to require Contractors to submit job risk assessments and method statements, that include mitigative actions for all identified potential negative impacts on the environmental and socio-economic components such as from air emissions, noise, water pollution, and waste management. In collaboration with the Community Relations Department of GNGLC, the Contractor shall also inform all public and private stakeholders about his/her before to the commencement of works. Furthermore, Ghana Gas shall use only permitted companies in sourcing materials – sand/laterite/quarrying to ensure compliance along the value chain.

### ***Air Quality***

During the construction phase, dust and emissions from vehicles, machinery, and other equipment will be generated from land clearing, land preparation, and the construction of roads and infrastructure. To maintain safe ambient baseline levels of suspended particulate matter and emissions such as CO, SO<sub>2</sub>, and NO<sub>2</sub> as well as to mitigate the impacts of dust, the Contractor shall among others:

- Ensure that site preparation and clearing are conducted in phases to minimise exposed areas.
- Maintain all work equipment and vehicles at optimal operating conditions, according to the manufacturers' specifications.
- Minimize dust generation by using covers for sand heaps and/or control systems such as dust suppression by dowsing with water.
- Ensure that all project personnel use approved PPE to minimize effect of inhalation of dust and noxious fumes on worker health.
- Ensure a strict no burning policy is implemented.

### ***Noise***

To mitigate the negative impacts of increased noise levels arising from the various construction activities and maintain noise levels within the GSA standards for both light industrial and residential areas, the Contractor shall:

- Use construction vehicles and equipment with low noise and vibration capacity.
- Use well-maintained equipment and screen or muffle noisy systems.
- Ensure that all personnel wear appropriate Personal Protection Equipment (PPE) such as ear plugs in areas of high noise.

In addition, to reduce the adverse impacts of noise in the post-construction period on the Asemnda community, which is nearest to the Train 2 project site, the Contractor shall include in the zoning design the creation of a vegetative buffer area between Asemnda and the site for Train 2.

### ***Drainage***

To mitigate the impacts of construction activities on flooding in the project site and its environs, the GNGLC's Contractor shall:

- Ensure that facilities and structures are not sited within any waterway that would cause flooding of the project area and associated communities.
- Design and construct adequate drainage systems at the project site and associated local communities for evacuation of post-construction stormwater based on the results of the specialised study on flood control and management in the pre-construction phase.
- Avoid creating or covering exposed surfaces from land clearing and excavations that will generate loose sediment to be carried by surface runoff to cause sedimentation of local drains.

### ***Soils and Erosion***

Based on the job risk assessment and method statement approved by the HSE Department of GNGLC, the Contractor shall maintain a system of construction and water management that will minimise soil erosion during the construction phase. This will involve the two basic approaches of i. reducing the volumes of runoff and ii. reducing runoff velocity as follows:

- Using types of heavy-duty trucks and equipment that will not overburden the soils.

- Ensuring that the heavy-duty trucks and equipment used for the construction are properly maintained on schedule to prevent oil/diesel leakages into the soils.
- Ensuring that appropriate and efficient water and waste management practices are adopted during the construction period.

### *Surface Water and Groundwater Quality*

As required by WRC, construction and operations activities should not affect the quality and quantity of surface and groundwater resources within the project's catchment. To minimise the impacts on water, the Contractor shall institute the following mitigation measures:

- Schedule site clearing and road construction activities to avoid heavy rainfall periods to the extent that is practical.
- Avoid or cover exposed surfaces from land clearing and excavations to prevent loose sediment from being transported by surface runoff into surface waters.
- Use impervious surfaces for refuelling and other fluid transfer areas to prevent their discharge into surface waters or seepage into shallow groundwater.
- Train workers on the correct transfer, handling of fuels, chemicals, and response to spills.
- Provide portable spill containment and clean-up equipment on site and training in the use of the equipment.
- Develop an efficient Waste Management Plan to, among others:
  - Provide labelled waste bins with covers at vantage points at the construction site for collection of solid waste.
  - Contract a certified waste management company, in collaboration with GNGLC's HSE Department, to collect solid waste from the construction site for final disposal.
  - Provide sanitary facilities at any temporary work camp and around the project site for workers to prevent open defecation.
  - Prohibit dumping or storage of litter/debris, tools, and equipment on the sides of public or private roads.
  - Ensure personnel working at the site are trained in the handling and management of wastes.

## ***ii. Biological Environment***

### ***Flora, Fauna, and Ecosystem Services***

To mitigate the moderately significant potential negative impacts on flora during construction, the Contractor shall refrain from activities that may damage the aquatic ecosystems in the project area and ensure that buffer vegetation is not degraded by adhering to the Riparian Buffer Zone Policy. Specifically, the Contractor shall institute the following measures:

- Minimise earth movements at the construction site.
- Minimise disturbance of vegetation and where necessary, restore with native vegetation after construction in consultation with the Department of Parks and Gardens.
- Use impervious surfaces at refuelling and other fluid transfer areas at the site.
- Train workers on the correct transfer, handling of fuels, and chemicals.
- Provide portable spill containment and clean-up equipment on site and training in the use of the equipment.

In addition to the measures proposed for flora above, the Contractor shall seek the help of the Ghana Wildlife Division of the Forestry Commission to relocate any large reptiles or mammals found at the construction site.

## ***iii. Socio-economic Component***

### ***Occupational Health and Safety***

Based on the job risk assessment and method statement approved by the HSE Department of GNGLC, the Contractor shall be responsible for ensuring the health and safety of all persons involved in the construction works, whether directly or indirectly, by providing a safe working environment, suitable protective equipment, and effective training, among other measures required by statutory regulations. Also, to cope with, and help control the spread of the COVID-19 pandemic, the Contractor shall observe all recommended protocols during the construction phase.

In practice, the Contractor shall use construction principles that adapt to local conditions, ensure safety, and protect the environment. Specifically, the Contractor shall:

- Appoint an HSE Officer to liaise with GNGLC's HSE Department.
- Provide PPE and training on safety procedures.
- Provide First Aid posts and display safety / precautionary measures at selected points at the construction site to guide the movement and activities of workers and visitors.
- Train selected workers as first aid givers and provide adequate first aid kits to treat minor ailments. Major cases shall be referred to the Eikwe St. Martin de Porres Hospital.
- Provide periodic medical examinations for employees:
- Train drivers at the site to understand road traffic regulations.
- Enforce speed limits of 30 km/hr. in built-up areas and 10-30 km/hr. at the project site.
- Ensure that movements of heavy-duty trucks and equipment to site or storage areas are carried out in phases and regulated to control the number of trucks and reduce the risk of accidents.
- Ensure that all equipment to be used are in good condition and undergo scheduled regular maintenance to minimise accidents.

### ***Public Health and Safety***

The Contractor, in consultation with GNGLC's HSE Department, shall:

- Maintain security personnel who are trained to respect the human rights of the public at the construction site.
- Provide workers and security personnel with toilet facilities during the construction period.
- Use indicator linings / reflective warning notices or wire mesh to prevent falls into uncovered trenches or deep excavations.
- Ensure that all the drivers to be engaged possess the requisite qualifications.
- Enclose the project site and strictly control the admission of job seekers to discourage idling and irresponsible behaviour.
- Observe all recommended protocols to control the spread of the COVID-19 pandemic.

### ***Local Traffic and Land Use***

In the construction phase, increased traffic will occur during the mobilization of equipment and transportation of construction materials to the project site. There could also be an increased risk of

accidents and exposure of the public to increased noise, dust, and gaseous emissions. Ghana Gas and its Contractor shall, therefore:

- Enforce speed limits of 50 km/hr. in built-up areas and 10-30 km/hr. at the project site.
- Train drivers to observe all road traffic regulations.
- Provide advance information through public announcements on mobilization schedules.
- Use road signs, sirens, and security escorts to warn people and communities of on-coming heavy-duty vehicles.
- Avoid night mobilization trips.
- Engage flagmen to man all major intersections to assist with the passage of trucks conveying materials and equipment to and from the construction site and storage areas.
- Use bypass road as much as possible instead of the main Krisan to Baku Road.

### ***Regulatory Requirements***

To ensure that construction activities are implemented as scheduled, GNGLC and its Contractor shall:

- Be guided by all the relevant regulations such as the Environmental Assessment Regulations, 1999 L.I. 1652, National Petroleum Act, 2005 (Act 691), the Labour, 2003 (Act 651), and Labour Regulations, 2007 (L.I. 1833).
- Apply for and obtain all other relevant permits.
- Ensure local content and local participation, with respect to the employment of workers and general procurement according to the Petroleum (Exploration and Production) Act, 2016 (Act 919), Petroleum (Local Content and Local Participation) Regulations, 2013 (L.I. 2204), Labour Act, 2003 (Act 651), and Labour Regulations, 2007 (L.I. 1833).

### ***Relevant Stakeholders***

To minimise social conflicts and delays in construction schedules, the Community Relations Department of GNGLC, in collaboration with the Contractor, shall continue its consultations with all relevant local and administrative stakeholders concerning all construction-related activities that may directly or indirectly affect the public, especially, the nearby communities and businesses.

### 8.2.3 *Operations Phase*

In the operations phase of the project, the new GPP Train 2 will process dense phase gas from the Jubilee field (100 MMSCFD), TEN fields (50 MMSCFD) and from new fields currently under investigation (50 MMSCFD) into various quantities of propane (C3), butane (C4), pentane (C5) and stabilized condensate (C5+) fractions using the same offshore gas supply and sales gas pipelines as the existing 150 MMSCFD-capacity GPP Train 1 (GNGLC, 2019b). Thus, the combined gas treatment capacity at Atuabo on completion of Train 2 will be 350 MMSCFD, three times the current capacity.

There will be potential negative impacts on all the components (physical, biological, and socio-economic) in this phase. Activities that will generate the most negative interactions are handling and storage of raw materials and finished products, solid waste management and flaring (Tables 51 and 52). These will mainly affect air quality and noise levels, occupational and public health, and safety as well as regulatory requirements. Mitigation measures are discussed below.

From its experience in the operations of GPP Train 1, Ghana Gas has indicated in its current Environmental Management Plan (GNGLC, 2019e) that the major issues of safety and environmental concerns are to do with risks of fire outbreaks, spillages/leakages, emissions, and public/occupational health and safety incidents/accidents. To ameliorate these risks, GNGLC has developed a Corporate Environmental Policy (GNGLC, 2021b) that, among others, will:

- Contribute to a reduction in global flaring and greenhouse gases 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 discharges.
- Comply with all applicable environmental laws, regulations, and international codes and standards, and supervise contractors to manage the environment in line with its environmental goals.
- Engage positively with its stakeholders and conduct business in a socially responsible and ethical manner.
- Incorporate internationally acceptable standards in establishing environmental management systems.

In addition to the environmental policy, Ghana Gas has developed an Occupational Health and Safety Policy (GNGLC, 2021c), a Community Affairs Policy (GNGLC, 2018), and a Waste Management Plan (GNGLC, 2021a) to ensure the safe operations of GPP Train 1. The guiding principles of the waste management plan are:

- Waste Avoidance.
- Waste Reduction.
- Waste Reuse.
- Waste Recycling.
- Waste Treatment.
- Waste Disposal.

Ghana Gas intends to continue using these policies and principles to manage the operations of the GPP Train 2. Also, Ghana Gas shall use only permitted companies to provide services during this phase. In response to the expected expansion in production, Ghana Gas shall strengthen its HSE Department to not only protect the GPPs that are important national assets but also to protect its workers and the public from the potential negative impacts. For example, GNGLC shall enhance the human, material, and financial resources of the Environmental Unit of the HSE Department.

### ***i. Physical Environment***

#### ***Air Quality***

In the operations phase of the GPP Train 2 and just as for Train 1, the primary sources of air emissions will be from flaring and fugitive gases. Fugitive emissions will occur from leaks in tubing and piping, valves, connections, pump, and compressor seals, tanks for storing gases and loading operations of gas and liquid hydrocarbons. Another important source of emissions will be the combustion of fuel for electricity and flaring. High levels of gaseous emissions and fine particulate matter in the atmosphere will cause increased occupational and public health problems.

Gaseous emissions will also contribute to climate change and global warming, while increased levels of atmospheric carbon dioxide are causing the oceans to become more acidic, threatening the viability of fisheries and marine ecosystems. It has also been deduced in Section 7.3.3 that

during the operations of both GPPs at full capacity, about three times the current quantities of emissions will be generated.

To mitigate the above potential impacts in accordance with the WBG EHS General Guidelines for air emissions management and Ghana Standards, GNGLC shall:

- Widen the area of monitoring of its air emissions beyond the A3 Communities. For example, this may cover the stretch from Krisan to Ekebaku;
- Expand the scope of monitoring to include periodic night measurements and increase averaging times for monitoring of particulates to allow comparison with GSA standards.
- Implement a dust emissions control program including measures such as wetting and covering to minimize atmospheric dust from construction activities.
- Ensure all excavation activities are closely supervised to ensure minimal disturbance to surrounding land users and dust.
- Ensure vehicles and machinery are fitted with appropriate exhaust systems and emission control devices and devices are maintained in good working order.
- Ensure the use of equipment, generators, machines, and vehicles with atmospheric emissions meeting the standards set by EPA/GSA and industry best practice.
- Ensure all equipment and engines are maintained and operated as original designed.
- Ensure all equipment are properly operated according to standard operating procedure that will ensure safe operation of equipment/vehicle/generator while meeting best environmental emission targets.

Concerning fugitive gaseous emissions, Ghana Gas shall continue the following existing practices:

- Monitoring the presence of gases with portable and fixed flame and gas detectors.
- Undertaking routine inspections and maintenance works for optimal operating conditions.
- Using storage tanks with internationally acceptable standards.

Mitigation measures for flaring shall include:

- Treating waste gas produced with pollution abatement equipment (scrubbers, filters and knockout drums) before being sent to the flare stack.
- Locating the flare stack away from residential areas.

- Increasing recovery of iso-pentane from the GPPs.
- Increasing and maintaining vegetation cover around the GPPs to support carbon capture.

In Table 62 is presented recent data on quantities of iso-pentane flared from the operations of GPP Train 1.

Table 62 Natural Gas Processed and Iso-pentane Flared

Description	Units	2016*	2017*	2018*	2020**
Gas Processed	MMSCF	20,929	29,492	27,753	31,943
Iso-pentane Flared	m <sup>3</sup>	24,628	34,560	26,076	66,383
EPA Limit	m <sup>3</sup>	69,600 – 74,000			
Ratio of Gas Processed/Flared	-	0.85	0.85	1.06	0.48
Mean Ratio	-	0.81			

\* GNGLC, 2019e;

\*\* GNGLC, 2021a

Using a mean ratio of natural gas processed and iso-pentane flared of 0.81 and a full annual capacity production of the two GPPs of 108,100 MMSCF (350 MMSCFD), it can be estimated that a cumulative amount of 210,000 m<sup>3</sup> of iso-pentane will be produced, about 3 times the current allowable limit by EPA.

Ghana Gas is continuously instituting mitigation measures to minimise flaring and increase the amount of valuable iso-pentane recovered. Ghana Gas intends to discontinue flaring the iso-pentane. Since it is a valuable economic commodity, there is a strong incentive to resolve all setbacks in engaging an off taker to utilize the gas. Ghana Gas will also continue with its efforts to identify other relevant power generators in Takoradi, Tema, Kumasi, and other industrial enclaves in West Africa. Ghana Gas will also continue with its efforts to identify and engage an off taker to utilize the iso-pentane produced.

For other equipment such as gas and diesel generators used for power supply, Ghana Gas shall continue to:

- Maintain all equipment at optimal operating conditions, according to the manufacturers' specifications.

- Reduce the use of diesel through process optimisation and education of staff.

Since the Atuabo enclave will continue to be of growing importance, especially with the addition of Train 2 to all the other existing gas industry activities, it is important to install a state-of-the-art continuous air quality monitoring station such as was recently installed in Accra by EPA in collaboration with the United States Embassy <https://gh.usembassy.gov/us-and-ghana-air-quality-monitoring/>. In addition to its current air quality monitoring activities, Ghana Gas shall therefore liaise and collaborate with the EPA to install a new monitoring station. This would also allow EPA to conduct independent monitoring activities.

### *Noise*

The major sources of noise during the operations phase of Train 2 will include compressors, inlet air coolers, pumps, inlet separators, and generators, as well as the movement of vehicles. To maintain ambient noise levels within the GSA limits, mitigation measures to be continued by Ghana Gas shall include:

- Using well maintained equipment and screens or muffling noisy systems.
- Using plant vehicles with low noise and vibration capacity.
- Ensuring that all personnel wear appropriate PPE such as ear plugs in areas of high noise.
- Maintaining a vegetative buffer between the Asemnda community and the site for Train 2.

### *Soils*

Ghana Gas shall continue with mitigation measures that have resulted in no major spills since Train 1 operations began. These include:

- Maintaining bunds around the storage tank areas to contain any spills from the tanks.
- Storing obsolete or expired chemicals and waste oil on non-permeable surfaces under the hazardous waste shed.
- Treating liquid wastes to permissible standards before discharge.

### *Wastewater Management*

During the operations phase of GPP Train 2, the main types of wastewater to be generated continuously will be similar to those of Train 1. Thus, they will be in the form of:

- Oil contaminated water from the main processing area, condensate storage tank area, workshop, chemical shelter, and laboratory.
- Sewerage from various sources including the administration block and guard houses;
- Surface runoff from the main processing area, condensate loading area, LPG storage tank area, and the LPG recovery train.

In addition to recommendations made for the construction phase, further measures to mitigate the potential negative impacts of wastewater management will basically follow the principles of pollution minimisation, decontamination, and treatment for the various types of wastewater generated. In general, the following wastewater management practices shall be implemented (IFC, 2016):

- Prevention and control of accidental releases of liquids through regular inspections and maintenance of storage and conveyance systems.
- Provision of sufficient capacity for storing process fluids to enable maximum recovery into the process and, therefore, avoid large discharges of wastewater.
- Design and construction of wastewater and hazardous materials storage containment areas with suitably impervious surfaces to prevent infiltration of contaminated water into soil and groundwater.
- Segregation of process wastewater from stormwater and segregation of wastewater and hazardous materials containment basins; and
- Implementation of general good housekeeping practices.

Specifically, Ghana Gas shall continue with the same mitigation actions for GPP Train 2 based on its environmental policy and waste management principles by directing oil-contaminated water, sewerage, and surface runoff to the Oily Water Treatment System, Sanitary Treatment System, and Control Water Basin respectively. These facilities, which have enough capacity to accommodate the liquid wastes from the operations of Train 2, shall be regularly maintained.

As already described, effluents from the Oily Water Treatment System and the Sanitary Treatment System shall be directed to the Observation Pond for treatment to meet effluent quality guidelines. Accumulated wastewater contained in the Observation Pond shall be periodically analysed and if parameters do not meet effluent guideline values, an accredited service provider shall be engaged to dislodge, while other liquid wastes for which Ghana Gas does not have in-house treatment capability, shall be stored in labelled containers, and collected by licensed waste management companies for treatment and safe disposal. Ghana Gas shall also improve the drainage system around the GPPs by constructing a stormwater drain to direct treated wastewater from the area.

In addition, Ghana Gas would consider including surface water, seawater, and rainwater sampling and analyses to its monitoring of the physicochemical and biological quality of groundwater and effluents. Concerning the high levels of phosphates in effluents, Ghana Gas shall upgrade the treatment processes to ensure their removal (GNGLC, 2019e; 2021a). It shall also educate staff on the need to reduce the quantities of soap used for in-house purposes. For example, liquid detergents placed in washrooms and kitchens may be diluted and used without losing their effectiveness.

### ***Solid Waste Management***

The quantities of solid wastes currently generated are expected to increase by about 3 times during operations of both GPPs at full capacity. Ghana Gas shall therefore expand the space available for storing both hazardous and non-hazardous wastes. A new storage facility with adequate space and appropriate signage shall be constructed to enhance waste storage.

Ghana Gas shall recycle, reuse, or dispose permanently of solid non-hazardous waste and hazardous waste including obsolete chemicals offsite in a manner that complies with:

- Section 13 (1) of the Hazardous, Electronic, and Other Waste Control and Management Act, 2016 (Act 917), to minimize the potential negative impacts on human health and the environment.
- Section 19 (1) of the Hazardous, Electronic, and Other Waste (Classification) Control and Management Regulations, 2016 (L.I. 2250) on the management of hazardous wastes.
- Public Procurement Act 2016 (Act 194).
- Ghana Gas Environmental Policy.

The Solid waste generated will be segregated into labelled colour-coded bins as follows:

- General Waste            Black Bin with Yellow Lid
- Metals                    Aluminium Skip
- Organic                   Green Bin
- Polythene/Plastics      Blue Bin
- Oily Rags                Black Bin

According to the classification of Hazardous, Electronic, and Other Waste (Classification) Control and Management Regulations, 2016 (L.I. 2250), and the First Schedule Section 1 (1) - *Categories of Wastes to be Controlled* of Act, 2016 (Act 917), the operations will generate wastes which fall under waste streams Y9 (waste oil/water, hydrocarbon/water mixture, and emulsion), Y18 (residues from industrial waste disposal operations) and Y19 (metal carbonyls).

Ghana Gas shall also ensure that items such as hazardous materials and old vehicles are not kept for too long and are disposed of as soon as practicable.

## ***ii. Biological Environment***

### ***Flora and Ecosystem Services***

In the operations phase, although the expected loss of vegetation will be insignificant, the degrading vegetation of the project area will need to be augmented and maintained. Ghana Gas shall, therefore:

- Where applicable, landscape the project site and its adjoining areas and maintain a policy of minimum disturbance of vegetation.
- Limit physical developments in the wetlands south of Train 2 and construct appropriate bunds and drains to effectively control flooding.
- Maintain a vegetation boundary between the project site and Asemnda.

### *iii. Socio-economic Environment*

#### *Occupational Health and Safety*

As summarised in Section 7.3.3 above, negative potential impacts concerning occupational health and safety during operations of GPP Train 2 will be manifested through such hazards as poor ambient air quality from gaseous and particulate emissions, increased risk of fires and explosions as well as from increased noise levels, exposure to hazardous chemicals, and waste generation. These potential impacts also include the risk of Coronavirus infections, all of which can negatively affect workers and lead to loss of productivity. Ghana Gas shall carry out the mitigation measures for the potential negative impacts according to its Environmental Policy and Waste Management Plan as well as its Occupational Health and Safety Policy. The latter seeks to protect the health and safety of its workforce and others affected by the Company's business activities (GNGLC, 2021c). Among others, Ghana Gas shall provide safe and healthy working conditions for the prevention of work-related injury and/or ill health and eliminate hazards and risks.

#### *Ambient Air Quality*

In addition to mitigation measures proposed for fugitive gaseous emissions and flaring during the operations phase above, Ghana Gas shall:

- Protect its workers from exposure to potential inhalation hazards (e.g., Nitrogen, carbon monoxide and volatile organic compounds) during routine plant operations. Protection measures shall include worker training.
- Ensure that the workers are provided with adequate PPE.
- Continuously monitor the quality of air in the workplace.
- Use the results of specialised studies on emissions modelling to improve the management of its emissions.

#### *Noise*

The same measures proposed for the physical environment above shall be applicable for mitigation of the potential adverse impacts of increased noise under occupational health and safety.

### *Fires and Explosions*

During the processing of natural gas, most of the raw materials, semi-finished products, and final products are flammable and explosive liquids and gases. The potential for fires from GPP Train 2 is summarised in Table 7-3.8. Fires and or explosions resulting from ignition of flammable materials or gases can lead to loss of property as well as possible injury or fatalities to plant workers and even the public. Added to these are the similar potential impacts from Train 1 and the fact that at full capacity the two GPPs will process 350 MMSCFD of natural gas compared to about 88 MMSCFD in 2020.

Fire is a major cause of concern for Ghana Gas at its GPP Train 1 and other current operational facilities. Thus, the company has developed a comprehensive fire prevention and response programme to ensure the continuous safety of Train 1 and its associated human and material resources (GNGLC, 2019e; 2021a). The mitigation measures outlined for Train 2 shall be based on the same programme. These include:

- Installation of early warning devices such as fire alarm systems and fixed fire and gas detectors supplemented by portable gas detectors.
- Installation of fixed firefighting equipment and placement of portable fire extinguishers at vantage points in work locations.
- Periodic inspection by the HSE Department and servicing of the fire alarms, fire and gas detectors, fire extinguishers, and other equipment by a licenced service provider.
- Maintenance of a permanent mobile GNFS fire tender in the GPP enclave.
- Provision of a permanent station for the National Ambulance Service at the GPP to provide first aid services and respond to emergencies.
- Maintenance of continuous links with the St. Martin de Porres Hospital at Eikwe to which major cases shall be referred.
- Provision of fire safety training to all employees, contractors, and visitors.
- Undertaking annual drills and simulation exercises to keep staff alert.
- Ensuring that available groundwater resources can provide sufficient firefighting water in the event of a fire emergency or accident.
- Using experienced and competent personnel in all departments of the GPPs.

With the establishment of new District offices for the GNFS and Ghana Police Service, Ghana Gas shall strengthen its links with these institutions to ensure efficient coordination of emergency and security services.

#### *Hazardous Chemicals*

The major chemicals used in the processing of natural gas are methanol, monoethylene glycol, and petro-therm (GNGLC, 2019e), all of which are hazardous to human health and the environment. Thus, improper handling and storage or accidental spills of these chemicals can pose health hazards to workers. During the operations of both GPPs at their full capacities, much larger quantities of chemicals will be used. As part of mitigation measures, Ghana Gas shall expand the space available for storing hazardous chemicals. The company shall also continue to:

- Provide PPEs to workers during the handling and use of these chemicals.
- Conduct training for the relevant staff on the use of the chemicals in consultation with EPA.
- Store chemicals according to the manufacturers' recommendations.
- Store obsolete chemicals in labelled containers for collection and disposal by accredited companies according to the relevant local legislative requirements, such as the Hazardous and Electronic Waste Control and Management Act 2016, (Act 917).
- Track the quantities of hazardous waste chemicals generated and how they are disposed of by the service providers.

#### *Solid Waste and Wastewater Management*

The same measures proposed for the physical environment above shall be applicable for mitigation of the potential adverse impacts of wastewater and solid waste management. In addition, Ghana Gas shall continue with its community sensitisation and public education programme to increase awareness of the potential negative impacts of solid and wastewater management.

#### *COVID-19 Pandemic*

The HSE Department shall continue to insist on the observance of all recommended protocols to control the spread of the COVID-19 pandemic by staff, contractors, and visitors.

### ***Public Health and Safety***

Ghana Gas has developed a Community Affairs Policy, which seeks to create a better environment for community inhabitants in the catchment areas of its activities (GNGLC, 2018). Through its CSR initiatives, the host communities are expected to benefit from:

- Enhanced socio-economic well-being.
- Improved health.
- Educational and training opportunities.

Within the above context, and as part of its Corporate Environmental Policy that seeks to among others, engage positively with its stakeholders and conduct business in a socially responsible and ethical manner (GNGLC, 2021b), Ghana Gas shall:

- Continue with its community sensitisation on the company's proposed activities and prevention of bush fires and encroachment on the RoW of pipelines.
- Involve the nearby communities in emergency drills and mass casualty exercises.
- Concerning the COVID pandemic, continue to provide support to the local health and administrative authorities as part of its corporate social responsibility activities.

### ***Regulatory Requirements***

Ghana Gas shall continue to produce its water and energy resources and use them efficiently, even to the point of declining use (GNGLC, 2019e; 2021a). The company shall also operate GPP Train 2 taking into consideration the current regulatory requirements in Ghana. Thus, GNGLC shall:

- Be guided by all the relevant regulations such as the Environmental Assessment Regulations, 1999 L.I. 1652 and the National Petroleum Act, 2005 (Act 691).
- Ensure local content and local participation with respect to the employment of workers and general procurement (Petroleum Local Content and Participation Regulations, 2013).
- Comply with other regulations such as those for employment, (Labour Act 651, 2003) and Labour Regulations, 2007 (L.I. 1833), water use (Water Use Regulations, 2001 (L.I. 1692), and the GSA Environmental Quality Standards for noise, air quality and effluent discharges.

### ***Relevant Stakeholders***

During the operations phase, Ghana Gas shall, through its Community Affairs Corporate Social Responsibility Policy and Practice, continue consultations with the relevant stakeholders to maintain a conducive environment for its activities. It shall also strengthen its collaboration with the associated District and Metropolitan Assemblies and their decentralised departments.

As already indicated, Ghana Gas shall in all phases of the project, positively consider the concern of giving priority to local skilled and unskilled workers as part of its Corporate Social Responsibility programme.

In addition, Ghana Gas shall strengthen its Community Relations Department into a Public Relations Department to allow for expanded and more effective interaction with the local communities and district assemblies as well as to respond to the rapidly expanding businesses and opportunities in the oil and gas sector, especially in the Western Region.

### ***8.2.4 Decommissioning and Closure Phase***

During the decommissioning and closure phase, GPP Train 2 will cease functioning and all structures and equipment will be dismantled to be followed by reclamation of the project site, according to a Rehabilitation and Decommissioning Plan. Most negative interactions will result from the dismantling of infrastructural components and waste disposal and will affect air quality, noise levels, surface water quality, as well as occupational and public health and safety. Mitigation measures are proposed below.

#### ***i. Physical Environment***

##### ***Air Quality***

In the decommissioning and closure phase, to control gaseous emissions from vehicles and operations of machinery as well as dust emissions, Ghana Gas and its Contractor shall:

- Use water bowsers to dampen dusty roads to ensure dust suppression.
- Impose vehicle speed limitations on all unpaved roads and tracks.
- Ensure strict compliance with the maintenance schedule of all vehicles and equipment.

- Comply with the GSA Air Quality Standards for light industrial and residential areas.

### ***Noise***

To protect personnel from being exposed to high noise levels, Ghana Gas and its Contractor shall:

- Ensure that all personnel use the appropriate personal protection equipment.
- Comply with the GSA Ambient Noise Standards.

### ***Soil and Erosion***

Ghana Gas shall apply the same mitigation measures as for the construction phase as the impacts here are like those for soil and erosion in that phase.

### ***Surface Water and Groundwater Quality***

These impacts will occur under similar conditions as for pollution of surface water and groundwater in the construction phase. The Contractor shall therefore use the same mitigation as for the construction phase.

### ***Waste Management***

To ensure safe disposal of waste, the Contractor shall:

- Provide sanitary facilities for workers to prevent open defecation.
- Prohibit dumping or storage of litter/debris, tools, and equipment on the sides of access or side roads.
- Use impervious surfaces at refuelling and other fluid transfer areas.
- Train workers on the correct transfer, handling of fuels, chemicals, and response to spills.
- Provide portable spill containment and clean-up equipment on site and training in the deployment of the equipment.
- Ensure personnel working at the site are trained in the handling and management of wastes.

## ***ii. Socio-economic Components***

### ***Occupational and Public Health and Safety***

To mitigate the potential negative impacts on the health of workers and the public, the Contractor shall apply the same mitigation measures as proposed for the construction phase.

### **Regulatory Requirements**

Ghana Gas shall require all contractors to conduct the decommissioning and closure phase activities taking into consideration the relevant regulatory requirements such as those for employment (Labour Act 651, 2003), fire prevention (Ghana National Fire Services Act, 1997 (Act 537), and the GSA Environmental Quality Standards for noise, air quality, and effluent discharges.

### **8.3 Summary of Proposed Actions to Address Stakeholder Concerns**

The issues raised by stakeholders during the scoping exercise have been addressed in various sub-sections of this chapter. In Table 63 below is summarised the actions to be taken to address the stakeholder concerns.

Table 63 Summary of Proposed Actions to Address Stakeholder Concerns

<b>Concern/Issue</b>	<b>Proposed Action</b>
Strengthening communication and awareness creation on GPP Train 2 project	<b>Pre-construction:</b> Ghana Gas shall strengthen its general collaboration with the relevant District and Metropolitan Assemblies and their decentralised departments to increase awareness of the project.
Request for more support from GNGLC – hospital, schools, police, etc.	<b>Operations:</b> Ghana Gas shall strengthen its general collaboration with the relevant District and Metropolitan Assemblies to plan and implement activities prioritised by the Assemblies.
Increased local employment and use of local content	<b>All Project Phases:</b> Ghana Gas shall positively consider giving priority to local skilled and unskilled workers as part of its Corporate Social Responsibility programme and the Agreement /Memorandum to be signed with the A3 communities.
Proximity of GPPs and safety of A3 communities	<b>Pre-Construction:</b> Ghana Gas shall establish emergency assembly points for the A3 communities. QRA and FERA have been carried out and the outcome of the studies puts the A3 communities at no risk, particularly Asemnda. To improve the safety of nearby communities, GNGLC shall also consider the possibility of rearranging various components of the GPP Train 2 to locate the most dangerous ones furthest away from residential areas such as Asemnda.

Concern/Issue	Proposed Action
	<p><b>Construction:</b> The Contractor, in consultation with the GNGLC’s Community Relations Department, shall inform all public and private stakeholders in the area about the construction activities before the commencement of the works.</p> <p>The Contractor, in consultation with the HSE Department, shall create a vegetative buffer area between the Asemnda community and the site for GPP Train 2.</p> <p><b>Operations:</b> Within the context of its Environmental Policy and Community Affairs Policy, GNGLC shall:</p> <ul style="list-style-type: none"> <li>• Continue with efforts to reduce flaring during operations.</li> <li>• Locate the flare stack away from residential areas.</li> <li>• Maintain a vegetative buffer zone between Asemnda and the site for Train 2 and increase vegetation cover around the GPPs to support carbon capture.</li> <li>• Continue with its community sensitisation on the company’s proposed activities and prevention of bush fires and encroachment on the RoW of pipelines.</li> <li>• Involve the A3 communities in emergency drills and mass casualty exercises.</li> </ul>
Land and compensation issues	Ghana Gas shall, within the context of its Community Affairs Corporate Social Responsibility Policy and Practice, liaise with the Land Valuation Division of the Lands Commission to ensure that all associated court matters are settled, and fair compensation is paid within a reasonable period.
Loss of livelihoods	<b>Operations:</b> GNGLC shall strengthen its general collaboration with the relevant District and Metropolitan Assemblies to plan and implement activities prioritised by the Assemblies.
Flaring, heat and other impacts	Same as for proximity of GPPs to A3 communities above.
Signing of Agreement / Memorandum of Understanding	<b>Pre-construction:</b> As part of its Community Affairs Corporate Social Responsibility Policy and Practice, GNGLC shall sign an Agreement/Memorandum of Understanding with the A3 communities to cover the concerns raised and as recommended by various stakeholders.

Concern/Issue	Proposed Action
Flooding and drainage	<b>Construction:</b> GNGLC's Contractor shall design and construct adequate drainage systems at the project site and associated local communities for evacuation of post-construction stormwater based on the results of the specialised study on flood control and management in the pre-construction phase.
Youth training/capacity building	<b>Operations:</b> Ghana Gas shall strengthen its general collaboration with the relevant District and Metropolitan Assemblies to plan and implement activities prioritised by the Assemblies, including capacity building and training for the youth.
Emergency assembly points and involvement of communities in safety drills	Same as for proximity of GPPs to A3 communities above.
Need for peaceful co-existence	<b>Pre-construction:</b> GNGLC shall sign an Agreement/Memorandum of Understanding with the A3 communities to cover the concerns raised including provision of the football park at Anokyi and the restoration of footpath.  <b>Operations:</b> GNGLC shall continue with its community sensitisation on the company's activities.
Cumulative impacts of Trains 1 and 2	<b>All Project Phases:</b> Various mitigation proposed in Section 8.2 for all the different phases of the project such as for specialist studies, noise, air quality, and public health and safety.
Acquisition of permits and approvals	<b>All Project Phases:</b> Ghana Gas shall apply for and obtain all the relevant permits and approvals during all phases of the project as detailed in Section 8.2 above.
Use of permitted companies	<b>All Project Phases:</b> Ghana Gas shall use only permitted companies in providing services required.
Provision of football park at Anokyi	As already indicated above.
Strengthening of general security	<b>All Project Phases:</b> Ghana Gas shall strengthen its general collaboration with the relevant District and Metropolitan Assemblies to plan and implement activities prioritised by the Assemblies, including strengthening security.
Encroachment of RoW and GPP	<b>Operations Phase:</b> GNGLC shall continue with its community sensitisation on the company's proposed activities and on the prevention of bush fires and encroachment on the RoW of pipelines.
Restoration of footpath to Anokyi	As already indicated above.

Concern/Issue	Proposed Action
Controlling the increasing cost of living	<b>Operations Phase:</b> Ghana Gas shall strengthen its general collaboration with the relevant District and Metropolitan Assemblies to plan and implement activities prioritised by the Assemblies.
Controlling increasing social vices	<b>Operations Phase:</b> Ghana Gas shall strengthen its general collaboration with the relevant District and Metropolitan Assemblies to plan and implement activities prioritised by the Assemblies, including controlling of social vices.

**8.4 Mitigation Measures Resulting from Specialist Studies**

**8.4.1 Flood Risk Mitigation Measures**

According to the FRA studies, the proposed GPP Train 2 area clearly impedes the natural flow of water which will cause the inundation level at the west side of the GPP2 project site to rise even higher (see Plate 18). This will then affect GPP1 and expand the inundation area without proper drainage. Furthermore, stored water will seep through soil and embankments which can trigger other problems such as soil consolidation, erosion, piping phenomenon among others.

Thus, to prevent this scenario, a drainage culvert is then proposed to be constructed across the existing road as shown in Plate 28. The discharge will be diverted to the coastal side, instead of the town of Anokyi. This will effectively eliminate the flooding specifically at the community area. This will also discharge the storage at the west side of the GPP2 project site to prevent other potential major disasters that can occur.

The maximum water level reached for 100-yr flood event is computed to be 5.84 meters amsl. The inundation results at the end of 4-day flood simulation with GPP Train 2 and proposed drainage culvert is shown in Plate 30 to 31.

The contributed flooding to the town of Anokyi, on the other hand, can be eliminated since no more flow will come from the west of GPP2. Nevertheless, saturation of the area can still be expected with local precipitation and runoff from its own catchment.

The discharge on the coastal area, however, imposes no substantial damage and negative effect due to minimal discharge with a peak of only 12.85 cms at a velocity of 0.43 m/s.

- The floor level will be elevated to at least 7.0 meters amsl or will be levelled with the existing GPP1 at an elevation of 8.0 meters to make sure a smooth transition of facilities

and mobility in between the GPP areas. This will also allow enough freeboard from the maximum water level of the most extreme flood event.

- Floor surface will be sloped at a minimum of 1% gradient to allow runoff and avoid accumulation of rainwater that may disrupt operation of the facility, and movement of people and equipment.

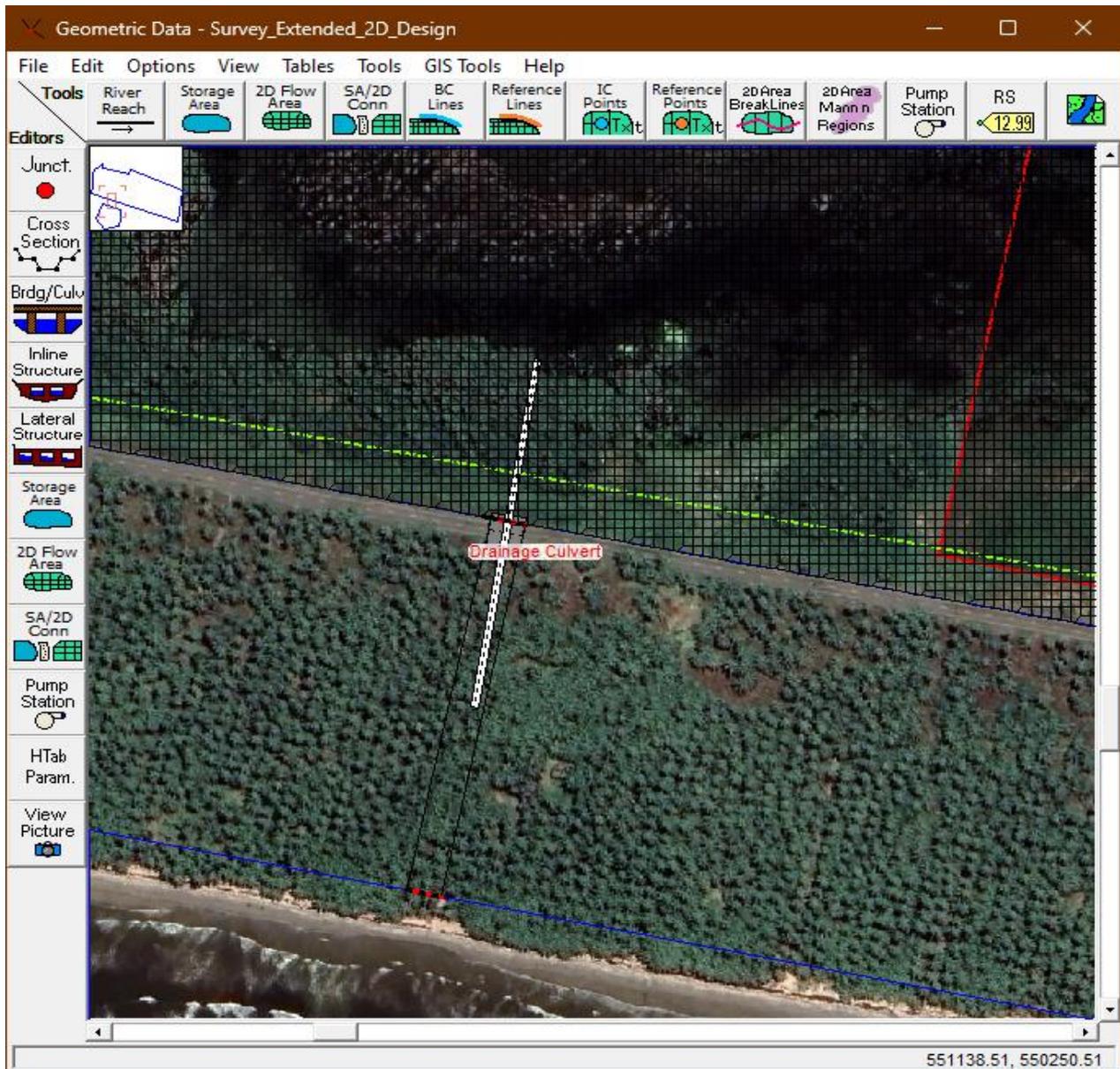


Plate 28 Drainage Culvert Model in HEC-RAS

The drainage culvert is designed as box type with a span of 4.0 meters, a rise of 2.0 meters and slope of 0.005. The entrance is provided with flared wingwalls to increase discharge and decrease entrance losses with a coefficient of 0.2. The upstream invert is set equal to the average minimum elevation of the swampy area to lower the flood depth effectively.

**Culvert Data Editor**

Culvert Group: **Culvert #1** [dropdown] [down arrow] [up arrow] [copy] [paste] [cancel] [help]

Solution Criteria: **Computed Flow Control** [dropdown]

Shape: **Box** [dropdown] Span: **4** Rise: **2**

Chart #: **8 - flared wingwalls** [dropdown]

Scale #: **1 - Wingwall flared 30 to 75 deg.** [dropdown]

Culvert Length: **200** Depth to use Bottom n: **0**

Entrance Loss Coeff: **0.2** [?] Depth Blocked: **0**

Exit Loss Coeff: **1** [?] Upstream Invert Elev: **4.2**

Manning's n for Top: **0.015** [?] Downstream Invert Elev: **3.2**

Manning's n for Bottom: **0.015**

**Culvert Barrel Data**

Barrel Centerline Stations # Barrels: **1**

	Barrel Name	US Sta	DS Sta	GIS Sta
1	1	9	9	
2				
3				
4				
5				

Barrel GIS Data: 1 Length: 0

	X	Y
1		
2		
3		
4		
5		

Individual Barrel Centerlines ... Show on Map OK Cancel Help

Select culvert to edit

Plate 29 Culvert Data Editor



Plate 30 Inundation Map with GPP Train 2 and Drainage Design for 4 Days Flood Simulation (5-yr Return Period)

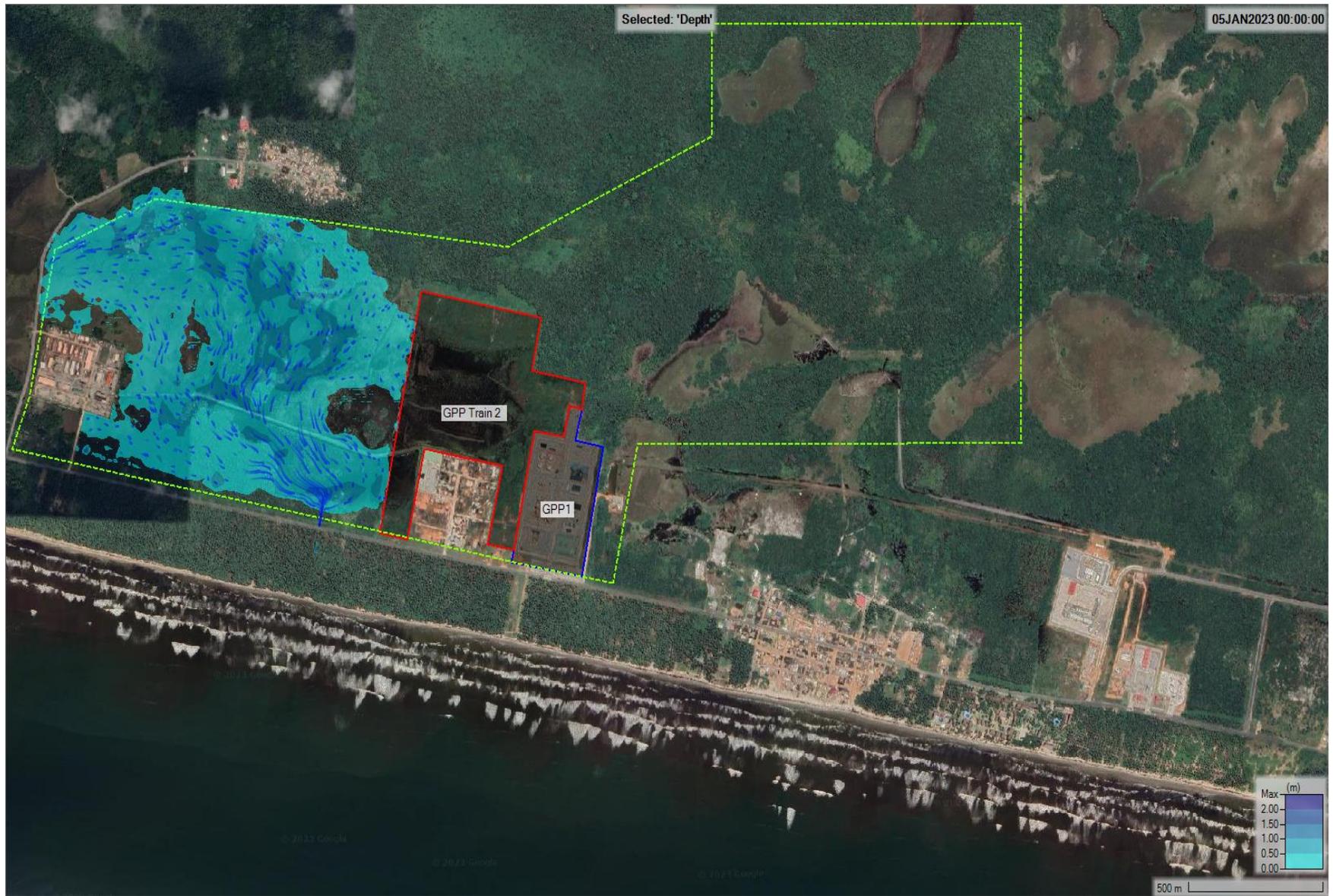


Plate 31 Inundation Map with GPP Train 2 and Drainage Design for 4 Days Flood Simulation (15-yr Return Period)

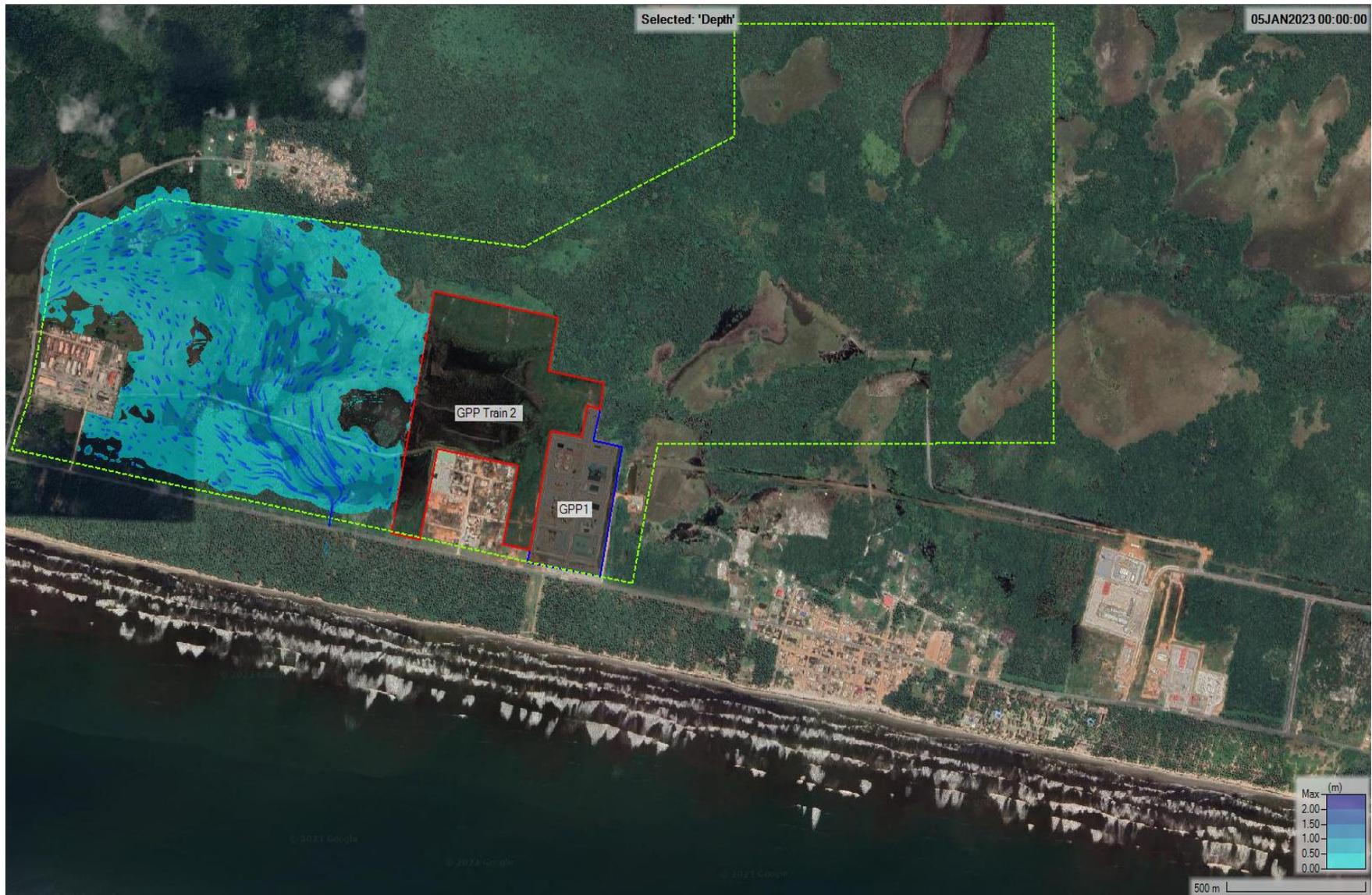


Plate 32 Inundation Map with GPP Train 2 and Drainage Design for 4 Days Flood Simulation (25-yr Return Period)

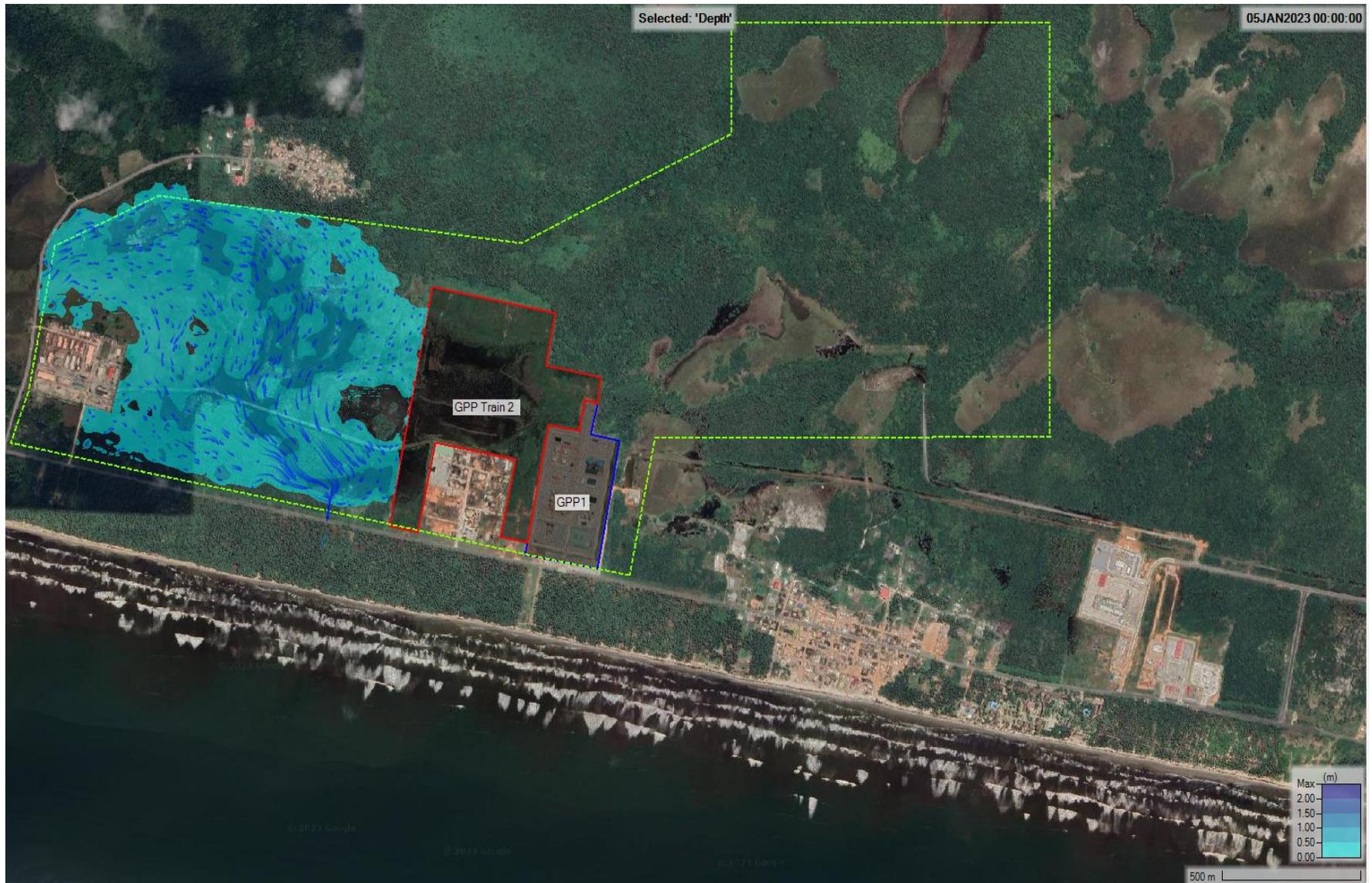


Plate 33 Inundation Map with GPP Train 2 and Drainage Design for 4 Days Flood Simulation (50-yr Return Period)



Plate 34 Inundation Map with GPP Train 2 and Drainage Design for 4 Days Flood Simulation (100-yr Return Period)

#### ***8.4.2 Fire and Explosion Risk Mitigation Measures***

Fire and explosion risk reduction measures were made to improve the design or operation of the GPP2 facility that need to be made to reduce risks and enhance its functional and HSE performance. Risk reduction measures are usually proposed due to technical feasibility and practical measures in the following categories:

- **Prevention:** Activities that eliminate or reduce process incidents. Generally, prevention activities such as modifications in operating and maintenance practices, equipment, maintenance, inspection, personnel training, and audits may reduce the process incident occurrence rate.
- **Mitigation:** Activities that reduce the consequences associated with the occurrence. Mitigation measures may include installation of detection and isolation systems, fire suppression systems, structural enhancements, and emergency response planning.

Based on the QRA and FERA studies, the following preventative and mitigating risk reduction measures will be implemented by GNGLC:

- xi. Since the study is based on the Philosophy stated at the blowdown philosophy that (In case of confirmed gas leak, involved area depressurization will be automatically initiated by the ESD system.), which have a great contribution for risk reduction measures, The facility will be provided with an effective fire and gas detection system that will take automatic action (Isolation & depressurization), based on confirmed detection of hydrocarbon gas release or fire. A fire and gas mapping study will be performed to ensure appropriate coverage of fire and gas detectors in GPP2.
- xii. Ensuring that ignition prevention is practiced onsite by the classification of hazardous areas, in addition to preventative maintenance on electrical systems and inspection activities. Work activities within hazardous areas will be controlled by the Permit to Work system.
- xiii. Equipment, vessel, pumps etc. which are part of top risk contributing scenarios will be given priority in inspection.

- xiv. Review the possibility of providing (analysing the pros and cons) water connection at the sphere bottom that can be used in the event of Loss of Containment (LOC) from bottom of the sphere.
- xv. In case of sphere fires, the potential always exists for an Explosion/BLEVE. To reduce this risk, it is recommended to ensure that the emergency response plan includes following:
  - F. Mitigate fire from the maximum distance possible or use portable monitors or fixed fire monitors.
  - G. Cool spheres by flooding (externally) them with large quantities of water.
  - H. Leave the area immediately if you hear a rising sound from venting safety devices or see discoloration of the sphere.
  - I. For massive fires, use unmanned hose holders or monitor nozzles; and
  - J. Be aware that when BLEVE occurs, sections of the sphere can fly in any direction. Just avoiding the ends of sphere should not be considered for a safe operating procedure.
- xvi. Ensure that fire responders (Emergency Response Team) to be aware of the hazards associated with tank fires, including BLEVE.
- xvii. Ensure spill containment plan is in place to avoid spread of pool of liquid in case of LOC from large inventory equipment such as spheres and storage tanks.
- xviii. Passive fire protection (PFP) will be provided for isolation and depressurization valves ESD/EDP/XV (which are considered in intolerable risk area) which is located inside the exceedance contour, based on the pool and jet fire events at 10 minutes at a thermal radiation level of 37.5 kW/m<sup>2</sup> with cumulative fire frequency of 1.0E-04/yr, in accordance with the requirement in API 2218 (see Appendix C).
- xix. Shifting of the occupational building zone include the (LAB-Control room – Warehouse – Workshop), slightly to the west to be totally inside the low-risk area (The 10-6 risk contour from jet fire & Pool fire reaching the workshop and warehouse – also the 10-6 risk contour from 0.14 barg overpressure reaching the workshop and control room), it is better to keep occupational building in the low-risk area (see Appendix C)..
- xx. Ensure the drainage facilities are designed to sufficiently contain or drain to a safe area to limit the extent of pool fires and prevent escalation between process equipment.

### 8.4.3 Climate Change Risk Mitigation Measures

The following mitigation measures have been proposed in accordance with the recommendations of the TCFD.

Table 64 Climate Change Risk Mitigation Measures

Risk		Risk Driver	Mitigation Actions
Physical	Chronic	Sea-level rise, drought and variable rainfall patterns.	<ul style="list-style-type: none"> <li>Periodic assessment of physical risks to GPP2 assets, operations, and host communities. Positive stakeholder engagement with local communities and active CSR initiatives to reduce the risk of agitations against GPP2 operation.</li> <li>Develop physical climate risk management plan.</li> </ul>
	Acute	Flooding from heavy rainfall.	Implement the recommendation of the Flood Risk Assessment (FRA) during construction to construct appropriate storm drain to channel excess water into the sea. Continuous engagement and sensitization of the local communities.
Transition	Market	Increased uncertainty and volatility for gas prices.	<ul style="list-style-type: none"> <li>Conduct scenario analysis to demonstrate that the gas portfolio of Ghana is resilient to lower prices and lower demand.</li> </ul>
		Reduced demand for gas.	<ul style="list-style-type: none"> <li>Diversification into renewable energy should be considered in order to boost revenue.</li> </ul>
		Increased costs of raw materials.	<ul style="list-style-type: none"> <li>Consider deployment of biofuels from organic waste.</li> <li>Consider other renewable and sustainable raw material for GPP2 operations.</li> <li>Consider factoring these risks into the GPP2 business thereby considering new energy business.</li> </ul>
		Repricing and stranding of assets.	For now, scenario analysis indicate that global LNG and NG demand will continue to rise thus no foreseen decrease in LNG and NG yet, principally due to the current geopolitical climate.
		Cost of capital.	The Consortium should strategize to play a leading role in Ghana's energy transition and decarbonization plan. This will bolster the resilience of the GPP business and the Consortium's reputation and ensure that investors maintain a positive view of the Consortium in absolute terms and relative to its peers.
	Policy and	Carbon pricing mechanisms.	Institute measures to mitigate exposure to carbon pricing by eliminating or reducing Scope 1&2 emissions from GPP2

Risk		Risk Driver	Mitigation Actions
			operations as far as possible. Investment in nature-based carbon capture solutions to mitigate emissions that cannot be eliminated.
		Increased regulation and reporting requirements.	The Consortium/GNGLC will strive to ensure that they are fully aligned with climate reporting requirements and are enhancing their ESG performance and their wider non-financial reporting by working with ESG ratings agencies and other third parties.
		Growing numbers of legal cases being brought against fossil fuel companies.	It is recommended that GNGLC/Consortium works on its community relations and engagements to disabuse the perception of the communities on GPP1 being the cause of the high temperatures by doing the following: <ul style="list-style-type: none"> <li>▪ Conduct continuous ambient temperature monitoring.</li> <li>▪ Assist the communities to engage third party contractors to also conduct continuous ambient temperature monitoring.</li> <li>▪ The temperature results should be compared to ascertain the veracity of the claim that GPP flare stack is the cause of the high temperature and heat at the communities.</li> <li>▪ Furthermore, some communities outside of the catchment of GPP along the coast could be used as controls and conduct the continuous ambient temperature monitoring to compare the monitoring results and ascertain the veracity of the claim that GPP flare stack is the cause of the high temperature and heat.</li> <li>▪ Whatever the outcome of the continuous ambient temperature monitoring, Consortium/GNGLC could increase their community engagement and sensitization.</li> </ul>
	Technology	Substitution of gas with low-carbon forms of energy.	The Consortium/GNGLC should plan to play a leading role in Ghana's energy transition through diversification into renewables.  Efficient, low-cost, less-carbon intensive operations; Monitoring technological developments and introduction of cost-effective new technologies when applicable.
		Cost of GHG emissions reduction & reporting technology.	Budgetary allocations should be made to cater for the short to medium term costs for emissions reduction initiatives.

Risk	Risk Driver	Mitigation Actions
Reputation	Increased stakeholder concern or negative stakeholder feedback	<p>The Consortium/GNGLC should communicate its important role in Ghana’s energy transition to our stakeholders when it does take the lead.</p> <p>Set and achieving ambitious targets to decarbonize GPP business and aligning with best practice in climate-related disclosures.</p>

**8.4.4 Habitat Quality Mitigation Measures**

IFC PS6 requires that habitat quality mitigation should include avoidance, minimization and restoration measures which should be given paramount consideration in all project development phases before any offset or compensation in achieving measurable conservation outcome to achieve biodiversity protection and conservation.

Pursuant to the requirements of the IFC PS6, GNGLC together with the Consortium will incorporate some mitigation measures prior, during and post construction of the GPP2. For instance, during the construction phase of GPP2 a reconfiguration of the project layout could be considered to result in a reduced area of the swamp (natural habitat) being lost. When implemented, the ecological functions of the swamp will be retained. One of the key habitat restoration and enhancement activity could be a flora restoration programme supported by a nursery and a hardening site. GNGLC together with the Consortium could also prepare a Biodiversity Management Plan (BMP) to include the following work instructions which will guide the construction and operation of GPP2:

- Prevention and Control of Alien Species Work Instruction
- Reinstatement and Revegetation Plan
- Topsoil Management Work Instruction
- Bushmeat Action Plan Work Instruction
- Avian Biodiversity Action Plan

Based on the current information, the most pertinent and significant potential impacts (negative) associated with the GPP2 on indigenous fauna and flora would span from medium to low but with the activation of the appropriate mitigation measures in line with the IFC PS6 requirement, most negative impacts are expected to be low to negligible (see Table 65).

Table 65 Biodiversity Impact Mitigation

Negative Impact	Source of Impact	Impact (without measure)	Significance (with mitigation)	Impact Significance (with mitigation measures)
Habitat fragmentation	GPP2 construction could cause fragmentation of habitats or loss of natural habitats	<b>Medium</b>	<b>Low</b>	This is because GNGLC will implement biodiversity enhancement through reinstatement and revegetation programme within the wider GPP enclave.
Recurring disturbance to fauna utilizing the area	Operational noise from GPP2	<b>Medium</b>	<b>Low</b>	GNGLC and the Consortium shall ensure that mitigation and abatement measures are incorporated at the design phase of the project, and monitor performed during the Operational phase.
Destruction of food sources for fauna	Clearing of vegetation and land preparation activities for construction	<b>Medium</b>	<b>Low</b>	The retained vegetation within the wider GPP enclave contain key plant species more than those within the GPP2 project site to support fauna food resources. Hence, vegetation clearance will be limited/restricted to the GPPS project area

Negative Impact	Source of Impact	Impact (without measure)	Significance mitigation	Impact Significance (with mitigation measures)
Swamp wetland destruction	Swamp wetland habitat for construction	<b>Medium</b>		<p><b>Low</b></p> <p>Only 18ha representing 18.69% of the swamp wetland cover will be removed for permanent GPP2 infrastructure (see Figure 5).</p> <p>However, as per the IFC PS6 guideline and requirement, the swamp wetland is a natural habitat and as such the landcover taken will be compensated for through a NNL mechanism to be developed and implemented by GNGLC and the Consortium during construction.</p>

**8.4.5 Mitigating Human Right and Fragile Context Risks and Impacts**

When assessing how to respond to risks of impacts to people, it is helpful to consider the expectations contained in the UN Guiding Principles. The Guiding Principles make clear that the Consortium/GNGLC’s response to a human rights risk will not be the same for all risks: the expected actions differ, depending on how the Consortium/GNGLC could be involved with the adverse human rights impact. In practice, it will always be helpful for the Consortium/GNGLC to consider how it can build and exercise its leverage to prevent impacts from occurring. The major distinction between the three modes of involvement described in the UN Guiding Principles (cause, contribute, direct linkage) is the need to mitigate/ prevent the impact and provide remedy where the Consortium/GNGLC has caused or contributed to an impact, which does not exist in

situations of direct linkage. In practice, it is still helpful for the Consortium/GNGLC to consider how it can influence the provision of remedy in situations where it is directly linked to an impact. GNGLC has some comprehensive and detailed commitments, policies, and processes in place. Thus, the mitigation measures suggested in this human rights and fragile context risks and impacts assessment focus on ensuring that the GNGLC existing processes are applied, while ensuring that context-specific considerations are reflected in their application for the GPP2 construction and operation. The mitigation measures for the human rights and fragile context risks and impacts identified and their impact significance when the measures are implemented are provided in Table 66 below.

Table 66 Human Right and Fragile Context Risks and Impact Mitigation

Human Right and Fragile Context Issue	Mitigation Measures	Impact Significance after Implementation of Mitigation Measure.
The right to an adequate standard of living.	Although GPP2 construction and operation cannot improve the living standard of all the communities, it could improve the living standard of the local people to be engaged during the construction and operation by ensuring that the Labor Management Plan for GPP2 construction will include provisions for monitoring third party contractor recruitments so that the adequate number of locals are recruited to work during the construction phase and the appropriate wages paid to them.	Minor
The right to work.	The Consortium/GNGLC would ensure it increase local content and increase the participation of qualified and requisite locals in the recruitment process for GPP2 construction and operation. However, since the Consortium/GNGLC would not be able to provide work for all the locals in the communities, the community sensitization by GNGLC should educate the communities on this reality. GNGLC could use its CSR projects to offset its inability to provide work opportunities for all.	Minor

<b>Human Right and Fragile Context Issue</b>	<b>Mitigation Measures</b>	<b>Impact Significance after Implementation of Mitigation Measure.</b>
The right to freedom of association.	The current arrangement for GPP1 where staff are allowed to join labor unions would be encouraged and extended to GPP2 operations.	Negligible
Right to education.	The Consortium/GNGLC could use the CSR projects for GPP2 operation to fix the deplorable basic education facilities in the communities thereby enhancing the right to education.	Minor
Right to water and sanitation.	The Consortium/GNGLC could use the CSR projects for GPP2 operation to provide potable water and public toilet facilities for communities thereby enhancing the right to water and sanitation.	Minor
The right to liberty and security of persons.	GNGLC should improve its community engagement and sensitization process as well as its CSR projects within the local communities to prevent any likelihood of unrest and protests.	Minor
The right to life and the right to health.	GNGLC should tighten its safety protocols by ensuring its fire tender is operational and ready to be deployed at any time.	Minor
Conflict sensitivity and community tensions.	<p>GNGLC should work together with the traditional authorities of both Atuabo and Anokyi to resolve the land litigation issue and pay the appropriate compensations.</p> <p>GNGLC should endeavor to work as soon as possible with the leaders of Anokyi to develop the community park for them before the construction of GPP2 in order avert any future community agitation</p>	Minor
Perceived negative environmental impact from GPP1 operations.	It is evident that climate change has led to extreme weather events and in the last few years high rainfall and temperatures have occurred. It is therefore recommended that GNGLC works on its community relations and engagements to disabuse the perception of the communities on GPP1 being	Minor

Human Right and Fragile Context Issue	Mitigation Measures	Impact Significance after Implementation of Mitigation Measure.
	<p>the cause of the high temperatures by doing the following:</p> <ul style="list-style-type: none"> <li>▪ Conduct continuous ambient temperature monitoring for at least 14days at GPP1 and the communities particularly at the A3 communities (Atuabo, Anokyi and Asemnda).</li> <li>▪ Assist the communities to engage third party contractors to also conduct continuous ambient temperature monitoring for at least 14days at the communities particularly at the A3 communities.</li> <li>▪ The temperature results should be compared to ascertain the veracity of the claim that GPP1 flare stack is the cause of the high temperature and heat at the communities.</li> <li>▪ Furthermore, GNGLC could use some communities outside of the catchment of GPP along the coast as controls and conduct the continuous ambient temperature monitoring in order to compare the monitoring results and ascertain the veracity of the claim that GPP1 flare stack is the cause of the high temperature and heat.</li> <li>▪ Whatever the outcome of the continuous ambient temperature monitoring, GNGLC should increase their community engagement and sensitization.</li> <li>▪ GNGLC would continue its nature-based solutions (NBS) and increase carbon reduction initiatives such as tree planting at the Ankasa Conservation Forest.</li> </ul>	

## 8.5 Chance Finds Procedure

Although no cultural resource will be impacted directly on the GPP2 project site, but if there is a discovery of any physical cultural resource during construction, a Chance Finds Procedure in accordance with IFC PS 8 would have to be applied.

The Chance Finds Procedure outlines actions required if previously unknown heritage sources are encountered during the project construction. As outlined in IFC PS 8 the Chance Find Procedure is a process that prevents chance finds from being disturbed until an assessment by a competent specialist is made and actions consistent with the requirements are implemented. The procedure below is applicable to all activities to be undertaken by the Consortium/GNGLC and the EPC Contractor to be appointed for the construction of GPP2, that have the potential to uncover a heritage item/site.

In the event of a physical cultural resource such as archaeological sites, historical sites, remains and objects, individual graves during excavation or construction, the following steps shall be taken:

- All works in the vicinity of the find shall be put on hold until a solution is found for the preservation of these artefacts, or advice from the relevant authorities including Ghana Museum and Monuments Board (GMMB) and Ellembelle District Assembly (EDA) is obtained.
- Immediately notify Consortium/GNGLC's Community Relation Department. An officer from the department will then notify the Construction Manager and the HSE Manager from both GNGLC and EPC Contractor.
- Record details in Incident Report and take photos of the find.
- Demarcate the discovered site or area; secure the site to prevent any damage or loss of removable objects. In cases of removable antique or sensitive remains, a guard shall be arranged until the GMMB and EDA take over.
- Experts including archaeologist from GMMB must make a rapid assessment of the site or find to determine its importance to cultural heritage based on factors such as aesthetic, historic, scientific or research, social and economic values of find. Based on this assessment the appropriate strategy will be implemented.

- Sites of minor significance (such as isolated or unclear features and isolated finds) will be recorded by an expert from GMMB to limit disruption to the work schedule of the Contractor.
- In case of a significant find, GMMB will be informed immediately and put in writing within 7 days from the find.
- GMMB will investigate the fact within 2 weeks from the date of notification and provide response in writing.
- Decisions on how to handle findings will be the sole responsibility of GMMB.
- Construction works can resume only after permission is granted by GMMB. This may include changes in the layout, conservation, preservation, restoration, and salvage and in case of no response received within the 2 weeks period mentioned above, this can be considered an authorization to proceed with suspended construction works.

All records relating to the find shall be maintained by the EPC Contractor and provided to Consortium/GNGLC's Community Relation Department who will maintain duplicate copies. All finds should be registered, photologed, and copies of communication with relevant authorities, decisions and recommendations should be maintained.

## **CHAPTER 9 PROVISIONAL ENVIRONMENTAL MANAGEMENT PLAN**

### **9.1 Background**

This Chapter presents a Provisional Environmental Management Plan (PEMP) which among others, covers Action and Monitoring Plans to be used to monitor predicted environmental impacts and proposed mitigating measures for GPP Train 2 for the first 18 months before the issuance of an Environmental Permit to Ghana Gas.

The objective of this PEMP is to present the mitigation measures and monitoring requirements and other responsibilities in an actionable format for implementation during the different phases of the GPP Train 2 project. The PEMP defines steps that will be followed to ensure that environmental obligations and stewardship responsibilities are discharged. The validity period for a PEMP is the eighteen months of commencement of operations. The provisional EMP will cover:

- Summary of the existing Environmental Management Practices before the expansion.
- Proposed Management Practices for GPP Train 2.
- Environmental Action Plan.
- Monitoring Plan.

### **9.2 Summary of the Existing Environmental Management Practices**

Ghana Gas currently operates with an EPA-approved comprehensive EMP (GNGLC, 2019e) to manage the activities of GPP Train 1 and its associated facilities. The EMP covers details on how to:

- Manage the actual impacts during the project operational phase.
- Ensure proper implementation of project permitting conditions.
- Ensure continuous improvement in environmental performance.
- Create environmental awareness among staff and Communities in the project area.

The EMP has been incorporated into an Environmental Management System (EMS) designed to give full effect to GNGLC's environmental policy; meet national regulatory requirements and

international standards for Environmental Management Systems, ISO 14001:2004. Further details are summarized below.

### ***9.2.1 Raw Material Management***

Ghana Gas receives raw sweet gas from FPSO vessels through a 12" subsea gas transportation pipeline that has a total length of approximately 58 km, of which 14 km near the FPSOs, is located in deep water (depth up to 800 m) and 44 km is routed in shallow waters with a maximum depth of 81m. The raw gas on entering the plant is quantified with an ultrasonic metering device for fiscal and operating purposes. The reception facilities at Atuabo are designed to receive 150 MMSCFD raw gas at an operating pressure of 130 to 207 barg (design pressure is 238 barg) and operation temperature of 20°C to 30°C (design temperature is 0°C to 70°C).

In an event of over pressurization, leakage or fire, the emergency shutdown valve ESDV-01-001-GP installed upstream of the barred tee, isolates the 12" gas transportation pipeline towards the gas processing facilities. For offshore pipeline depressurization, a 6" line with manual relief valves is installed at a point upstream of the Emergency Shutdown Valve (ESDV) and the relief sent to a high pressure (HP) flare header. To equalize the pressure around the ESDV prior to opening, a 2" bypass line with one automatic shutoff valve and one manual choke valve, is installed. The bypass line starts upstream of the ESDV. The reception facility is connected to the HP flare system, vent and drain system with hard piping. Venting gas goes to the HP Flare header, and wastewater goes to the HP Closed Drain header.

### ***9.2.2 Gaseous Emissions Management***

Waste gas produced during gas processing is treated through pollution abatement equipment (scrubbers, filters, and knockout drums) before it is sent to the flare stack for safe disposal at a permitted height of 41 m above ground. The location and height of the flare stack are designed in accordance with best practice and industry standard to ensure emissions are treated to acceptable standards before discharge to prevent pollution. Vegetation growth is sustained around the plant to serve as a carbon sink for CO<sub>2</sub> produced. Ambient and occupational air quality monitoring is regularly carried out in the plant and other operational facilities.

### **9.2.3 Effluent Management**

Effluent generated at the GPP Train 1 is mainly sanitary water, oil-contaminated water, and runoff from the process area of the plant.

Sanitary water is channeled through existing sewers to the sanitary water collection sump and sent through a water treatment package, consisting of an Extended Aeration Activated Sludge process. Oil-contaminated water generated at the main processing area, LPG Tank area, condensate tank area, workshop, chemical shelter, and laboratory is channeled through a network of closed drains into an oily water collection sump and treated through the oily water treatment package.

The output from the two treatment systems mentioned above are collected in the Observation Pond. Rainwater that falls on the process area of the plant is directed through drains into a Control Water Basin and treated by adopting a combination of natural process (sun rays) and chemical/biological process (oily water treatment system).

Treated effluent is sampled regularly for laboratory analysis to ensure the physico-chemical parameters meet the Ghana Standards for Environment and Health Protection – Requirements for Effluent Discharge (GS 1212, 2019) before discharge into the environment. Effluents with levels of some parameters that exceed the respective standards are collected by a certified liquid waste management company and treated off-site to meet the standards before discharge. Regular maintenance is carried out on the treatment facility to ensure efficiency and prevent breakdown.

### **9.2.4 Solid Waste Management**

General solid wastes generated at GPP Train 1 are segregated at the point of collection and put into labelled colour coded bins while specialized solid waste is also collected and stored under waste sheds.

On-site waste storage areas at Ghana Gas operational facilities are on the company's premises. The selected area is not subject to flooding, located away from manufacturing/processing areas, away from employee activities, and away from foot and vehicular traffic. The area is divided into two

(2) sections, non-hazardous and hazardous storage areas. For hazardous waste storage, incompatible wastes are kept separated to ensure minimum risk of fire or explosion.

#### ***9.2.5 Waste Oil Management***

Waste oil consists of used oils generated from the usage of lube oil (engine oil, lubricants, generator oil, compressor oil). It is stored in clearly labelled metal drums and stored under the hazardous waste shed before collection by an approved waste oil contractor for reuse, recycle or disposal. Regular inspections for leaking, corroded or damaged container(s) are carried out. Continuous education on spill prevention and response is also provided for staff.

#### ***9.2.6 Storm Water/Run-off Management***

Storm water management at GPP Train 1 is carried out in two (2) ways, depending on the area of collection. The plant is divided into sections and all the floors in these sections are paved with reinforced concrete. Rainwater from the main processing area and the LPG holding tanks area, condensate holding tanks area, and condensate loading area, passes through interceptor metal mesh/grill covered drains into the Control Water Basin. Also, run-off from these areas, including storm water and accidental oil spills are channeled into the Control Water Basin where the water is treated and analyzed to meet the Ghana Standards for Environment and Health Protection – Requirements for Effluent Discharge (GSA, 2019) before discharge into the environment. All other surface water from the remaining areas of the plant (AIS, Utility area and Administration block) are directed into an open drain system and disposed of outside of the plant.

In the event of a spill, there is strict adherence to emergency response procedures to ensure that any spill is immediately and effectively contained to minimize or eliminate the adverse environmental impacts. There are bunds around the holding tanks areas to ensure that any spill from the tanks, joints and couplings are contained within the banded areas.

#### ***9.2.7 Energy Management***

GPP Train 1 generates its own power for consumption from three (3) gas combustion piston motor driven generators, each 850 kW, and one (1) ordinary diesel driven generator set, providing 300 kW for emergency power during start- up and black start conditions. During power failure or

maintenance, the plant relies on power supply from the national grid through a 33kV external power line. All generator containers are located close to the main electrical equipment housing and connected to a primary (main) 440V switchgear.

Fuel gas for the gas generators is supplied directly from two locations in the gas plant, one for start-up gas and one for ordinary fuel gas, via local equipment consisting of a heater, scrubber and filter. Resource efficiency is ensured by using lean gas as a source of raw material for power generation at the GPP thus, minimizing pressure on the national grid and reducing emissions and costs. Awareness training on energy use and management is also provided for staff to help change attitudes and further reduce the rates of consumption. M

ore energy efficient equipment and machinery are procured and used to further reduce rates of consumption.

### **9.2.8 Water Management**

The primary source of water at all Ghana Gas operational facilities is ground water (boreholes). At the GPP Train 1 site, a water intake system is in place to supply raw water to the plant and portable water unit as well as the firefighting unit. The system consists of a submerged pump, connecting piping to the mentioned units, a sampling connection for periodic sampling of the source water, a strainer to remove particulate matter, and an ultrasonic metering to measure the volumetric flow of the water.

The water that is obtained from the well does not meet water quality required for service and potable water and is therefore further treated by a treatment system before use by the plant. The tanks are sized to provide 48 hours of water storage at maximum consumption (500m<sup>3</sup> each). Firefighting water at the GPP is stored in two (2) tanks, each of which has a capacity of 4,080 m<sup>3</sup> to meet the maximum fire water demand based on 6 hours for one expected fire scenario. Regular maintenance works on the treatment system are carried out to ensure sustained efficiency. Awareness training on water use and management is also provided for staff.

### ***9.2.9 Chemical and Obsolete Chemicals Management***

A standard operating procedure (GNGLC/PRO/HSSE.ENV/004) for hazardous chemical management has been developed to manage the use of chemicals at GPP Train 1. The main chemicals used in operations include ethylene glycol, methanol, petrotherm, and demulsified, flocculating agent. A system of control is in place to outline the preferred hierarchy of different control options to reduce the risk from chemical exposure. Usually, a combination of control methods is used. In order of preference the hierarchy is: Elimination, Substitution, Isolation, Engineering, Administration, and PPE.

Chemicals are stored in accordance with relevant Ghanaian legislative requirements, industry standards and the manufacturer's recommendations. The Logistics Department is responsible for monitoring and maintenance of permanent and temporary storage areas under the jurisdiction of the warehouse. All waste and unused chemicals are removed from site in accordance with legislative requirements. Documented details of such disposal are made available to the HSE Manager, Operations and General Manger Operations for approval prior to disposal and records of all chemical disposals retained for inspection and audit.

## **9.3 Proposed Management Practices for GPP Train 2**

Ghana Gas Company will continue to use the existing management practices; however, the scope will be broadened to accommodate the operations of GPP Train 2. The major management measures proposed are summarized in the sections below.

### ***9.3.1 Physical Environment***

#### ***i. Gaseous Emissions Management***

The existing pollution control system in place will be upgraded to cater for the increased production capacity of the Gas Processing Plant. This will be done by procuring additional scrubbers, filters, and knockout drums to increase the existing capacity to manage waste gas and emissions. Additional pollution control equipment (scrubber, filters, and knockout drums) will be installed in the gas flare stack to treat the waste gas/emissions to meet the Ghana Standards for Environment and Health Protection – Requirements for Ambient Air Quality and Point Source/Stack Emissions (GSA, 2019) before flaring into the atmosphere.

Ghana Gas will also continue with its efforts to identify and engage an off taker to utilize the iso-pentane produced. Furthermore, Ghana Gas shall use the results of the proposed specialised studies on emissions modelling to improve management of its air emissions and widen the area of monitoring of its air emissions beyond the A3 Communities. All work equipment and vehicles shall be maintained at optimal operating conditions, according to the manufacturers' specifications.

The HSE Manager will be responsible for undertaking all HSE commitments and ensure that training activities are periodically organised for staff on gaseous emission management and effective measures in reducing emissions of waste gases.

#### ***ii. Noise and Vibration Management***

The construction and operation activities will potentially generate noise and vibration. Therefore, construction and operational equipment will be regularly serviced to reduce excessive noise. Noisy constructional activities will be undertaken in the daytime since the ambient noise standard level for the daytime is higher than at night. Equipment and machinery will operate in a manner that the noise level does not exceed the Ghana Standards for Health Protection – Requirements for Ambient Noise Control (GSA, 2018).

Line Managers shall ensure that all personnel wear appropriate Personal Protection Equipment (PPE) such as ear plugs in areas of high noise. Ghana Gas shall also maintain a vegetative buffer between the Asemnda community and the site for Train 2.

#### ***iii. Wastewater Management***

During the operations phase of GPP Train 2, the main types of wastewater to be generated continuously will be in the form of oil contaminated water, sewerage, and surface runoff from various sources. This is also applicable to the construction phase. Measures to mitigate the potential negative impacts of wastewater management will basically follow the principles of pollution minimization, decontamination and treatment for the various types of wastewater generated.

Ghana Gas shall continue with the same mitigation actions for GPP Train 2 based on its environmental policy and waste management principles by directing oil contaminated water, sewerage, and surface runoff to the Oily Water Treatment System, Sanitary Treatment System, and Control Water Basin respectively. These facilities, which have enough capacity to accommodate the liquid wastes from the operations of Train 2, shall be regularly maintained.

Effluents from the Oily Water Treatment System and the Sanitary Treatment System shall be directed to the Observation Pond for treatment to meet GSA's effluent quality guidelines. Accumulated wastewater contained in the Observation Pond shall be periodically dislodged by an accredited service provider while other liquid wastes for which Ghana Gas does not have in-house treatment capability, shall be stored in labelled containers, and collected by licensed waste management companies for treatment and safe disposal. In addition, Ghana Gas shall include surface water and rainwater sampling in monitoring of the physicochemical and biological quality of groundwater and effluents. The HSE Manager shall be responsible for the monitoring' including training to the relevant staff. The results will be published in the company's report and submitted annually to the EPA.

#### ***iv. Solid Waste Management***

In anticipation of the expected increase in the generation of general solid wastes due to the expansion, additional waste bins shall be procured to help manage them. The sheds for the storage of both non-hazardous and hazardous wastes shall be accordingly expanded to cater for additional waste storage. These sheds shall be clearly marked with international signage to alert both workers and visitors. Segregation of waste into clearly labelled bins will be continued. Ghana Gas shall recycle, reuse, or dispose permanently offsite solid non-hazardous waste and hazardous waste including obsolete chemicals in compliance with the Hazardous, Electronic and Other Waste Control and Management Act, 2016 (Act 917) the Hazardous, Electronic and Other Waste (Classification) Control and Management Regulations, 2016 (L.I. 2250). The waste management companies already engaged for waste collection and disposal will continue to work and management will engage more companies when the need arises.

The HSE Department shall facilitate training on effective waste handling and disposal, and fundamentals of chemical waste handling for all employees. The training will be organised in consultation with the EPA.

### **9.3.2 Biological Environment**

#### ***i. Flora and Ecosystems***

In both the construction and operations phases, GNGLC shall maintain a policy of minimum disturbance of vegetation. It shall landscape the project site and limit physical developments in the wetlands and construct appropriate bunds and drains to effectively control flooding while maintaining a vegetative boundary between the project site and Asemnda.

### **9.3.3 Socio-economic Environment**

#### ***i. Occupational Health and Safety***

Some of the management issues concerning occupational health and safety have been considered above under gaseous and particulate emissions, noise and vibration, wastewater, and solid waste management. The remaining issues include management of fires and explosions, hazardous chemicals, and the COVID-19 pandemic.

***Fire Risk Management*** - The existing fire prevention and response programme for Train 1 shall be reviewed and adopted for the Train 2 for the management of fire. During the review, the views of the Ghana National Fire Service (GNFS) and the National Ambulance Service, both of which are based at the premises of the GPP, will be taken into account. Experts will be engaged to provide firefighting training (techniques and drills) for relevant staff. GPP Train 2 shall maintain its own firefighting equipment such as fire extinguishers, fire hydrants, fire alarm systems, smoke detectors, and flame arrestors. Fire cautionary signage shall be displayed at all high-risk areas within the plant.

***Hazardous Chemicals*** – Just as for Train 1, Management shall ensure that appropriate PPEs are made available to workers during the handling and use of these chemicals and conduct training for the relevant staff on the use of the chemicals. Storage of these chemicals shall be in accordance with the manufacturers' recommendations and disposal of obsolete chemicals shall be through

accredited companies according to such relevant legislation as the Hazardous and Electronic Waste Control and Management Act 2016, (Act 917).

**COVID-19 Pandemic** - All recommended protocols to control the spread of the COVID-19 pandemic put in place by Management shall continue to be adhered to by staff, contractors, and visitors.

#### ***ii. Public Health and Safety***

Within the context of its Community Affairs Policy, Ghana Gas shall continue with its community sensitisation programme on the company's activities including prevention of bush fires and encroachment on the RoW of pipelines. The HSE and Community Relations Departments shall work together to involve nearby communities in emergency drills and mass casualty exercises; and also continue to provide support to the local health authorities as part of GNGLC's corporate social responsibility activities.

#### ***iii. Regulatory Requirements***

Ghana Gas shall be guided by all the relevant regulations such as the Environmental Assessment Regulations, 1999 L.I. 1652, the National Petroleum Act, 2005 (Act 691), Petroleum Local Content and Participation Regulations, 2013, Labour Act 2003 (Act 651), Water Use Regulations, 2001 (L.I. 1692), and the GSA Environmental Quality Standards for noise, air quality, and effluent discharges.

#### ***iv. Relevant Stakeholders***

Ghana Gas shall, through its Community Affairs Corporate Social Responsibility Policy and Practice, continue consultations with all relevant stakeholders to maintain a conducive environment for its activities. It shall also strengthen its collaboration with the associated District and Metropolitan Assemblies and their decentralized departments.

### **9.4 Environmental Action Plans**

Environmental Action Plans are proposed for the purpose of defining and assigning responsibility for coordinating and controlling the activities and resources required towards achieving

environmental objectives and targets within a defined time frame. Progress towards achieving environmental objectives and targets shall be monitored regularly and parties responsible for individual aspects of the Management Plans shall report on progress in management review meetings. The action plans are presented below detailing specific actions, objectives, targets, responsible personnel, and proposed budget.

For the Pre-construction Phase, the Action Plan presented in Table 67 covers only socio-economic issues of occupational and public health and safety, regulatory requirements, and consultations with relevant stakeholders. For the Construction (Table 68) and Operations (Table 69) phases, the action plans cover the Physical, Biological, and Socio-economic environments. More issues are thus presented including air quality, noise nuisance, wastewater management, solid waste management, and ecosystem services.

Table 67 Action Plan for Pre-Construction Phase Activities

Impact/Issue	Identified Action	Actual Action (Responsibility)	Objective	Target	Budget (GHC pa)
Occupational and Public Health and Safety	Ensuring effective occupational and public health and safety	Request all contractors to be engaged to prepare and submit job risk assessments and method statements for approval (1). *	To ensure occupational and public health and safety	Protection of GNGLC staff and the public	5,000
Regulatory Requirements	Compliance with regulatory requirements	Acquire all the relevant regulatory requirements such as permits for the start of construction and operations (2).	To minimise delays in starting the project	Approvals and permits obtained	1,000,000
Relevant Stakeholders	Settlement of compensation issues	Ensure that fair compensation is paid within a reasonable period (3).	To avoid local unrest and possible project delays	All affected persons are duly compensated	800,000
	Consultation with relevant stakeholders	Continue to create general awareness on the project and sign an agreement with the A3 communities (3).	To strengthen general collaboration with all relevant stakeholders	Effective consultations with stakeholders	20,000

\* 1: HSE Manager; 2: GM Operations; 3: Community Relations Manager; 4: Contractor

Table 68 Action Plan for Construction Phase Activities

Impact / Issue	Identified Action	Actual Action (Responsibility)	Objective	Target	Budget (GHC pa)
<b>Physical Environment</b>					
Air Quality	Controlling dust and gaseous emissions	Minimise dust generation by using covers for sand heaps and dowsing with water. Maintain construction equipment at optimal conditions (4).	To reduce dust and noxious gas emissions;	GSA Standards for Ambient Air Quality and Point Source / Stack Emissions (GS 1236, 2019) are complied with.	10,000
Generation of Noise	Efficiently conducting operations to ensure low noise levels	Service construction equipment frequently. Operate machineries at their installed capacities (1). Ensure that appropriate PPEs are worn by all at the project site. Limit construction work to daytime hours of 6:30am to 5:30pm (1, 4).	To maintain noise on site at acceptable levels	GSA Standards for Noise Levels (GS 1222, 2018) complied with.	10,000
Flooding	Reduction of floods at the construction site and its environs	Design and construct adequate drainage in the project area from GPP2 to the sea (see Plate 28).  The drainage culvert will be designed as box type with a span of 4.0 meters, a rise of 2.0 meters and slope of 0.005. The entrance will be provided with flared wingwalls to increase discharge and decrease entrance losses with a	To reduce flooding of the project area during construction	Project area and close communities are protected	To be part of Bill of Quantities for of EPC Contractor

Impact / Issue	Identified Action	Actual Action (Responsibility)	Objective	Target	Budget (GHC pa)
		<p>coefficient of 0.2. The upstream invert is set equal to the average minimum elevation of the swampy area to lower the flood depth effectively (see Plate 28).</p> <p>Avoid creating exposed surfaces that may result in excessive surface runoff and sedimentation of drains (2, 4).</p>			
Surface Water and Groundwater	Surface water and groundwater quality is preserved	<p>Schedule construction activities to avoid land exposure to soil erosion.</p> <p>Use impervious surfaces and handle fuels and fluids to avoid spills (1, 2, 4).</p>	To preserve surface water and groundwater quality	Surface water and groundwater quality maintained at baseline levels	-
Wastewater Generation	Reduction of wastewater generated during construction	<p>Install adequate washrooms for workers.</p> <p>Estimate materials to ensure no leftovers.</p> <p>Provide sizable containers for collection of construction slurry for reuse in concrete mixing (1, 2, 4).</p>	To prevent irresponsible generation and disposal of wastewater during construction	Minimisation, collection, and safe disposal of human wastes.	5,000.00
Solid Waste Generation	Reduction of solid waste generated during construction	<p>Engage an efficient waste management company and introduce a waste management system that enhances segregation on site.</p> <p>Provide sizable bins for collection of wastes.</p> <p>Sell wooden pallets to carpenters and store scrap for later use by artisans (1, 2, 4).</p>	To control littering with solid waste during construction	Minimisation, collection, and safe disposal of solid wastes	10,000

Impact / Issue	Identified Action	Actual Action (Responsibility)	Objective	Target	Budget (GHC pa)
<b>Biological Environment</b>					
Aquatic Ecosystems	Protection of the aquatic ecosystem services	Minimise earth movements and disturbance of vegetation. Handle chemicals, oil, and fuel on impervious surfaces. Provide portable spill containment and clean-up equipment on site (1).	To reduce the degradation of the aquatic ecosystems in the project area	Ecosystems in the project area preserved	-
<b>Socio-economic Environment</b>					
Occupational Health and Safety Issues	Preventive and control measures to protect workers	Provide required PPEs, First Aid Kits, Emergency Response Systems, safety signage for all construction activities. Ensure workforce is given safety training; Enforce usage of PPEs and compliance to safety procedures for work. Adhere to all recommended protocols on the COVID-19 pandemic (1, 4).	Create a safe working environment	All involved in the construction are protected	20,000.00
Public Health and Safety Issues	Protection of the public and nearby communities	Build a temporary perimeter wall to avoid unauthorized access. Post signage to notify the public of ongoing construction works. Use the bypass route as much as possible for transport of heavy equipment and loads.	To reduce negative impacts of construction on the public	The public and nearby communities are protected	10,000

<b>Impact / Issue</b>	<b>Identified Action</b>	<b>Actual Action (Responsibility)</b>	<b>Objective</b>	<b>Target</b>	<b>Budget (GHC pa)</b>
		Carefully transport construction materials through the communities to avoid accidents (1, 3,4).			
Regulatory Requirements	Compliance with regulatory requirements	Acquire all the relevant regulatory requirements such as permits for the start of construction and operations (2).	To ensure that activities are implemented as scheduled	All the relevant regulations are complied with.	-
Relevant Stakeholders	Consultation with all relevant stakeholders	Continue to inform the public on construction and related activities (3).	To minimise delays in construction schedules	All relevant stakeholders are continually consulted	10,000

Table 69 Action Plan for Operations Phase Activities

Impact / Issue	Identified Action	Actual Action (Responsibility)	Objective	Target	Budget (GHC pa)
<b>Physical Environment</b>					
Air Quality	Controlling gaseous and dust emissions	<p>Treat waste gas produced from operations with pollution abatement equipment (Scrubbers, filters, and knockout drums) before sending to the flare stack for disposal.</p> <p>Ghana Gas will also continue with its efforts to identify and engage an off taker to utilize the iso-pentane produced.</p> <p>Use the results of the proposed specialised studies on emissions modelling to improve management of air emissions.</p> <p>Increase the scope of monitoring of air emissions beyond the A3 Communities (1, 2).</p>	To control gaseous and dust emissions to comply with the GSA standards	To reduce flaring and stabilise iso-pentane production for sale	3,000,000
Noise Generation	Efficiently conducting operations to ensure low noise levels	<p>Service all equipment and vehicles as scheduled.</p> <p>Ensure that PPEs are worn by all personnel.</p> <p>Create a vegetative buffer zone to protect communities from excessive noise (1, 4).</p>	Reduce noise impact within plant and on nearby communities	GSA Standards for Noise Levels (GS 1222, 2018) complied with.	500,000
Soils	Avoidance of soil contamination	<p>Maintain bunds around the storage tank areas to contain any spills.</p> <p>Expand the area of the hazardous waste shed.</p> <p>Store obsolete/expired chemicals and waste oil on non-permeable surfaces (1, 2, 4).</p>	To avoid contamination of soils	Project area soils remain uncontaminated	-

Impact / Issue	Identified Action	Actual Action (Responsibility)	Objective	Target	Budget (GHC pa)
Wastewater Generation	Efficient management of wastewater	Dislodge accumulate waste in the observation pond periodically. Upgrade waste treatment process to remove phosphates. Expand monitoring to include surface water, seawater and rainwater. Comply with GSA effluent standards (1, 2, 4).	Prevent polluted wastewater from being discharged into the environment	GSA Standards for effluents complied with.	200,000
Solid Waste Generation	Efficient management of solid wastes	Expand the storage space for hazardous and non-hazardous waste for increased solid waste to be generated. Continue solid waste management practices – segregation and storage to be removed by licensed waste management companies. Continue awareness creation on need to reduce quantities of solid waste generated (1, 2, 4)	To reduce the severity of pollution of natural resources – water, soil, and other ecosystem resources in the project area	Pollution of natural resources reduced	1,500,000
<b>Socio-economic Environment</b>					
Occupational Health and Safety	Preventive and control measures to protect workers	Provide suitable PPEs and effective training to all workers. Provide periodic medical examinations for employees. Create safety awareness to the workers. Adhere to all recommended protocols of the COVID-19 pandemic (1, 3).	To provide a safe workplace for employees and visitors	All involved in the operation of the GPP, and visitors are protected	2,000,000

<b>Impact / Issue</b>	<b>Identified Action</b>	<b>Actual Action (Responsibility)</b>	<b>Objective</b>	<b>Target</b>	<b>Budget (GHC pa)</b>
Fires and Explosions	Protection of the GPP and its workers from fires and explosions	Maintain a permanent mobile GNFS fire tender in the GPP enclave. Ensure the availability of groundwater resources to provide sufficient firefighting water. Provide a permanent station for the National Ambulance Service at the GPPs. Train all employees, contractors, and others on fire safety issues (1, 2, 4).	To protect the workers and GPP from fires and explosions	Workers and GPP adequately protected	500,000
Hazardous chemicals	Reducing effects of hazardous chemicals	Actions specified under the physical environment shall apply in combating the adverse effects of the hazardous chemicals on human health and the environment (1, 2, 4).	To protect human health and the environment	Workers and GPP environs are adequately protected	100,000
Public Health and Safety	Prevention of negative impacts on the public and the communities	Continue with community sensitisation on the company's proposed activities. Involve the nearby communities in emergency drills and mass casualty exercises. Continue to provide support to the local health and administrative authorities as part of its corporate social responsibility activities (1, 3).	To protect the public and nearby communities	The public and nearby communities are adequately protected	800,000
Regulatory Requirements	Compliance with requirements	Acquire all the relevant regulatory requirements such as permits for the start of operations (2).	To ensure that activities are implemented as scheduled	All the relevant regulations are complied with.	1,500,000

Impact / Issue	Identified Action	Actual Action (Responsibility)	Objective	Target	Budget (GHC pa)
Relevant Stakeholders	Consultation with all relevant stakeholders	Continue to inform the public on operations and related activities. Strengthen Community Relations Department (3).	To maintain cordial relationships	All relevant stakeholders are continually consulted	2,000,000

## 9.5 Provisional Environmental Monitoring Plan

### 9.5.1 Purpose of Environmental Monitoring

Environmental Monitoring provides a basis for determining the pattern and nature of change resulting from the expansion and operations of the GPPs. This will allow Ghana Gas to assess the effectiveness of mitigation measures and develop action plans to rectify issues. Environmental Monitoring provides the means for assessing environmental management practices thus it is an important tool GNGLC will apply in enhancing its environmental performance.

The monitoring plans proposed for the different phases are presented below.

### 9.5.2 Pre-Construction Phase

Table 70 Environmental Monitoring Plan for Pre-Construction Phase

Parameter	Frequency	Method	Responsibility	Budget (pa)
Occupational and public health and safety	Quarterly	Medical screening/examination	Contractor, Gen-Manager Operations, HSE Manager, Accredited hospital	5,000
Regulatory requirements	Monthly	Inventory of relevant permits and licenses	Gen-Manager operations, Community Affairs Manager	-
Settlement of compensation	Monthly	Checking of compensation records and status of payment	Community Affairs Manager	-
Stakeholder Engagement	Monthly	Stakeholder List particularly from A3 communities.	Community Affairs Manager	-

### 9.5.3 Construction Phase

Table 71 Environmental Monitoring Plan for Construction Phase

Parameter	Frequency	Method	Responsibility	Budget (pa)
Ambient Air Quarterly	Monthly	Monitoring of CO, SO <sub>2</sub> , NO <sub>2</sub> TSP, PM <sub>10</sub> , and PM <sub>2.5</sub> at the selected monitoring sites. Speed tracking of company and contractor vehicles.	HSE Manager, Contractor	10,000
Noise Levels	Monthly	Monitoring of noise levels at selected sites.	HSE Manager, Contractor	5,000
Drainage	Weekly	Field inspection at Train 2 construction site	HSE Manager, Contractor	1,000
Surface Water and Groundwater	Bi-annually	Sampling and analyses of effluents, groundwater, surface water, seawater, and rainwater for physicochemical and biological quality parameters.	HSE Manager, Contractor	20,000
Solid Waste Management	Daily	Visual inspection of site and waste trail documents.	HSE Manager, Contractor	1,000
Occupational and public health and safety	Quarterly	Medical screening/examination	Contractor, Gen-Manager Operations, HSE Manager, Accredited hospital	5,000
Regulatory Requirements	Semi-annually	Review of permits and approvals required for compliance.	GM Operations	-
Relevant Stakeholders	Quarterly	Assessment of stakeholder meetings.	Community Affairs	-

### 9.5.4 Operations Phase

Table 72 Environmental Monitoring Plan for Operations Phase

Parameter	Frequency	Method	Responsibility	Budget (pa)
Air Quality	Monthly	Monitoring of CO, SO <sub>2</sub> , NO <sub>2</sub> , TSP, PM <sub>10</sub> , and PM <sub>2.5</sub> at the selected monitoring sites.	HSE Manager	200,000
Noise Generation	Monthly	Monitoring of noise levels at selected sites.	HSE Manager	100,000
Surface Water and Groundwater	Bi-annually	Sampling and analyses of effluents and groundwater for physicochemical and biological quality parameters.	HSE Manager	50,000
Wastewater Generation	Quarterly	Effluents from sanitary and oily water treatment units and control water basin, and observation pond are sampled and analysed.	HSE Manager	100,000
Solid Waste Generation	Weekly	Inspection of the solid waste storage sites.		400,000
<b>Socio-economic Environment</b>				
Occupational Health and Safety	Annually	Medical screening, examination, and review of employee medical records. Review of incidents and complaints records. Assessment for workers for their comprehension of safety systems.	HSE Manager	1,000,000
Fires and Explosions	Monthly	Inventory of fire and explosion incidents and accidents in the GPPs.	GM Operations. HSE Manager	-
Hazardous chemicals	Monthly	Audits of handling, storage, and spillage of hazardous chemicals used in the processing of natural gas.	GM Operations. HSE Manager	-
Public Health and Safety	Monthly	Audit of the implementation of the Community Affairs Policy. Checks on the observance of Covid-19 protocols by the public and visitors.	GM Operations. HSE Manager	-

<b>Parameter</b>	<b>Frequency</b>	<b>Method</b>	<b>Responsibility</b>	<b>Budget (pa)</b>
Regulatory Requirements	Semi-annually	Review of permits and approvals required for compliance.	GM Operations	1,500,000
Relevant Stakeholders	Quarterly	Assessment of stakeholder meetings.	Community Affairs	-

## CHAPTER 10 DECOMMISSIONING AND CLOSURE

### 10.1 Introduction

Decommissioning is defined as the shutdown of a facility to prepare it for complete closure, clean-up, and site reinstatement. At the cessation of operation of GPP Train 2, it will be decommissioned according to the statutory requirements in force at the time and in keeping with the fact that the land has been acquired by the Government through an Executive Instrument. Ghana Gas is required to develop a programme for the safe decommissioning and closure of both GPPs. This will be done at a time close to decommissioning to ensure that all the relevant environmental issues are properly identified and appropriately considered. The implementation of the programme would ensure that the site is rehabilitated to EPA's requirements. The extent of dismantling, demolition and site clearance will depend upon the future use of the site. There are likely to be three stages to the decommissioning:

- *Pre-decommissioning* consents and contracts: covering the site and structures, plant and processes, municipal and site utilities, fire safety, access and transport, and demolition of buildings, among others.
- *Decommissioning* activity obligations: environmental emissions including effluents discharges, air emissions, noise and dust generation, waste disposal, soil and water contamination, and associated health and safety issues.
- *Post decommissioning* responsibilities: These will ensure that the relevant data and information on the decommissioned site is passed on to the subsequent site owners and developers.

#### 10.1.1 Objectives

The specific environmentally related objectives of decommissioning and closure are to:

- Meet all pertinent Ghanaian legal and regulatory requirements and complete the site rehabilitation and reinstatement according to EPA criteria and standards.
- Protect the public health and safety of local people and the surrounding environment.
- Ensure that all residual environmental and social impacts are acceptable.
- Ensure that the need for long-term site maintenance is removed as much as possible.

- Ensure that post-reinstatement land use is according to national and other key stakeholder requirements.
- Dismantle all relevant structures.
- Safely dispose of hazardous materials, contaminated soils, steel structures, and equipment.
- Restore all distressed lands and areas with vegetation, where possible.

### ***10.1.2 Principles***

The principles of the decommissioning exercise are:

- Planning for decommissioning should begin as early as possible.
- Due to the long timeframe involved in the operations of the GPPs, the legislative requirements need to enable the flexibility to accommodate changes in context, technological developments or stakeholder priorities that may require adjustments in the final closure programme.

## **10.2 Preliminary Decommissioning Plan and Restoration Measures**

The description of restoration measures shall include the following:

- Timing and schedule for executing measures.
- Equipment and structure removal or conversion.
- Remedial measures, including success indicators and contingency measures if initial efforts are unsuccessful.
- Plans for reuse of all or parts of the plants.
- Commitment to perform restoration, decommissioning and closure plan if the initial efforts for reuse are unsuccessful.
- Roles of GNGLC staff and other hired staff in the process.
- Estimated cost of decommissioning.

## CHAPTER 11 CONCLUSION

GNGLC intends to expand its activities with the construction and operation of a new and larger GPP Train 2 at the same place as the existing Train 1 at Atuabo in the Western Region of Ghana.

There will be cumulative impacts from the operations of both GPPs that will use similar technologies including those associated with air emissions and the generation of liquid and solid wastes, a high proportion of which will be hazardous. Ghana Gas is aware that the implications for increased hazards to occupational and public health and safety require that it increases its efforts in terms of human, material, and financial resources to mitigate and control these potential negative impacts. These also require an expansion of staff and the scope (area and parameters) of monitoring.

The expansion of the activities of Ghana Gas will support the industrialisation of Ghana in diverse ways while providing jobs and contributing to local development. However, worldwide concern is growing about the contribution of fossil fuel use to climate change and the survival of the planet. At the most recent global climate change conference, 197 countries including Ghana adopted the Glasgow Pact, which aims to turn the next decades into a period of climate action and support (Earth Negotiations Bulletin, 2021). Ghana was also a signatory to a declaration (<https://www.gov.uk/government/publications/cop26-declaration-zero-emission-cars-and-vans>) on accelerating the transition to 100% zero-emission cars and vans.

Renewable energy currently accounts for only 2.4 percent of the power generated in the country. (<https://www.ghanaweb.com/Government-backs-VRA-Bui-Power-in-renewable-energy-drive-1380628>). However, the government intends to achieve a 10 percent renewable energy target by 2030 in line with the United Nations Sustainable Development Goals. In addition, the Government has completed the preparatory phase of the Scaling-up Renewable Energy Programme that would provide opportunities to both the public and private sectors in the deployment and use of renewable energy in the country.

It is a fact that Africa should be allowed to use its fossil fuel resources to develop itself and lift its population from the cycle of poverty (Ayuk, 2021). Similarly, it has been recently stressed that Ghana is not in a rush to transition from fossil fuels ([Ghana not in a rush to transition from crude oil to wind, solar energy – Energy Ministry \(ghanaweb.com\)](#)). While these policies may work for the next few decades, they may not be sustainable in the long term because of such possibilities as loss of interest by the larger global community in the use of fossil fuels, reduced markets for fossil fuel products, reduced investments in exploration, as well as the rise and dominance of new or existing renewable energy technologies. GNGLC shall therefore consider how to diversify its activities, while at the same time, continuing to support Ghana’s development with natural gas in the medium term ([https://www.ghanaweb.com/GhanaHomePage/ Gas-is-best-option-until-renewable-energy-transition-Ghana-Gas-CEO-1387927](https://www.ghanaweb.com/GhanaHomePage/Gas-is-best-option-until-renewable-energy-transition-Ghana-Gas-CEO-1387927)).

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## APPENDICES

The Appendices listed below have been compiled in a separate document because of the size of the Main Report.

### Part One

- Appendix A Flood Risk Assessment Report
- Appendix B Quantitative Risk Assessment Report
- Appendix C Fire and Explosion Risk Assessment Report
- Appendix D Associated E&S Studies
- Appendix E Additional Stakeholder Engagement Photos

### Part Two

- Appendix 1-1.1 Response from EPA after Project Registration
- Appendix 1-3.1 Letter to Stakeholders
- Appendix 1-3.2 Comments from EPA on Scoping Report
- Appendix 1-3.3 Scoping Notice Published in the Ghanaian Times
- Appendix 1-3.4 Scoping Notice Published in the Daily Graphic
- Appendix 3-2.1 E.I. 51, 2014
- Appendix 5-1.1 Ambient Air Quality and Noise Level Assessment Report
- Appendix 5-1.2 Laboratory Results: Surface Water and Groundwater Analyses
- Appendix 6-1.1 List of Stakeholders Consulted
- Appendix 6-1.2 Response from National Petroleum Authority
- Appendix 6-1.3 Response from Ministry of Energy
- Appendix 6-1.4 Response from Energy Commission
- Appendix 6-1.5 Response from Water Resources Commission
- Appendix 6-2.1 Petition to GNGLC from A3 Communities, June 2020