



REPORT

**Genser Energy Ghana Limited, Liquefaction and Gas
Conditioning Plant Project, Prestea**
Final Environmental Impact Statement

Submitted to:

Genser Energy Ghana Limited

Submitted by:

Golder Associates Ghana Ltd.

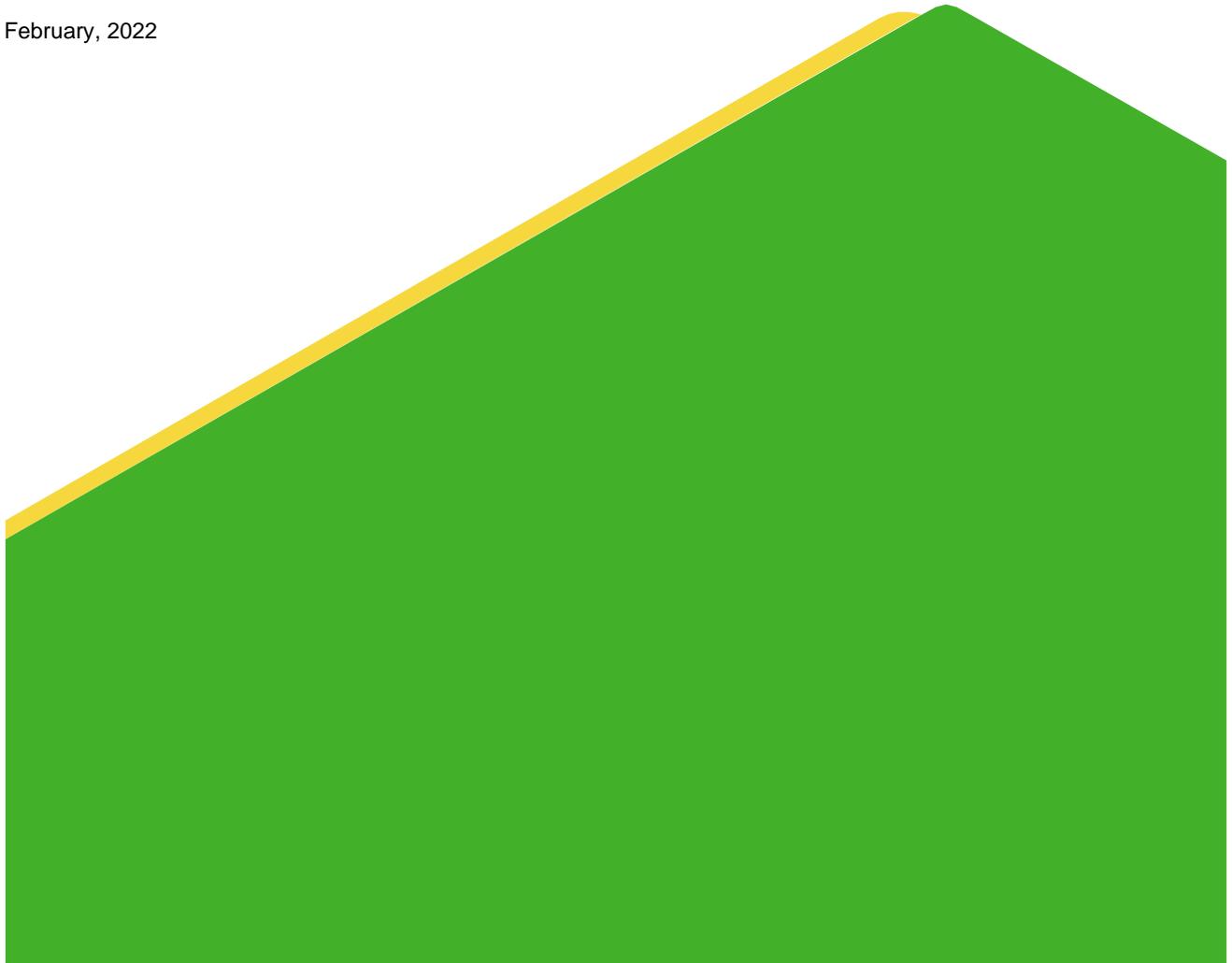
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Distribution List

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Executive Summary

Genser Energy Ghana Limited (GEGL) is an energy solution company incorporated in Ghana in April 2007 under the Companies Act 1963 (Act 179). Genser Energy Holdings Limited, a Mauritius-incorporated company with two Ghanaians as ultimate beneficiaries, owns 100% of GEGL.

GEGL intends to build a Liquefaction and Gas Conditioning Facility (the Project) with an installed capacity of 135 MMSCFD and 6.5km natural gas pipeline to at Prestea (project area). The main purpose of the Project is to liquefy and fractionate natural gas to Liquefied Natural Gas (LNG) and Natural Gas Liquids (NGLs) such as ethane, propane, and butane, among others from the associated gas supplied through GEGL's natural gas pipeline.

In compliance with the requirements of the Environmental Assessment Regulations, 1999 (LI 1652), GEGL duly registered the project with the Environmental Protection Agency (EPA). The EPA in a letter dated 16 April 2021, requested that GEGL submit a scoping report and Terms of Reference (ToR) for the project and an Environmental Impact Assessment (EIA) then after. This Environmental Impact Statement (EIS) is being submitted to the EPA to inform the decision on the project's environmental permit.

Project Justification

The anticipated benefits of the project include alignment with the government's vision of increasing cleaner, affordable and sustainable energy options within the energy mix and to meet the increasing demand for energy in the country, enhance the creation of jobs directly from the project and indirectly from industrial development and economic opportunities, generate revenue for the GEGL and the country from the exportation of ethane and propane to other West African countries.

Applicable Legislations, Policies and Standards

There are a number of national policies, laws, regulations and guidelines that mainstreams the integration of relevant environmental, social and economic issues regarding the energy production in Ghana. These regulations, policies, laws and guidelines identified for further study in this EIS include:

National Legislations and Policies
a) Constitution of the Republic of Ghana, 1992
b) Environmental Protection Agency (EPA) Act, 1994 (Act 490)
c) Environmental Assessment Regulations, 1999 (LI 1652)
d) Fees and Charges (Amendment) Instrument, 2019 (LI 2386)
e) Energy Commission Act, 1997 (Act 541)
f) Ghana Highway Authority Act, 1997 (Act 540)
g) Land Use and Spatial Planning Act, 2016 (Act 925)
h) Land Commission Act, 1994 (Act 483)
i) Water Resources Commission Act, 1996 (Act 522)
j) Ghana National Fire Service (GNFS) Act, 1997 (Act 537)
k) Local Governance Act, 2016 (Act 936)
l) Factories, Offices and Shops Act, 1970 (Act 328)

National Legislations and Policies
m) Electricity Regulations, 2008 (LI 1937)
n) National Energy Policy, 2010
o) Ghana National Environmental Policy, 2014
p) Ghana Forest and Wildlife Policy, 2012
q) National Water Policy, 2007
r) Environmental Sanitation Policy, 2010
s) National Wetlands Conservation Strategy, 1999
t) Ghana Climate Change Policy, 2013
u) Ghana Standards for Environment and Health Protection

The EIS has been prepared in accordance with the following international requirements:

International Standards
IFC Performance Standards (PS 1, PS2, PS3, PS4, PS6 and PS8)
Equator Principles (Principles 1-10)
IFC Environmental Health and Safety Guidelines

Project Description

The LNG and NGL's produced from the Prestea Liquefaction and Gas Conditioning Facility will then be marketed in Ghana and abroad (neighboring countries) through an export terminal at GEGL's Takoradi Port Facility. The Prestea Liquefaction and Gas Conditioning Facility and pipeline development will include gas pre-treatment station, cryogenic separation station, fractioning and separation station, gas compression station, a storage and loading terminal and ancillary facilities as well as 6.5km 24' natural gas pipeline from the existing gas regulating and receiving station in Prestea. The proposed pipeline will have one major river crossings on the Ankobra River.

Stakeholder Engagement

The stakeholder engagement process provided the platform for GEGL to share information on the project including project components, while also allowing stakeholders to raise issues and concerns about the project development. The engagements were generally conducted through face-to-face interactions with focus groups. The Police Commander, Fire Commander, leaders of Brumasi community and representatives of the Prestea Huni Valley Municipal Assembly.

The engagements took place between 28 October 2021 and 30 November 2021. A total of 4 meetings were held with approximately 20 participants in attendance. The process aided in the identification of mitigation measures to address concerns expressed about aspects of the construction and operational phases of the project.

Among the key issues and concerns raised by stakeholders during the consultations were queries on public education on natural gas and pipeline safety to allay any fears or concerns that people may have, GEGL urged to make timely payment of all compensations, community residents also wanted to know the benefits of the

liquefaction facility to the PACs. They inquired about employment opportunities associated with the project and whether training would be provided to the PACs.

Impact Assessment

The impact assessment methodology employed subject matter specialist assessment and interpretation of data collected to inform the assessment. The assessment is presented as a narrative and combined magnitude, duration and extent of the specific impact occurring at the project construction and operational phases. During the impact assessment, importance was placed on social values and concerns of stakeholders. The specialist studies focused on biophysical, socio-economic and traffic situation of the project area.

Soil and land use

The key soil impact anticipated from project activities are degradation of soil quality, loss of soil as a resource, land use change, soil contamination from hydrocarbon and other chemical spills and improper disposal of waste and soil compaction from the movement of construction equipment and vehicles.

Air quality

Potential activities and sources of air quality impacts were identified based on construction activities, and it was determined that the key impact of concern was particulate matter with diameter 10 micrometers and below (PM₁₀) and particulate matter which are two- and one-half microns or less in width (PM_{2.5}).

A dispersion modelling conducted for the operational phase for TSP, PM₁₀, PM_{2.5}, NO₂, SO₂, CO and VOCs. The predicted modelled concentrations were below Ghana Standards Authority (GSA) requirements for ambient air quality and point source/stack emissions (GS 1236:2019) and International Finance Corporation (IFC) guidelines at all sensitive receptors for all impact assessed. Also, the predicted concentrations for the highest offsite concentration across the modelling domain for most of the impact assessed were below the GS 1236:2019 standards and IFC guidelines except for NO₂ 1-hour and annual averaging periods. However, no sensitive receptors are located where the highest offsite NO₂ concentration occurred for both the 1-hour and annual averaging period.

Noise

A total of six sensitive receptors were identified for the study and these communities are within a 10km radius of the proposed Facility site.

For the construction phase of the project, a semi-qualitative assessment including attenuation-over-distance acoustic calculations showed that during the construction phase, increases in noise levels (i.e., from baseline noise levels) during the daytime as a result of the construction activities were below 3 dB(A) threshold for annoyance as per the IFC Noise Regulations at all receptor locations, with the largest change predicted at SR3 (Heman). Noise receptors were likely to experience noise levels that will be absorbed into the existing environment. During the night-time, increases in noise levels from construction activities were below the 3 dB(A) threshold for annoyance as per the IFC Noise Regulations at most receptor locations, except for SR3 (Heman). Increases in noise levels were likely to result in sporadic complaints at this location, given the proximity of the location in relation to the proposed construction activities. The remaining noise receptors were likely to experience noise that will be absorbed into the environment.

For the operational phase, a CadnaA (Computer Aided Noise Abatement) was used for the calculation, presentation, assessment and prediction of environmental noise levels for the proposed Liquefaction and Gas Conditioning Facility operations. Increases in daytime and night-time noise levels at all noise receptors from the operational activities were negligible. As such, it was likely that the noise levels from the project operations will

be absorbed into the existing ambient environment and will not contribute significantly to the existing noise levels.

Surface water

The proposed Facility site is in the Ankobra River Basin, one of the main rivers in the South-Western Rivers System comprising the Bia, Tano, Ankobra and Pra Rivers. It is bounded to the east; west and south by the Pra Basin, Tano Basin, and the Gulf of Guinea respectively. The main challenges related to water in the basin are artisanal mining activities, pollution from indiscriminate discharge of untreated mine effluents.

The main potential impacts of concern to the Ankobra River are high sediment run-off during the construction phase for the 6.5km pipeline specifically which crosses the Ankobra at one point, and potential contamination of the river due to hydrocarbon spills during the construction and operational phases of the project.

Groundwater

The groundwater in the project area may have mild acidity and elevated levels of trace metals. Groundwater level at the project site ranges from 1.05 m to 17.62 m below ground level with a mean of 10.9 m below ground level. The highest groundwater level was recorded at piezometer S7B (1.05m) and the lowest was registered in piezometer S10B (17.62m).

The potential groundwater impacts identified include contamination of groundwater due to leakages and spillages from vehicles and equipment during the construction operational phases. There is also the potential for the acidification of groundwater and dissolution of trace metals during the operational phase. All of these identified impacts would pose low to medium environmental consequence.

Visual amenity

Visual impacts will, stem from construction related activity and presence of construction machinery and associated material storage and laydown areas. Formation of dust plumes from construction activities and light pollution at night. Presence of project infrastructure (the Liquefaction and Gas Conditioning Facility, associated facilities and 6.5km gas pipeline) within the visual landscape could cause visual intrusion.

Biodiversity

The vegetation of the project area is considered largely modified, because of human activities such as cultivation of cash crops, arable/food crops, and artisanal mining activities, with remnant areas of natural habitat limited to freshwater swamp forest in areas unsuitable for cultivation. The faunal community observed during field surveys was largely consistent with the modified landscape of reduced diversity of habitat generalist species and with just four nationally protected bird species.

Most potential impacts on species and ecosystems were expected to occur due to site clearance activities during the construction phase. The construction of the Liquefaction and Gas Conditioning Facility and 6.5km gas pipeline will contribute to a cumulative impact within the Study Area. Activities such as vegetation clearance will introduce direct and indirect impacts such as potential invasive species introductions, soil erosion and loss of natural habitat. Increased presence of people and operation of heavy machinery during construction will result in temporarily increased levels of sensory disturbance to fauna, reducing the area of available secondary forest habitat for foraging and breeding purposes. During operation, the potentially increased presence of people in the project area, could also exacerbate existing pressures on species and ecosystems of concern due to increased demand for natural resources, such as bush meat, fuel wood and charcoal. It is therefore crucial that the mitigation hierarchy is followed and all efforts to avoid and minimise impacts on biodiversity during construction and operation of the Facility and the pipeline are made. Where avoidance of impacts is impossible,

application of the recommended mitigation measures is critical in reducing the significance of predicted project impacts, to environmentally acceptable residual impacts.

Socio-economic

The project area falls within the Prestea Huni Valley Municipality in the Western Region of Ghana. The average household size in the Municipality is 4.0, lower than the average household size of 4.96 in the study area. About four persons out of ten were born outside the municipality and most of them migrated into the area to seek for employment. Most of them are Christians.

There are four communities (project affected communities (PACs)) within 5 km radius of the project area. Most of the dwelling units in the PACs are either owned by the households' extended family, rented or household itself. Cement blocks and aluminium are the dominant materials used for constructing houses.

There is no health facility in the PACs apart from the Heman Health Centre. About 80% of health seekers have the national insurance policy. The main challenge of health care accessibility are the high cost of services and inadequate health care infrastructure and logistics. Out of every 10 households, only three have their own functional toilet. Ankobra, Brumase and Barrier each have only one public toilet facility. Some of the toilet facilities and dumping sites are closer to the main Ankobra river and other water bodies in the project area.

Standpipes and boreholes are the commonest sources of water. Apart from Barrier, residents who have streams as the main source of drinking water, all the other communities have, a functioning borehole.

The municipality has about 43,500 pupils in basic schools with 51.46% males. There are 102 Kindergarten (KGs)/Pre-schools, 102 Primary, 71 junior high schools (JHS) and three senior high schools (SHS) in the municipality. The average number of students managed by a teacher is 35. More than 40% of the household members leave school early mainly because of artisanal mining activities. The major industrial activity in the area is mining.

The road conditions in the entire municipality are very poor. Unemployment rate in the area is about 5% and about one-third of the employed population is engaged in farming. The major food crop produced are plantain, maize, and cassava. The major problems of farmers are encroachment mainly by artisanal mining activities.

Electricity is the commonest source of light energy while charcoal and Liquefied Petroleum Gas are used for cooking. In one out of every 10 households, at least one member has some form of minor disability.

The socio-economic assessment indicated that the construction and the operation of the project will have both positive and negative impacts including employment creation and boost to the local economy. On the other hand, all the impacts discussed for the various specialists' studies will affect the social environment too.

Mitigation Measures

An Environmental and Management Plan (EMP), which will serve as the primary monitoring programme with the key additional mitigation measures has been developed as part of this EIS. Mitigation measures to avoid, minimize, rectify, or reduce identified impacts were developed focusing on technical evaluations by discipline-specific experts, issues from stakeholder engagements and industry best practices. Where all else was not possible, offset measures were put in place.

Monitoring Programmes

The monitoring programme developed for the project will enable GEGL to identify aberrations quickly and apply appropriate mitigation measures. The monitoring programme will include:

- Abi-annual two-week period wet and dry season air quality monitoring.

- Monthly sampling and testing of piezometers within the project footprint
- Quarterly surface water monitoring to enable the establishment of a trend surface water in the project area.

Rehabilitation and Decommissioning

The end of the construction phase will result in the demobilization of machines and equipment from site, as well as the rehabilitation of any remaining laydown areas that will not be required during the operational phase.

A Detailed Decommissioning Plan will be developed during the project implementation and prior to the end of the service life of the project, where all these measures and end uses of all project infrastructure will be firmed up.

Abbreviations and SI Units

ABBREVIATIONS

EHS	Environmental health and safety
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EPC	Engineering, Procurement, and Construction
EPFI	Equator Principles Financial Institution
ESMP	Environmental and Social Monitoring Plan
ESMS	Environmental and Social Management System
ESSSs	Environmental and Social Safeguards Standards
GEGL	Genser Energy Ghana Limited
GHG	Green House Gas
GWCL	Ghana Water Company Limited
IFC	International Finance Corporation
PS	Performance Standards

SI Units

°	Degrees
Bcf	billion cubic feet
cm	Centimetres
ha	Hectares
km	Kilometre
mm	Millimetres
mm ²	Square millimetre
m	Metres
m ³	Cubic metre

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APPENDICES

APPENDIX A

EPA letter requesting and EIA for the project

Detailed PIP

EIA Project Team

APPENDIX B

Biodiversity Baseline and Impact Assessment Report

Construction Plan for River Crossing

Alternative Route Analysis Report for the 6.5km Pipeline

APPENDIX C

Stakeholder Engagement Report

Project Equipment List

APPENDIX D

Compensation Action Plan

Compensation Details for Project Affected Persons

1.0 INTRODUCTION

Genser Energy Ghana Limited (GEGL) is a wholly owned Ghanaian Independent Power Producer incorporated under the Companies Code, 1963 (Act 179) in April 2007. Genser Energy Holdings Limited (GEHL), a Mauritius-incorporated company with two Ghanaians as ultimate beneficiaries, owns 100% of GEGL. GEGL specialises in providing custom-engineered turnkey energy solutions to industrial clients with high energy requirements including mining companies.

The company engages in engineering, procurement, and construction (EPC) as well as operations and maintenance of its power generation plants and sells electricity and/or steam to its clients. GEGL has developed seven distributed power generation projects since its inception in Ghana and intends to expand further. The distributed power generation projects are:

- GP Bogoso Plant – 36.0MW Single Cycle Plant fired by distillate on the mining concession of Golden Star Resources, Bogoso mine.
- GP Unilever Plant – 5.5MW Cogeneration of Heat and Power Plant fired by Liquefied petroleum gas (LPG) on the premises of Unilever Ghana Limited, Tema.
- GP Chirano Plant – 30.0MW Steam Turbine Plant fired by natural gas and natural gas liquids (NGLs) on the mining concession of Chirano Gold Mines Limited, Chirano mine.
- GP Tarkwa Plant – 66.0MW Single Cycle Plant fired by natural gas and NGLs on the mining concession of Gold Fields Ghana Limited, Tarkwa mine.
- GP Damang Plant – 25.0MW Single Cycle Plant fired by natural gas and NGLs on the mining concession of Abooso Goldfields Limited, Damang mine.
- GP Wassa Plant- 33.0MW Single Cycle Plant fired by natural gas and NGLs on the mining concession of Golden Star Resources, Wassa mine.
- GP Edikan Plant- 33.0MW Single Cycle Plant fired by natural gas and NGLs on the mining concession of Perseus Mining Ghana Limited, Edikan mine.

In a bid to significantly minimize the operational challenges experienced by GEGL given the presence of liquids in the natural gas utilized for power generation, GEGL is constructing a 135 million standard cubic feet per day (mmscfd) Liquefaction and Gas Conditioning Plant and associated infrastructure and 6.5km 24' natural gas pipeline in Prestea for the extraction of Liquefied Natural Gas (“LNG”) and NGLs, specifically ethane, propane, butane, Iso-pentane and condensates. The proposed Liquefaction and Gas Conditioning Plant, 6.5km natural gas pipeline and associated infrastructure at Prestea will be collectively known as “Prestea GCP”. The Prestea GCP will commence operations with the processing of 135 mmscfd of natural gas per day and gradually increase to 200 mmscfd. The Prestea GCP will facilitate the compression/liquefaction of natural gas and sale of LNG to GEGL’s power generation facilities in the West African region.

The project will comply with all applicable legislation, particularly the Environmental Assessment Regulations 1999 (LI 1652) and international requirements particularly the requirements of the International Finance Corporation (IFC) performance standards to access international funding.

This Environmental Impact Statement (EIS) is being submitted to the Environmental Protection Agency (EPA) to enable the relevant government authorities, particularly the EPA to provide an environmental permit for the implementation of the project.

1.1 Background

GEGL engages in the full value chain of energy generation and transmission including the EPC of power plants and natural gas pipeline infrastructure for power generation as well as Operation and Maintenance of its assets. GEGL's current operations reflect its firm commitment to increase electricity and natural gas access throughout Africa.

GEGL currently operates in Ghana and has identified a clear need for its services elsewhere in West Africa. GEGL sees opportunities to add value in Mali, Burkina Faso, and Cote d'Ivoire, and is in the process of establishing country level subsidiaries to develop projects in these countries.

GEGL therefore intends to build the Prestea GCP and the 6.5km natural gas pipeline, with an ultimate operating capacity of 200 mmscfd to supply LNG and NGL (in the form of butane, propane, ethane) to developers within and outside Ghana for industrial users for power generation, manufacturing and mining process that rely heavily on diesel/HFO. Currently GEGL receives lean gas from Ghana National Petroleum Commission (GNPC)¹ at Prestea from Ghana's gas fields after pre-treatment at the Atuabo gas processing facility.

The natural gas supplied by GNPC is transported via Ghana National Gas Company's (GNGC) natural gas pipeline from Atuabo through to Essiama and Prestea, where GNGC pipeline terminates. From Prestea, GEGL's existing Gas Regulating and Receiving Station will receive natural gas via the GNGC's Regulating and Metering Station (RMS) in Prestea. GEGL will construct a 6.5km 24-inch pipeline to interconnect the GRRS to the Prestea GCP.

1.2 Ownership

Although GEGL is 100% owned by GEHL, GEGL is the owner and proponent of the Prestea GCP and the 6.5km pipeline Project. The proposed land area for the proposed Prestea GCP and Pipeline are farm lands owned by the Traditional Chiefs of the Prestea Heman Community.

1.2.1 Details of Proponents

The project proponent is GEGL, and their details are as provided in Table 1.

The Prestea GCP and Pipeline will be owned and managed by GEGL.

Table 1: Details of the Project Proponents

Item	Description
Proponent	Genser Energy Ghana Limited
Address	Horizon Plaza, First Floor #60 Liberation Road, Airport, Accra-Ghana
Telephone	+233 244428335
Project Manager	Samuel Abeiku Omane
Chief Executive Officer	Baafour Asiamah-Adjei

¹ GNPC is the national gas sector aggregator and has the responsibility of ensuring the availability of adequate gas supply for energy generation. GNPC controls the upstream gas, midstream infrastructures, and final gas delivery to downstream consumers.

1.2.2 Consultant

GEGL appointed Golder to undertake the EIA for the GCP and Pipeline Project. The details of the consultants are provided in Table 2.

Table 2: Details of Consultants

Item	Description
Name of Consultants	Golder Associates Ghana Ltd
Address of Consultants	Densu Point Building, 3 Fofu Link, North Dzorwulu, Accra, Ghana P.O. Box KIA 16092, Airport, Accra, Ghana
Telephone	+233 302 978 819/823
Email address	esarpey@golder.com

The details of the EIA team area attached in APPENDIX A.

1.3 Location of the Project

The Prestea GCP and 6.5km natural gas pipeline project is proposed to be sited in Prestea- Heman in the Western Region of Ghana. The area mapped for the Prestea GCP is approximately 100 hectares (Ha), while the area mapped for the pipeline right of way is 65km long and 12m wide. Figure 1 provides a satellite image of the Prestea GCP project site, and the GPS coordinates of the plant boundary are provided in Table 3.

Table 3: GPS coordinates of project boundary

Location	GPS coordinates	
Northwest Point	5° 28.577'N	2° 7.237'W
Northeast Point	5° 28.579'N	2° 6.929'W
Southeast Point	5° 28.269'N	2° 6.930'W
Southwest Point	5° 28.270'N	2° 7.238'W

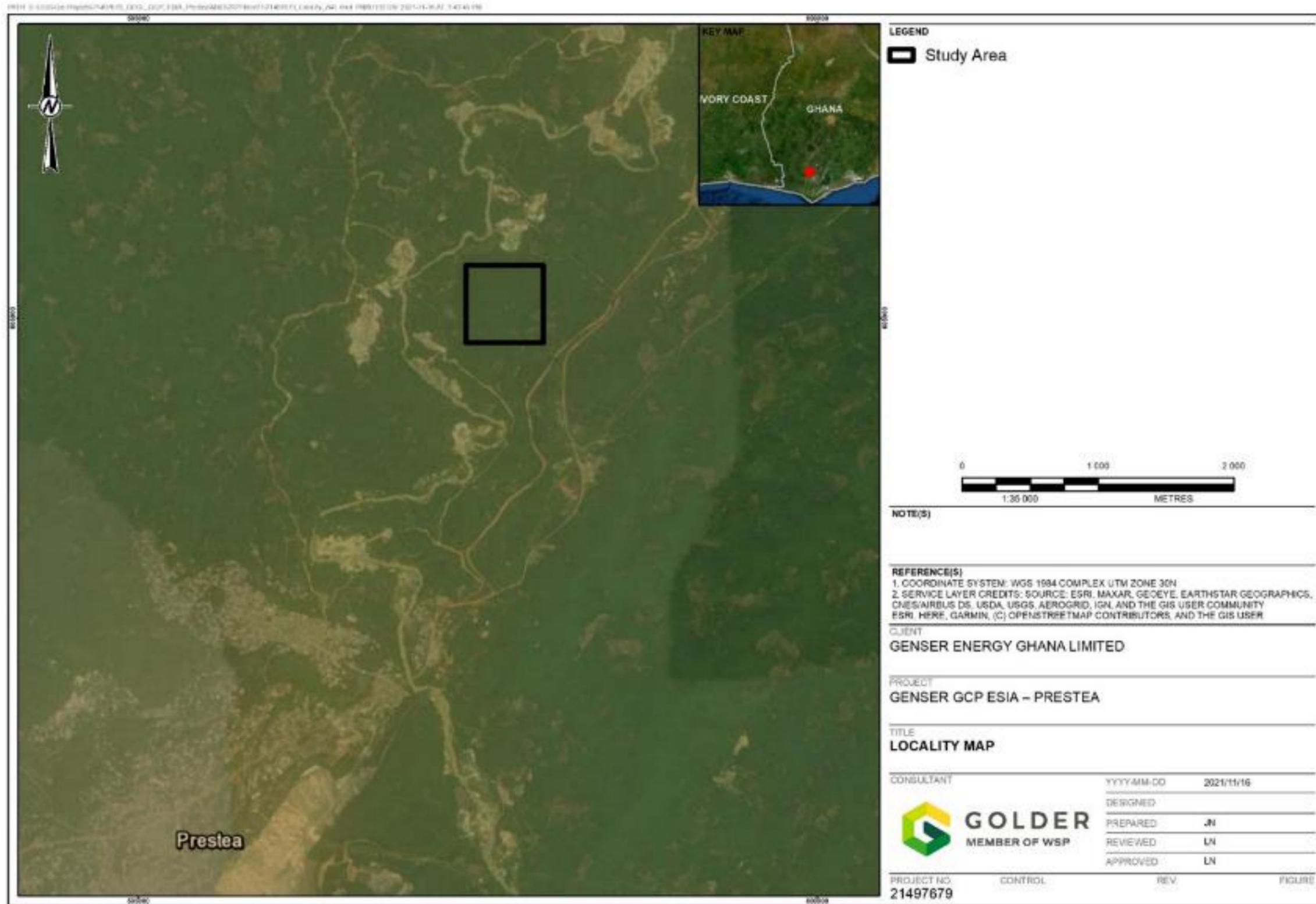


Figure 1: Project Location

1.4 An Analysis of the need for the Undertaking

Ghana discovered its first Deepwater oil and gas in 2007. Presently, the most advanced reserves identified are: The Jubilee field, with associated gas reserves estimated at 490 billion cubic feet (Bcf); the TEN fields with associated gas reserves of 363 Bcf and the Sankofa field with non-associated gas reserves of 1,107 Bcf. Plans are underway to develop the Mahogany and Teak fields with estimated total reserves of 120 Bcf as part of the Greater Jubilee Full Field. Most of the natural gas from these fields were previously flared into the atmosphere for safety reasons. However, the natural gas will be put to beneficial use with the implementation of the project.

Globally, there is a recognition of the benefits of utilizing natural gas over other sources of energy. For a developing country like Ghana, which have discovered oil and gas in commercial quantities, there is an opportunity to utilise natural gas in powering industries. In addition to the advantage of reduced greenhouse emissions that natural gas has over other energy sources, there are cost saving opportunities from its use.

Natural gas often has entrained liquids (ethane, propane, butane, Iso-pentane and condensates), which must be separated to improve the efficacy of LNG. Furthermore, these liquids are of higher value as separate products. The NGLs if not removed from natural gas also have the potential to damage the gas turbine that are solely powered with natural gas (STI Group, 2018). The removal of the entrained liquids reduces the concentration of higher hydrocarbons and water to prevent the formation of hydrocarbon liquids and hydrates in the natural gas pipeline (Khan and Islam, 2007).

It is important to note that there are many uses for NGLs. NGLs are used as inputs for petrochemical plants, they are burned to provide heat and blended into vehicle fuel (US Energy Information Administration, 2012). Table 4 presents some of the uses of the NGLs, which could be explored for further development in the country.

Table 4: Some uses of Natural Gas Liquid

Natural Gas Liquid	Applications	End Use Products	Primary Sectors
Ethane	Ethylene for plastics production; petrochemical feedstock	Plastic bags, plastics, anti-freeze, detergent	Industrial
Propane	Residential and commercial heating, cooking fuel, petrochemical feedstock	Heat for cooking, small stoves and barbeques, LPG	Industrial, residential, commercial
Butane	Petrochemical feedstock, blending with propane or gasoline	Synthetic rubber for tires, LPG, lighter fuel	Industrial, transportation
Isobutane	Refinery feedstock, petrochemical feedstock	Alkylate for gasoline, aerosols, refrigerant	Industrial
Pentane	Natural gasoline, blowing agent for polystyrene foam	Gasoline, polystyrene, solvent	Transportation
Pentanes Plus*	Blending with vehicle fuel, exported for bitumen production in oil sands	Gasoline, ethanol blends, oil sands production	Transportation

*Pentane plus is also known as "natural gasoline". They contain pentane and heavier hydrocarbons. US Energy Information Administration, 2012.

GEGL is proposing the development of the GCP and the 6.5km natural gas pipeline to:

- Liquefy and fractionate natural gas to LNG and NGLs (mainly ethane, propane and butane) to:
 - Diversify and increase their stream of income.

- Export ethane and propane to other West African countries by road trucking to the Takoradi Port to be offloaded into fuel vessels through the Amandi oil jetty at the Takoradi Port.
- Locally supply LNG, propane, butane, and ethane by road trucking.
- The Facility when completed and operationalized will also serve as a backup fuel source for GEGL's power plants should there be a natural gas disruption. It should be noted the natural gas used in these plants will be free of these NGLs, which will provide additional benefits including:
 - Increase the life and overall efficiency and performance of the gas turbine.
 - Meet equipment warranty requirements.
 - Minimise maintenance costs and unscheduled downtime.
- Meet the Government of Ghana's vision of increasing cleaner, affordable and sustainable energy options within the energy mix and to meet the increasing demand for energy in the country.
- Enhance creation of jobs directly from the project and indirectly as a result of industrial development and economic opportunities.

1.5 Environmental Impact Assessment Methodology and Objectives

1.5.1 EIA Methodology

The EIA was conducted in line with LI 1652 and followed the procedure shown in Figure 2. GEGL registered the project with the EPA and the EPA in a letter dated 16 April 2021 (APPENDIX A) requested that GEGL to Scoping exercise to generate the relevant Terms of Reference (ToR) to guide the EIA for the Prestea GCP and 6.5km natural gas pipeline project. The Scoping exercise, which preceded this EIS was completed in December 2021.

The approach to completing this EIS was done systematically and included: (i) stakeholder engagements; (ii) completion of critical baseline studies; and (iii) review of available technical information for the project.

1.5.1.1 Scoping Phase

The Golder Project team visited the project site to assessment the bio-physical environment of the project area to inform the scoping and terms of reference of the EIA

Stakeholder engagement process, facilitated by GEGL was initiated and the documentation from the engagements were provided to Golder for review and incorporation into this report. A stakeholder engagement plan and project background information document (PID) guided the stakeholder engagement. Consultations were held with traditional leadership, local leaders, community residents and governmental agencies at the local, district and regional levels. The engagements were conducted from 28 October 2021 and 30 November 2021. A summary of the engagements is as follows:

- All engagements were conducted in the form of face-to-face interactions and focus group discussions.
- The meetings were conducted in Twi and in some cases English and were documented (photographs were taken, attendance registers completed, and notes taken).
- Meetings were held at venues easily accessible to stakeholders.
- Comments and issues raised, and responses provided by GEGL were captured in a Stakeholder Engagement Report attached to this EIS as APPENDIX C.

1.5.1.2 Baseline Studies and Impact Analyses

A key aspect of the EIA process is to define the existing baseline conditions in the project area. The project team identified vital aspects of the biological and socio-economic environments that required additional studies during the EIA phase. Baseline data including historical data was collated to characterize the physical, biological and socio-economic environments, which then informed the impact assessment. The impact assessment entails the use of models, and other analytical methods to determine the potential impacts of the project. This impact assessment provided a basis for the development of the required mitigations that may be necessary to meet the various environmental and social standards.

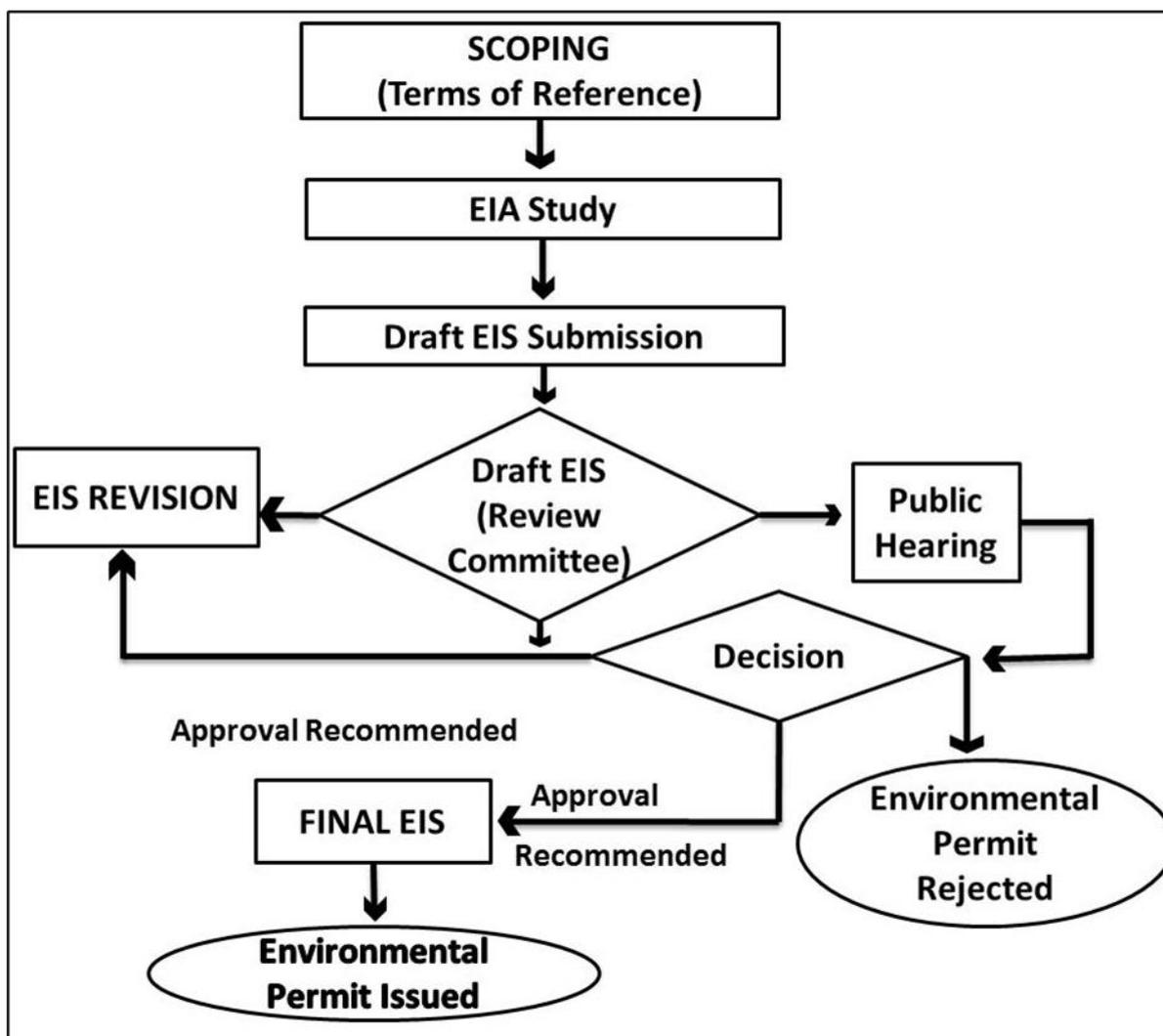


Figure 2: Layout of the EIA Process (EPA, 2015)

1.5.2 Objectives of the EIA

The EIA process aims at identifying potential environmental and social impacts of the project, to inform decision-making, determine compliance with various policies, and aid in the planning of the project. The specific objectives of this EIA are to:

- Document the existing environmental and socio-economic conditions of the project area.
- Present a detailed project description to stakeholders and elicit stakeholders’ inputs on the project.

- Identify and assess all the potential environmental and social impacts associated with the project throughout the life of the project.
- Provide appropriate and effective mitigation measures for the management of the impacts and key issues raised by stakeholders.
- Design management plans to implement and monitor the measures required to mitigate and manage the adverse environmental and social effects of the project.
- Provide a rehabilitation and decommissioning plan for the project
- Fulfil the legal requirements (LI 1651).

1.6 Layout of the EIS

The format of the EIS is consistent with the EPA EIS format. Brief descriptions of the various sections of this EIS are presented in Table 5.

Table 5: Layout of EIS

Chapter	Description of Content
Executive Summary	This chapter provides a non-technical description of the entire project, predicted environmental and social impacts, and the mitigation measures proposed.
Chapter 1- Introduction	This chapter contains a brief description of the project background, the justification for, and potential benefits of the Prestea GCP and pipeline project, and the objectives of the EIA.
Chapter 2 – Policy Legal and Regulatory Framework	The chapter entails a review of the relevant policies, laws and regulations which are applicable to the project.
Chapter 3 - Project Description and Alternatives	This chapter describes the Prestea GCP and pipeline project and provides a summary of alternatives considered.
Chapter 4 - Baseline Information	Existing environmental and social conditions in the vicinity of the Prestea GCP and pipeline project are described in this chapter. Biological, physical, and socio-economic resources that potentially could be impacted by the construction and operation of the Prestea GCP and pipeline project are discussed.
Chapter 5 – Public Participation	This chapter provides information on consultations and stakeholder engagement conducted in conjunction with the engagement process for the Prestea GCP and pipeline project.
Chapter 6 – Impact Identification and Prediction	This chapter presents key impacts associated with the construction and operational phases of the project with particular focus on assessing potential impacts on the biological, physical, and socio-economic resources.
Chapter 7 – Impact Mitigation	This chapter describes mitigation measures that will minimize, rectify, or reduce impacts identified in Chapter 6.
Chapter 8 - Monitoring Programmes	A description of programmes that will be used to monitor various resources during the construction and operation phases of the project is provided in this chapter.
Chapter 8 – Provisional Environmental Management Plan	This chapter includes GEGL's provisional EMP specific to the Prestea GCP and pipeline project. The plan governs activities that will occur during the initial 18-month period after commencement of operations for the Project.

Chapter	Description of Content
Chapter 10 - Reclamation and Decommissioning	Methods and measures to be used to rehabilitate and decommission the project site after the cessation of construction are described in this chapter.
Chapter 11 - Conclusion	This chapter presents conclusions reached from preparing this EIS for the project.
References	All references cited in the EIS are included in this section.

2.0 POLICY, LEGAL AND REGULATORY FRAMEWORK

Ghana has well-established laws, policies guidelines and regulations to promote and regulate the energy sector and the environmental landscape. Relevant laws applicable to the project are summarized in the following sub-sections.

2.1 Constitution of the Republic of Ghana, 1992

Chapter 21, Article 257 (section 1) of the Constitution states that: “all public lands in Ghana shall be vested in the President on behalf of, and in trust for, the people of Ghana”. Chapter 6, Article 36, Clause 9, requires the State to take appropriate measures to protect and safeguard and seek the co-operation of all stakeholders to protect the environment.

GEGL understands that land is vested in the President of the Republic of Ghana. Thus, GEGL will put in measures to mitigate the environment impacts and ensure that all requisite permits from various government agencies are obtained before project implementation.

2.2 National Policy and Legislative Framework

The relevant legislations and policies applicable to the project has been presented in Table 6.

Table 6: Applicable Policies and Legislation

Framework	Description	Applicability to Project
Policy		
Ghana National Energy Policy, 2010	The National Energy Policy (2010) is the underlying policy guiding governmental actions and strategies in the energy sector. Generally, the policy is targeted at ensuring that Ghana become a major exporter of power in the West African sub-region. This is intended to be achieved through capacity addition, modernization of transmission and distribution infrastructure. The policy also focuses on institutional and regulatory reforms intended to create competitive electricity markets. Ghana’s Energy Policy is premised on the need to increase installed generation capacity to more than 5,000MW and to achieve universal access.	The project aims at providing materials for the production of clean energy and thereby contributing to electrical power increase in the country and to diversify the energy mix in power generation.
National Environmental Policy, 2014	The reviewed National Environmental Policy (2014) was first formulated in 1995 to improve the surroundings, living conditions and quality of life of present and future generations. The policy seeks to promote sustainable development by ensuring a balance between economic development and natural resource conservation. It requires the implementation of strategies and programmes for the sustainable management of Ghana’s resources.	The project will be aligned with the supporting principles of the policy for the realisation of sustainable outcomes.
National Water Policy, 2007	The National Water Policy (2007) provides the framework for the sustainable development of water resources in Ghana. The overall goal of the policy is to “achieve sustainable development, management and use of Ghana’s water resources to improve health and livelihoods, reduce vulnerability while assuring good governance for present and future generations.”	GEGL understands the importance of water and is committed to put in place appropriate measures to protect water resources. For the construction of pipeline especially at river crossings, GEGL has in place a river crossing plan which includes

Framework	Description	Applicability to Project
		detailed mitigation measures to be implemented during pipeline installation. GEGL will ensure that all the necessary permits are obtained from Water Resources Commission (WRC) prior to pipeline construction.
Environmental Sanitation Policy, 2010	The overarching goal of the Environmental Sanitation Policy (2010) is to develop a clear and nationally accepted vision of environmental sanitation as an essential social service and a significant determinant for improving the health of its citizens and quality of life in Ghana.	This policy will guide GEGL in the development of waste management strategies for project implementation.
Ghana Forest and Wildlife Policy, 2012	The Ghana Forest and Wildlife Policy (2012) aims to promote conservation and the sustainable development of forest and wildlife resources. The policy calls for the maintenance of environmental stability and continuous flow of optimum benefits from the socio-cultural and economic goods and services that the forest environment provides to present and future generations. It also helps Ghana to fulfil its commitments under international agreements and conventions.	GEGL has undertaken a biodiversity assessment as part of the EIA studies and developed a biodiversity management plan which aligns with the dictates of the policy.
National Wetlands Conservation Strategy, 1999	The purpose of this strategy is to protect and drive the sustainable use of wetland resources which occupies approximately 10% of the country's total land surface. Ghana is a signatory to the Ramsar Convention, which seeks to protect all wetlands.	GEGL will comply with the dictates of the strategy for the realisation of intended outcomes.
Ghana Climate Change Policy, 2013	The National Climate Change Policy provides strategic direction and coordinates issues of climate change in Ghana. The three objectives of the Policy are effective adaptation, social development and mitigation. To address the adaptation issues in Ghana, five areas have been identified, namely, (1) energy, industrial and infrastructure development, (2) natural resources management, (3) agriculture and food security and (4) disaster preparedness and response and (5) equitable social development. In the effort of aligning with its energy strategy, one of the government's aims includes the development of a local market for the industrial use of natural gas by 2015.	This project will further strengthen the development of the local market as heavily industrialized activities such as the mining industries will rely on the use of natural gas for their operations.
Legal and Regulatory Framework		
Environmental Protection Agency Act, 1994 (Act 490)	The Environmental Protection Act, 1994 (Act 490) was enacted for the amendment and consolidation of laws relating to environmental protection, pesticides control and regulation, and for other related purposes. Section 12 (1) of the Act mandates the Agency to request an EIA report from any person responsible for an undertaking which, in the opinion of the Agency, has or is likely to affect the environment. Sections 28(1) and (2) of the Act mandate the	All requirements of the Act will be adhered to.

Framework	Description	Applicability to Project
	development of regulations and guidelines for project implementation.	
Ghana Highway Authority Act, 1997 (Act 540)	<p>The Act mandates states that no person shall without the written permission of the Authority make any excavation in a trunk road; or construct access road to link a trunk road.</p> <p>Where a person makes any excavation in a trunk road, he shall fill up the excavation and restore the surface of the trunk road to the satisfaction of the Authority as soon as possible after completing the work within such time as the Authority may specify.</p>	The 6.5km pipeline might cross some roads in the project affected communities. Thus, GEGL will engage the GHA where application before any excavation is undertaken on a truck road.
Energy Commission Act, 1997 (Act 541)	The Act mandates the Commission as the only body authorized to license any entity engaging in the processing, transmission, distribution, wholesale supply or sale of electricity and natural gas. The Commission is required by law to prepare, review, and update periodically indicative national plans to ensure that all reasonable demands for energy are met in a sustainable manner. Other functions of the Commission include determination of fees and documents needed to apply for a license to operate.	GEGL will obtain all relevant approvals from the Energy Commission prior to the commencement of construction.
Water Resources Commission Act, 1996 (Act 522)	The Water Resources Commission is empowered by Act 522 to grant water rights. Section 13 prohibits the diversion, damming, and storing of water resources except when in accordance with the provisions of the Act. The Act provides that any person may apply to the Commission in writing for the granting of a water right, which then permits the proponent to dam, store, divert or use water. On receipt of the application, the Commission investigates as it considers necessary, including consultations with the inhabitants of the area of the water resources concerned. Section 24 also provides that: "... except in accordance with the provisions of Act 522, or with the approval of the EPA, a person who interferes with, or alters the flow of water resources beyond such levels as the EPA may prescribe, commits an offence".	A water use permit will be required for the diversion or interruption of river flow are anticipated during construction of the pipeline over the Ankobra river.
Local Governance Act 2016 (Act 936)	<p>This Act replaces the Local Government Act 1993, (Act 462) and provides for local governance and National Development Planning System for the Districts. The Act also defines and regulates planning procedures of District Assemblies. The Assembly is mandated to initiate programmes for the development of basic infrastructure and provide municipal works and services as well as be responsible for the development, improvement and management of human settlements and the environment in the district.</p> <p>Section 91 (1) states that no physical development shall be carried in a district without prior approval in the form of a written permit granted by the District Planning Authority.</p>	GEGL will work with the Prestea Huni Valley Municipal Assembly to obtain all necessary approvals for the proposed Prestea GCP Facility and 6.5km Natural Gas Pipeline Infrastructure Project.
Lands Commission	This is an Act to establish the Lands Commission to integrate, subject to the Constitution, the operations of	For this project, the land for the project are mostly

Framework	Description	Applicability to Project
Act 2008, (Act 767)	<p>public service land institutions under the Commission in order to secure effective and efficient land administration and to provide for related matters.</p> <p>The Act empowers the Land Commission to, on behalf of the Government, manage public lands and any other lands vested in the President by the Constitution or by any other law and any lands vested in the Commission.</p>	<p>farmlands owned by the traditional chiefs. Farmers affected by the implementation of the project will be engaged and compensation process initiated according to the land and crop valuation policies of Ghana.</p>
Land Use and Spatial Planning Authority Act 2016, (Act 925)	<p>The Land Use and Spatial Planning Act aims to provide for sustainable development of land and human settlements through a decentralised planning system. It establishes processes to regulate national, regional, district and local spatial planning, and generally to provide for spatial aspects of socio-economic development.</p> <p>The Act includes sections on structure plans (sections 61-70), local plans (sections 71-82), zoning schemes (sections 83-103) and permits (113-125).</p>	<p>GEGL will engage applicable authorities and obtain all needed approvals before project implementation.</p>
Factories, Offices and Shops Act, 1970 (Act 328)	<p>The Act spells out the responsibilities of an employer in ensuring a safe and healthy work environment that guarantees the health and safety of employees. It defines a factory to include any premises (whether in or not in a building) in which one or more persons are employed in manual labour in any activity including the work activities for this project. The Act mandates the Factories Inspectorate Department to register such activities and ensure that internationally accepted standards of providing safety, health and welfare of persons are adhered to.</p>	<p>GEGL will engage the Factories Inspectorate Department and obtain the approval prior to the operation of the facility.</p>
Legislative instruments		
Environmental Assessment Regulations, 1999 (LI 1652)	<p>The Environmental Assessment Regulations, 1999 (LI 1652), set out the requirements for environmental permitting/certification including requirements for environmental assessment and Environmental Management Plans (EMPs). Schedule 1 of Regulation 1 of LI 1652 lists all activities that require an EIA. Under Schedule 2 of Regulation 3, the construction of oil and gas separation, processing, handling, and storage facilities are classified as undertakings for which an EIA is mandatory.</p>	<p>This EIS is in alignment with LI 1652.</p>
Fees and Charges (Amendment) Instrument, 2019 (LI 2386)	<p>The Fees and Charges (Amendment) Instrument 2019 (LI 2386) provides comprehensive rates, fees and charges collectable by Ministries, Departments and Agencies, such as the EPA, for goods and services delivered to the public. The Instrument stipulates the fees and charges to be paid by Companies.</p> <p>The Ghana Immigration Service, through this instrument, has introduced a residence permit fee to ECOWAS nationals and Ghanaians holding foreign passports. Other nationals entering the country for work will also be required to apply for residence permit and pay the accompanying fees.</p>	<p>GEGL will comply with permit fees and all charges pertaining to the obtaining approvals for the implementation of the pipeline as well fees for resident permit for expatriates hired for the project.</p>

Framework	Description	Applicability to Project
Electricity Regulations, 2008	The purpose of these Regulation includes, among others, the regulation of wholesale electricity market, minimum standards and procedures for the construction and maintenance of facilities and installations.	The dictates of these Regulations will be adhered to throughout the project implementation.

2.2.1.1 Environmental Guidelines and Standards

Several environmental guidelines have been developed in Ghana to support environmentally sound design and management during project implementation. Some of the guidelines relevant to an EIA include:

- Environmental Assessment in Ghana, A Guide (1996) and Environmental Impact Assessment Procedures (1995) are EPA guidance documents which outline procedures to be adhered to when undertaking an EIA.
- Standard for Health Protection - Requirements for Ambient Noise Control (GS 1222:2019).
- Standard for Water Quality – Specification for Drinking Water (GS 175:2017).
- Standard for Environment and Health Protection – Requirements for Ambient Quality and Point Sources/Stack Emissions (GS 1236:2019).
- Standard for Effluent Discharge (GS 1212: 2019) provide guidance on maximum permissible effluent discharge.
- Standard for Motor Vehicle Emissions (GS 1219: 2018) specifies the requirements for exhaust emissions of motor vehicles, tractors, construction machines.

2.2.2 International Environmental Treaties and Conventions

The Government of Ghana is a party to several international treaties relating to the environment, notably:

- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) – a treaty which prevents species from becoming endangered or extinct because of international trade.
- Convention on Biological Diversity– a treaty established by the United Nations aimed at preserving biological diversity around the world.
- Convention on the Conservation of Migratory Species of Wild Animals – (also known as the Bonn Convention) the main objective of this international agreement is the conservation and sustainable use of terrestrial, aquatic and avian migratory animals and their habitats.

2.3 International Standards and Guidelines

The IFC Performance Standards and Equator Principles are the benchmarks for good internal environmental practice for many organisations. They are often applied to evaluate EIAs and Environmental and Social Management System (ESMS) proposals when considering a project and provide a level of assurance for investing partners. The principles have been designed to allow project developers and their backers to understand the environmental and social implications of their project and assess whether good practice for managing potential impacts is in place or could be developed. These Principles are supplemented by additional industry focused Environmental health and safety (EHS) Standards for selected sectors.

There is a range of international organisations that have variants of these requirements. Many have been prepared in line with the IFC standards and the principal interests remain common among them. The principles set out expectations that the environmental and social issues pertinent to a project have been adequately studied and assessed, and that management and mitigation measures will meet appropriate levels and systems.

2.3.1 IFC Performance Standards on Social and Environmental Sustainability

Of the eight Performance Standards (PS) issued by IFC (Published January 1, 2012 (updated June 14, 2021)), seven PSs (PS 1, PS2, PS3, PS4, PS5, PS6 and PS8) have been defined as applicable to the project and thus will be adhered to.

Performance Standard 1² establishes the importance of:

- Integrated assessment to identify the social and environmental impacts, risks, and opportunities for projects.
- Effective community engagement through the dissemination of project related information and consultation with local communities on matters that directly affect them.
- The management of social and environmental performance throughout the life of the project.

Performance Standard 2³ establishes the importance of:

- Employment creation and income generation being accompanied by protection of fundamental rights of workers.
- Constructive worker-management relationships, treating workers fairly and providing them with safe and healthy working conditions as this may enhance efficiency and productivity.
- The protection of workers, including vulnerable categories of workers such as children, migrant workers, workers engaged by third parties, and workers in the client's supply chain.

Performance Standard 3⁴ establishes the importance of:

- The avoidance or minimising adverse impacts on human health and the environment by avoiding or minimising pollution from project activities.
- Promoting sustainable use of resources, including water and energy.
- Reducing project related Green House Gas (GHG) emissions.

Performance Standard 4⁵ establishes the importance of:

- The anticipation and avoidance of adverse impacts on the health and safety of the affected community during the project life from both routine and non-routine circumstances.
- Ensuring that the safeguarding of personnel and property is carried out in accordance with relevant human rights principles and in a manner that avoids or minimises risks to the Affected Communities.

Performance Standard 5⁶ establishes the importance of:

- The avoidance of involuntary resettlement wherever possible and to minimise its impact on those displaced through mitigation measures such as fair compensation and improvements to living conditions.
- Actively engaging community throughout the land acquisition and involuntary resettlement process.

² (International Finance Corporation, 2012b)

³ (International Finance Corporation, 2012c)

⁴ (International Finance Corporation, 2012d)

⁵ (International Finance Corporation, 2012e)

⁶ (International Finance Corporation, 2012a)

Performance Standard 6⁷ establishes the importance of:

- Biodiversity conservation and sustainable management of living natural resources.
- Protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development.
- How developer can sustainably manage and mitigate impacts on biodiversity and ecosystem services throughout the project's lifecycle.

Performance Standard 8⁸ establishes the importance of:

- Protecting cultural heritage during the project activities for current and future generations.
- Providing mitigation measures to address impacts to cultural heritage during the project life cycle and applying the provisions of Convention Concerning the Protection of the World Cultural and Natural Heritage.

2.3.2 IFC Environmental Health and Safety Guidelines

These guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice as defined in IFC's Performance Standard 3 on Pollution Prevention and Abatement. The EHS Guidelines contain the performance levels and measures that are normally acceptable to IFC and are generally considered to be achievable in new and existing facilities at reasonable costs. The dictates of the guidelines will be adhered to during the EIA process.

⁷ (International Finance Corporation, 2012e)

⁸ (International Finance Corporation, 2012e)

3.0 PROJECT DESCRIPTION AND ALTERNATIVES

The proposed Prestea Liquefaction and Gas Conditioning Facility will commence with an initial processing capacity of 135 mmscfd to process associated gas from the Ghana gas fields. Eventually the capacity of the Facility will be increased to process about 200mmscf natural gas per day. In addition, the project will require the installation of a 24-inch 6.5km gas pipeline interconnecting the Liquefaction and Gas Conditioning Facility to GEG's Gas Receiving and Regulating Station ("GRRS") in Prestea. The natural gas for the project will be supplied by the Ghana National Petroleum Corporation ("GNPC") via Ghana National Gas Company's (GNGC) natural gas pipeline from Atuabo through to Essiama and Prestea, where the pipeline terminates.

3.1 Project Scale

The project site is in Prestea Heman in the Western Region of Ghana. While the size of the area proposed for the Prestea GCP is approximately 100ha, the pipeline RoW will be 6.5km long and 12m wide.

Part of the produce from processing will be exported, hence, the Prestea GCP will be linked to storage facility and export terminal at the Takoradi Port.

Figure 4 and Figure 4 provides an aerial view of the proposed site and pipeline route respectively, and GPS coordinates are as shown in Table 7.

Table 7: GPS coordinates of stations proximal to the Prestea GCP and 6.5km Pipeline

Name	GPS coordinates		Elevation
	Northings	Eastings	
Prestea GCP			
GCP1	605331.363	598340.339	37.126
GCP2	605484.067	597902.524	32.202
GCP3	605339.168	597413.634	35.081
GCP4	604884.929	598306.700	28.562
GCP5	604267.423	597767.084	23.535
GCP6	604855.930	597270.816	28.886
Pipeline			
GRRS	603164.00	595198.00	N/A
AP 1	603929.00	593503.00	N/A
AP 2	604237.08	595363.45	N/A
AP 3	604571.69	596323.80	N/A
AP 4	604473.32	596930.84	N/A
Ankobra Crossing	604601.00	597090.00	N/A
Tie-in	604904.46	597090.00	N/A

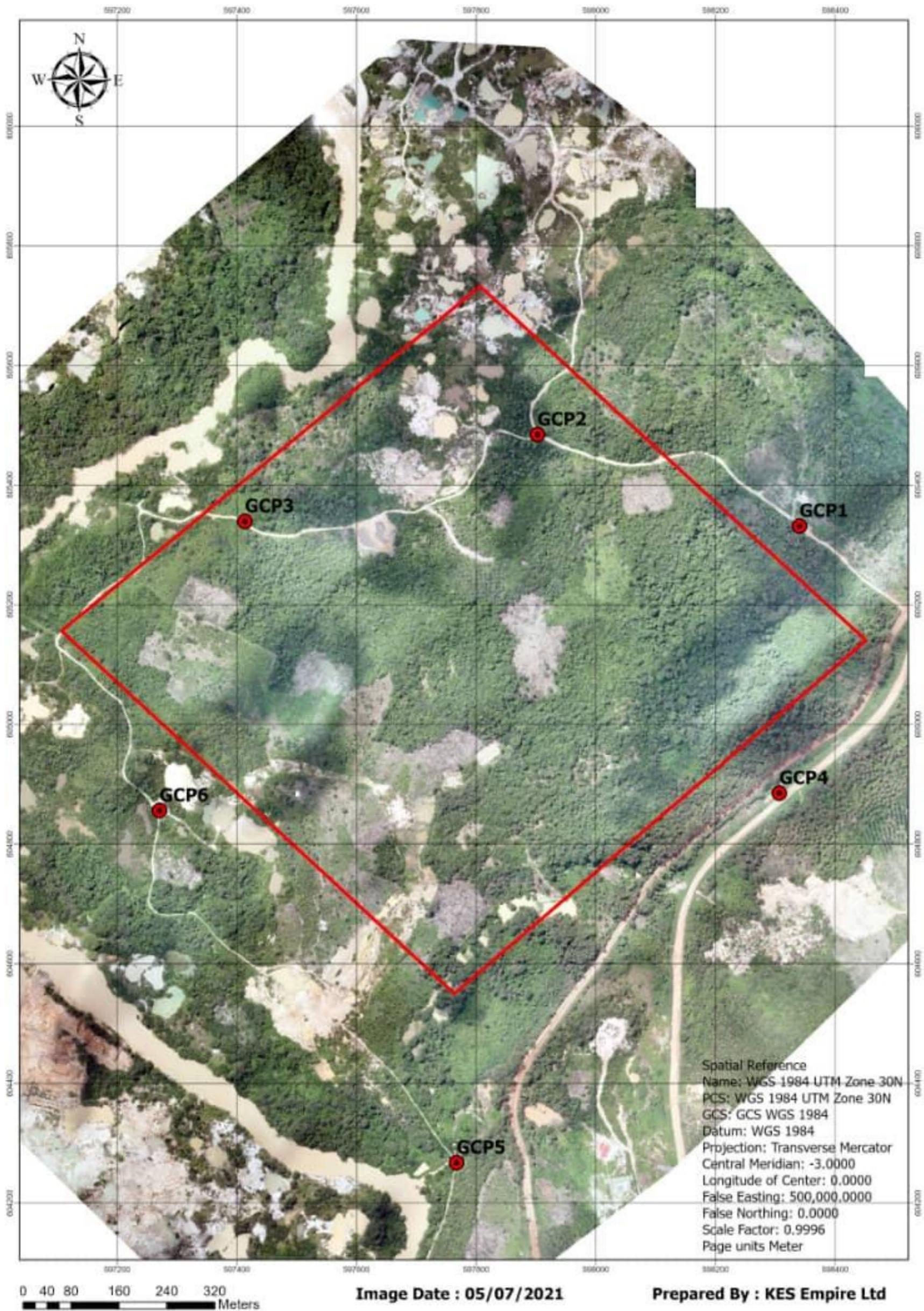


Figure 3: Proposed Site for Prestea GCP Project

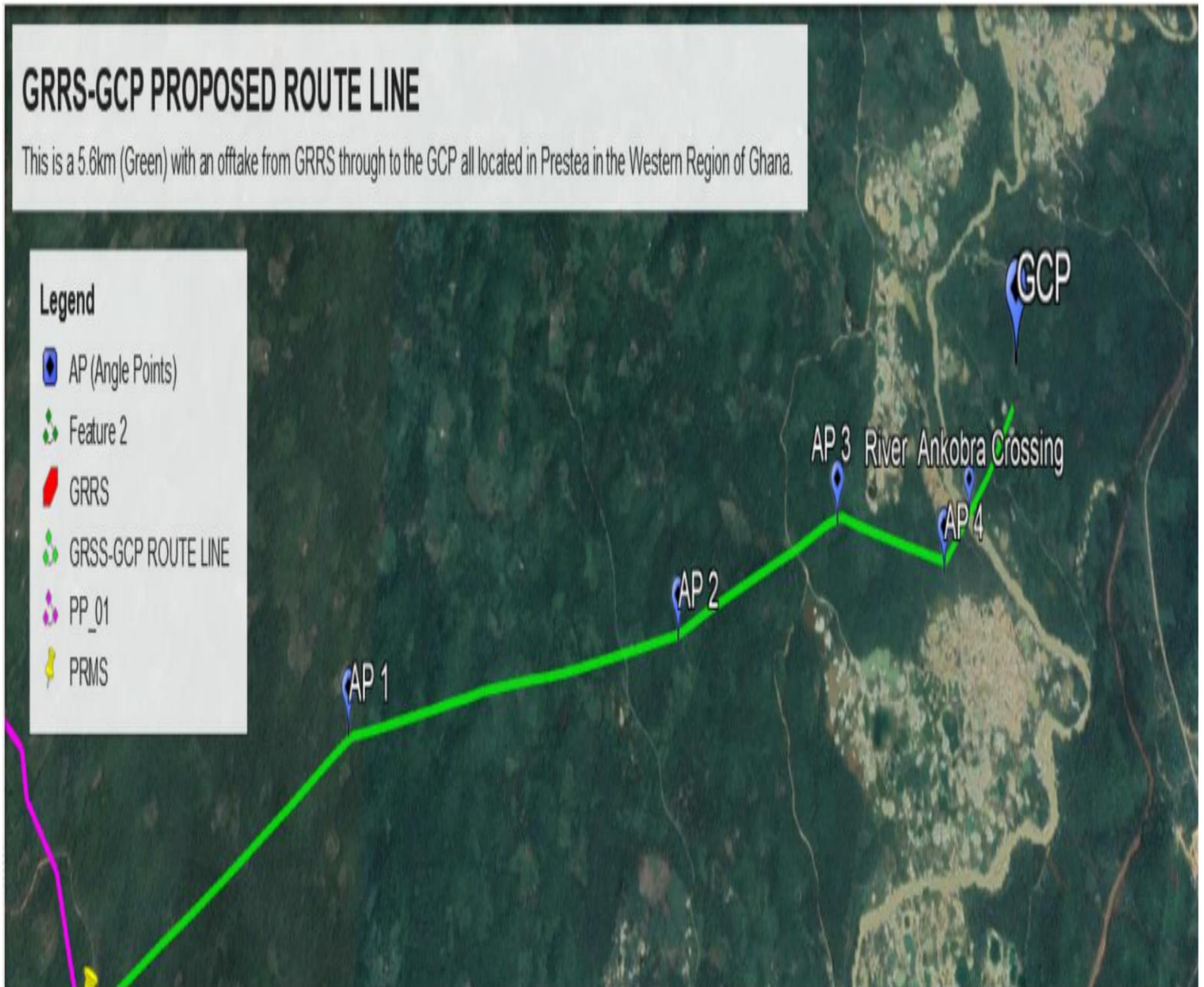


Figure 4: Proposed Route for the 6.5km Pipeline

3.2 Project Components

The Prestea GCP development will include the following major components:

- Gas pre-treatment station
- Cryogenic separation station
- Fractioning and separation station
- Gas compression station
- NGL storage and loading terminal
- 6.5km 24-inch Pipeline
- Ancillary facilities

The project layout is as shown in Figure 5.

Gas pre-treatment station

The pre-treatment section will process the gas to meet the required specification for onward processing. CO₂ and H₂O will be removed from the natural gas or associated gas at the pre-treatment station. Pre-cooling of the gas to -45°C also takes place in the station.

Cryogenic separation station

At this station, turbo-expansion and di-methanization will take place to separate the natural gas or associate gas into methane and NGLs. The cryogenic process will cool the gas stream to very low temperatures using refrigerants and a system of tanks and pipes to condense NGLs.

Fractioning and separation station

This station performs the fractionation processes of di-ethanization, di-propanization and di-butanization to separate the NGLs into ethane, propane, and butane respectively.

Gas compression station

This station compresses methane stream (lean natural gas) from ~25bar to ~85bar.

Storage and loading terminal

The Storage and Loading Terminal will consist of three 5000m³ storage tanks, boil-off gas recycling and truck loading to maintain efficient storage and transportation of NGLs. Figure 5 shows the conceptual layout of the Storage tank to be installed in Prestea.

6.5km Primary Pipeline

GEGL will extend a 24-inch primary gas pipeline from GEGL's GRRS to the Prestea GCP to interconnect the facility to the national natural gas supply pipeline. GEGL will ensure that all components that ensure the efficiency and reliability of a system that delivers natural gas year-round are operational 24 hours a day, seven days a week (except for scheduled and unscheduled maintenance).

3.2.1 Ancillary Facilities

Systems required for the safety, maintenance, monitoring and control of the Prestea GCP include the following auxiliary equipment:

Interconnections: This will include gas pipelines, control, and instrumentation modules.

Utilities: This will include relief system, fire and gas system, fresh and raw water tanks, hot oil system, instrument air, nitrogen, drains and power generation facility to provide base load power of ~10MW.

A Fire Pump Station: This is to provide fire protection for all equipment on site.

A Control Room: For monitoring and control of all site facilities and instrumentation.

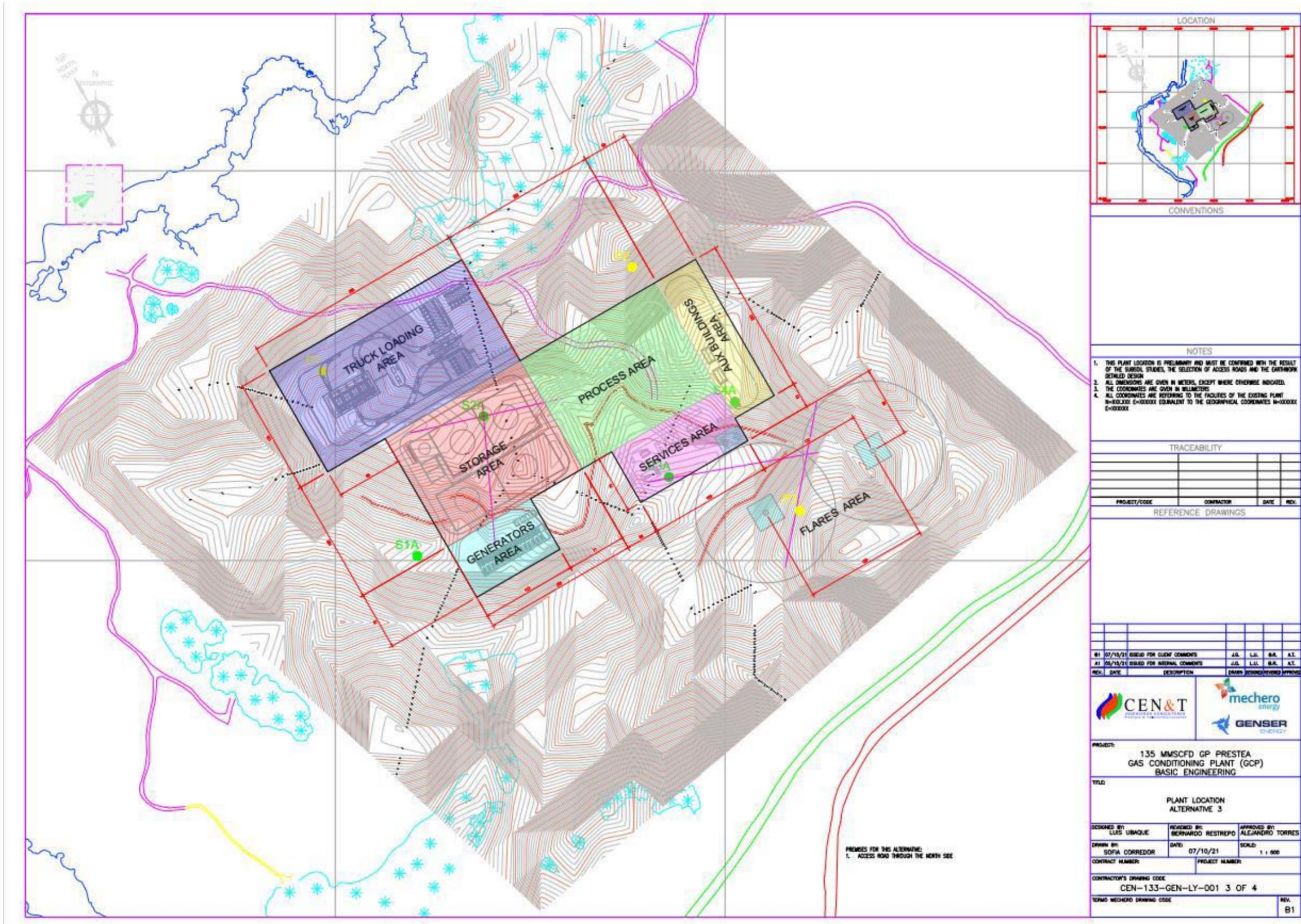


Figure 5: Project Layout (GEGL, 2021)

3.3 Project Design

The Prestea GCP project will have an installed capacity of 200mmscfd but will initially operate at 135mmscfd with Rich Gas⁹ (associated gas) and Lean Gas¹⁰ (pipeline natural gas) transported via the Essiama-Prestea pipeline. Table 8 illustrates the energy and mass balance of the plant.

Table 8: Feed and Product Gases Specifications

			Rich Gas	Lean Gas
Feed Gas		Molar flow (MMSCFD)	135	135
		HHV (BTU/scf)	1,206	1,111
		Energy (MMBTUD)	162,810	149,985
Sales Gas (Delivery @ 1,378 psig)		Mass flow (ton/day)	2,051	2,228
		Energy (MMBTUD)	111,599	118,353
NGLs	C2 (Ethane) -129°F	Mass flow (ton/day)	275.8	256.0
		Energy (MMBTUD)	13,488	12,512
	C3 (Propane) -45°F	Mass flow (ton/day)	450.6	221.0
		Energy (MMBTUD)	21,401	10,495
	iC4 – nC4 (Butanes) 20.4°F	Mass flow (ton/day)	243.0	94.1
		Energy (MMBTUD)	11,341	4,393
Plant self-consumptions		Gas flow for power generation (MMSCFD)	3.0	2.4
		Gas flow for sales compressor (MMSCFD)	1.6	1.7
		Gas flow for hot oil system (MMSCFD)	0.0	0.0
Shrinkage		Energy (MMBTUD)	51,211	31,632
		Products (MMBTUD)	46,229	27,400
		Auto-consume (MMBTUD)	4,628	4,135
		Losses (MMBTUD)	354	97

The following aspects were also taken into consideration in the design of the pipeline:

- Appropriate cathodic protection system to prevent leakages resulting from the effects of external corrosion of the pipe.
- External and internal pipeline coating system to prolong the service life of the pipeline.
- Measures to protect the internal layers of the pipeline from the detrimental effects.

⁹ Rich gas is a combination of dry gas (methane) and NGL (ethane, butanes, propane and naphtha) which is transported through a pipeline

¹⁰ A lean gas refers to natural gas containing very few or no liquefiable liquid hydrocarbons (Schlumberger Limited, 2022)

- d) The ability of the pipeline to remain in place on sediment and not float, even if empty or filled with gas rather than liquids).
- e) Proposed operating pressures.
- f) Adequate provisions to protect other pipelines the proposed route crosses over.
- g) Compliance with all applicable regulations.

The design and construction of the pipeline will be aligned to the requirements of international codes and standards such as the American Petroleum Institute (API), the American Society of Mechanical Engineers, the National Association of Corrosion Engineers and British Standards.

The pipeline will consist of lengths of carbon steel pipe which will be welded together and buried with a depth of cover of at least 1.5m. The pipeline will be designed to operate at a maximum permissible pressure of 7.5MPa. The buried section of the pipeline will be coated with an anti-corrosion agent to prevent corrosion and supplemented with a cathodic protection system.

The parameters of the pipeline are as provided in Table 9, and the mechanical data of the pipeline are also provided in Table 10.

Table 9: Pipeline Design Parameters

Design Parameter		Specification
Fluid		Lean gas
Pipeline installation		Buried
Pipeline length		6.5 km
Pipe nominal diameter (main line)		24"
Corrosion allowance		1.5 mm
Pipe specification / material grade		API 5L PSL2 X65 Carbon Steel
Maximum allowable operating pressure		72.00 barg
Hydro test pressure		84.38 barg
Design Temperature		0-50°C
Operating temperature	Maximum	50°C
	Minimum	10°C
Ambient temperature	Maximum	40°C
	Minimum	18°C
Product densities	Maximum	97.0 kg/m ³
	Minimum	55.1 kg/m ³

Table 10: Pipeline Mechanical Data

Parameter	Specification
Inside diameter	600 mm
Wall thickness tolerances	+15%/-12.5% (as per API 5L specs)

Parameter	Specification
Material standard of line pipe	API5LX52M
Line pipe manufacturing process	SAWH/SAWL
Lengths	Fixed (average 12.0m)
Ends	30 +5°, 0°
External Coating	3LPE
Concrete Coating	For mechanical protection where required on alignment sheets

3.3.1 Geology and Seismology

According to the Seismology Division of the Ghana Geological Survey Authority (GGSA), the site for the Prestea GCP project and the 6.5km natural gas pipeline has argillitic rocks (Figure 6) that give rise to clay soils. To avoid the effect of clayey soil expansion and contraction on the Prestea GCP, the GGSA recommended that the plant be sited at a higher elevation, as the soils on top of the elevation are often lateritic and have good bearing capacity. The GGSA recommended a peak ground acceleration value of 0.1g for the design and construction of the plant and all other ancillary structures.

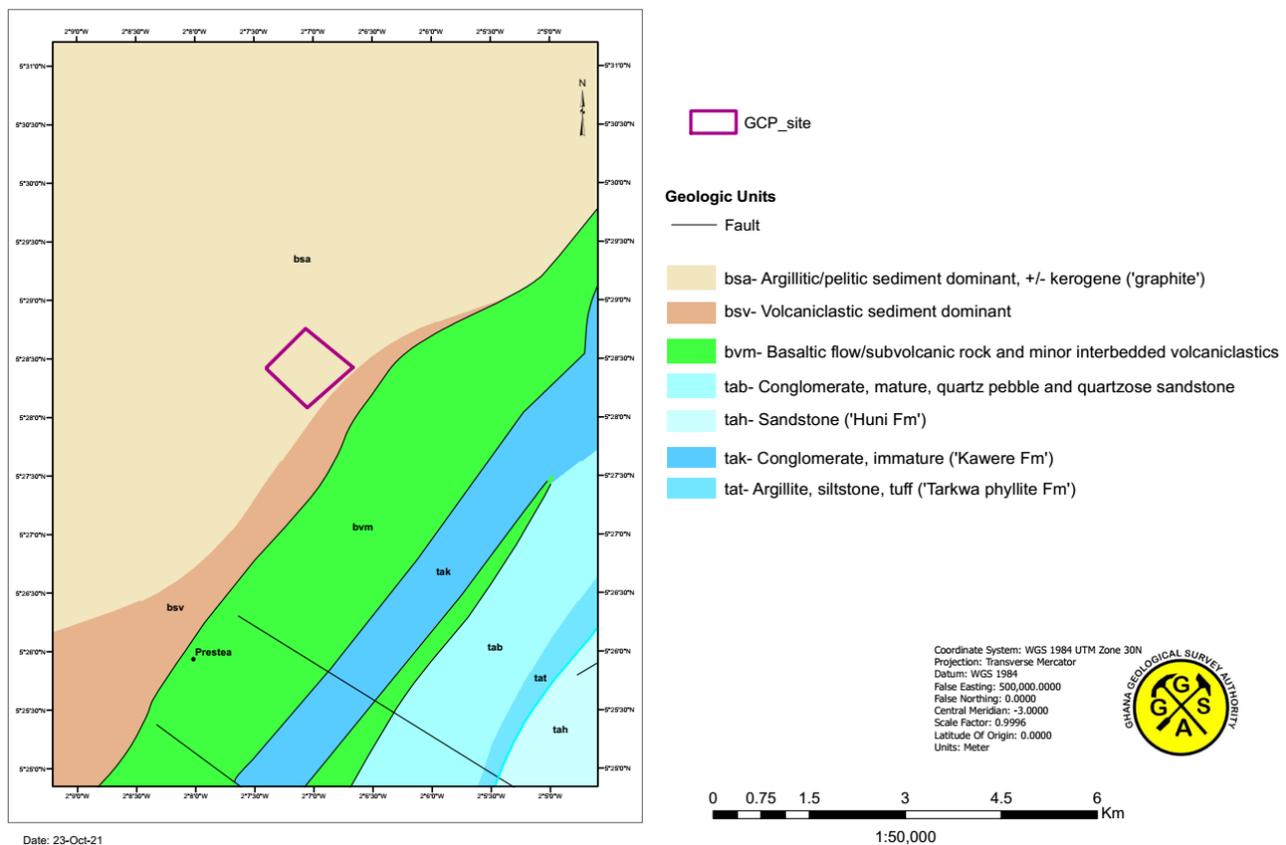


Figure 6: Geological Map showing the Geology of the Prestea GCP site

3.4 LNG and NGL Processing

There are several methods for cooling a natural gas stream to extremely low temperatures, but one of the most efficient is the turbo expander process which will be adopted for the Prestea GCP. In this process, external refrigerants are used to cool the natural gas stream, which is then followed by an expansion turbine, which rapidly expands the chilled gases. This causes the temperature of natural gas to drop significantly and quickly (to as low as -45°C), condensing ethane and other hydrocarbons, whilst methane continues to exist as a gas.

For the Prestea GCP, the feed gas will be passed through a pre-treatment unit before entering the liquefaction train to remove any traces of CO_2 and water that may be present. The pre-treatment process results in a cleaner and purer natural gas stream, as well as the hydrocarbons of NGLs. Following the removal of all contaminants, the stream is routed to the cryogenic separation station, where turbo expansion and di-methanization will separate the methane stream from the heavy hydrocarbon stream. The extracted methane gas will be used as feedstock for the production of LNG, which will be compressed and routed back to GEGL's pipeline. While the extracted heavy hydrocarbons will be used to produce NGLs (ethane, propane and butane). The resulting LNG liquid stream will be cooled to -160°C . At this temperature, LNG will then be transported into onsite LNG storage tanks via cryogenic pipelines.

After the heavy hydrocarbons have been removed from the natural gas stream, they will be separated into their individual products for use in a fractionating separation station. The different boiling points of the different hydrocarbons in the hydrocarbon stream will be used to determine fractionation. The fractionation process will begin with the removal of the lighter NGLs from the stream and proceed in the following order before being routed into the cryogenic storage tanks:

- De-ethanizer - ethane removal
- De-propanizer – propane removal
- De-butanizer – butanes (normal and iso) removal

From the onsite storage tanks, the LNG/NGLs will then be loaded onto 20MT Bulk Road Vehicles to be safely hauled to the Takoradi.

3.5 Project Services

A summary of other infrastructure and services to support the Prestea GCP and 6.5km natural gas pipeline project is presented in the following sections.

3.5.1 Accommodation Facilities

GEGL workers and contractors will be accommodate in camp containers that will be mounted as part of the project. For existing projects visitors are normally accommodated in hotel facilities close to the working locations and this will be the case for the Prestea GCP project.

3.5.2 Offices

An administration block will be constructed as part of the project. The administration block will consist of offices, a conference room, washroom, a kitchen, and a storeroom. The administration block will be built with containers and will be located at 5m from the housing unit.

3.5.3 Workshop

A workshop will be provided at the Prestea GCP site for the maintenance of project equipment. The area for the workshop will be situated within the space allocated to EPC Contractors (Exterran Corporation, Mechero Energy, Solar Turbines Incorporated and CIMC Enric Hongtu).

3.5.4 Health Care

An infirmary will form part of the accommodation facilities to cater for the health needs of the employees. The infirmary would have resident nurse and offsite medical personnel who will attend to the sick.

In the case of an emergency, workers will be transferred to the closest public health facilities for medical attention. The closest medical facilities identified for use in the case of emergency are the Heman Health Centre and the Prestea General Hospital.

The EPC contractors will have specific work standard first aid kits to respond to injuries and other ailments until individuals are attended to at a medical facility (where required).

3.6 Water Needs

The site will be connected to the Ghana Water Company Limited (GWCL) water supply system, where possible, to cater to the water needs of the project. There will be boreholes with attached overhead tank at each of the camp where access to GWCL water supply is not possible. The borehole water will be treated and tested to meet the Ghana Standards for Water Quality - Specification for Drinking Water (GS 175: 2017) before use. A water storage tank will be provided to supplement water needs in the case there is no flow from GWCL.

3.7 Waste Management

GEGL will classify wastes into streams to enable appropriate segregation, handling, transport, disposal, and where possible recycling/recovery in a manner appropriate to the waste materials. Colour coded waste receptacles will be provided by GEGL at vantage points on site to enable waste segregation and subsequent management.

Hazardous liquid and solid waste will be collected in a secure, enclosed location and transported offsite to a licensed hazardous waste facility. Options for hazardous waste disposal are currently being evaluated for the project. Hydrocarbon wastes, mostly from waste oils and lubricants, will be managed as part of hazardous waste and the waste management plan will utilize the waste hierarchy framework of mostly prevention, reduction, recycle, recovery and the least of all, disposal.

Domestic wastewater and sewage will be channeled to a septic tank located at the site. The sewage built up will be removed by a vacuum truck sourced from Prestea to be transported to appropriate and approved waste disposal site.

Training will be provided to staff and the workforce to increase familiarity with competence in appropriate waste handling and disposal methods. Accidental releases will be managed through development and implementation of a spill response and emergency response procedures.

3.8 Scheduling and Activities

GEGL plans to complete the design, construction, and commissioning of the project in 18 months once the environmental permit is obtained. The construction activities are anticipated to consist of the following:

- Site preparation
- Mechanical and civil works
- Installation of all major mechanical equipment, controls for electricals and instrumentation in the following order:
 - Pretreatment station
 - Cryogenic station

- Fractioning station
- Power generation and Gas Compression Station
- Storage systems
- Fuel systems
- Electrical systems
- Portable water system
- Plant fire system
- Containerized construction camps and administrative building
- Interconnection facility
- 6.5km natural gas pipeline
- Commissioning
 - All gas conditioning and liquefaction processing stations
 - Power generation station
 - Balance of plant system
 - Fuel supply and storage system
 - Fire suppression and detection system
 - Interconnection facility
 - 6.5km Natural Gas pipeline

The detailed schedule of activities is as provided in APPENDIX A.

3.9 Construction Approach to Pipeline River Crossings

The approach that will be taken for construction of the pipeline at the river crossings is detailed in the Construction Plan for River Crossing attached as APPENDIX B to this EIS

GEGL will continue to engage the meteorological stations to be aware of any weather changes before construction commences at river crossings.

Following the completion of the 6.5km pipeline, it will be hydrostatically tested in accordance with EPA regulations and under the supervision of a qualified engineer. Water for testing will be obtained and discharged in accordance with EPA and local regulations. Prior to the commencement of operation of pipeline, GEGL will submit a hydrotest to the EPA for consideration of a Hydrotest Permit.

3.10 Staffing and Employment

GEGL has a pool of qualified and experienced nationals available to support this project during the construction and operational phases. However, GEGL will specifically employ qualified people during the construction phase of the project. The people to be employed will consist of skilled labour (including professionals such as Engineers and Medical personnel) and unskilled labour. The list of technical people required for the project are:

- Project manager
- Construction supervisors
- QA/QC engineers
- Health, Safety and Environment (HSE) engineers
- Community relations representatives
- Doctors
- Nurses
- Local contractors
- International contractors for specialized work

The accommodation facility will include a clinic and there will be medical personnel assigned to facility to cater to ailments of the workforce.

During the operational phase, approximately skilled people unskilled labour will be outsourced. The list of technical people required for the operational phase of the project are:

- Fuel supply manager
- Operations Superintendent
- Mechanical Reliability Engineers
- Electrical & Instrumentation Engineers
- Civil Engineers
- Human Resource personnel
- Supply Chain personnel
- HSE personnel
- Community Relations personnel
- Operations Engineers
- Operations Mechanics and Technicians

It is anticipated that a total of 64 new workers will be employed for the Prestea GCP and pipeline construction out of this, it is projected that not less than 12 will be females (Table 11).

Table 11: Staff Strength for GEGL EPC

Designation	Number of People to be Employed	Projected Number of Females
Managerial Role	10	2
Functional Head	15	3
Sectional Head	22	4
Entry Level	12	3
Operator Level	5	0

Designation	Number of People to be Employed	Projected Number of Females
TOTAL:	64	12

According to the GEGL EPC (GCP & PIP) Employment Statistics, November 2021, the total number of people to be employed for the Prestea GCP project are 64, of which, the projected number of females are 12. This was deduced from the current GEGL workforce which has 18.5% females excluding 3rd party contractors.

3.11 Economic Displacement and Compensation

The development of the Prestea GCP and 6.5km natural gas pipeline project will impact farmlands in the project area. Thus, all project affected persons (PAPs) will be compensated for crops to be destroyed on their farmlands. Land compensations will however be paid to the custodians of the lands. The compensation process will be in line with the Land Commission Act, 2008 (Act 767). This law together with the regulatory guidelines promulgated by the Commission establish minimum requirements for accessing or acquiring land before any site-related activities commence. This law also ensures the rights and needs of PAPs are assessed prior to impact.

A Compensation Negotiation Committee (CNC) will be formed to foster the interactions between GEGL, and the project affected persons (PAPs). The CNC will oversee the compensation negotiations for all issues in relation to economic displacement. The committee will be responsible for addressing the following:

- Key issues related to economic displacement
- Processes to be used for negotiations
- Preparations and steps to be taken to ensure readiness to undertake and conclude negotiations

The CNC will consist of representatives from GEGL, Land Valuation Board, PAPs leadership, traditional leadership, and other governmental agencies. The CNC will be chaired by an independent Moderator who will be agreed on by GEGL and PAPs leadership.

The PAPs will also be given the opportunity to appoint a suitable valuer whose role will be to provide objective and fact-based technical and other relevant expertise and advice to the PAPs.

Interactions between GEGL and the PAPs throughout the compensation process will be conducted in a manner that fosters trust and mutual respect. The process to be employed by GEGL will adopt appropriate mitigation measures and livelihood re-establishment programmes to address impacts associated with economic displacement.

Based on initial survey by GEGL, it is anticipated that 29 persons with 47 independent farms, two mud houses and three shelters will be affected. A compensation framework will be developed and implemented, which will include the following aspects:

- Details of compensation eligibility and entitlements
- Grievance procedure to manage complaints in a planned and systematic manner
- Budget and implementation schedule following conclusion of compensation negotiations

3.12 Alternatives to Proposed Undertaking

The alternatives considered for the Prestea GCP project, and discussed in the following sections, consisted mainly of the site selection alternatives and the project No-Go option.

3.12.1 Site Selection

The sites that were proposed for the Prestea GCP and 6.5km natural gas pipeline was significantly informed by the recommendations of GGSA 3.3.1.

Options Considered

The principal parameters considered for the selection of a suitable location for the implementation of the Prestea GCP project included the size of land available for the facility (the desired size was 100 Ha), onsite storage, terrain of land, proximity to the existing natural gas pipeline network, issues of environmental and social concern including proximity to habitations, accessibility for construction purposes, and anticipated LNG carriers to be accepted and communication and data network.

Following the completion of a reconnaissance study three primary locations Figure 7 were identified for consideration:

- Option 1: located at Prestea - Anyinam with geographical coordinates Latitude 5.452777° and Longitude - 2.171048°
- Option 2: located at Prestea-Heman with geographical coordinates Latitude: 5.472521° and Longitude: - 2.117039°
- Option 3: located at Bogoso with geographical coordinates Latitude: 5.505075° and Longitude: - 2.085930°



Figure 7: Satellite image of site location options for the Prestea GCP

The site investigations conducted by GEGL revealed a number of potential opportunities and constraints at each location.

Option 1

The following were the opportunities presented by the location:

- The closest possible connection to the GEGL natural gas pipeline system. GRRS is only 50m away from this location.
- It is approximately 2.5 km to the nearest community.
- It has a good communication and data network.

The following were the constraints with the location:

- The available land area for development was inadequate is approximately 60 Ha.
- There was dispute regarding the rightful owner of the land.
- The landscape is hilly, necessitating more cutting to fill volumes of earthworks.
- The access road to this location is in poor condition. The 2.5km road is disconnected from the existing main road network. Thus, GEGL will need to build two bridges to connect the road to the highway to improve the road network to this location. GEGL does not have the required time to construct the two bridges.

Option 2

The following were the opportunities presented by the location:

- This is approximately 100 Ha area available for the development the facility.
- The terrain for the site is best described as flat and gradually rises to the North-Eastern Boundary, with vegetation consisting of some forest cover, palm trees, coconut trees, and shrubs.
- The site is easily accessible, but GEGL may be required to develop a new access route of approximately 250m to connect the existing main road network.
- It has a good communication and data network.

The following were the constraints with the location:

- The nearest possible connection to the GRRS from this location is approximately 6.5km. GEGL will need to build a natural gas pipeline to connect the plant at this location to the GRRS.
- The 6.5km natural gas pipeline will encounter a water crossing at the River Ankobra during its construction.
- The location is approximately 0.83 km to the nearest community.
- There are heavy artisanal mining activities in that enclave.
- The site may be prone to flooding due to its proximity to the Ankobra River.

Option 3

The following were the opportunities presented by the location:

- The landscape for this site is flat.
- The site is accessible.

- It has a fairly good communication and data network.

The following were the constraints with the location:

- There is approximately 52 Ha of land available for the development of the Prestea GCP.
- The nearest possible connection to the GRRS from this location is approximately 11km away. GEGL will need to construct a natural gas pipeline to connect the facility at this location to the GRRS.
- During its construction, the 11 km natural gas pipeline will cross the Ankobra River.
- The construction of a pipeline to the GRRS will go through the mining concession of Golden Star Resources.
- The location is approximately 0.38 km from the nearest community, with a few mud houses (settlements) within the area.
- Even though the site is easily accessible, GEGL will be required to renovate approximately 1km of existing road to connect this alternative option to the main road network.
- The level of artisanal mining in this enclave is moderate.

Selected Option

Option 2 was deemed feasible of the three sites evaluated due to the availability of land, proximity to existing natural gas pipeline systems, and distance from residences. The remaining two options were deemed insufficient in size and were eliminated from further consideration. Based on this, the 6.5km pipeline route was selected.

3.12.2 No-Go Project Alternative

GEGL previously relied on liquefied petroleum gas, primarily propane and butane, to generate electricity from its power plants. However, the discovery of natural gas in Ghana has resulted in reforms in the country's natural gas market, allowing private industries to invest in natural gas projects. Furthermore, the Prestea GCP project will contribute to the advancement of the LNG sector in Ghana by promoting the use of the clean energy, generating economic opportunities for GEGL and both Ghanaian and foreign-based industries such as the mining industry, which are involved in large-scale heating or burning processes (such as Carbon-in-Leach (CIL) Elution Burners) that rely on heavy energy.

The Prestea GCP and 6.5km natural gas pipeline project will provide opportunities for quantities of associated natural gas that was flared into the atmosphere for safety reasons, to be put to beneficial use.

Should the project not advance, all the anticipated benefits of the project will not be realised, and the following would occur:

- There will be no further investment by GEGL in the project and no realisation of returns for GEGL.
- Potential employment and skills transfer/development would be lost.
- There would be no project related taxes paid to the government.
- All the benefits outlined above and in section 1.4 under project justification will not be realized.

The Alternative Route Analysis for the 6.5km Pipeline has been attached to this EIS as APPENDIX B

4.0 BASELINE INFORMATION

The purpose of baseline data collection is to provide credible data and information on the existing conditions of the project area to support engineering design of project components and the EIA process. It is also to have benchmark data for future reference. Findings from these studies informed the impact assessments, supported development of proposed mitigation measures, and provided indicators against monitoring programmes.

The methodology applied in completing the baseline studies consisted of desktop review of existing data and information, historic and recent imagery. Following the review of desktop data, a field sampling strategy was developed for aspects requiring the collection of additional data for the project. Fieldwork was undertaken for surface and ground water, biodiversity and socio-economic.

A summary of the baseline information is presented in the following sections.

4.1 Physical Environment

4.1.1 Topography and Drainage

The project site is generally flat but with some undulating sections and the area characterized by vegetation comprising some forest cover, palm trees, coconut trees and shrubs (Gyropod, 2021). The highest land area is 54 m, and the lowest area is about 31m above sea level. Elsewhere in the Ankobra Basin, land rises from about 240m to about 300m above sea level with the topography generally undulating with few scarps ranging between 150m and 300m above sea level. The Prestea-Huni Valley Municipal of which the project site is located, falls within the forest dissected plateau physiographic region.

The Ankobra River drains on the western boundary of the Prestea GCP project site boundary to the south with the nearest location being about 30 m away. Drainage from the proposed site will lead to the Ankobra River.

4.1.2 Site Geology

The Project site is underlain by the Birimian Supergroup as shown in Figure 9. This is made up of the Birimian metasediments and the metavolcanics. Rocks of the Birimian metasediments includes the Greywackes, Phyllites, Slates, Schists, Sandstones and quartzites. The Birimian metavolcanics on the other hand consists of rocks of Basaltic and Andesitic compositions including hornblende actinolite-schists, calcareous chlorite schists and amphibolites.

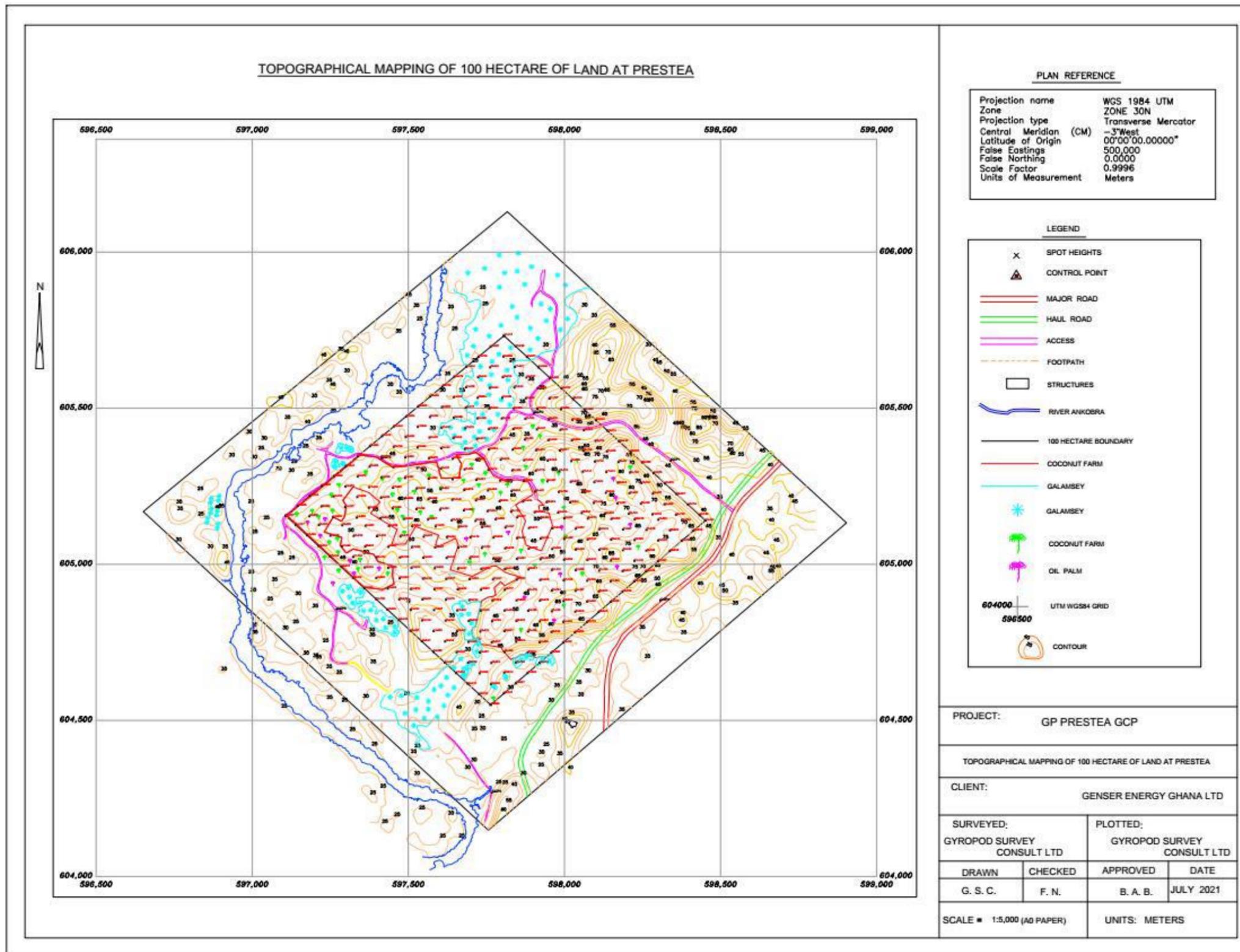


Figure 8: Project Site Topography

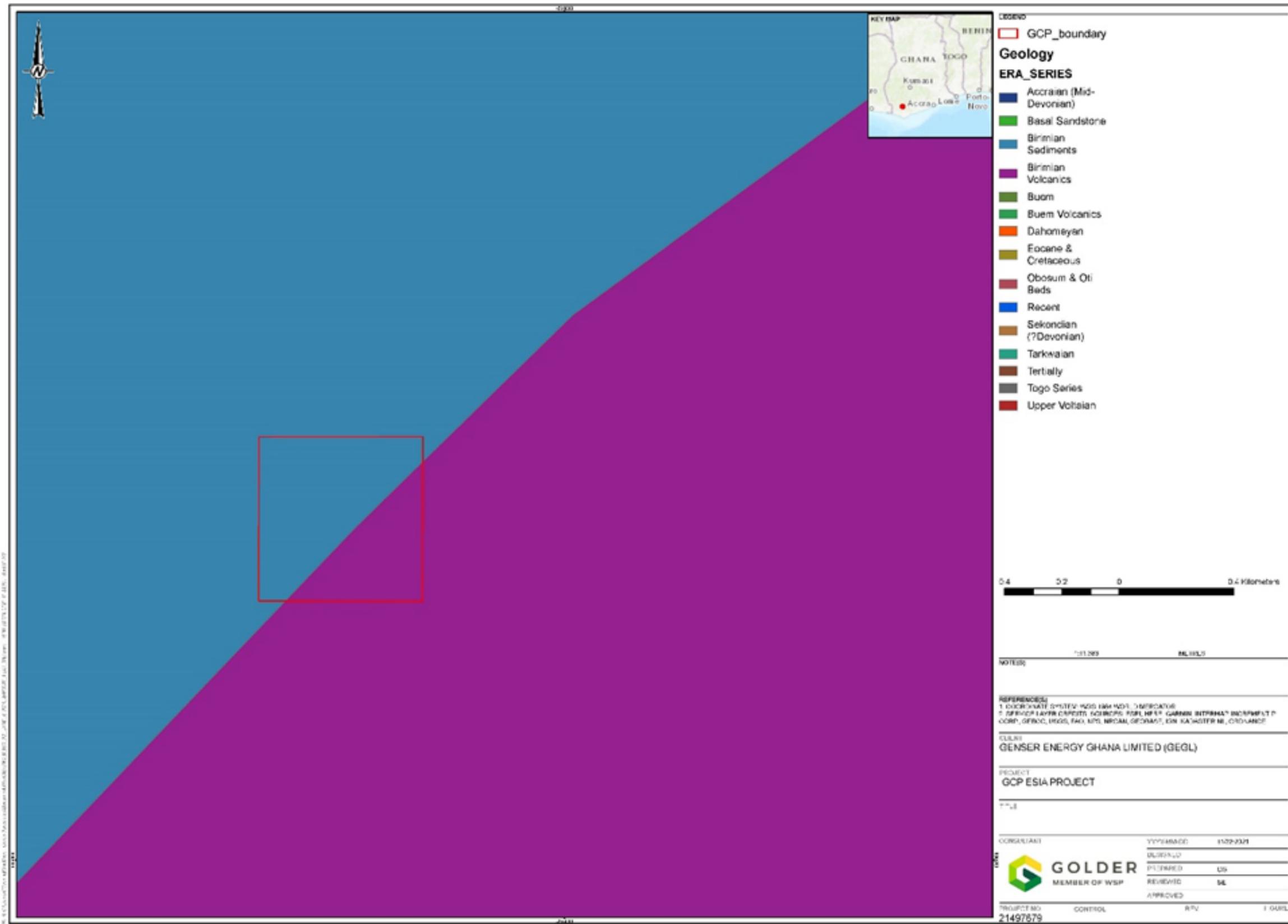


Figure 9: Project site geology

4.1.3 Climate

The area falls under the South-Western Equatorial and the Wet Semi-Equatorial climatic regions. The South-Western Equatorial is the wettest climatic region in Ghana with mean annual rainfall above 1,900 mm.

Average monthly temperatures range between 24°C to 31°C. The average annual rainfall for Prestea is 1,593 mm with the winter months of May and June having the highest rainfall. High relative humidity occurs throughout the year ranging between 78.95 to 86.8%.

Climatic and Meteorological Overview

Ghana is located in West Africa between the latitudes of 4-12°N (USAID, 2011). Ghana is located along the Atlantic coast and is dominated by the interaction of the Inter-Tropical Convergence Zone (ITCZ) and the West African Monsoon seasons. The ITCZ is a belt of low pressure which circles the Earth, generally near the equator where the trade winds of the Northern and Southern Hemispheres come together. The ITCZ is a critical link in global circulation patterns and the redistributing solar energy from the tropics toward the poles.

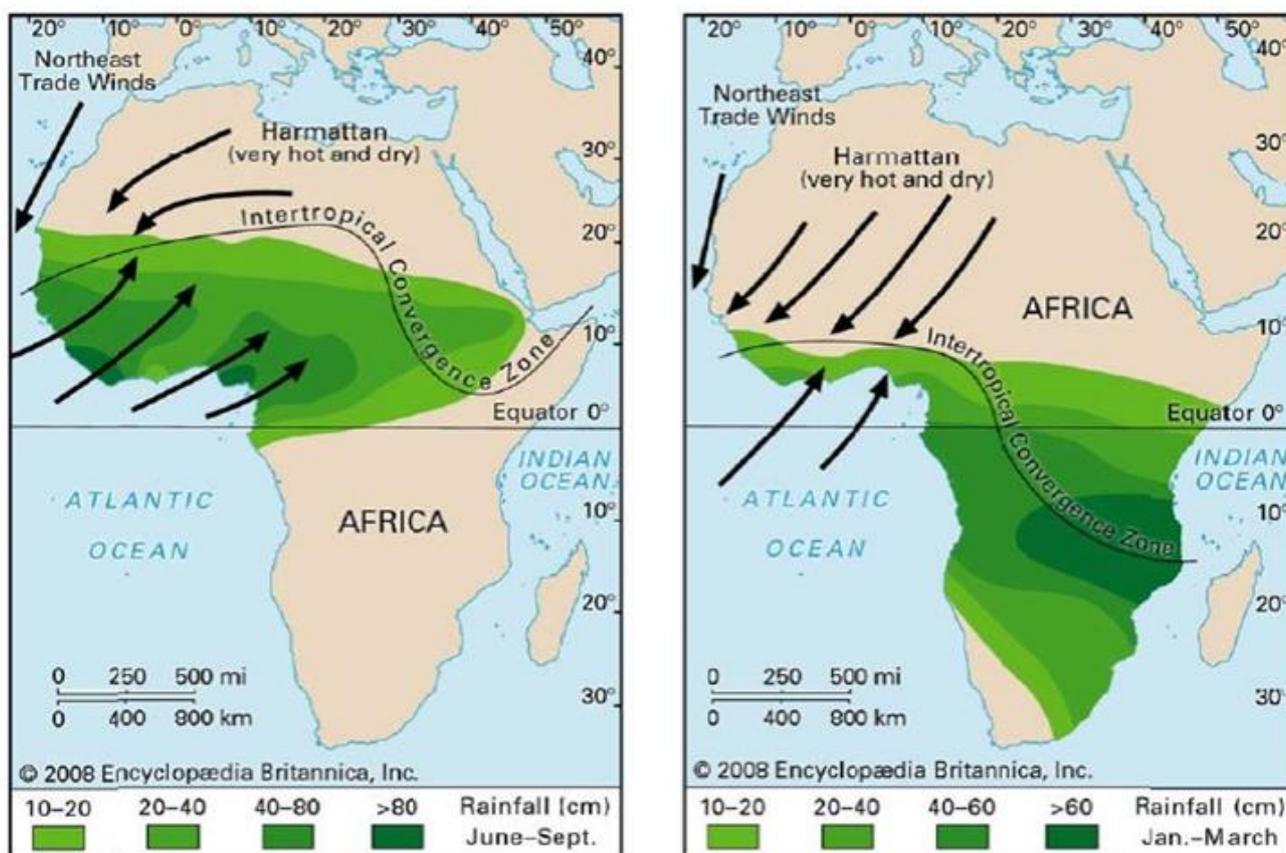


Figure 10: Movements of the ITCZ and West African Monsoon (USAID, 2011)

The climate of Ghana and its alternating wet and dry seasons is largely driven by the movements of the ITCZ and West African Monsoon seasons (Figure 10). During the warmer months (June to September), the ITCZ lies near the Tropic of Cancer. The dominant wind direction in regions to the south of the ITCZ is south westerly, bringing in warm, moist air from the Atlantic Ocean onto the continent, resulting in the Ghanaian wet season. During the cooler months (January to March), the ITCZ moves southwards towards the Tropic of Capricorn. The dominant wind direction in the regions to the north of the ITCZ is north easterly, bringing hot, dry, and dusty air from the Sahara Desert, resulting in the Ghanaian dry season.

To assess ambient meteorological conditions, site-specific modelled Weather Research and Forecasting (WRF) meteorological data was sourced. The WRF data was purchased from Lakes Environmental Software for the period January 2018 to December 2020 to provide an understanding of surface and upper air dispersion characteristics. The data coverage is centred over the GCP and pipeline with a grid cell dimension of 4 km x 4 km over a 50 km x 50 km domain. The data is assumed and expected to be representative of the actual experienced meteorological conditions onsite. The percentage recovery for parameters recorded is 100 % and is thus considered reliable for use in this assessment. The meteorological conditions for the site are discussed in the following sections.

4.1.3.1 Temperature

The variation in temperatures throughout the year is about 5°C. Average monthly temperatures range from 23°C to 30°C. Record high temperatures have reached 38°C during January, with record lows of 19°C recorded in January and July. Average and record low and high monthly temperatures are set out in Table 12 and illustrated in Figure 11.

Table 12: Average monthly and record temperatures, and average sun hours for Prestea

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg. max temp (°C)	30	30	30	30	30	28	26	25	26	27	28	29
Ave min temp (°C)	25	26	26	26	26	25	24	23	23	24	25	25
Record high temp (°C)	38	37	36	41	40	39	34	32	36	35	36	37
Record low temp (°C)	19	20	22	22	22	21	19	20	21	22	22	21
Avg. sun hours/ day	6.9	7.0	7.2	7.1	6.8	4.8	4.6	5.2	5.7	7.1	8.0	7.6

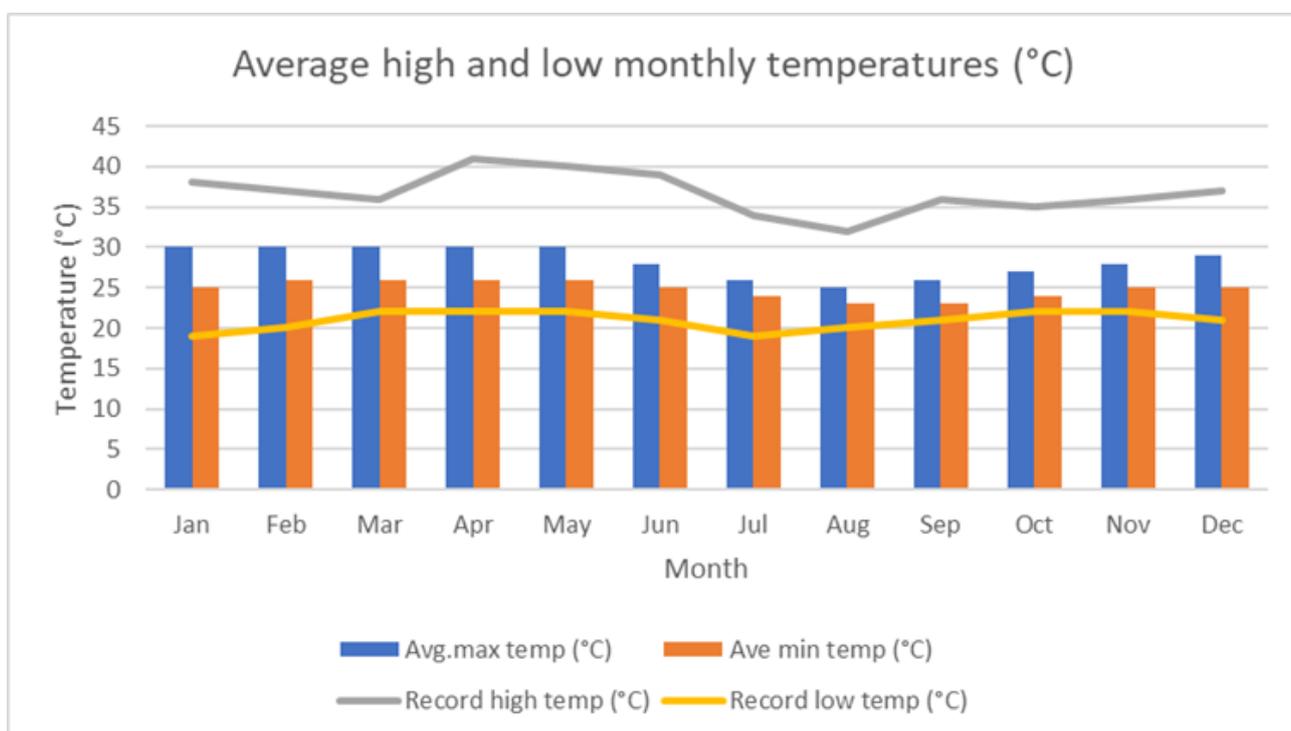


Figure 11: Average and record high and low monthly temperatures for Prestea

4.1.3.2 Rainfall and Evaporation

Rainfall is year-round; however, the lowest rainfall occurs in the November to February period, and the highest rainfall in May, June, September, and October. Humidity is high throughout the year, ranging between 79% and 86%. The difference in precipitation between the driest and wettest months is 330 mm (Figure 12). The month with the highest number of rainy days is June with 25 days on which rain occurs. The month with the lowest number of rainy days is January with 5.2 days on which rain occurs. These data are set out in Table 13 and illustrated in Figure 12.

Table 13: Average monthly rainfall and humidity

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall mm	24.4	60.7	113.1	145.3	246.4	354.3	143.8	81.6	117.7	157.8	102.5	45.3	1,593
Rain days (d)	5.2	8.1	12.5	14.2	20.7	25	18.5	16.8	19.4	21	15.2	8.5	185
Humidity (%)	78.9	79.1	80.4	81.5	83.6	86	86	86.8	86.3	84.5	83.1	81.4	

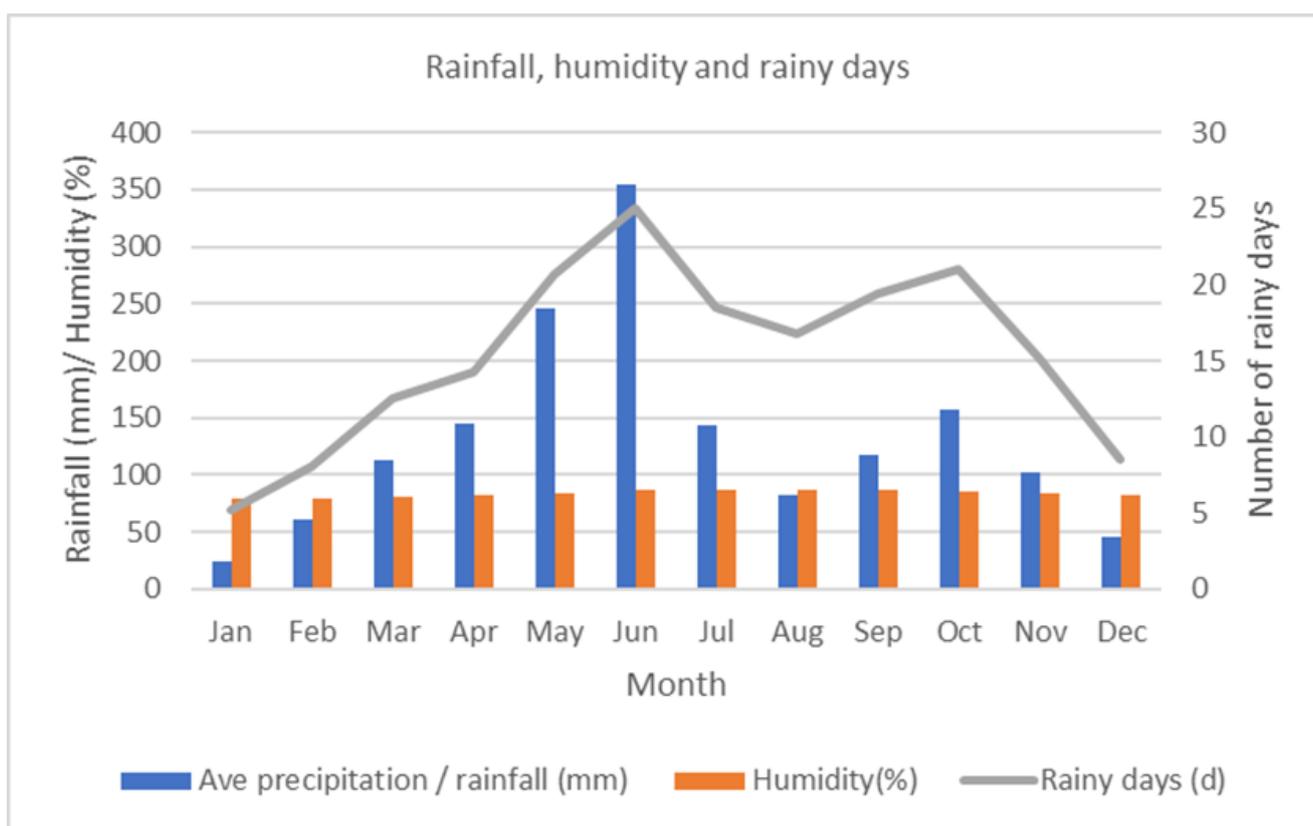


Figure 12: Average monthly rainfall, percentage humidity and number of rainy days

4.1.4 Soil

The soil assessment included accessing the International Soil Reference and Information Centre (ISRIC) World Soils Database, based on the World Reference Base Classification System (WRB, 2006) in order to establish the soil types according to an international standard system. Information associated with the outcomes of the ISRIC world soils database were reviewed. Existing field Borehole and Geotechnical Test Pit Logs were used

to classify the soils at the site by soil form. Soils were classified at 3 points within the site and two points just outside of the site.

4.1.4.1 Soil Classification

Ferralsols

The ISRIC World Soils Database shows the study site is dominated by Ferralsols. These are deep, highly weathered soils with a low Cation Exchange Capacity and base saturation that are largely devoid of weathered minerals.

Based on the information gathered from the 5 Borehole Geotechnical Logs and the Test Pit within or near the study site (Figure 13), the site appears to be dominated by what are termed Oxidic soils or Oxisols, depending on which classification system one uses. Soils that are described as Oxisols in one system can be described as Ferralsols in another. These terms broadly describe weathered, clay-rich soils of the humid tropics that are red or yellow and dominated by kaolinitic clays. These soils do not show signs of wetness.

Plinthosols

Based on the information from the 5 Borehole Geotechnical Log and the Test Pit within or near the study site (Figure 13), it appears that Plinthosols may also be present at the site. These soils form under a variety of climatic and topographic conditions and are defined by a subsurface layer containing an iron-rich mixture of clay minerals (chiefly kaolinite) and silica that hardens on exposure into ironstone concretions known as plinthite. A soft plinthic horizon usually merges to a gleyed horizon and often underlies an E horizon. These soils do show signs of wetness.



Figure 13: Study Site Soil Photographs

4.1.4.2 Soil Capability

Using the South African soil capability guidelines (Scotney et al., 1987), Ferralsols can be assigned to Land Capability Group 'Arable Soils' and Land Capability Class II, as they have 'Slight limitations' and 'Low erosion hazards' and can be used for (in order of increased intensity of use) 'Wildlife, Forestry, Light Grazing, Moderate Grazing, Intensive Grazing, Light Cultivation, Moderate Cultivation and Intensive Cultivation' (Table 1, Scotney et al., 1987).

Using the South African soil capability guidelines (Scotney et al., 1987), Plinthosols can be assigned to Land Capability Group 'Grazing' and Land Capability Class V, as they have 'Watercourse and land with wetness limitations' and can be used for (in order of increased intensity of use) 'Wildlife, Light Grazing and Moderate Grazing' (Table 1, Scotney et al., 1987). Arpad (2013) states that the fluctuating water table that produces a plinthite layer restricts the use of these soils to grazing or forestry.

4.1.5 Air Quality

4.1.5.1 Sensitive Receptors

Sensitive receptors are defined by the United States Environmental Protection Agency (USEPA) as areas within the surrounding project environment where occupants are more susceptible to the adverse effects of exposure to pollutants. These areas include but are not limited to residential areas, hospitals/clinics, schools and day care facilities and elderly housing. For the purpose of this study the following sensitive receptors within a 10 km radius for the proposed GCP and pipeline operations were identified and are presented in in Table 14 and Figure 14.

Table 14: Sensitive receptors for the proposed GCP and Pipeline operations

Location ID	Description	GPS Coordinates (Latitude)	GPS Coordinates (Longitude)	Distance (km) from Boundary	Direction from Site Boundary
SR1	Anomabu	5.4285°	-2.0930°	5.26	South southeast
SR2	Asuohiami	5.4704°	-2.1940°	7.99	West
SR3	Heman	5.4520°	-2.1294°	2.27	South southwest
SR4	Prestea	5.4454°	-2.1387°	3.45	Southwest
SR5	Prestea Huni Valley District	5.4742°	-2.0665°	5.24	East
SR6	Tarkwa Breman	5.5560°	-2.1508°	9.46	North northwest

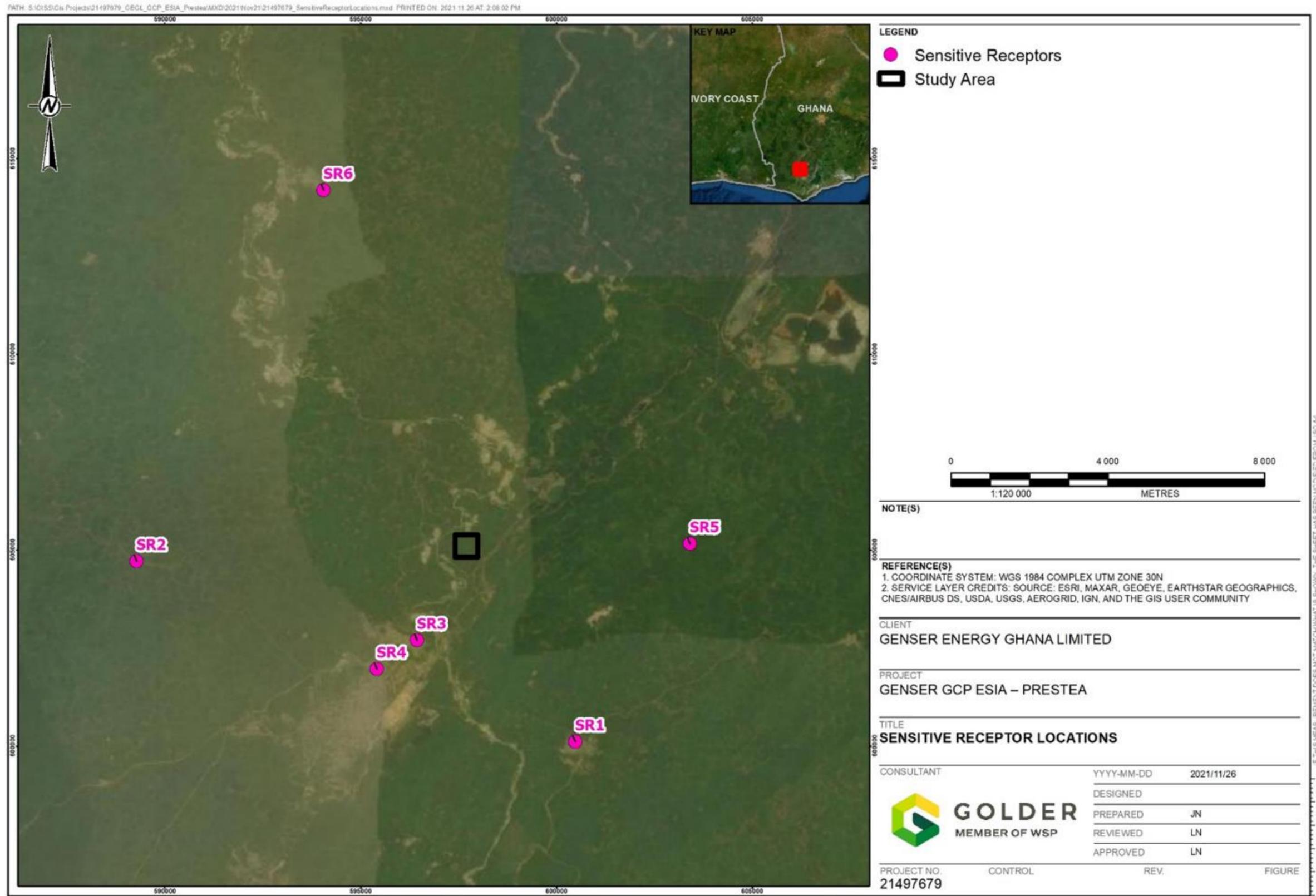


Figure 14: Sensitive receptors for the proposed GCP operations

4.1.5.2 Atmospheric Dispersion Potential

Meteorological characteristics of a site govern the dispersion, transformation and eventual removal of pollutants from the atmosphere. The extent to which pollution will accumulate or disperse in the atmosphere is dependent on the degree of thermal and mechanical turbulence within the earth's boundary layer. Dispersion comprises vertical and horizontal components of motion. The vertical component is defined by the stability of the atmosphere and the depth of the surface mixing layer. The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field. The wind speed determines both the distance of downwind transport and the rate of dilution as a result of plume "stretching". The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness. The wind direction and the variability in wind direction, determine the general path pollutants will follow, and the extent of crosswind spreading.

Pollution concentration levels fluctuate in response to changes in atmospheric stability, to concurrent variations in the mixing depth, and to shifts in the wind field. Spatial variations, and diurnal and seasonal changes, in the wind field and stability regime are functions of atmospheric processes operating at various temporal and spatial scales. Atmospheric processes at macro-scales and meso-scales need therefore be considered in order to accurately parameterise the atmospheric dispersion potential of a particular area.

Boundary Layer Properties and Atmospheric Stability

The atmospheric boundary layer constitutes the first few hundred metres of the atmosphere and is directly affected by the earth's surface. The earth's surface affects the boundary layer through the retardation of air flow created by frictional drag, created by the topography, or as result of the heat and moisture exchanges that take place at the surface.

During the day, the atmospheric boundary layer is characterised by thermal heating of the earth's surface, converging heated air parcels and the generation of thermal turbulence, leading to the extension of the mixing layer to the lowest elevated inversion. These conditions are normally associated with elevated wind speeds, hence a greater dilution potential for the atmospheric pollutants.

During the night, radiative flux divergence is dominant due to the loss of heat from the earth's surface. This usually results in the establishment of ground-based temperature inversions and the erosion of the mixing layer. As a result, night-time is characterised by weak vertical mixing and the predominance of a stable layer. These conditions are normally associated with low wind speeds, hence less dilution potential.

The mixed layer ranges in depth from a few metres during night times to the base of the lowest elevated inversion during unstable, daytime conditions. Elevated inversions occur for a variety of reasons, however typically the lowest elevated inversion occurs at night during winter months when atmospheric stability is typically at its maximum. Atmospheric stability is frequently categorised into one of six stability classes, these are briefly described in Table 15.

The atmospheric boundary layer is normally unstable during the day as a result of the turbulence due to the sun's heating effect on the earth's surface. The thickness of this mixing layer depends predominantly on the extent of solar radiation, growing gradually from sunrise to reach a maximum at about 5-6 hours after sunrise. This situation is more pronounced during the winter months due to strong night-time inversions and a slower developing mixing layer. During the night a stable layer, with limited vertical mixing, exists. During windy and/or cloudy conditions, the atmosphere is normally neutral.

Table 15: Atmospheric stability classes

Designation	Stability Class	Atmospheric Condition
A	Very unstable	Calm wind, clear skies, hot daytime conditions

Designation	Stability Class	Atmospheric Condition
B	Moderately unstable	Clear skies, daytime conditions
C	Unstable	Moderate wind slightly overcast daytime conditions
D	Neutral	High winds or cloudy days and nights
E	Stable	Moderate wind slightly overcast night-time conditions
F	Very stable	Low winds, clear skies, cold night-time conditions

For elevated releases, the highest ground level concentrations would occur during unstable, daytime conditions. The wind speed resulting in the highest ground level concentration depends on the plume buoyancy. If the plume is considerably buoyant (high exit gas velocity and temperature) together with a low wind, the plume will reach the ground relatively far downwind. With stronger wind speeds, on the other hand, the plume may reach the ground closer, but due to the increased ventilation, it would be more diluted. A wind speed between these extremes would therefore be responsible for the highest ground level concentrations. In contrast, the highest concentrations for ground level, or near-ground level releases would occur during weak wind speeds and stable (night-time) atmospheric conditions.

4.1.5.3 Ambient Air Quality Overview

Existing sources of air pollution which may impact on the ambient air quality within the airshed include:

- Agricultural activities
- Mining activities
- Domestic fuel burning
- Biomass burning
- Vehicle emissions (tailpipe and entrained emissions)

Agricultural Activities

Emissions from agricultural activities are difficult to control due to the seasonality of emissions and the large surface area producing emissions (US-EPA, 1995). Most of the agricultural activities in the proposed GCP operations region appear to be of a subsistence nature thus emissions are not anticipated to significantly influence the air quality in the area. Although particulate emissions may increase during drier periods, when fields are ploughed in preparation for planting and/or due to seasonal wildfires on fallow farmlands.

Mining Activities

Dust emissions from typical mining operations is commonly generated by wind erosion from waste rock dumps, tailings facilities (slimes dams, ash dumps etc.), open mining pits, unpaved mine access roads and other exposed areas. Dust emissions occur when the threshold wind speed is exceeded (Cowherd, Muleski G, & Kinsey, 1988). Factors which influence the rate of wind erosion include surface compaction, moisture content, vegetation, shape of storage pile, particle size distribution, wind speed and rain. Dust generated by these sources is termed 'fugitive dust' as it is not emitted to the atmosphere in a confined flow stream (US-EPA, 1995). These emissions are often difficult to quantify as they are very diffuse, variable and intermittent. Mining activity within the proposed GCP operations area is limited and is not expected to have a significant impact on air quality, as mining is artisanal in nature (i.e., sand and stone/aggregate extraction).

Domestic Fuel Burning

Domestic fuel burning of charcoal emits a large amount of gaseous and particulate pollutants including methane, CO₂, CO, non-methane volatile organic compounds, TSP, NO_x and products of incomplete combustion (Sparrevik *et al*, 2015). Pollutants arising due to the combustion of wood include PM₁₀, PM_{2.5} and TSP, inorganic ash, polycyclic aromatic hydrocarbons (PAH), benzo(a) pyrene, NO₂, CO, and formaldehyde. The main pollutants emitted from the combustion of kerosene (paraffin) include PM₁₀, PM_{2.5}, TSP, CO, PAH, and NO₂. Most of the housing within the proposed GCP operations area is informal and thus it is highly likely that most households within the communities are likely to use coal, wood and paraffin for space heating and/or cooking purposes. Emissions from these communities are anticipated to impact the ambient air quality however as the density of households is not significant the impacts are likely to be limited and disbursed.

Biomass Burning

Biomass burning may be described as the incomplete combustion process of natural plant matter with CO, Methane (CH₄) and NO₂ being emitted during the process. During the combustion process, approximately 40% of the nitrogen in biomass is emitted as nitrogen, 10% remains in the ashes and it is assumed that 20% of the nitrogen is emitted as higher molecular weight nitrogen compounds. In comparison to the nitrogen emissions, only small amount of SO₂ and sulphate aerosols are emitted. With all biomasses burning, visible smoke plumes are typically generated. These plumes are created by the aerosol content of the emissions and are often visible for many kilometres from the actual source of origin.

The extent of emissions liberated from biomass burning is controlled by several factors, including:

- The type of biomass material
- The quantity of material available for combustion
- The quality of the material available for combustion
- The fire temperature
- Rate of fire progression through the biomass body

Crop-residue burning and general wildfires in the study area represent significant sources of combustion-related emissions associated with these agricultural areas. Given that the region is dominated by subsistence farming rather than large scale commercial farming, it is anticipated that general wildfires are likely to be more important than controlled burning related to the agricultural activities as emission sources.

Vehicle Emissions

Air pollution generated from vehicle engines (including motorised boats) may be grouped into primary and secondary pollutants. Primary pollutants are those emitted directly to the atmosphere as tailpipe emissions whereas, secondary pollutants are formed in the atmosphere from atmospheric chemical reactions, such as hydrolysis, oxidation, or photochemical reactions. The primary pollutants emitted typically include CO₂, CO, hydrocarbons (including benzene, 1,2-butadiene, aldehydes and PAH), SO₂, NO_x and particulates. Secondary pollutants formed in the atmosphere typically include NO₂, photochemical oxidants such as ozone, hydrocarbons, sulphur acid, sulphates, nitric acid, sulphates and nitrate aerosols. The quantity of pollutants emitted by vehicles depend on specific vehicle related factors such as vehicle weight, speed and age; fuel-related factors such as fuel type (petroleum or diesel), fuel formulation (oxygen, sulphur, benzene and lead replacement agents) and environmental factors such as altitude, humidity and temperature. Vehicle entrainment of particulates from roads is anticipated to be one of the dominant sources of particulate emissions in the region.

4.1.5.4 Ambient Air Quality Monitoring

No ambient air quality monitoring has been undertaken within the project region. From a cumulative impact, the following air pollution sources are considered to be contributing factors:

- Mining and processing activities
- Combustion engines
- Domestic fuel burning
- Clay brick manufacturing
- Charcoal production
- Biomass burning

4.1.6 Noise

4.1.6.1 Sensitive Receptors

The sensitive receptors for noise are the same for air quality and are as provided in Section 4.1.5.1.

4.1.6.2 Existing Noise Sources

The immediate area of influence, in terms of noise, includes agriculture, mining and vehicular activities.

4.1.6.3 Noise Monitoring

No noise monitoring data for the study area is available. As such, in the absence of ambient daytime and night-time noise data and as a conservative approach, the IFC Residential daytime and night-time guideline of 55 dB(A) and 45 dB(A), has been used to represent the baseline daytime and night-time noise levels, respectively.

4.1.7 Surface Water

4.1.7.1 Water Users

The water users in the area along the Ankobra River in the vicinity of the proposed GCP and 6.5km natural gas pipeline site are artisanal. There do not appear to be any other water users using water directly from the river at this point. There may however be communities downstream of the site that use water from the river for domestic purposes. The Prestea- Heman township is approximately 2km downstream of the site, is seen as a rural community and is noted to rely solely on groundwater as their source of drinking water, with very little community reliance on surface water for domestic use (Water Resources Commission¹¹).

4.1.7.2 Catchment Description

The proposed GCP and Pipeline site lies within the Ankobra River Basin, one of the main rivers in the South-Western Rivers System comprising the Bia, Tano, Ankobra and Pra Rivers. It is bounded to the east; west and south by the Pra Basin, Tano Basin and the Gulf of Guinea respectively. The Ankobra Basin covers an area of 8,403 km² crossing 11 districts in three regions.

As for many of the main rivers in Ghana, surface water quality considerations are becoming increasingly important because of impacts from mining activities, urban and industrial pollution and agricultural development. From photographs at areas up and downstream of the proposed site, the Ankobra River is a turbid river. As described by the Water Resources Commission of Ghana², the Ankobra Basin is one of the most exploited basins in Ghana in terms of natural resources. The major minerals mined in the basin include gold, manganese, bauxite, and diamond. The main challenges related to water in the basin are:

¹¹ [Ankobra » Water Resources Commission Of Ghana \(wrc-gh.org\)](http://Ankobra » Water Resources Commission Of Ghana (wrc-gh.org))

- Artisanal mining activities (popularly known as Galamsey)
- Pollution from indiscriminate discharge of untreated mine effluents
- Indiscriminate use of chemicals especially DDT for fishing
- Clearing of forests for mining leading to erosion and ultimately high sediment loads to the water resources
- Poor sanitation in almost all the towns in the basin
- Conflicts between Communities, NGOs' and Mining Companies

4.1.7.3 Local Hydrology

The proposed site is located approximately midway within the Ankobra River Basin. The Ankobra River drains south/ southwest on the western boundary of the proposed GCP. Drainage from the proposed site will be to the Ankobra River. The local hydrology and the site in relation to the Ankobra River is illustrated in Figure 15. Figure 15 the local hydrology of the site in relation to the Ankobra River, artisanal mining activity along the river, and surface water monitoring sites. The north-west corner of the boundary is closest to the Ankobra River, approximately 120m. The south-west corner sits over some pans and water bodies.

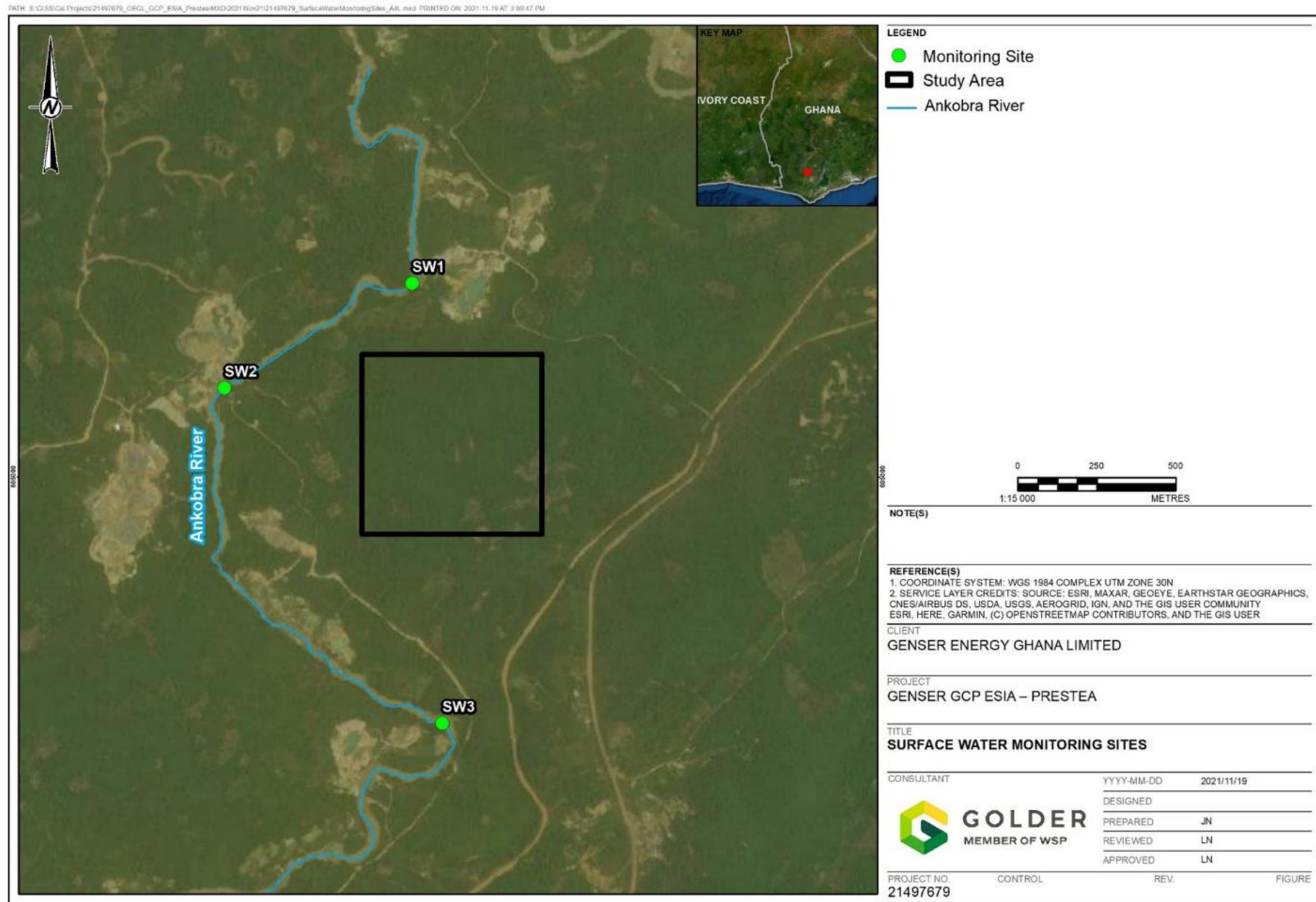


Figure 15: Local hydrology in relation to the Ankobra River

4.1.8 Groundwater

According to the new hydrogeological zonation of Ghana (Banoeng-Yakubo et al, 2010), the project site falls within the Birimian Province which is made up of aquifers of the Birimian metasedimentary and metavolcanic rocks, and the Tarkwaian aquifers.

The occurrence of groundwater in these aquifers depend on the existence of secondary structures made up of fractures, veins, and faults. The development of secondary permeability in these rocks is dependent on the nature, aperture, length, density, thickness, and the degree of interconnection of the fractures and in-filling of the fractures as well as the extent of weathering.

Aquifer transmissivity of the productive zones of the Birimian and Tarkwaian Systems ranges between 0.2 m²/d and 119 m²/d, with an average of 7.4 m²/d. In these aquifers, storativity ranges between 0.003 and 0.008.

4.1.8.1 Site Lithology

Drilling of the geotechnical borehole is currently on going, the drill logs showed that drill depths ranged from 8.5 to 47.0 m below the ground level. The drilling was terminated based on the target depth for the investigation and progressed through a topsoil, saprolite of completely to highly weathered bedrock and saprock of moderately weathered bedrock (Phyllite or Gneiss).

The soil samples collected during the geotechnical investigation were described or classified as sandy clay, sandy gravel, gravelly silty clay, and gravelly clayey silt. The clays were soft or stiff and hard and may not transmit groundwater. The sandy, gravelly or silty material encountered at the shallow depths can hold and transmit groundwater and thus could become a potential unconfined aquifer in the project area.

The Groundwater is directly determined and controlled by lithology which are characterized by the intergranular system. The saprock zones showed moderately weathered phyllites or gneiss having signatures of the parent rock mass.

4.1.8.2 Groundwater Strikes and Quality

The moist samples were generally encountered between 0.7 to 2.0 mbgl for the boreholes, the drilling method used employs mud/water as drilling fluid, so water strike depths were difficult to determine and because of the introduction of this foreign water into the borehole, in-situ water quality test became a challenge due to possible misrepresentation of actual results.

4.1.8.3 Piezometer Construction and Groundwater Level Measurements

Seven of the geotechnical boreholes were converted into monitoring piezometers to enable groundwater level and quality monitoring. The groundwater levels were monitored for two weeks as part of the geotechnical investigations. Generally, the groundwater level at the project site ranges from 1.05 m to 17.62 m below ground level with a mean of 10.9 mbgl. A detailed piezometer construction depth and average recorded groundwater level is presented in Table 16.

Table 16: Piezometer construction details and recorded groundwater level

Piezometer ID	Drilled depth (mbgl)	Constructed depth (mbgl)	Depth to top of screen (mbgl)	Mean groundwater level (mbgl)
S5B	36.0	35.8	33.8	13.57
S7B	24.0	5.3	3.3	1.05
S8B	12.0	11.8	9.8	11.36
S9B	19.0	18.8	17.8	Dry

Piezometer ID	Drilled depth (mbgl)	Constructed depth (mbgl)	Depth to top of screen (mbgl)	Mean groundwater level (mbgl)
S10B	19.0	19.0	18.0	17.62
S11B	10.0	10.0	8.0	Dry
S12B	10.0	10.0	8.0	Dry

Meanwhile, available literature on the Ankobra basin shows that groundwater levels vary with depth depending on the existing geological formation as shown in Table 17.

Table 17: Groundwater characteristics in the Ankobra Basin (WRC, 2010)

Geological zone	Depth of borehole (mbgl)	Depth to aquifer top (mbgl)	Static water level (mbgl)	Borehole yield (l/min)
Tarkwaian	22-61	9-40	0-25	8-120
Upper Birimian	18-48	13-52	2-12	0-300
Lower Birimian	23-75	10-60	1-25	10-300
Granites	18-65	6-52	1-24	10-500

Source: WRC 2010

Groundwater quality in the Ankobra Basin was determined to be mildly acidic, poor in conductivity and carbonates with high HCO_3 and silicates concentrations attributed to the weathering processes in the area (WRC, 2010). Majority of the groundwater tested had a Ca-Mg- HCO_3 dominance. There were elevated levels of As, Al, Mn, Fe and Hg in some of the groundwater samples in concentrations exceeding WHO maximum acceptable limits for drinking water according to the WRC, 2010.

4.1.9 Visual Amenity

The baseline assessment and resultant resource determination was conducted based on a site visit of the study area carried out 09 November 2021, as well as the latest available Google Earth satellite imagery. The existing visual baseline is summarised in terms of the individual attributes listed below.

- **Topography:** The natural topography of the project site is generally rolling to undulating, with a series of hills and valleys. Elevation ranges between ~30m and 55m. The view towards the southern end of the site is quite significant as Brumase can be viewed, however the view facing northwards and westwards is generally obscured by the presence of the secondary forests. In addition, at the northern part of the site, the general area is characterised by artisanal mining activities which are visually intrusive and detract from the visual resource value of the area due to the approach to mining and the presence of some equipment.
- **Water bodies:** The Ankobra is the only water body that traverses the project site. It flows north in a south westerly direction, around the western boundary of the project site before exiting at the southwest. In addition, the area along the Ankobra has a number of artificial ponds and a combination of active and abandoned pits created from the artisanal mining activities.
- **Vegetation cover:** The visual character of the vegetation cover in the study area varies greatly across the site, with the transition formed by the presence of farmlands, fallow secondary forests and artisanal mining activities. The vegetation cover at the northern boundary is predominantly secondary thickets with open spaces dominated by artisanal activities. Towards the western boundary there are abandoned oil palm and coconut plantations interspersed with some thickets. At the eastern boundary, thickets and abandoned

farmlands dominate the vegetation cover with some wetland vegetation. However, towards the southern boundary it transitions to cultivated lands of cash crops.

- **Sense of place:** Sense of place describes the “uniqueness” of a given locality or entire study area, within the larger context within which it is situated. The Prestea region is characterised by urban and semi-urban areas, and farmlands. The immediate area is characterised by secondary forests, interspersed with farmlands or varying ages and some level of artisanal mining activities. In general, the sense of place of the project site is not characteristically different from its surroundings.

4.2 Biological Environment

The project area is in the wet-ever ecological zone of the Tropical and subtropical Moist Broadleaf Forest Biome (Hall and Swaine, 1981). This biome is characterised low variability in annual temperature and high levels of rainfall (WWF, n.d). The area is dominated by the high forest area of Ghana with vegetation characterized by evergreen trees in vertically stratified multi-storey forest. The 100-Ha site and RoW for the Prestea GCP and 6.5km pipeline project is located off the main Bogoso-Prestea Road at Brumase, about two kilometres from Prestea Town.

The Prestea GCP and pipeline project site is a mosaic of several land uses including cocoa farms and food crops and patches of fallow secondary forest in early stages of regeneration. Another significant human activity on the proposed site and surrounding areas is widespread artisanal gold mining locally known as Galamsey (Figure 16), which has resulted in open pits and pools at previous mined areas. The core area of the Prestea GCP and pipeline project appeared to be a relic of old coconut and oil palm plantation and early stages of secondary forest, regenerating from previous farming activity. Topography of the area is generally undulating, but with isolated hill separated by valleys. The northern limits of the Prestea GCP project site interphases with the Ankobra River.



Figure 16: A picture showing artisanal mine degraded area and the resultant pond from mine excavation

4.2.1 Vegetation Composition in the Project Area

The Prestea GCP project site and pipeline RoW has an undulating topography with well drained middle and upper slope and swampy or wet valley bottoms. The valley bottoms have been subjected to artisanal mining while the middle and upper slopes have mostly been cultivated. Secondary forests or thickets intersperse the landscape, giving it a mosaic/fragmented appearance. The existing vegetation of the Prestea GCP project site and pipeline RoW is thus a mixture or mosaic of farmlands, farm re-growth/secondary thickets, Acacia woodlot, secondary forest with broken canopy and swamp/wetland.

Cocoa farms dominate the project site. New cocoa farms are inter-cropped with food crops such as cassava and plantain. The cocoa farms have isolated trees, notably *Morinda lucida*, *Persea americana*, *Myrianthus libericus* and *Albizia zygia*. Oil palm and coconut plantations constitute the other cash crops cultivated on the Project site. The Oil palm plantations formed closed canopy that shaded out most tree species. Abandoned coconut and oil palm plantations on the site are in the process of being converted to secondary thickets and secondary forests. Forbs and herbaceous species which constitute the undergrowth of the farms include *Nephrolepis biserrata*, *Spigelia anthelmia*, *Schranckia leptocarpa*, *Mimosa pudica*, *Stachytarpheta cayennensis* and *Erigeron floribundus*.

The farm re-growth and secondary thickets have species such as *Chromolaena odorata*, *Ficus sur*, *Funtumia africana*, *Anthocleista nobilis*, *Solanum torvum*, *Cecropia peltata*, *Anthonotha macrophylla*, *Albizia zygia*, *Sterculia tragacantha* and *Griffonia simplicifolia*.

The swamp and wetland vegetation has species such as *Raphia hookeri*, *ludwigia leptocarpa*, *Scleria naumanniana* and *Alchornea cordifolia*.

4.2.1.1 Floristic Analysis of the Project Area

The species lists for the 15 samples analysed are presented in the Biodiversity Baseline Report (APPENDIX B). The floristic composition and analyses of the project site are also presented in the Biodiversity Baseline Report. The Biodiversity Baseline Report (APPENDIX B) shows that the survey recorded a total of 93 species in 79 genera belonging to 49 families. The families with high species representation were the Fabaceae (14), Malvaceae (8), Euphorbiaceae (6), Poaceae (6), Apocynaceae and Cyperaceae (4 each). These six families (out of total of 41) accounted for 45.2% of the species recorded. The rest of the families were poorly represented with less than four species.

The Life form composition of the flora (Table 18) showed a dominance of the Tree Life form (about 42%). The Climber and Herb life forms had equal representation with 21.5% each while the Shrub life form constituted about 15% of the flora. The diversity of the life forms indicate that the site is in a state of flux. Disturbance due to land cultivation and regeneration in the secondary thickets and secondary forests could explain the observed diversity of life forms. No mature secondary forest occurs on the project site.

Table 18: Life form composition of the flora

Life form	No.	%
Climber	20	21.5
Herb	20	21.5
Shrub	14	15.1
Tree	39	42
Total	93	100.1

The ecological guilds of the species, which gives an indication of the developmental/successional stage of the vegetation, shows a dominance of the pioneers (Table 19). The dominance of pioneers (55.9%), which are secondary species, confirms that the vegetation of the project site is highly disturbed and is in a state of flux. The primary species (shade-bearing and non-pioneer light demanders) constituted only 22.6% of the flora, a further indication of the disturbed nature of the vegetation. The isolated patches of secondary forest and cocoa farms mostly harbour the primary species. The major drivers of vegetation disturbance in the project site are agriculture (cultivation of food and cash crops) and, to a small extent, alluvial gold mining.

Table 19: Ecological guilds of the flora

Guild	No.	%
Not Assessed	14	15.1
NFS/P	3	3.2
Non-Pioneer Light Demander	12	12.9
Pioneer	52	55.9
Shade-bearing	9	9.7
Swamp	3	3.2
Total	93	100

4.2.1.2 Species Abundance/Frequency Distribution

APPENDIX B shows the frequency distributions of the species encountered in the project area. It is evident that *Nephrolepis biserrate* (92.9%), *Cecropia peltata* (78.6%), *Albizia zygia* (71.4%), *Alchornea cordifolia* (71.4%), *Funtumia africana* (71.4%), *Anthonotha macrophylla* (50%) and *Sterculia tragacantha* (50%) were the most frequent species encountered in the project site. All other species had frequencies below 50%.

4.2.1.3 Species of Natural Conservation Concern

Most of the species (about 94%) recorded are of no conservation concern, being either Green stars or species not yet assessed (Table 20). Most of the species not yet assessed are weeds of waste places and open areas. Of the species recorded six (6.5% of the species recorded) are of national conservation concern (Table 21). The Blue Star species are rare in Ghana while the Pink Star species are mostly species under commercial exploitation.

Table 20: Star Rating Composition of the flora

Star	No	%
Blue	4	4.3
Green	64	68.8
Not Assessed	23	24.7
Pink	2	2.2
Total	93	100

Table 21: Species of national conservation concern

Species	Family	Life Form	Star Rating
<i>Mapania baldwinii</i>	Cyperaceae	Herb	Blue
<i>Millettia thonningii</i>	Fabaceae	Tree	Blue
<i>Mussaenda chippii</i>	Rubiaceae	Climber	Blue
<i>Xylopia aethiopica</i>	Annonaceae	Tree	Blue
<i>Elaeis guineensis</i>	Arecaceae	Tree	Pink
<i>Sterculia rhinopetala</i>	Malvaceae	Tree	Pink

4.2.1.4 Species of International Conservation Concern

The floristic analysis (Table 22) shows that no species of global conservation concern were recorded at the project site. All the species were either Data Deficient, Least Concern or Not Assessed and do not merit conservation action globally.

Table 22: IUCN Red list status Composition of the flora

IUCN Red list Status	No.	%
Data Deficient	1	1.1
Least Concern	50	53.8

IUCN Red list Status	No.	%
Not yet Assessed	42	45.2
Total	93	100.1

4.2.1.5 Invasive Species

The study revealed that two of the species recorded were Invasive Alien Species viz., *Chromolaena odorata* (Siam weed) and *Lantana camara* (wild sage). These two species are listed among the top 100 invasive species of the world by the IUCN Invasive Species Specialist Group. The most widespread of them within the project site was *Chromolaena odorata* with a frequency of (42.9%). *Lantana camara* had a frequency of 7.1% at the project site. The construction and operation phases of the project should be carried out in such a manner as to prevent the proliferation of these species within the project's area of influence.

4.2.1.6 Natural Habitats

The land cover in the project area demarcated for the GCP and 6.5km natural gas pipeline project consists mainly of tree cover area, cropland and grassland as shown in Figure 17.

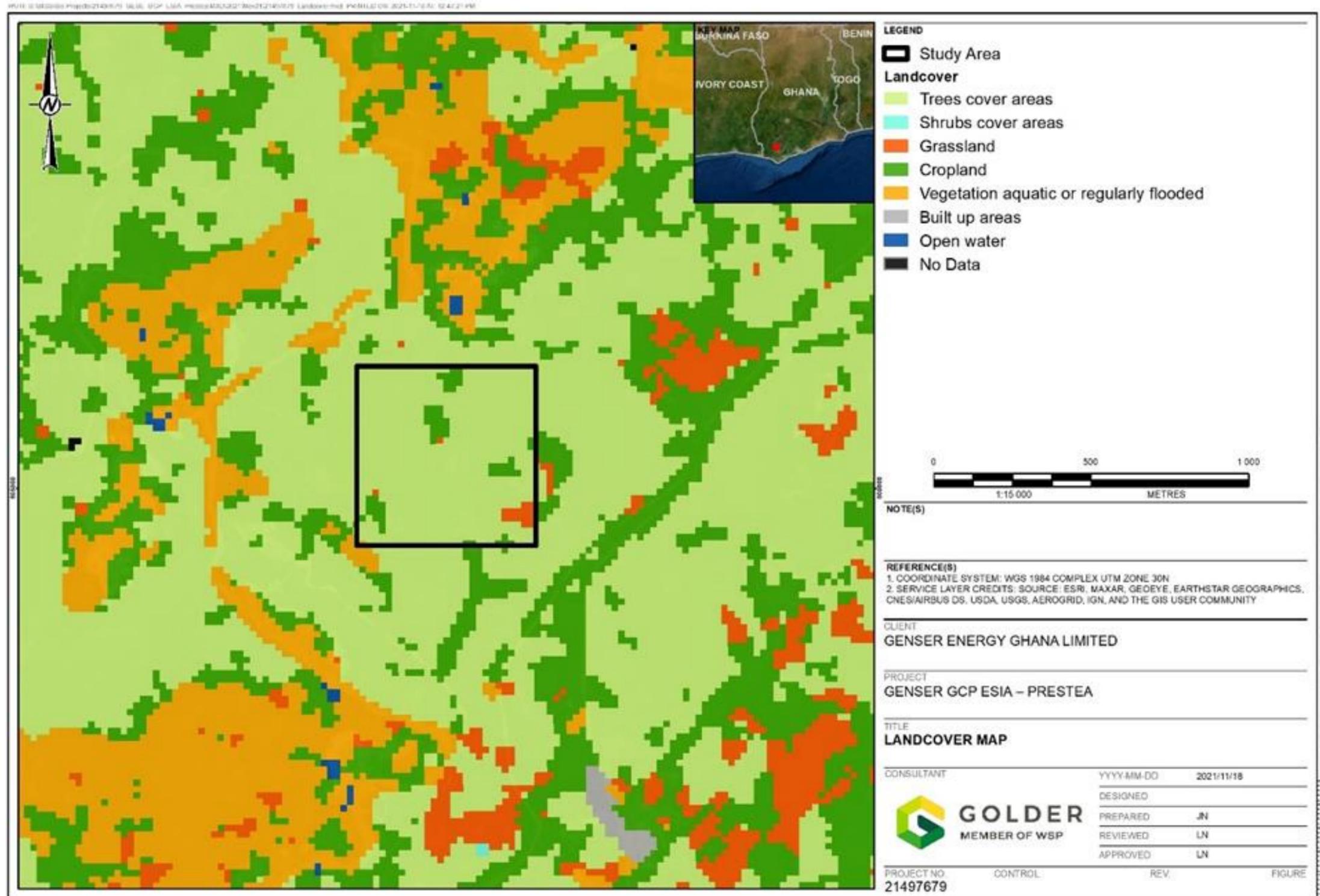


Figure 17: Landcover within the Project Area and surrounding areas

4.2.2 Fauna

Human economic development activities such as large-scale housing projects, mining and conversion of natural habitats such as forests and fallow lands to plantation agriculture and crop farms has the potential to disrupt ecological community structure (Goosem, 1997). Large scale infrastructure development has the potential to impact negatively on the environment in terms of loss of natural habitats and local biodiversity. Such activities are known to have specific adverse impacts on fauna as habitat integrity is one of the key ecological requirements of fauna species (Andrews, 1990; Bennett, 1991). Although the study area is quite degraded and generally devoid of the natural climax vegetation and habitat condition of the moist evergreen vegetation, it was not expected to be completely devoid of any fauna community and indeed some fauna species are known to persist in ecologically degraded and stressed areas (Thiollay, 1985, Ntiamoa-Baidu et al. 1998a). The baseline fauna study focused on three vertebrate fauna taxonomic groups, namely large mammals, avifauna and herpetofauna (reptiles and amphibians).

4.2.2.1 Mammals

Large mammals are of key ecological and socio-economic importance in most Ghanaian social communities. Besides their aesthetic values especially in ecotourism, large mammals serve as major sources of animal protein in both rural and urban communities in Ghana, a factor that makes large mammals the worst victims of the bushmeat trade. Large mammal species richness and diversity in any habitat or area reflects the level of biological richness and also indicates the extent and intensity of human pressure on the habitat. Several large mammal species are globally threatened, hence their diversity and richness in an area gives a measure of the conservation value of the habitat.

Species Richness and Diversity

The occurrence of large mammals at the project area was limited to few species. This reflected the extent of fragmentation and physical disturbances and the high presence of human activities in the area. In all only seven medium-sized mammal species were recorded (Table 23), and these were by way of footprints, feeding activities, faecal pellets as well as on the account of local farmers who were encountered at the project area.

Large mammal species recorded at the project area were obvious remnants of a climax population that have persisted through the different disturbance regimes in the landscape. Maxwell's duiker, bushbuck and the African civet are all secondary forest, forest edge and generally open habitat species in forest zones. They are mainly habitat generalist and can persist in fragmented and patchy landscape amid intense human activities.

Table 23: Checklist of large mammal species recorded at the Prestea GCP and 6.5km pipeline project site

Family Name	Common Name	Scientific Name	Method of obs.	IUCN Status	National Status
ARTIODACTYLA					
Bovidae	Bushbuck	<i>Tragelaphus scriptus</i>	FP, FA	LC	II
	Maxwell's Duiker	<i>Philantomba maxwellii</i>	FP, F	LC	II
CARNIVORA					
Herpestidae	Marsh Mongoose	<i>Atilax paludinosus</i>	S	LC	II
Nandiniidae	African Civet	<i>Civettictis civetta</i>	FP, F	LC	II
RODENTIA					

Family Name	Common Name	Scientific Name	Method of obs.	IUCN Status	National Status
Sciuridae	Western Palm Squirrel	<i>Epixerus ebii</i>	S, H	LC	I
Nesomyidae	Giant Pouched Rat	<i>Cricetomys gambianus</i>	FP	LC	III
Thryonomyidae	Greater Cane Rat	<i>Thryonomys swinderianus</i>	FA, B	LC	

(Legend: S= Seen; FP= Footprint; FA= Feeding activities; H= Heard; LC= Least Concern)

The presence of cane rat in a predominantly wet forest landscape attested to the extent of degradation, as this species is generally associated with grassland and herbaceous farm bushes. Due to the mode of detection, bioquality assessment could not be done for the seven species recorded.

4.2.2.2 Avifauna

Birds are one of the taxonomic groups that are present in almost every habitat type. In Ghana, birds constitute a significant component of the fauna resources of all ecological zones and have also been the flagship taxonomic group of several biodiversity conservation programs and projects in Ghana (BirdLife International, 1998). Birds have been used in many instances in identifying priority areas for biodiversity action (Conservation International, 1999). Results of ornithological studies in a variety of ecosystems have shown that birds are reliable measures of conservation values of an area. National and global conservation and protection status of most species of birds are continuously assessed with respect to the anthropogenic and natural events that impact negatively on them (BirdLife International 2000, Collar *et al.*, 1994, IUCN, 2020). The taxonomy and global geographical distribution of birds and their specific habitat associations are relatively well documented (Dowsett-Lemaire, and Dowsett, 2005; Fishpool and Evans, 2001).

Avifauna species richness and diversity

A total of 81 species of birds from 27 avian families were recorded in the avifauna study of the Prestea GCP project Area. Bird community on the Prestea GCP and natural gas pipeline project site and immediate surrounding area was quite consistent with the prevailing habitat condition of the study areas. The generally patchy and fragmented nature of the landscape was reflected strongly in the avifauna community at the site; dominated by species closely associated with secondary forest patches, forest edge and open habitat species; a reflection of the fragmented nature of the habitat.

Despite the high level of degradation of the Prestea GCP and pipeline project site and the immediate surrounding area, the diversity and richness of the bird community was quite significant with values of 4.12 and 14.41 respectively. Checklist of the species recorded at the site is presented in APPENDIX B.

4.2.2.3 Amphibians and Reptiles (Herpetofauna)

Herpetofauna (amphibians and reptiles) are a prominent and conspicuous component of the West African forest fauna. They can occur at high densities in the tropics and play important roles as consumers (Leache and Caleb, 2009). For biological baseline assessment, amphibians are especially useful for evaluating the health and integrity of the environment (Leache and Caleb, 2009). Amphibians respond early to environmental changes and are relatively easy to detect in even the most complex forest habitats. Over one-third of amphibian species are globally threatened as amphibian populations worldwide are negatively affected by anthropogenic factors such as habitat modification or invasive predators.

Herpetofauna species richness and diversity

Herpetofauna species as with large mammal was very limited at the project area. The study recorded only nine herpetofauna species comprising six reptiles and three amphibians Table 24.

The herpetofauna species were encountered in the secondary forest patches as well as in the cultivated areas (food crops and cocoa farms). As with the large mammals, herpetofauna species recorded are mainly characteristic remnant species in a landscape with high human disturbance footprints.

Table 24: Checklist of herpetofauna species recorded in the study

Species		IUCN	WCR	Mode of Observation
Scientific name/Family	Common name			
Amphibia				
<i>Bufo regularis</i>	Common Toad	LC		Seen
<i>Hylarana galamensis</i>	Common Frog	LC		Seen
<i>Phrynobatrachus latifrons</i>	Ahl's river frog	LC		seen, heard
Reptilia				
SQUAMATA: LACERTILIA				
	Lizards			
<i>Agama agama</i>	Agama Lizard	LC		Seen
<i>Trachylepis quinquetaeniata</i>	African Five-lined Skink	LC		Seen
<i>Varanus niloticus</i>	Nile Monitor	LC	II	Seen
SQUAMATA: SERPENTES				
	Snakes			
<i>Bitis arietans</i>	Puff Adder	LC		Reported
<i>Atheris squamigera</i>	Green bush viper	LC		Seen
<i>Naja melanoleuca</i>	Black (Forest) Cobra	LC		Reported

4.2.2.4 Conservation Value of the Fauna Community

Conservation value of the fauna community at the 100ha Prestea GCP project site and the 6.5km natural gas pipeline was rather low. None of the 98 vertebrate fauna species recorded at the site were of global conservation significance, as all the species recorded were listed as of least concern on the IUCN Red List. At the national level only four species (all birds) were listed on Schedule I of the Wildlife Conservation Regulation (WCR) as Wholly Protected species. These include red-necked buzzard, black goshawk, black kite, and cattle egret. In all, the vertebrate fauna community at the Prestea GCP and natural gas pipeline project site and immediate adjoining areas were common open habitat species with no significant conservation value or protection status. This appeared to be a direct reflection of the extent of degradation and intensity of physical disturbance regime stemming from several habitat degrading human activities. This notwithstanding a significant number 43 (53.75%) of the bird recorded are limited in global distribution to the Guinea-Congo Forest Biome, which is an indication of the fact that the area still retains some measure of natural identity as far as birds are concerned.

4.3 Socio-Economic

The project area falls within the Prestea Huni Valley Municipality in the Western Region of Ghana. There are four communities: Heman, Ankobra, Brumase and Barrier, (project affected communities (PACs)) within 5 km radius of the project area. However, the Heman is the community where the project is being sited.

4.3.1 Project Area Characteristics

Demography

The average household size in the Prestea Huni Valley Municipality is 4.0, lower than the western regional average of 4.2. Children constitute the largest proportion of the household population (45.1%). The average household size in the study area is 4.96. Brumase has larger household sizes (5.37) than the other communities. About four persons out of ten were born outside the municipality and most of them migrated into the area to seek for employment. More than 90% of the community members across the study area are Christians.

all the communities are under the stool of the Wassa Traditional area. Apart from Heman, whose name is from traditional philosophy, all the other communities derived their names from historical incidences or activities.

Housing Conditions

Most of the dwelling units in the area are either owned by the households' extended family (28.9%), rented (30.2%) or household itself (36.2%). Cement blocks are the dominant materials (60.4%) used for constructing household structures. 40% of household kitchens in the study area are located within the dwelling unit of household structures. Most of the houses are roofed with Aluminium.

Supply of Health Services

There are two main public health facilities located around the area; the Prestea Government Municipal Hospital and the Heman Health Centre. There is no health facility in any of the other PACs. Households prefer orthodox medication rather than traditional herbal medicine. The commonest disease or health problem faced by most households in the area is malaria.

There are 278 health workers and 90% are working at Prestea Government Hospital. Also, one-third of the health workers are administrative support staff. The Prestea Government Hospital records a yearly average of 21,974 patients and about 80% of people who access the facility's services have an insurance policy.

About 50% of the household members in the PACs are NHIS subscribers. The level of subscription to the NHIS among households in Brumase is the highest (63.5%), while that of Heman is the lowest (46.4%). The main challenge of health care accessibility by household members in the PACs is the high cost of services (40%) and inadequate health care infrastructure and logistics (22.1%).

Water and Sanitation

There is only one toilet facility at Ankobra, Brumase and Barrier each, and all of them are KVIPs except for the one at Barrier, which is modern technology. There are also two public and two other private toilet facilities in Heman. However, all the toilets in the PACs are unhygienic and dilapidated. There is at least one major dumping site in each community. The major water body in the area is the Ankobra River which passes through Heman and Ankobra. There are other smaller water bodies in Brumase and Barrier. Some of the toilet facilities and dumping sites are closer to the main Ankobra river and other water bodies.

Households owning toilet facilities for their exclusive use are not common in the study area. Out of every 10 households, only three have their own functional toilet. The commonest toilet facilities in the area are KVIPs/VIPs toilet facilities.

Standpipes and boreholes are the most common water facilities in the area. Apart from Barrier, all the other communities have, at least, a functioning borehole. Most people within the study area rely on pipe-borne water (40%). Borehole and streams are the major sources of drinking water for the people of Bromase and Barrier respectively.

Education

The municipality has about 43,500 pupils in basic schools (preschool-junior high school (JHS)), 51.46% are males and 48.58% female. The basic public schools have a total staff strength of about 1300. This gives a teacher-pupil ratio of approximately 1:34. There are 102 Kindergarten (KGs)/Pre-schools, 102 Primary, 71 JHSs and three senior high schools (SHS). Generally, the level of higher education and training among household members in the area is low. More than 40% of the household members are early school dropouts.

Generally, public schools are more preferred than private schools, especially in underserved communities such as Barrier and Ankobra. The main challenge of education is financial costs and lack of motivation and mentorship (26.9%) because of the prevalence of Galamsey activities.

Roads

Road conditions in entire municipality is very poor. apart from the Heman community township, where almost all the inner major roads within the community have been overlaid with bitumen gravels. The municipality has over 80% feeder roads that are untarred. The major means of transportation is by vehicle (80.9%). However, motorbikes and tricycles are very common, especially in the rural communities, Prestea and Bogoso townships.

Employment

About 95% of the household of working age are employed. Most of the employed population are engaged in low paying jobs, underemployed or engaged in diverse informal and artisanal mining. About one-third of the employed population is engaged in farming.

Industry

The Municipality is one of the most vibrant retail trading economic areas in the Western Region. The municipality has major market centres located at Bogoso, Damang and Prestea, and these markets are among the most vibrant and patronised business centres in the entire Region.

The major industrial activity in the area is mining. The municipality is a hub for gold mining in Ghana. It has major mining companies including Aboso Goldfields, Golden Star Resources, Bogoso/ Prestea Ltd, Prestea Sankofa Gold Ltd, New Century Mines (Prestea), Tarkwa Goldfields and AngloGold Ashanti Ltd. Small scale mining activities in the area is very common.

Agriculture

Agricultural activities are gradually declining in the study area due to upscaling of small-scale mining, industrial, and other non-farm commercial activities.

The major food crop produced are plantain, maize and cassava. More than 25% of the farmers complain about the soils' poor fertility in the areas, climate change (43%) and small-scale mining activities (27.7%).

Income and Expenditure

The average annual income of households in the study area is about Ghc 30,000.00. Income levels at Heman are highest, while Ankobra is the lowest. On average, a typical household spends about Ghc 25, 000.00 every month, giving an annual saving of about 4000 per household.

Energy

Electricity is the commonest source of light energy in the area. Charcoal (54%), Liquefied Petroleum Gas (LPG) (25.1%) and Firewood (17%) are rather used for cooking. There are eight functioning fuel retail stations at Prestea and the PACs. Two of the stations are located at Ankobra. A study of retail fuel prices shows that the highest price is Ghc 6.90 and the lowest is Ghc 6.60 per litre.

Communication

The quality of telecommunication network signal in the area is not so good and even worse in Brumase and Barrier. Generally, the internet penetration rate in the study area is 65%; only about one-third have had no access to the internet for the past one week before data collection. Poor network quality signals and fluctuations in network quality are the main sources of concern for electronic communication.

Gender Equality

According to 30% of the household respondents, there is a gender-based division of labour and responsibility and approximately 50% of the households do not also respect the right of children. In one out of every 10 households, at least one member has some form of disability, but most of these disabilities are minor.

4.3.2 Customary Rites for Sacred Areas

Customary rites are often performed in our host communities at sacred and religious places, such as groves and sanctuaries in which gods or spirits of their ancestors are believed to live and manifest. Sacred places are also sites of natural and historical significance to communities: springs, rivers, forests and mountains - which once served as safe havens from enemies.

In addition, there exist specific days reserved for traditional worship and prayer rituals to the gods and ancestors of some communities. There are also days termed as 'taboo days', in which communities are prohibited from farm work, and such sacrosanct days vary from one ethnic group, tribe, or community to the other. In the Ashanti Region for instance, 'Yawooda' and 'Fiada', (representing Thursday and Friday), are the two 'taboo days' observed by the Akan people.

There are also two 'Aday' festivals; 'Awukudae' and 'Akwasidae'. The 'Awukudae' is a festival celebrated on Wednesday ('Wukuda'). According to the Akan calendar, the 'Aday' is counted nine times every six weeks or a 40-day period. The 'Awukudae' occurs every 40 days or in some cases 42 days, and this 40th day is supposed to fall on a Wednesday ('Wukuda'). Since these days have deep cultural and religious significance to chiefs and traditional leaders in the Ashanti Region, scheduled meetings which happen to coincide with these special days are often times postponed.

Customary rites have been performed by the Himan traditional authorities "to seek the approval of the gods and ancestors of the land for" the commencement of the GCP project. The rites involved pouring of libations and offering of prayers using several items including crates of eggs, schnapps, and some cash to the gods at the. These items were requested by the traditional authorities and were supplied by GEGL.

5.0 PUBLIC PARTICIPATION

Stakeholder consultation is a major component of the EIA process and is generally completed to direct impact assessments on issues of most concern and inform project planners and decision-makers. Effective stakeholder consultation helps build trust and credibility, provides a platform for effective information management, and facilitates the development of positive, long-term relationships with the project proponent, its neighbours, and other stakeholders in the quest for sustainable project development and implementation.

As part of the EIA process, stakeholder engagements were conducted from 28 October 2021 to 30 November 2021 (Table 25). An additional engagement was carried out with the Ghana National Gas Company on 23 February 2022.

5.1 Objectives

The objectives of the stakeholder consultations were to share project information with identified stakeholders and solicit their views, inputs, and concerns regarding the project. Specific objectives of the consultations included:

- Provide adequate and accessible information to enable stakeholders:
 - Understand the context of the EIA process.
 - Be informed and educated on the project and its potential impacts.
 - Identify issues of concern, make suggestions for improved benefits and comment on project alternatives.
- Provide opportunities for stakeholders to comment and provide input/feedback (local knowledge and experiences) to be documented for consideration as part of the EIA process.

Build community understanding and support for the EIA process and the project in general and incorporate stakeholders' comments and views into project planning and decision-making, including development of mitigation measures.

5.2 Approach and Methodology

The approach and methodology applied to the public consultation process were influenced by the need to ensure broader stakeholder participation, reliability and validity of data collected. Genser is committed to engaging with stakeholders in decision-making processes, improve communication, share information, and obtain views and feedback to enhance the consultation and decision-making process.

The methodology employed during the public consultation process included the following:

- All the engagements were in the form of key informant (face-to-face) and focus group discussions.
- The meetings were conducted in Twi and English and were documented (photos, completion of attendance registers and note-taking).
- Meetings were held at venues easily accessible to stakeholders.
- The project was introduced to stakeholders using a map displaying the pipeline route and the surrounding communities.
- Comments and issues raised were captured and minutes recorded. The minutes of the stakeholder meetings were used to develop the stakeholder engagement reports.

5.2.1 Development of a Stakeholder Database

A stakeholder database was developed comprising a list of stakeholders representing various sectors of society, namely those who live in proximity of the project area and directly affected stakeholders. The participation of the following clusters or organisations in the stakeholder engagement process was considered of key importance:

- Traditional and religious authorities.
- Local communities likely to be directly affected by the project.

5.2.2 Methods of Engagement

5.2.2.1 Notification

The community engagements were face-to-face interactions. Upon arrival in a community the community relations team from GEGL contact the stakeholders via telephone calls to their community representatives and community leadership structures.

5.2.2.2 Invitations and presentation

Invitations were extended through the regional government and community representatives. The invitation request was through letters and follow-up telephone calls. Mobilisation requests were made progressively as the meetings were conducted from one area to the next. Mobilisation took place one week before the engagement date.

5.2.3 Outcome of Consultation

The issues and concerns raised during the various meetings were noted, responses were given, and the comments and responses included in the attached comments and responses report.

Table 25: Stakeholder Engagement List

Date	Group Engaged	Venue	No of Participants
28 October 2021	Prestea Police Commander	Prestea Police Station	1
29 October 2021	Fire Commander	Prestea Fire Station	1
09 November 2021	Leaders of Brumasi Community	Community Centre	7
30 November 2021	Prestea-Huni Valley Municipal Assembly	Prestea Huni-Valley Assembly	11
23 February 2022	Ghana National Gas Company	Virtual Meeting (Microsoft Teams)	9
	TOTAL No. of Participants		29

The consultation process identified a range of potential social, environmental and economic impacts and benefits of the project. Even though feedback varied from each stakeholder group, some consistent themes emerged. A summary of the comments raised by the stakeholders is presented in the following sections:

5.2.3.1 Summary of key issues raised

- **Public education:** The stakeholder wanted GEGL to increase its public education on natural gas and pipeline safety to allay any fears or concerns that people may have.
- **Compensation:** The stakeholders wanted to urge GEGL to ensure that all compensations were paid in a timely manner through their residence representatives.

- **Benefit of the liquefaction facility to the community:** Stakeholders wanted to know the benefits the project would bring to their community.
- **Employment and training:** Stakeholders wanted to know the available employment opportunities associated with the project and whether training would be provided to the PACs to enable them to qualify for employment.

The detailed stakeholder engagement report and comments and responses report are attached in APPENDIX C.

6.0 IMPACT IDENTIFICATION AND PREDICTION

In this chapter, potential impacts that could occur from the implementation of the project are described and evaluated with respect to significance prior to and following implementation of mitigations. The various impacts identified (both positive and negative) on the physical, biological and the socio-economic environment of the project area and beyond are discussed by project construction and operational phases). Where possible, impacts are quantified by comparing the predicted effect to established standards or criteria or through comparison with baseline conditions.

Impacts were initially identified by evaluating the various activities to be undertaken during each phase of the project and reviewing the comments from the various stakeholders engaged for the project. Details on the engagements and feedback received from the stakeholders are provided in Chapter 5.0. These impacts were augmented by those identified by specialists, who reviewed the various aspects of the Prestea GCP and 6.5km natural gas pipeline project and operational aspects considering their areas of expertise.

A summary of the project impacts is provided in the following sections. Furthermore, an evaluation of cumulative impacts is provided, considering reasonably foreseeable activities within the project area.

6.1 Impact Identification Methodology

Each of the impacts identified through engagements with stakeholders as well as those identified by the specialists was assessed, to establish the significance of the effect on a particular resource area and/or local or regional residents. This effect was evaluated relative to its magnitude, extent, duration and ultimately its significance during the construction and operation phases of project development. The findings from these analyses were compared to quantitative criteria, when possible, to assist in determining the significance of the impact. For resource areas where such numeric impacts could not be established (e.g., impact to socio-economic), the specialists either described the impact or applied their professional judgment in establishing, qualitatively, the degree of impact.

However, this impact assessment is presented in a narrative form, as required by the EPA, in presenting the results of the analyses (based on their magnitude, duration, and scale) of the specific impacts occurring during each of the project phases.

6.2 Impacts Assessment for the Prestea GCP and Liquefaction Facility

In assessing impacts, the specialists evaluated potential effect to social values of the communities proximal to the project area. In some cases, the specialists determined that it was vital to assess worst-case scenario, using the outcome to help develop appropriate mitigations measures. The general objective of the impact assessment was to describe impacts and, when possible, predict the significance of the impacts associated with the project to inform the mitigation measures that would need to be implemented to avoid, minimise, or reduce negative impacts and enhance positive impacts associated with the project. The specific objectives were as follows:

- Apply discipline-specific impact analysis methods (including predictive modelling, where warranted) to evaluate each of the potential impacts identified to determine their magnitude, extent, duration and, ultimately, significance.
- Formulate mitigation measures to reduce the significance of the impact to acceptable risk levels (including regulatory requirements and baseline values).
- Discuss and assess the significance of cumulative effects for each impact, where applicable.
- Assess the significance of residual impacts and where possible to inform compensation.

6.2.1 Soil

The key soil aspects that will be affected due to the project activities for the project phases are as described below.

Degradation of soil quality and change in land capability:

Land degradation means that the soil has lost the capacity to function within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water quality, and support human health and habitation (Maxmillian, *et al*, 2019). The vegetation removal and soil disturbance expected during the construction phase could result in the disruption of the nutrient cycling process in the soil, i.e., the source of organic matter (vegetation, debris) is removed with a subsequent reduction in soil biodiversity and distortion in soil aggregate stability. In a worst-case scenario, the project activities could sterilise the soil, which could affect the land capability of the soil. Construction activities are anticipated to be for a short-term and there will be concurrent rehabilitation, and therefore the restoration of soil aggregate stability could be quicker.

Loss of soil as a resource:

The project will involve the excavation of soil material to enable the laying of the pipeline and the construction of other project facilities. These could result in the loss of soil, particularly topsoil. The boreholes and test pit dug on and near the proposed power plant site show that the topsoil is between 20cm and 30cm deep. Although topsoil will be lost from the site during the construction phase, it can potentially be transferred to an alternative area for continued cultivation or stockpiled and reused.

Therefore, during the construction phase, the significance of the impact is assessed to be high, but it is anticipated that the topsoil can be transferred and reused elsewhere which reduces the impact of one low significance. No further impact on the soil and land use is anticipated during the operational phase.

Change in surface profile:

To create platforms for development of the plant, the surface profile of the sites will be changed during the construction phase. This will affect water flow, sedimentation, and erosion patterns. This impact cannot be mitigated against and therefore assessed to be of high significance.

Land use change:

The proposed development activities will result in a change in current land use from artisanal mining and farmlands during the construction and operational phases. This impact is assessed to be high since the loss of the project site for farming cannot be mitigated and operations could be for a period of over 50 years.

Soil contamination from hydrocarbon and other chemical spills and improper disposal of waste:

The contamination of soil from hydrocarbon spillages associated with machinery used for construction activities will likely occur since the machinery used rely on fuels. Contamination is anticipated to occur in areas for the construction of project infrastructure and access roads. Improper disposal of waste could also result in the contamination of soil during the construction and operational phases. Overall, the impact is assessed to be medium, however the implementation of recommended mitigation measures will reduce it to low.

Soil loss through erosion:

Despite the soil forms identified at the site not being highly erosive soils, development of the proposed plant area will lead to some erosion during the construction and operational phases. The soil which was initially covered with vegetation would be exposed resulting in the increased potential for soil erosion, especially if the soil is left bare during the wet season. Non-vegetated soil stockpiles will be prone to wind and water erosion. Due to earthwork activities, it is anticipated that the soil characteristics controlling soil erodibility (i.e., soil organic

matter content, structure, and permeability) are likely to be altered. The impact is assessed to be high, however, it is anticipated that the implementation of recommended mitigation measures could result in a low impact.

Soil compaction:

Some soil compaction is anticipated to occur during the construction activities and the operational phases from the use of equipment and movement of vehicles. Although compacted soils could be ripped after decommissioning of the project infrastructure, the soils will never regain their original structure. This impact is therefore assessed to be high during the construction phase, however, it is anticipated that the implementation of appropriate mitigation measures could minimise the effect of the impact to medium.

6.2.2 Air Quality

6.2.2.1 Emission Estimation

An emission factor is a value representing the relationship between an activity and the rate of emissions of a specified pollutant. These emission factors are developed based on test data, material mass balance studies and engineering estimates. Emission rates for the proposed activities associated with the project operations were calculated using GEGL data and the USEPA AP-42 Chapter 13.2.3: Heavy Construction Operation.

Construction Phase Assessment

TSP emissions generated by general construction activities, were calculated using the following equation:

$$E_{TSP} = 2.69 \text{ tons/ha/month of activity}$$

The emission factor relates the tons of TSP emitted per hectare covered by construction activities per month of activity. Based on the USEPA particle size distribution data, PM₁₀ and PM_{2.5} constitute 35% and 5.3% of TSP, respectively. A control efficiency of 50% has been applied for wetting during the construction activities.

It must be noted that the estimation of emissions from construction activities are erratic in nature and emissions calculated may be higher than what will be experienced in reality. As such, the construction phase has only been semi-quantitatively assessed and is presented in Table 26.

Table 26: Calculated emission rates for the construction phase of the proposed GCP operations

Location	Emission Rate (g/m ² /s)		
	TSP	PM ₁₀	PM _{2.5}
Construction phase activities for the GCP operations	5.19E-05	1.82E-05	2.75E-06

Operational Phase Assessment

Emissions from the proposed operations have the potential to arise from the following sources:

- Generators
- Heat Oil System

Importantly, the following was considered:

- Emissions as a consequence of line losses from the pipelines is considered to be negligible due to the piping connections likely to be welded and thus enclosed
- Emissions from the storage tanks and loading/unloading of tanks to the GCP is considered to be negligible as tanks are small with a total capacity of only 141 m³. Additionally, the loading of tanks from trucks is enclosed

- Emissions from the flare will only be used for emergency cases and will be intermittent, short-lived and has thus been excluded from this assessment as this is not considered to be normal continuous operations

Stack Emissions

Emission rates from the stacks were calculated based on data obtained from GEGL. Table 27 and Table 28 presents the parameters and subsequent emission rates.

Table 27: Source parameters for the point sources of the proposed GCP operations

Source Name	Stack Height (m)	Stack Diameter (m)	Gas Exit Temperature (°C)	Actual Gas Volumetric Flow (m ³ /s)	Gas Exit Velocity (m/s)
Natural Gas Generator (one operating and one on standby)	12	2.36	514	69.32	15.85
Natural Gas Hot Oil System 1	6	0.3048	388	8.71	119.42
Natural Gas Hot Oil System 2	6	0.3048	388	8.71	119.42

Table 28: Emission rates for the point sources of the proposed GCP operations

Pollutant	Emission Limit (mg/Nm ³)	Emission Rate (g/s)
Natural Gas Generator 1		
TSP ¹	-	-
PM ₁₀ ¹	-	-
PM _{2.5} ¹	-	-
NO ₂	513	12.34
SO ₂ ¹	-	-
CO	62	1.49
VOCs	17	0.41
Natural Gas Hot Oil System 1 and 2		
TSP	121.6	0.44
PM ₁₀	96.1	0.35
PM _{2.5}	54.7	0.20
NO ₂	800	2.88
SO ₂	9.60	0.08
CO	1 344	4.84
VOCs	264	0.95

Notes: The fuel composition for the generator contains no particulates or sulphur content (given that the fuel is natural gas), which results in negligible emissions being emitted into the atmosphere

6.2.2.2 Dispersion Modelling

Dispersion modelling is an effective tool for predicting the ambient air concentrations from pollutants emitted to the atmosphere from a variety of processes.

As per the South African Regulations Regarding Air Dispersion Modelling (2014) (to complement the Ghana Standards Authority standards: GS 1236:2019), this assessment was considered a Level 2 assessment as emissions were from sources where the greatest impacts were in the order of a few kilometres (less than 50 km), downwind. As such, the AERMOD modelling software was used to determine likely ambient air pollutant concentrations from the proposed operations, for comparison against ambient air quality standards. The AERMOD modelling software calculated likely changes in dispersion plume trajectory and concentrations in response to changes in local terrain, meteorology, and source data. Model inputs were verified before the model was executed.

Data input into the model included modelled WRF meteorological data with wind speed, wind direction, temperature, pressure, precipitation, cloud cover and ceiling height for January 2018 to December 2020. Terrain data at a resolution of 90 m (SRTM3) was also input into the model. The modelling domain is provided in Table 29.

Table 29: Modelling domain coordinates for the proposed GCP operations

Domain Point	UTM East (m)	UTM North (m)
North-Eastern Point	622696.46	630228.97
South-Western Point	572659.76	580096.48

Modelling Scenarios

Only one modelling scenario was modelled:

- All proposed activities for the Prestea GCP operations.

Model outputs for the above scenarios were generated as follows:

- Long term averages: Refers to the predicted annual average outputs, which is calculated by averaging all hourly concentrations
- Short-term averages: Refers to the predicted 100th percentile or 99th percentile (P99) 24-hour average outputs. The P99 is required as per the PM ambient air quality guidelines and makes allowance for exceedances, eliminating outliers

It must be noted that ambient air quality objectives were applied to areas beyond the facility boundary but within the facility boundary, occupational health and safety criteria need to be applied.

Operational Phase Assessment

The results of the atmospheric dispersion modelling conducted for the operational phase of the proposed operations for TSP, PM₁₀, PM_{2.5}, NO₂, SO₂, CO and VOCs are presented in the following sections. Importantly, in the absence of a VOC standard or international guideline, all predicted VOC concentrations have been assumed to comprise 100% of C₆H₆ as a worst-case scenario (and in the absence of a VOC composition). Given that the C₆H₆ standard is the most stringent standard for VOCs, VOCs have thus been compared to the annual standard of C₆H₆.

Results at key sensitive receptors and the highest offsite concentrations are presented in Table 30. Comparison of the predicted concentrations was made with the GS 1236:2019 and IFC guidelines to determine compliance.

Predicted Concentrations

- Predicted concentrations were below their relevant ambient air quality standards at all sensitive receptors for all pollutants assessed.
- Predicted concentrations were below their relevant ambient air quality standards for the highest offsite concentration across the modelling domain for most pollutants assessed, with the exception of the NO₂ 1-hour and annual averaging periods. The highest offsite concentration for the NO₂ annual averaging period only slightly exceeds the ambient air quality standard by 0.38 µg/m³ which is not significant. Furthermore, no sensitive receptors are located where the highest offsite NO₂ concentration occurs for both the 1-hour and annual averaging period.

During the construction and decommissioning and closure phases of the Prestea GCP project, impacts are expected to be of medium significance, whilst during the operational phase impacts are anticipated to be low with mitigation measures in place. Without mitigation, impacts are predicted to exacerbate slightly.

Table 30: Predicted concentrations for the proposed GCP operations (exceedances are highlighted in bold red)

ID	Name	TSP		PM ₁₀		PM _{2.5}		NO ₂			SO ₂		CO			VOCs
		24-hour	Annual	24-hour (P99)	Annual	24-hour (P99)	Annual	1-hour	24-hour (P99)	Annual	1-hour	24-hour (P99)	1-hour	8-hour	24-hour (P99)	Annual
Ambient Air Quality Standard		150¹	80¹	45²	15²	15²	5²	200²	25²	10²	520¹	40²	30 000¹	10 000^{1,2}	4 000²	5¹
SR1	Anomabu	0.089	0.003	0.044	0.0024	0.025	0.0014	8.86	0.44	0.06	0.247	0.010	14.95	2.54	0.62	0.007
SR2	Asuohiami	0.051	0.001	0.007	0.0004	0.004	0.0002	7.80	0.26	0.04	0.222	0.002	13.54	1.69	0.12	0.001
SR3	Heman	0.225	0.002	0.034	0.0019	0.019	0.0011	17.06	0.64	0.10	0.472	0.008	28.59	5.66	0.49	0.006
SR4	Prestea	0.136	0.001	0.021	0.0011	0.012	0.0007	13.02	0.49	0.08	0.378	0.005	22.90	3.42	0.32	0.004
SR5	Prestea Huni Valley District	0.166	0.014	0.077	0.0113	0.044	0.0064	13.85	0.82	0.16	0.384	0.018	23.23	4.59	1.08	0.033
SR6	Tarkwa Breman	0.235	0.005	0.052	0.0041	0.030	0.0023	18.38	0.50	0.07	0.484	0.012	29.42	7.78	0.74	0.012
Highest Offsite Concentration		5.71	1.22	2.09	0.97	1.19	0.55	314.37	22.56	10.38	8.77	0.48	530.62	178.04	29.46	2.72

Notes:

1. GSA Standard
2. IFC guideline

6.2.3 Noise

Construction Phase Assessment

Given that the construction phase of the proposed GCP operations will be short and transient in nature, a semi-qualitative assessment was undertaken for this phase (i.e no modelling required as impacts are short-lived). As such, attenuation-over-distance acoustic calculations were undertaken (the equation below) to calculate the sound power level (PWL) using the sound pressure level (SPL) of the noisy equipment, as provided by the GEGL, and the distance (r) from the source.

$$PWL = SPL - 10 \log \frac{2}{4\pi r^2}$$

As a conservative approach, the PWL from all construction equipment operating concurrently, was logarithmically summed together to obtain a cumulative PWL for the construction phase. Further, during the construction phase the equipment will be mobile, with no set location at any one point in time. It is assumed that the equipment used concurrently will be at a location on the project area in closest proximity to each sensitive receptor. The full list of equipment is presented in APPENDIX C **Error! Reference source not found.** The list of equipment as well as the PWL of the equipment used simultaneously is given below in Table 31.

Table 31: Construction phase equipment and sound power level ratings during the daytime from the proposed GCP operations

Equipment	No. In Operation (simultaneously)	Operational Hours per Day	Sound Power Level (dB(A)) per unit
Heavy machinery	1	8	109
Electric gensets	1	24	103
Motorcycle welders	1	10	119
Lighting equipment	1	8	123
Polishing machines	1	16	113
Manual assembly activities	1	16	113
Telescopic cranes	1	10	119
Personnel vehicles	1	16	119
Trucks	1	8	123
Water pumps	1	4	116
Logarithmic Total			129

Table 32: Construction phase equipment and sound power level ratings during the night-time from the proposed GCP operations

Equipment	No. in Operation (simultaneously)	Operational Hours per Day	Sound Power Level (dB(A)) per unit
Electric gensets	1	24	103
Polishing machines	1	16	113
Manual assembly activities	1	16	113
Personnel vehicles	1	16	119

Equipment	No. in Operation (simultaneously)	Operational Hours per Day	Sound Power Level (dB(A)) per unit
Logarithmic Total			121

As a conservative approach the cumulative PWL of 129 dB(A) and 121 dB(A) (Table 31) from all construction equipment operating concurrently during the day-time and night-time, respectively were used to determine the resultant noise levels at various distances from the source (Figure 18). From 2 km during the daytime and 2.5 km during the night-time from the source, noise levels will drop to below the IFC residential daytime and night-time guideline rating levels of 55 and 45 dB(A), respectively.

Predicted impacts and resultant noise levels during the day and night times at the key noise receptors are presented in Table 33 and Table 34.

During the daytime increases in noise levels (i.e from baseline noise levels) as a result of the construction activities are below the 3 dB(A) threshold for annoyance as per the IFC Noise Regulations at all receptor locations, with the largest change predicted at SR3 (Heman). Noise receptors are likely to experience noise levels that will be absorbed into the existing environment.

During the night-time increases in noise levels as a result of the construction activities are below the 3 dB(A) threshold for annoyance as per the IFC Noise Regulations at most receptor locations, except for SR3. Increases in noise levels are likely to result in sporadic complaints at this location, given the proximity of the location in relation to the proposed construction activities. The remaining noise receptors are likely to experience noise levels that will be absorbed into the existing environment.

Therefore, during the construction phase for the project, noise impacts are likely to be short-lived and transient in nature, resulting in an impact of low significance with mitigation in place.

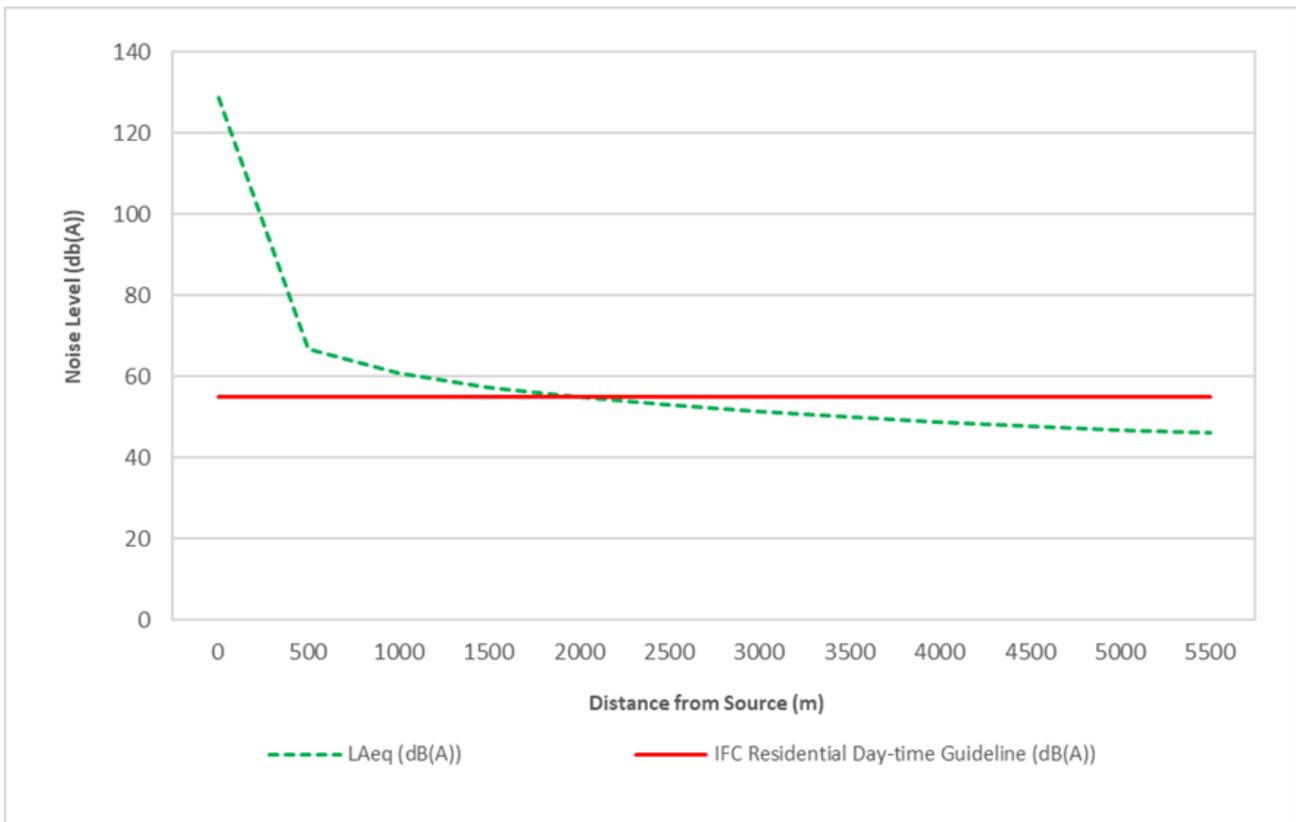


Figure 18: Predicted day-time noise levels with distance during the construction phase of the proposed GCP operations

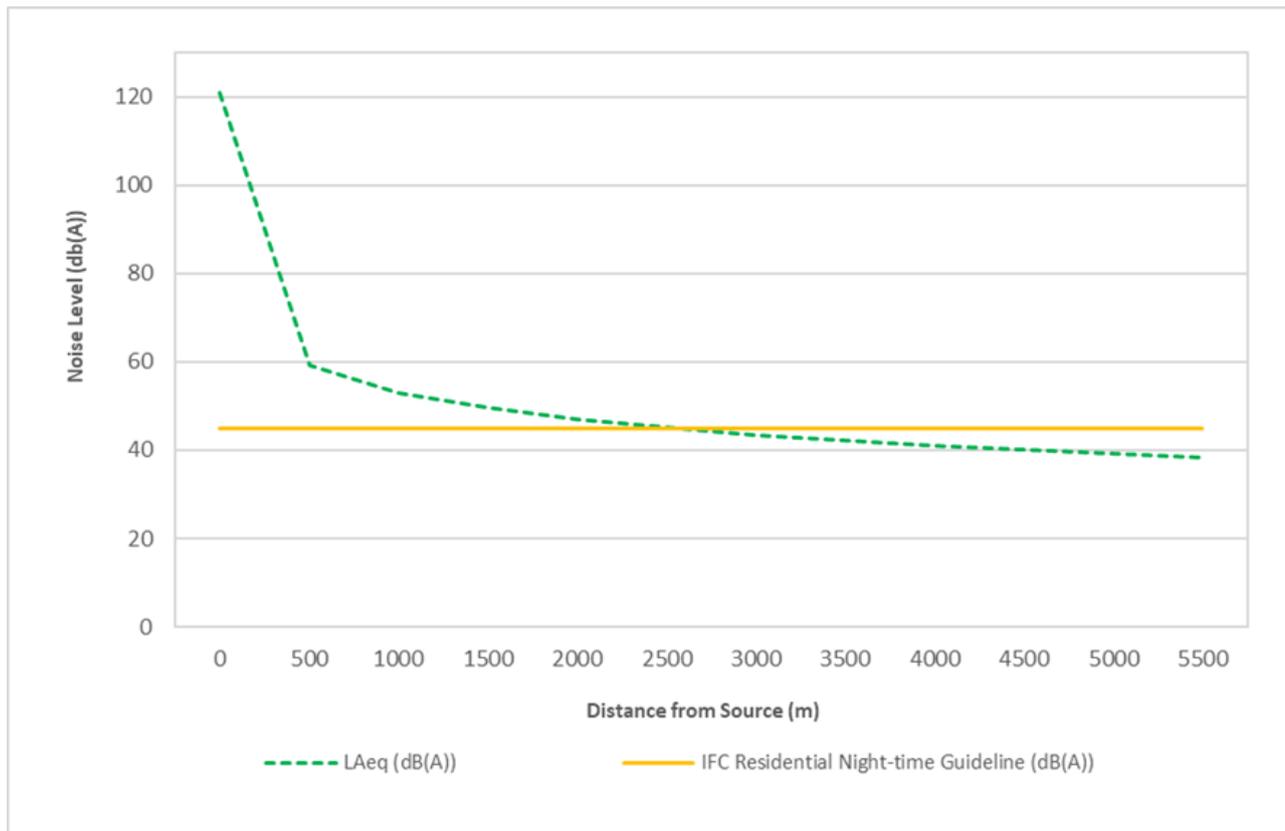


Figure 19: Predicted night-time noise levels with distance during the construction phase of the proposed GCP operations

Table 33: Predicted day-time noise levels at the receptors during the construction phase of the proposed GCP operations

Receptor ID	Distance from Prestea Boundary (m)	Predicted Noise Level (dB(A))	Existing Day-time Noise Level (dB(A))	Cumulative Noise Level (dB(A))	Change (dB(A))	Above or Below 3 db(A) Change
SR1	5.26	46.5	55.0	55.6	0.6	Below
SR2	7.99	42.9	55.0	55.3	0.3	Below
SR3	2.27	53.8	55.0	57.5	2.5	Below
SR4	3.45	50.2	55.0	56.2	1.2	Below
SR5	5.24	46.5	55.0	55.6	0.6	Below
SR6	9.46	41.4	55.0	55.2	0.2	Below

Table 34: Predicted night-time noise levels at the receptors during the construction phase of the proposed GCP operations

Receptor ID	Distance from Nearest Source (m)	Predicted Noise Level (dB(A))	Existing Night-time Noise Level (dB(A))	Cumulative Noise Level (dB(A))	Change (dB(A))	Above or Below 3 db(A) Change
SR1	5.26	38.6	45.0	45.9	0.9	Below
SR2	7.99	35.0	45.0	45.4	0.4	Below
SR3	2.27	45.9	45.0	48.5	3.5	Above
SR4	3.45	42.3	45.0	46.9	1.9	Below
SR5	5.24	38.7	45.0	45.9	0.9	Below
SR6	9.46	33.5	45.0	45.3	0.3	Below

Operational Phase Assessment

CadnaA (Computer Aided Noise Abatement) has thus been used to assess noise levels for the proposed GCP operations. Table 35 presents the noise sources that were identified and modelled during the operational phase of the project together with the number in operation and PWL, as per GEGL data and/or the modelling database, that were utilised in the noise model. The operational activities are assumed to be operational 24 hours/day, 7 days a week, as provided by GEGL.

Table 35: Operational phase equipment and sound power level ratings during the day/night-time from the proposed GCP operations

Equipment Item	Number of Items	Sound Power Level (dB(A)) per unit
Module 01 Gas Pre-treatment		
Control valves	5	105
Compressors	2	114
Pumps	4	116
Air coolers	2	133
Module 02 Cryogenic Separation		
Control valves	6	105
Compressors	2	114
Pumps	2	116
Air coolers	4	133
Module 03 Fractional Separation		
Control valves	12	105
Compressors	8	114
Pumps	8	116
Air coolers	16	133
Module 04 Services		

Equipment Item	Number of Items	Sound Power Level (dB(A)) per unit
Control valves	8	105
Compressors	6	114
Pumps	16	116
Electric generators	16	116
Module 05 Sales Gas		
Control valves	2	105
Compressors	2	114
Air coolers	2	133
Module 06 Storage & Transfer		
Control valves	7	105
Pumps	14	116
PSVs	7	105

Predicted impacts and resultant noise levels during the day-time and night-time at key noise receptors are presented in Table 36 and Table 37, with the predicted noise contour illustrated in Figure 20. Please note that only one map is shown for both daytime and night-time as noise levels are identical during both times, given that all equipment is operational for 24 hours a day.

Increases in daytime and night-time noise levels at all noise receptors as a result of the operational activities are negligible. As such, it is likely that the noise levels from the proposed GCP operations will be absorbed into the existing ambient environment and will not contribute significantly to the current existing noise levels.

Based on the above, during the operational phase, noise impacts are predicted to be of a low significance with mitigation in place, as the impacts are within the site.

Table 36: Predicted day-time noise levels at the receptors during the operational phase of the proposed GCP operations

Receptor ID	Distance from Prestea Boundary (m)	Predicted Noise Level (dB(A))	Existing Day-time Noise Level (dB(A))	Cumulative Noise Level (dB(A))	Change (dB(A))	Above or Below 3 db(A) Change
SR1	5.26	-	55.0	55.0	0	Below
SR2	7.99	-	55.0	55.0	0	Below
SR3	2.27	-	55.0	55.0	0	Below
SR4	3.45	-	55.0	55.0	0	Below
SR5	5.24	-	55.0	55.0	0	Below
SR6	9.46	-	55.0	55.0	0	Below

Table 37: Predicted night-time noise levels at the receptors during the operational phase of the proposed GCP operations

Receptor ID	Distance from Prestea Boundary (m)	Predicted Noise Level (dB(A))	Existing Night-time Noise Level (dB(A))	Cumulative Noise Level (dB(A))	Change (dB(A))	Above or Below 3 db(A) Change
SR1	5.26	-	45.0	45.0	0	Below
SR2	7.99	-	45.0	45.0	0	Below
SR3	2.27	-	45.0	45.0	0	Below
SR4	3.45	-	45.0	45.0	0	Below
SR5	5.24	-	45.0	45.0	0	Below
SR6	9.46	-	45.0	45.0	0	Below

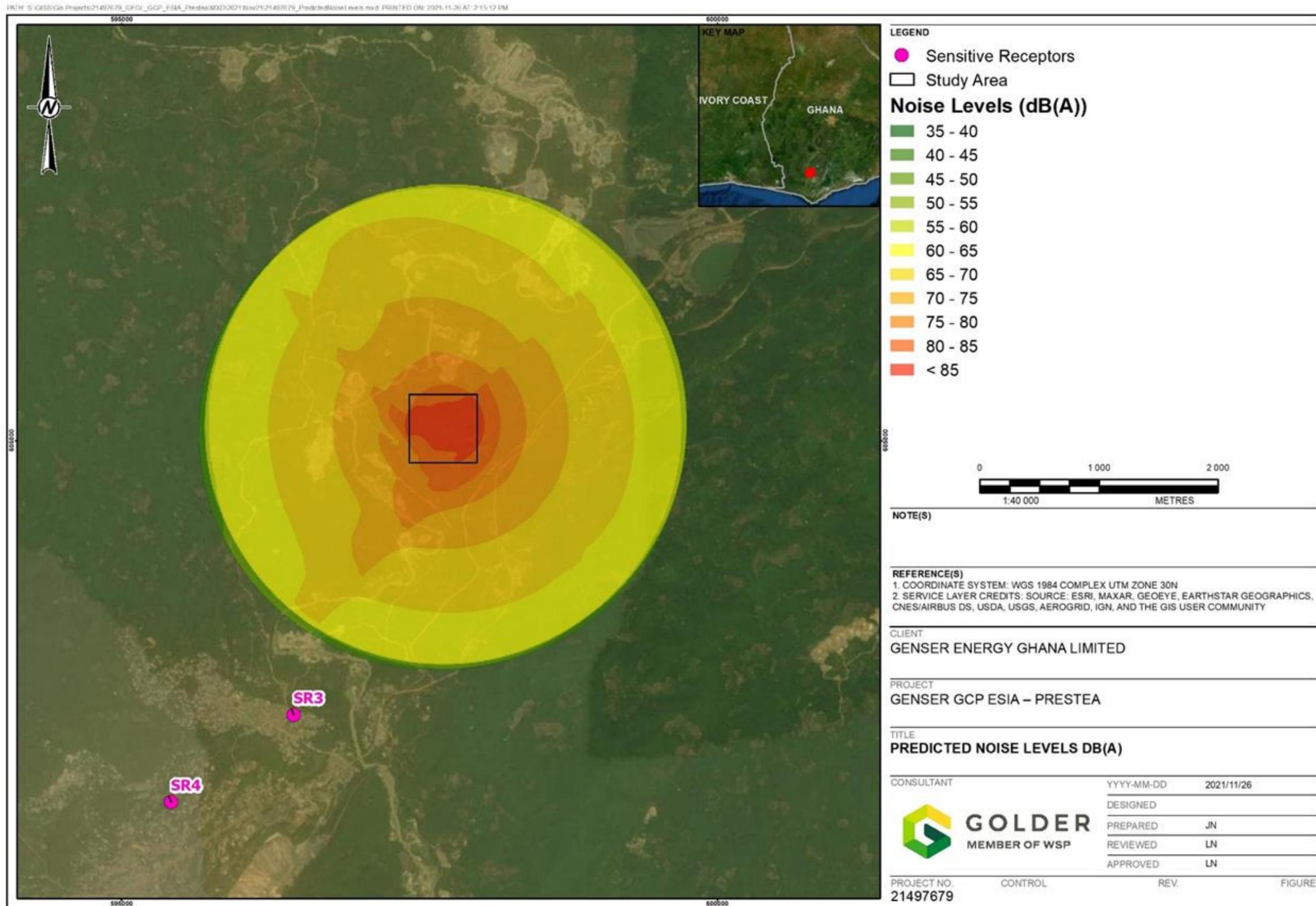


Figure 20: Predicted noise levels during the day/night-time for the proposed GCP operations

6.2.4 Surface Water

Construction Phase Assessment

The main construction phase activities that will impact the water courses will be the clearing of the area in which infrastructure will be constructed. The slope is towards the Ankobra River all around the site. In this case if erosion protection is not put in place, there may high sediment run-off to the river will could impact the banks and the bed of the river.

In addition, the use of earthmoving equipment may lead to hydrocarbon spills that could also be washed into the water resources.

These activities can have an impact on those communities who have a direct reliance on the water resource for domestic and subsistence agricultural needs as well aquatic ecosystem health.

Sedimentation of water bodies due to site clearing and earthwork activities

The process of site clearance will result in disturbance to the area, loosening soil and potentially resulting in erosion and high sediment loads to the river. Without mitigation, the magnitude of the impact is likely to be low considering the gradual slope and distances to the river, the duration is expected to be short-term, and the impact will be local. Therefore, the overall significance of the impact is considered to be low.

Water contamination from hydrocarbon spills from mechanical equipment to the soil around the excavation with the potential to be washed downstream as the water flows through the construction site

The use of machines and equipment for excavation could result in the contamination of the soil and this has the potential to be washed downstream into water bodies from runoff. The magnitude is expected to be low considering the gradual slope and distances to the river, with the duration very short term (immediate) and the scale would be local, so that the significance is low.

Operational Phase Assessment

During the operation of the facility, it is not expected that there will be any further impacts, however hydrocarbon spills may occur, and contaminated water potentially be washed to the Ankobra River. It is anticipated that the mitigation measures outlined for the construction phase could be relevant.

6.2.5 Groundwater

Construction Phase Assessment

Contamination of groundwater due to leakages and spillages from vehicles and equipment

During the construction phase, there is a potential for groundwater quality to be impacted as a result of surface or shallow subsurface releases from accidental spillages or inappropriate disposal of hydrocarbons from heavy equipment. Vegetation clearance could also create preferential pathways for the infiltration of leaked or spilled fuel into the shallow groundwater system. This impact is considered to be of medium, without mitigation. It is anticipated that the implementation of appropriate mitigation measures will reduce the impact to low.

Operational Phase Assessment

During the operational phase it is anticipated that hydrocarbon spills could occur, and this could infiltrate the soil to contaminate the groundwater resource. It is anticipated that the mitigation measures outlined for the construction phase will be applicable during this phase.

Acidification of groundwater and dissolution of trace metals

The potential leaks of natural gas at the pipe joints could result in the release of CO₂ and methane into the shallow aquifer system which may dissolve into groundwater and decrease aqueous pH resulting in subsequent acidification and dissolution of trace metals in solution. This impact is considered to be medium given that the pipeline will be monitored for prompt response in the case of any leakage.

6.2.6 Visual Amenity

Landscape changes that will take place within which the project area and the receptors potentially affected by it are discussed herein. The discussion takes into consideration the level of visibility of the project components, their degree of visual intrusion, and the potential impacts to receptors (people) relative to the visibility of the project.

Potential visual impacts that may occur during the construction and operational phases of the Prestea GCP project are described below. These two phases have been for purposes of this analysis owing to the similarity of impacts, although potentially of varying magnitudes.

Construction and Operational Phases Assessment

Reduction in visual resource value due to presence of project infrastructure, construction machinery and associated material storage and laydown areas

The proposed Prestea GCP and associated facilities will cover approximately 40 hectares with a height infrastructure being approximately 20 m. The project infrastructure could be visible from sensitive receptors close to the project area. The project infrastructure could also be visible from various points along access roads in the area.

The Prestea GCP will consist of various components of geometric shapes that will contrast sharply with the existing visual context, both in form and colour. Existing vegetation may block the view of this infrastructure from certain vantage points, making the impact much less.

Predicated on these metrics, the significance of construction related activities is assessed to be of low significance. The impact was not further assessed as the project infrastructure presents technological/functionality constraints for the implementation of practical mitigation measures.

Formation of dust plumes as a result of construction activities (e.g., earthworks)

During the construction and operational phases, especially during dry and windy conditions, it is expected that activities on site will result in airborne dust plumes. These dust plumes may be visible over great distances. Dust plumes are often one of the more socially objectionable impacts associated with construction activities, due to the associated potential health risks, the nuisance factor, and degradation of the visual amenity value of the surrounding landscape. The visual impact associated with dust plumes is especially relevant in a greenfield setting, such as the Prestea GCP project site.

This impact is assessed to be low during both phases and it is anticipated that the implementation of the appropriate measures will render the impact negligible.

Light pollution at night:

Light pollution will primarily be associated with the GCP and surrounding infrastructure, created by fixed lighting systems. Lighting during operations and vehicle lights will also increase light pollution at night. As with dust plumes in the daytime, light pollution during the night-time can be a highly objectionable impact in rural landscapes where they are not used to large scale developments.

The impact of artificial lighting is assessed to be of low significance. GEGL will direct the light plants only on the features that require such illumination to provide for a safe working environment.

6.2.7 Biodiversity

Although all species and habitats occurring within an area of interest form a component of the overall biodiversity and ecological value, it is neither practical nor necessary to assess potential effects of a project on every species/habitat that might be affected. Therefore, species and ecosystems of conservation concern confirmed or considered likely to occur within the project area, were considered as receptors for impact assessment.

The flora and fauna species and ecosystems of concern identified as receptors/valued components for the impact assessment are summarised in Table 38.

Table 38: Flora and fauna receptors for impact assessment

Category	Sub-category	Receptors
Ecosystems of concern	Natural habitats	Ankobra River Freshwater swamp
Plant SoCC	Plants with black/blue/gold national status	<i>Mapania baldwinii</i> <i>Millettia thonningii</i> <i>Mussaenda chippie</i> <i>Xylopia aethiopica</i> <i>Elaeis guineensis</i> <i>Sterculia rhinopetala</i>
Fauna SoCC	Nationally protected species (Schedule I of the WCR- Wholly Protected)	Red-necked buzzard Black goshawk Black kite Cattle egret
	CITES species	Red-necked buzzard Black goshawk Black kite

Construction Phase Assessment

A greater portion of the project area is dominated by secondary forest habitat and farmlands. Potential impacts on biodiversity associated with the construction phase for the Prestea GCP relates to vegetation clearing, topsoil removal, excavation, placement of GCP infrastructure, noise and vibrations and increased human presence. The construction phase will result in the loss of modified habitat, disturbance of natural habitat (freshwater swamp and Ankobra river) as well as the disturbance of flora and fauna species of national conservation concern.

Loss/disturbance of ecosystems of concern

The clearing of vegetation and removal of topsoil during the construction of the GCP will result in the loss of the remaining secondary forest habitat and disturbance of freshwater swamp within the project area. Although these habitats are slightly to moderately degraded, they support flora and fauna species of national conservation concern, including nationally protected tree and bird species.

The magnitude of the impact is considered moderate, due to the degraded nature of the secondary forest in the project area. This impact is considered to be of local extent as vegetation clearing and disturbances will be site based. This impact is expected to be of long-term duration and is of medium significance before the implementation of mitigation measures. With the implementation of recommended mitigation measures, the impact can be reduced to low.

Loss of flora species of national conservation concern

The clearance of vegetation in advance of construction work will result in direct loss of flora species of national conservation concern that occur within the project area. The magnitude of the loss of these species in the project area is considered moderate as these species occur throughout the project site. The loss of these species will occur at the local extent and will be permanent. The impact significance is considered medium prior to mitigation and can be reduced to low by the implementation of the recommended mitigation measures.

Disturbance/contamination of aquatic ecosystems

Although the GCP project footprint does not necessarily intersect any natural water courses, it is located within 500 m of the Ankobra River. Therefore, activities within the project area can have an indirect impact on surrounding watercourses.

The Surface Water Baseline Report (Golder, 2022) states that the Ankobra River is highly turbid and is significantly impacted by artisanal mining activities. The magnitude of the potential contamination of this system with sediments during the construction of the GCP project infrastructure is therefore considered to be low, and of medium-term duration, ceasing with the end of the construction phase. The extent of the potential impact is considered local, resulting in a low impact significance prior to the implementation of the required mitigation measures. A low/negligible impact significance can be maintained by the implementation of mitigation measures.

Erosion

Vegetation clearing and soil disturbance may leave disturbed areas vulnerable to erosion. Construction laydown areas and new road access routes will create hardened surfaces in the project area which will leave the project area more susceptible to erosion through increased runoff.

The potential impact of erosion on adjacent habitats is considered to be of moderate magnitude, which extends to a local extent and lasting for a medium-term (ceasing with construction). The impact is anticipated to be low. With the implementation of mitigation measures, particularly limiting vegetation removal to the infrastructure footprint and revegetation of disturbed areas, the impact significance will remain Low/negligible.

Use of herbicides and pesticides

Harsh chemical control measures used during site clearance activities can have negative impacts on non-target plant species and the environment. The magnitude of this impact is considered moderate because chemical drift can result in damage to non-target plants and animals. Over time, the vegetation of the project site and its footprint will change because of residual chemicals in the soil. Chemical usage in weed and pest control is probable and long-term activity that will last throughout the construction and operational phases of the project, resulting in an impact of medium significance prior to mitigation measures. With the successful implementation of the recommended mitigation, the significance of this impact is expected to decrease to very low/negligible.

Introduction of alien and invasive species

During the construction phase, the introduction of exotic vegetation or the invasion of disturbed areas by exotic vegetation through either a physical vector (e.g., movement of machinery, vehicles, etc.) or dispersion vectors (e.g., wind, birds) is possible.

For ecosystems of concern and associated flora SoCC, the magnitude of the impact could be moderate prior to mitigation, potentially extending beyond the immediate site footprint, and would likely persist for the duration of construction and operation activities, resulting in an impact of high significance prior to mitigation. With the application of recommended mitigation measures the impact can be reduced to low environmental significance for both ecosystems and flora species of concern.

Loss and disturbance of fauna SoCC

Vegetation clearance for construction of the Prestea GCP project infrastructure will result in the loss of habitat for species of conservation concern and could cause fatalities to individuals of species of concern, particularly mammals and herpetofauna; injuries or mortalities of fauna species could also be sustained as a result of collisions with vehicles travelling in the construction area. In addition, indirect effects due to the presence of people and heavy machinery, associated noise and vibration, and site lighting at night, may impact faunal species of conservation concern in unaffected habitats adjacent to the project area. The direct construction activities as well as the indirect disturbance by people and machinery could create a barrier to movement and dispersal of faunal species of conservation concern, particularly (ground-dwelling) mammals and herpetofauna.

The magnitude of the potential loss and disturbance of species of conservation concern is considered moderate. Although the project area is largely characterized by relatively common habitat generalists and disturbance-tolerant species that have persisted through the habitat-degrading and habitat-altering human activities in the landscape, any loss or disturbance of these species could result in impacts of moderate magnitude that would be at least long-term.

The extent of loss of species of national species of conservation concern is assessed at a local scale, within the project footprint, and the potential losses will be at least long-term. The impact prior to mitigation is medium. With the application of the recommended mitigation measures for employee management, prevention of hunting, and rehabilitation/re-vegetation activities the duration of the impact may be confined to the construction phase, or medium-term only, and the magnitude reduced, resulting in a residual impact of low significance.

Operational Phase Assessment

The operation of the GCP project is anticipated to have a reduced impact on biodiversity compared to the construction phase. Predicted significant operational phase-related impacts are largely related to the increased human presence during operations.

Increased human presence and activity

Indirect effects due to the increased presence of people on site is expected to affect the faunal species population, particularly fauna SoC which may be targets for hunting or trade that are likely to occur in the RSA.

The magnitude of loss and disturbance of faunal species of conservation concern is assessed as being potentially low, since no mammal SoC were recorded in the project area, although some of the recorded mammal species (e.g., Maxwell's duiker) are vulnerable to hunting, and the current and future intensity at which bush meat hunting takes place is uncertain. The extent of the impact during operation could be regional, extending beyond the local study area and into adjacent forested areas. Impacts may be long-term and could persist beyond decommissioning. The impact prior to mitigation is therefore considered to be of potentially medium significance.

Implementation of the required mitigation measures may reduce the magnitude of the impact to low; however, the impact would still occur at a local extent, and at best the duration of the impact could be limited to the operation phase only (medium-term), resulting in impacts of low significance after mitigation.

6.2.8 Socio-Economic Construction and Operational Phases Assessments

Employment

Considering the nature of the project, unskilled labour will be needed and hired for pre-construction and construction-related activities. Activities where these types of skills will be needed include site clearance, trenching, road flagging and traffic assessment and many others. Looking at the level of youth unemployment in the area, and the extent of anxiety among the unemployed to secure jobs, the construction phase will present enormous opportunities for the youth to gain employment, at least in the short term.

Considering the number of workers needed for construction purposes, the magnitude of this impact may be high, but this will last for a very short duration. Impact may be felt at the local study area, but the likelihood of the being employed is high, and therefore the impact is considered to be of medium significance. It is anticipated that the implementation of appropriate mitigation measures will enhance this impact.

Increase in local economic activities

Increase in disposal incomes within the local economy may also result in higher sales of local businesses. This may result in high savings and investments and general expansion of local business. Influx of job seekers and migrants may also encourage the establishment of new business enterprises to serve the increasing demand. The establishment of the facility may further create an economy of scale for the energy and mining sector. This has the potential of attracting other local businesses and suppliers.

This is a positive impact. The project impact on local businesses and economic activities during construction will be low before mitigation and low after mitigation.

Cost of living and local inflation

Already, cost of living in the area, particularly with regards to housing, food and transportation is quite high. This is due to the presence of industrial activities and the influx of non-community members into the area as well as the increasing rate of labour mobility in favour of non-farming activities such as small-scale mining. The project is therefore likely to further induce influx of job seekers. Also, the employment of labour will cause a sharp increase in the disposable income levels of the population in the area. This may result in high purchasing power, and excess demand for consumer goods which may result in high demand-pull local inflation and cost of living. Local inflation may also be increased because of reduced food production land due to land take.

This is a negative impact. The project impact on local cost of living and inflation during construction will be low before mitigation and negligible after mitigation.

Livelihood changes

Affected landowners and farmers and other potential farmers may consider diversifying into other livelihood activities. Some community members may also be exposed to non-farm opportunities, which can change their focus livelihood. Also, land resources that could have been used to undertake other developmental projects may be limited. This has a negative opportunity cost for future non-gas development prospects. Additionally, community members who may have the required skills, life experiences, and contextual understanding of the project may benefit from the project.

This is both a positive and negative impact. However, the net impact will be positive as the negative impact is almost negligible. The project impact on livelihoods will be low before mitigation and low after mitigation.

Population influx and demographic changes

Construction activities of the GCP project could lead to a change in the number and composition of the population within the affected communities, which in turn could lead to demographic change processes such as:

- In-migration of job seekers and families of GEGL employees which may lead to:
 - high population density in the PACs
 - higher rate of unemployed groups in the area
 - dominance of youth and economically active groups
 - emergence of heterogenous and alien culture.

This is a negative impact. The project impact will be low before mitigation and low after mitigation

Infrastructure and social amenities

Already, there is pressure on the available community infrastructure, roads, schools housing stock, and other social amenities in the project area. Due to the potential of the project to attract influx of population, there will be pressure on the available social amenities such as water, electricity, toilet and housing. This is a negative impact. The project impact on will be moderate before mitigation and low after mitigation.

Conflicts

Already, most of the youth and community members are not excited because they hold the opinion that the existing mining and industrial companies in the area have not significantly impacted positively on the lives and conditions in the communities particularly with regards to employment and infrastructure. Also, there is high rate of unemployment, aggression, and anxiety among unemployed local population in the area. Considering these issues, any perceived unfavourable activities or unfair recruitment procedures which may tend to favour non-community members may result in conflict and community protests which could affect the project implementation plan. This is a negative impact. The project impact on will be medium before mitigation and low after mitigation.

Psycho-social and sense of risk exposure

Considering the recent gas explosion in Apeatse-Bogoso in the same municipality which has claimed dozens of lives and destroyed properties, and the fact that the GCP project also deals with gas, there could be increase in sense of risk exposure through psychological, health, and safety. There could also be changes in relation to health and safety because of the presence of construction activities, workers and job seekers during construction. Also, many trucks, cars, and equipment such as forklifts, cranes, and excavators will be used, and these could increase stress, anxiety and fear among community members.

This is a negative impact. The project impact on will be medium before mitigation and negligible after mitigation.

Social vices

Already, there are scores of robbery and theft crimes in the area. Most of these crimes are explained by the high levels of unemployment and a sense of livelihood loss and rejection by the firms operating in the area. Additionally, due to the Immigration of outsiders and increase in income levels which may also encourage

ostentatious lifestyles among community members. All of these have the tendency to promote social vices such as robbery, crimes, smoking, and alcoholism especially among the youth. This is a negative impact. The project impact on will be low before mitigation and low after mitigation.

Cultural heritage

Culture dilution by “external community members or in-migrants” due to differences in social and cultural practices. Impacts on social and cultural history, especially in communities (especially Heman) with a deep sense of traditional values and customs interlinked with forest, water resources, cemeteries, and other sacred places where the GCP and auxiliary infrastructure is likely to interfere. This is a negative impact. The project impact on will be low before mitigation and negligible after mitigation.

Vulnerable groups and PwDs

Increased in incomes of economic active labour force and non-vulnerable and population has the tendency of worsening the inequality gap between vulnerable groups/PwDs and the active groups.

Due to the nature of unskilled labour needed, there is the tendency of employing more males than females especially during site construction activities. This has the likelihood of worsening the gender income inequality gap in the area.

Female headed households and PwDs who are likely to be impacted by the project are likely to bear a higher incidence of livelihood loss impact, because there may be limited opportunities for them to diversify into other livelihood options.

This is a negative impact. The project impact on will be low before and after mitigation.

Food insecurity and access to resources

The project area and its nearby surroundings provide a source of medicine, domestic energy, food resources, water and forest resources. The construction of the facility may restrict entry into such areas and deny community members the opportunity to access these resources. Additionally, because livelihood assets will be reduced through the reduction in access to agriculture lands, food production by the farmers will reduce, and this is likely to threaten the food system in the area. This is a negative impact. The project impact on will be low before mitigation and negligible after mitigation.

Diseases and infections

The presence of migrant construction workers may increase activities such as prostitution and promiscuous behaviour. This could result in the spread of diseases such as HIV and AIDS.

Considering the high number of unskilled labour needs and the nature of construction activities which involves much human interactions, juxtaposing with the nature and manner of the spread of Covid- 19, there is the likelihood of further spread of Covid 19 among workers and in effect, community members.

The project could result in a relatively high generation of waste discharges which may affect public health.

Influx of people and increase in income levels may also encourage ostentatious lifestyles and peer induced social vices such as smoking and alcoholism. This could result in diverse health issues such as lung/respiratory problems, cancer, and others.

This is a negative impact. The project impact on will be moderate before mitigation and low after mitigation.

Health infrastructure

Already, the doctor and nurse population ratio of the area is very high. Additionally, the available facilities in the health facilities are unable to meet health demand in the area leading stress on the existing health system. With the commencement of the project, there will be pressure on the available health facilities, due to the likelihood of injuries and accidents from project activities and spread of diseases and viruses due to increased population and risk exposure to public health. This aspect may worsen the already deteriorating health care delivery system, especially the Heman Health Centre.

This is a negative impact. The project impact on will be moderate before mitigation and low after mitigation.

Pollution and public health

There could be an increase in noise, including noise generated by construction vehicles, excavation vehicles, moving tracks, hooters etc. The increase in noise will be a nuisance for sensitive receptors such as farmers, households, and activities near construction sites.

Considering the proximity of the facility to water resources such as the Ankobra River and other streams, any negligence on waste management, water consumption and utilisation may affect the surface water supply. This and other issues of health concern such as waste management and soil contamination may present health issues for the communities which rely on such water resources.

Assessments of air quality, noise and water quality have been assessed above.

Accidents and injuries

There will be more vehicles plying on the roads towards the plant site and the nearby major communities. These could lead to risk to community members and pedestrians who normally use the roadside or even sell by the roads. Additionally, the increased in the number of cars in the area may also lead to speeding which can cause accidents and other road related problems to the PACs.

This is a negative impact. The project impact on will be moderate before mitigation and low after mitigation.

Explosions

There will be an increase in the possibility of uncontrolled fires during the construction process, particularly when construction activities are undertaken in the dry season. Such fire explosions may be because of poor management of highly flammable liquids and other materials. This could result in situations where bush burning is undertaken at farms closer to the GCP or a construction worker or even a nearby farmer smoking cigarettes recklessly without regard to fire outbreak.

This is a negative impact. The project impact on will be low before mitigation and negligible after mitigation.

6.2.9 Traffic

Operation traffic impacts were assessed based on the transportation of LNG and NGLs by Bulk Road Vehicles (BRVs) from the Prestea Liquefaction Facility to the Takoradi Port where the hydrocarbons will be offloaded and temporarily stored at the Takoradi Storage Terminal before being loaded into vessels for export. Thus, as part of the EIS for the Takoradi Storage Terminal, a detailed traffic impact assessment will be conducted to be included as part of the report. GEGL will submit the finalized traffic impact assessment report to the EPA when completed.

6.3 Cumulative Impacts

Cumulative impacts are those that will occur due to a combination of the project and other project activities that may result in the total impacts being greater than with the project alone. For each impact identified for the project, an analysis was performed to consider if other projects or activities ongoing in the region will contribute to the same effects present within the spatial and temporal extent associated with the project itself.

6.3.1 Air Quality

PM₁₀ and PM_{2.5} are likely to be moderate, whilst NO₂, SO₂, CO and VOC impacts are likely to be insignificant, given the existing background sources.

6.3.2 Surface Water

The cumulative impacts to the Ankobra River are related to increased sedimentation if erosion and hydrocarbon spills occur. However, the part of the Ankobra River that could be impacted is within an area of extensive artisanal mining activities. Hence the cumulative impacts from the project in relation to the current state of the Ankobra River, are predicted to be negligible.

6.3.3 Groundwater

Based on the available groundwater quality information from the Water Resources Commission (WRC, 2010), the report suggests that groundwater in the Ankobra Basin is already impacted with mild acidity and elevated levels of trace metal at some localities mainly due to large industrial activities including mining.

The potential leaks of natural gas at the pipe joints will release CO₂ and Methane into the shallow aquifer system which may dissolve into groundwater and decrease aqueous pH resulting in subsequent acidification and dissolution of trace metals in solution.

Considering the potential sources of contamination, during the various phases of project, it is highly unlikely that the development of the Prestea GCP project will adversely impact on groundwater resources provided that the recommended mitigation measures are implemented.

6.3.4 Visual Amenity

Although the Prestea GCP infrastructure will reduce the visual value of the site, the existing artisanal mining activities being undertaken close to the site has reduced the visual value of the area. Therefore, it is anticipated that the cumulative impacts from the plant are expected to be negligible.

6.4 Impacts Assessment for the 6.5km Pipeline to the Prestea GCP

6.4.1 Air Quality

A dispersion model for determining pollutant concentration estimates based on screening-level procedures was completed using SCREEN3. SCREEN3 is a Gaussian plume model which provides maximum ground-level concentrations for point, area, flare, and volume sources (US EPA 1992). The model is a single source model, and the impacts from multiple SCREEN3 model runs can be summed to conservatively estimate the impact from several sources. SCREEN3 calculates 1-hour concentration estimates in simple terrain areas. These modelled estimates must be converted to the averaging period of each applicable national ambient air quality standards. SCREEN3 incorporates source related factors and meteorological factors to estimate pollutant concentration from continuous sources. The model assumed that the pollutant does not undergo any chemical reactions, and that no other removal processes (wet or dry deposition) act on the plume during its transportation.

SCREEN3 examines a range of stability classes and wind speeds to identify the combination of wind speed and stability that results in the maximum ground level concentrations, the “worst case” meteorological conditions. The maximum ground level concentration predicted using a screening dataset is normally regarded as conservative, often termed 'worst-case scenario' impacts.

Scenarios

Only one scenario has been considered:

- Impacts from the construction phase activities.

Note: Impacts from the operational phase are considered to be minimal and does not need to be screened further.

The model output figures and tables that follow show concentrations that would be experienced at 1.5 m above the ground (considered representative of average human breathing height). The following statistical outputs were calculated:

- Peak 24-hour and annual averages were calculated using the equation below. The dispersion model's lowest temporal resolution is one hour. The equation was used to convert P100 1-hour average concentrations over the modelled period to peak 24-hour and annual average concentrations. Values can be compared with the relevant 24-hour and annual average NAAQs to assess likely air quality impacts across the model domain.

$$C_p = C_M \times \left(\frac{T_M}{T_P}\right)^P$$

Where:

C_P = Peak concentration, expressed on the new averaging time [μm^3]

C_M = Mean concentration on one hour averaging time [μm^3]

T_M = Averaging time for mean hour [60 minutes]

T_P = New averaging time [minutes]

P = Decay value = 0.2 [non-dimensional]

It must be noted that ambient air quality objectives are applied to areas beyond the facility boundary but within the facility boundary, occupational health and safety criteria need to be applied.

Construction Phase Assessment

Increase in dust and particulates:

The results if the atmospheric dispersion modelling conducted for the construction phase are as follows and the Figure 21 to Figure 26 show the dispersion over distance graphs for the predicted concentrations for the construction phase:

- **TSP Concentrations:**
 - Beyond approximately 4.5 km from the construction phase pipeline operations, 24-hour TSP concentrations will drop below the 24-hour TSP GSA Standard of $150 \mu\text{g}/\text{m}^3$ (Figure 21)
 - From approximately 3 km from the construction phase pipeline operations, annual TSP concentrations will drop below the annual TSP GSA Standard of $80 \mu\text{g}/\text{m}^3$ (Figure 22)

■ **PM₁₀ Concentrations:**

- Beyond approximately 4 km and 5 km from the construction phase pipeline operations, 24-hour PM₁₀ concentrations will drop below the 24-hour PM₁₀ GSA Standard of 70 µg/m³ and 24-hour PM₁₀ IFC Standard of 50 µg/m³, respectively (Figure 23)
- From approximately 1.6 km from the construction phase pipeline operations, annual PM₁₀ concentrations will drop below the annual PM₁₀ GSA Standard of 70 µg/m³ and annual PM₁₀ IFC Standard of 20 µg/m³ (Figure 24)

■ **PM_{2.5} Concentrations:**

- Beyond approximately 1.6 km and 2 km from the construction phase pipeline operations, 24-hour PM_{2.5} concentrations will drop below the 24-hour PM_{2.5} GSA Standard of 35 µg/m³ and 24-hour PM_{2.5} IFC Standard of 25 µg/m³ (Figure 25)
- From approximately 1.7 km from the construction phase pipeline operations, annual PM_{2.5} concentrations will drop below the annual PM_{2.5} IFC Standard of 10 µg/m³ (Figure 26)

Based on the predicted concentrations from the model it is evident that that the construction activities will result in particulate emissions from the site clearance and earthworks. Although such activities will be for a short-term, they are likely to reach a local level even with mitigation measures in place, resulting in an overall medium impact on the key surrounding receptors.

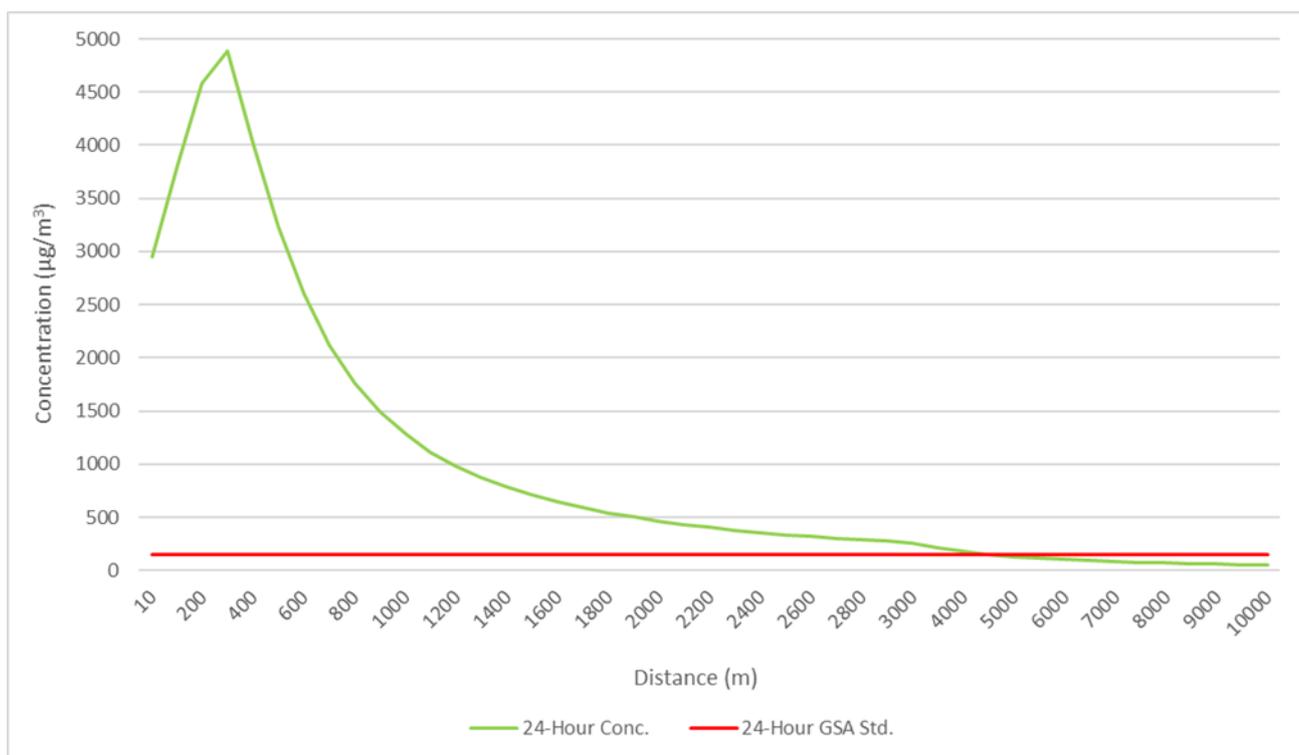


Figure 21: Predicted 24-hour TSP concentrations during the construction phase (µg/m³)

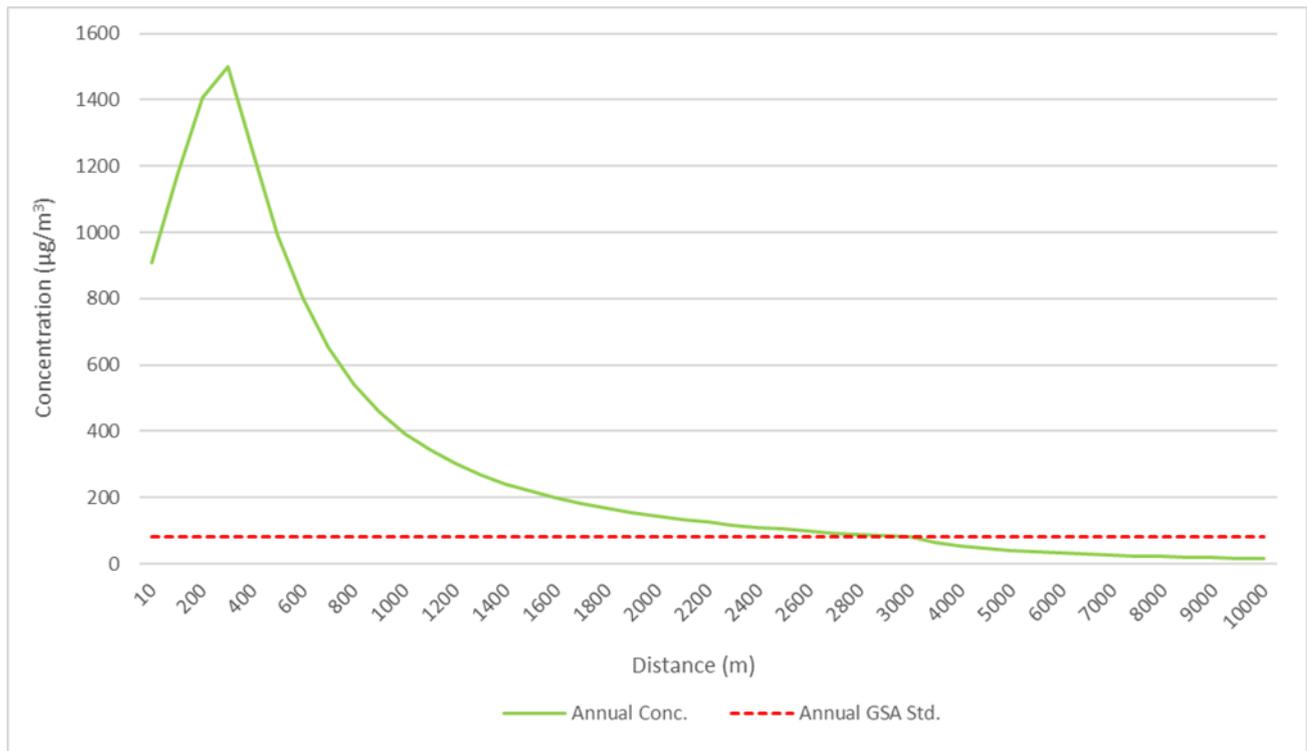


Figure 22: Predicted 24-hour TSP concentrations during the construction phase (µg/m³)

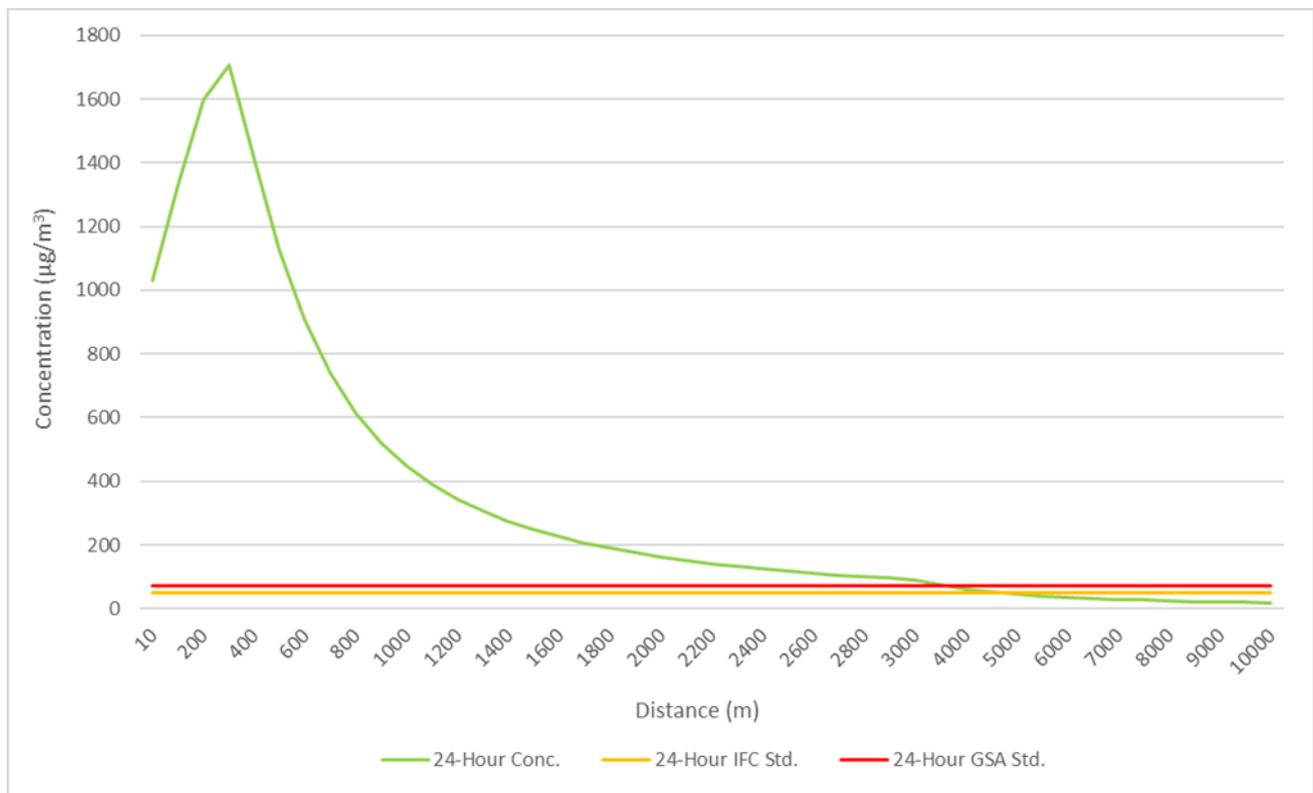


Figure 23: Predicted 24-hour PM₁₀ concentrations during the construction phase (µg/m³)

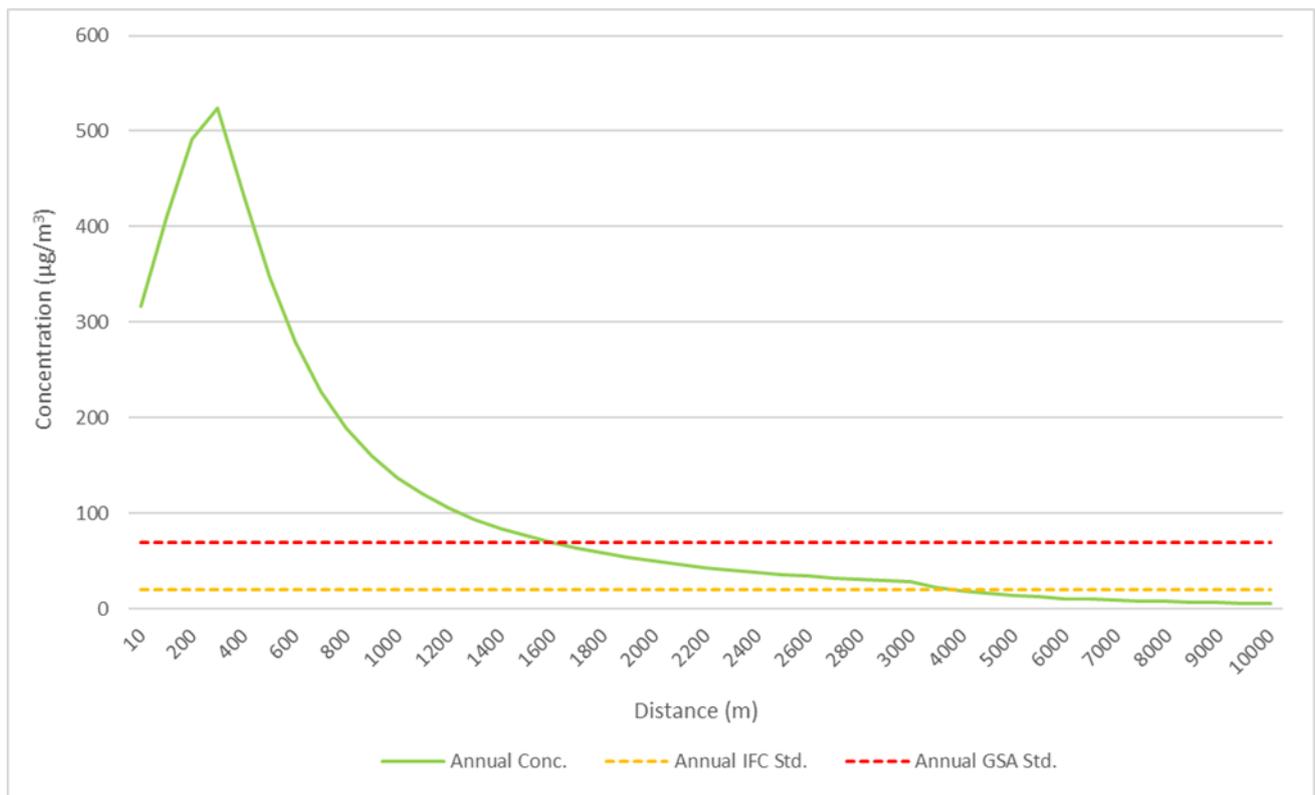


Figure 24: Predicted annual PM₁₀ concentrations during the construction phase (µg/m³)

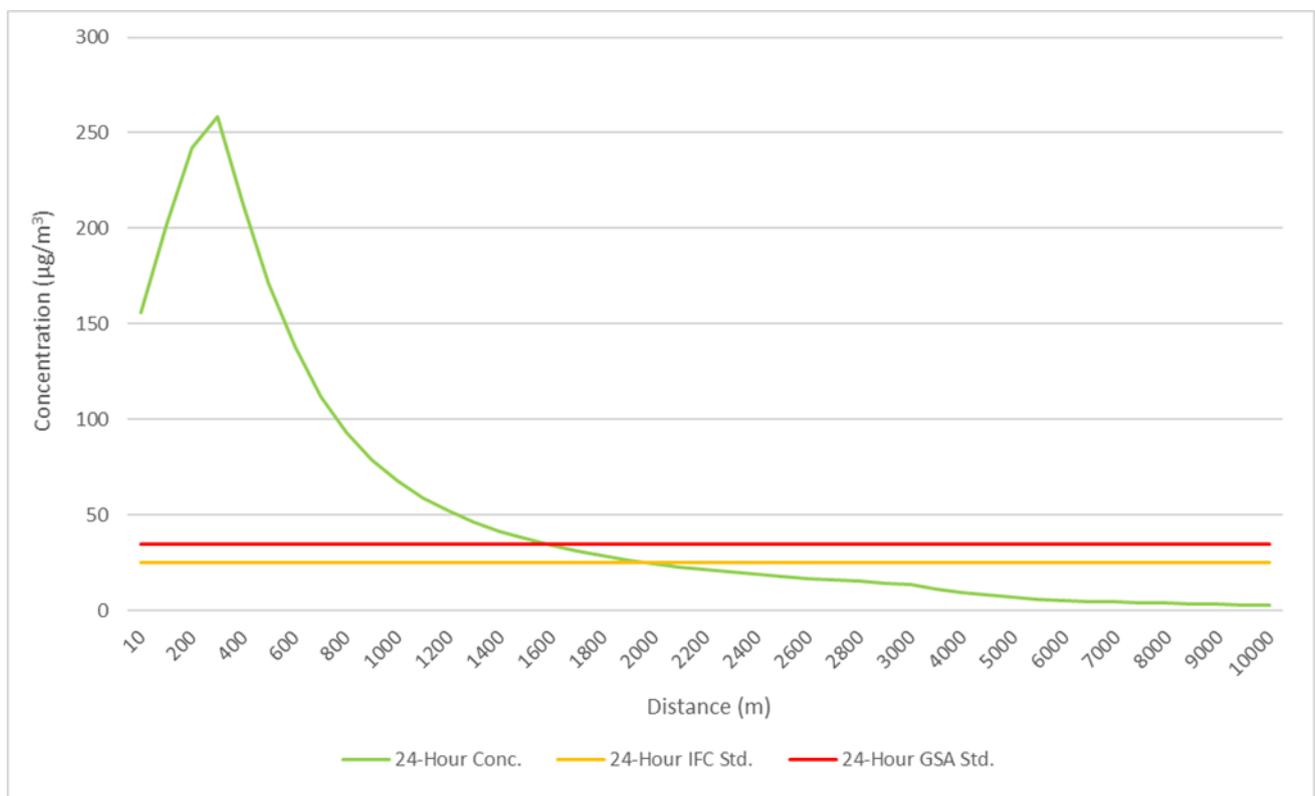


Figure 25: Predicted 24-hour PM_{2.5} concentrations during the construction phase (µg/m³)

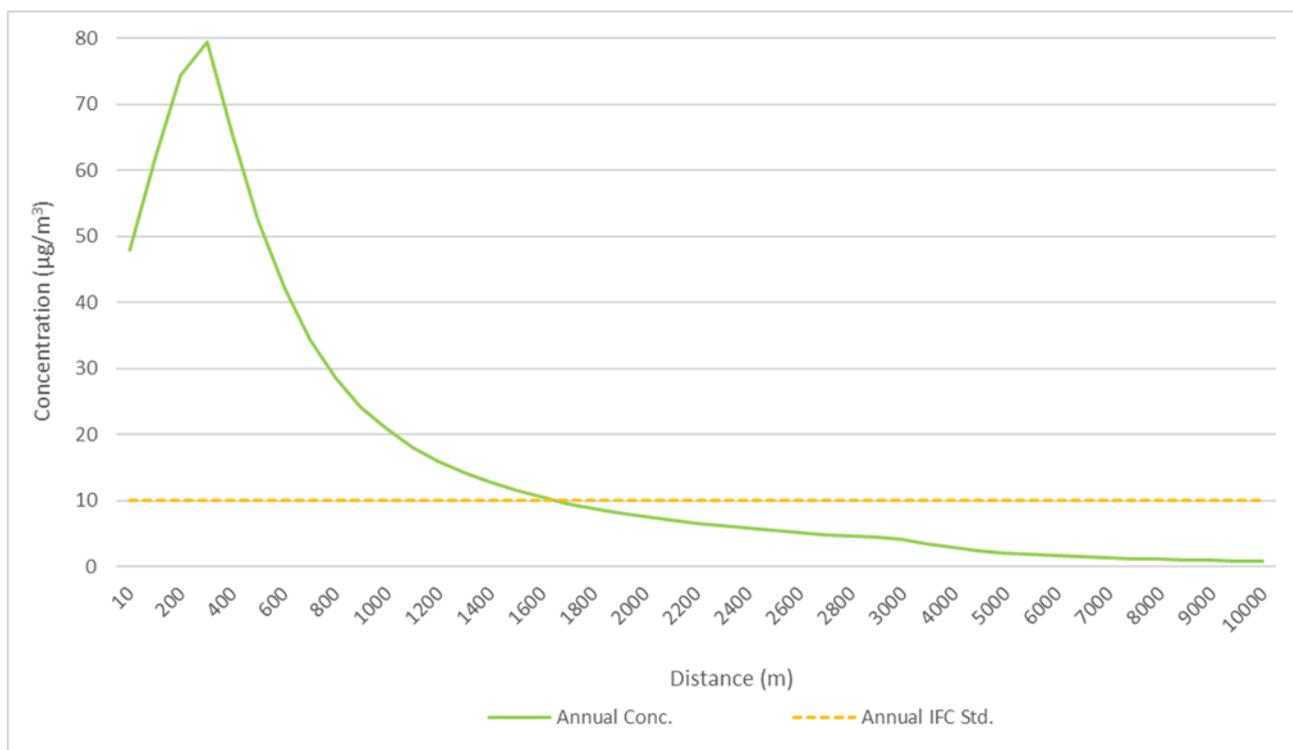


Figure 26: Predicted annual PM_{2.5} concentrations during the construction phase (µg/m³)

Operational Phase Assessment

Operational activities will result in VOCs being emitted into the atmosphere however this will be minimal and as such the overall impact is anticipated to be low on the key surrounding receptors.

6.4.2 Noise

The standards considered in the assessment are the Ghana Health Protection Requirements for Ambient Noise Control (GS 1222:2018) and the IFC Environmental, Health, and Safety Guidelines for noise management (IFC, 2007). However, when the host country regulations differ from the levels and measures presented in the IFC Guidelines, projects are required to achieve whichever is more stringent. If less stringent levels or measures than those provided in the IFC Guidelines are appropriate in view of specific project circumstances, a full and detailed justification must be provided for any proposed alternatives through the environmental and social risks and impacts identification and assessment process. As such, the most stringent standards for this assessment have been used, being the IFC Residential Noise Regulations.

A semi-qualitative assessment was undertaken to assess the impacts from the construction and operational phases. This included attenuation-over-distance acoustic calculations (the equation below) to calculate the resulting sound power level (PWL), using the sound pressure level (SPL) data sourced from the British Standards Code of Practice for Noise and Vibration Control on Construction and Open Sites (BS5228-1:2009) and the distance (r) from the source.

$$PWL = SPL - 10 \log \frac{2}{4\pi r^2}$$

Construction Phase Assessment

Increase in noise levels at sensitive receptors:

As a conservative approach the cumulative PWL of 122 dB(A) (Table 39) from all construction equipment operating concurrently was used to determine the resultant noise levels at various distances from the source (Figure 27). Noise levels below 100 m are predicted to be significantly higher. From 920 m from the source (i.e., the construction activities associated with the proposed pipeline route), noise levels will drop to below the IFC residential daytime guideline rating levels of 55 dB(A).

Predicted impacts and resultant noise levels during the daytime at the noise receivers are presented in Table 40. Results indicate that increases in noise levels (i.e., from baseline noise levels) as a result of the construction activities are above the 3 dB(A) threshold for annoyance as per the IFC Noise Regulations at receptors SR4 to SR6, SR9, SR11, SR12, SR22, SR24, SR27, SR29, SR30 and SR32 to SR37 during the day. The largest change was predicted at SR37, located approximately 140 m away from the proposed construction activities.

As such, increase in noise levels are likely to result in sporadic complaints at these receptor locations, given the proximity of these locations in relation to the proposed construction activities. The remaining noise receivers are likely to experience noise levels that will be absorbed into the existing environment.

The magnitude of the impact is moderate and although the construction activities are for a short-term, they are likely to reach a local level. The impact remains medium even with the implementation of mitigation measures.

Table 39: Construction Phase Equipment and Sound Power Level Ratings from the proposed Project

Equipment	No. in Operation (Simultaneously)	Sound Power Level (dB(A))
Excavators	1	105
Bulldozers	1	111
Graders	1	105
Compactors	1	110
Backhoe	1	95
Grinding and Cutting Machines	1	108
Welding Machines	1	101
Power Tools	1	105
Shovels	1	108
Spades	1	113
Wheelbarrows	1	116
Hammers	1	115
Saws	1	115
Logarithmic Total		122

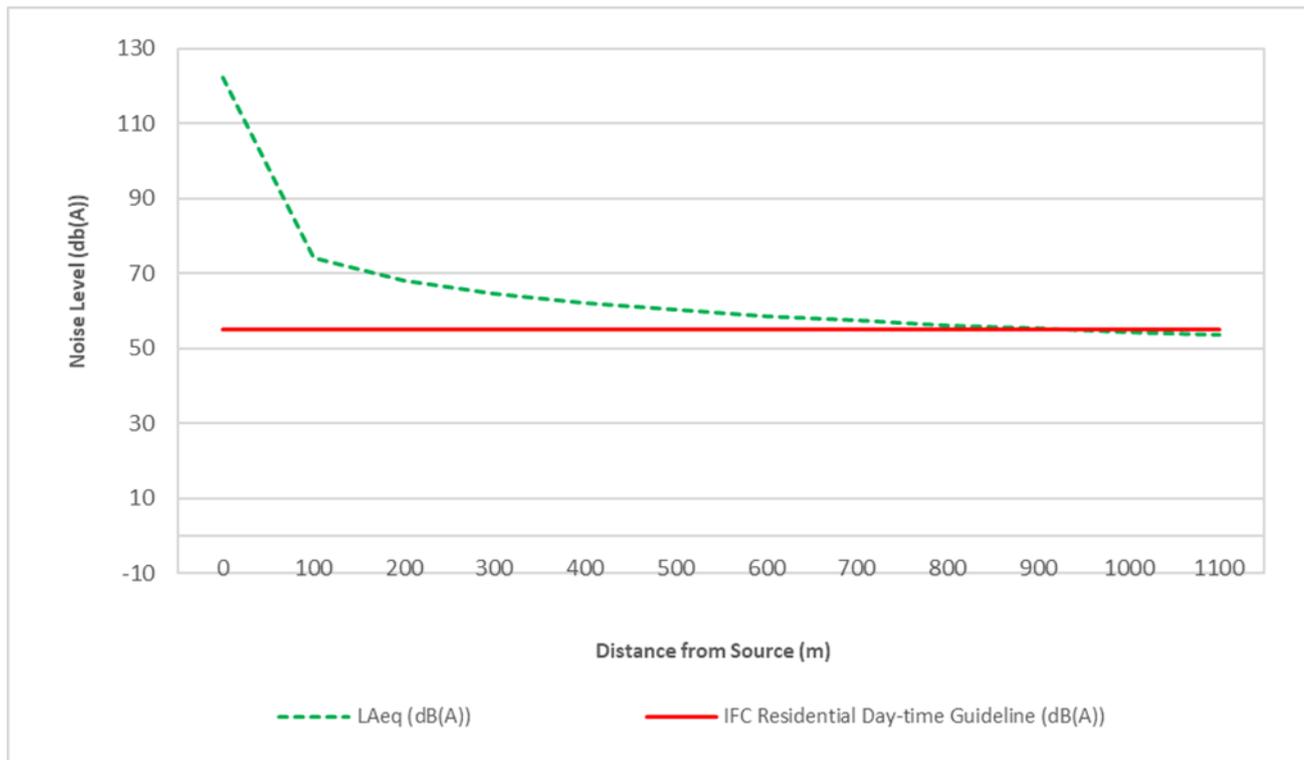


Figure 27: Predicted day-time noise levels with distance during the construction phase

Table 40: Predicted day-time noise levels at the receptors during the construction phase

Receptor ID	Distance from Pipeline Route (km)	Predicted Noise Level (dB(A))	Baseline Day-time Noise Level (dB(A))	Cumulative Noise Level (dB(A))	Change (dB(A))	Above or Below 3 db(A) Change
SR1	2.76	45.5	55.0	55.5	0.5	Below
SR2	1.84	49.0	55.0	56.0	1.0	Below
SR3	4.60	41.0	55.0	55.2	0.2	Below
SR4	0.59	58.9	55.0	60.4	5.4	Above
SR5	0.45	61.2	55.0	62.2	7.2	Above
SR6	0.41	62.0	55.0	62.8	7.8	Above
SR7	0.97	54.6	55.0	57.8	2.8	Below
SR8	5.38	39.7	55.0	55.1	0.1	Below
SR9	0.84	55.8	55.0	58.4	3.4	Above
SR10	3.29	43.9	55.0	55.3	0.3	Below
SR11	0.37	62.9	55.0	63.6	8.6	Above
SR12	0.72	57.1	55.0	59.2	4.2	Above

Receptor ID	Distance from Pipeline Route (km)	Predicted Noise Level (dB(A))	Baseline Day-time Noise Level (dB(A))	Cumulative Noise Level (dB(A))	Change (dB(A))	Above or Below 3 db(A) Change
SR13	2.69	45.7	55.0	55.5	0.5	Below
SR14	2.68	45.7	55.0	55.5	0.5	Below
SR15	1.52	50.6	55.0	56.4	1.4	Below
SR16	1.95	48.5	55.0	55.9	0.9	Below
SR17	2.42	46.6	55.0	55.6	0.6	Below
SR18	2.92	45.0	55.0	55.4	0.4	Below
SR19	1.79	49.2	55.0	56.0	1.0	Below
SR20	2.32	47.0	55.0	55.6	0.6	Below
SR21	2.13	47.7	55.0	55.7	0.7	Below
SR22	0.92	55.0	55.0	58.0	3.0	Above
SR23	0.95	54.7	55.0	57.9	2.9	Below
SR24	0.71	57.3	55.0	59.3	4.3	Above
SR25	1.13	53.2	55.0	57.2	2.2	Below
SR26	1.53	50.6	55.0	56.3	1.3	Below
SR27	0.23	67.1	55.0	67.3	12.3	Above
SR28	1.11	53.4	55.0	57.3	2.3	Below
SR29	0.15	70.8	55.0	70.9	15.9	Above
SR30	0.42	61.8	55.0	62.6	7.6	Above
SR31	0.94	54.8	55.0	57.9	2.9	Below
SR32	0.50	60.3	55.0	61.4	6.4	Above
SR33	0.67	57.8	55.0	59.6	4.6	Above
SR34	0.74	56.9	55.0	59.1	4.1	Above
SR35	0.49	60.5	55.0	61.6	6.6	Above
SR36	0.31	64.5	55.0	64.9	9.9	Above
SR37	0.14	71.4	55.0	71.5	16.5	Above
SR38	3.09	44.5	55.0	55.4	0.4	Below
SR39	2.86	45.2	55.0	55.4	0.4	Below

Operational Phase Assessment

Increase in noise levels at sensitive receptors:

As a conservative approach the PWL of 108 dB(A) (Table 41) from the gas station linking the 6.5km pipeline to the Prestea GCP was used to determine the resultant noise levels at various distances from the source (**Error! Reference source not found.**). Noise levels below 50 m are predicted to be significantly higher. Beyond 180 m during the daytime and 560 m during the night-time from the source, noise levels will drop to below the IFC residential daytime and night-time guideline rating levels of 55 dB(A) and 45 dB(A), respectively.

Predicted impacts and resultant noise levels at the noise receivers state that during the day indicate that increases in noise levels as a result of the operational activities are well below the 3 dB(A) threshold for annoyance as per the IFC Noise Regulations. During the night, increases in noise levels due to the operational activities are below the 3 dB(A) threshold for annoyance as per the IFC Noise Regulations. Thus, the noise receivers are likely to experience noise levels that will be absorbed into the existing environment. Overall, the impact is assessed to be low with mitigation measures implemented.

Table 41: Operational phase equipment and sound power level ratings from the proposed Project

Equipment	Distance from Pipeline Route (km)	Predicted Noise Level (dB(A))
Pipeline	1	N/A
Gas Stations	2	54
Logarithmic Total		54

6.4.3 Soil and Land use

The key soil aspects that will be affected due to the project activities for the project phases are as described below.

Degradation of soil quality:

Soil is degraded when it partially or totally loses its capacity to support vegetation productivity. Land degradation means that the soil has lost the capacity to function within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water quality, and support human health and habitation. The vegetation removal and soil disturbance expected during the construction phase could result in the disruption of the nutrient cycling process in the soil, i.e., the source of organic matter (vegetation, debris) is removed with a subsequent reduction in soil biodiversity and distortion in soil aggregate stability. The magnitude of this impact is high. However, due to the localised construction activities, concurrent rehabilitation and the activities being for a short-term, could be quicker restoration of soil aggregate stability, the overall impact is anticipated to be medium.

Loss of soil as a resource:

The pipeline project will involve the excavation of soil material to enable the laying of the pipeline. It will also entail the clearance of vegetation for the construction of the other associated facilities such as the gas stations and camps, and these could result in the loss of soil, particularly topsoil. The geotechnical pits dug along the pipeline route show that the topsoil depths vary significantly and are between 10cm and 80cm deep. Although topsoil will be lost from the site during the construction phase, as this is a pipeline project this will be limited, and the topsoil can potentially be transferred to an alternative area and stockpiled for reuse. Therefore, during

the construction phase, the significance of the impact on soil as a resource and land use is medium since the soil excavated from the pipeline trench could be reused. No further impact on the soil and land use is anticipated during the operational phase.

Land use change:

The proposed development activities will result in a change in current land use from natural forests and farmlands during the construction and operational phases. This impact is assessed to be high since operations could be for a period of over 50 years.

Soil contamination from hydrocarbon and other chemical spills and improper disposal of waste:

The contamination of soil from hydrocarbon spillages associated with machinery used for construction activities will likely occur since the machinery used rely on fuels. Contamination is anticipated to occur along the pipeline route and the areas for the gas stations. Improper disposal of waste could also result in the contamination of soil. Overall, the impact is assessed to be low as it is anticipated to be limited to the site only.

Soil loss through erosion:

The soil which was initially covered with vegetation would be exposed resulting in the increased potential for soil erosion. Erosion will be more pronounced when the vegetation is removed, and the soil is left bare during the wet season. Non-vegetated soil stockpiles will be prone to wind and water erosion. Due to earthwork activities, it is anticipated that the soil characteristics controlling soil erodibility (i.e., soil organic matter content, structure, and permeability) are likely to be altered. The impact is assessed to be medium during construction phase, however, it is anticipated that the implementation of appropriate mitigation measures could minimize the effect of the impact.

Soil Compaction:

Some soil compaction is anticipated to occur across the pipeline site during the construction. Compaction of further areas of the site will occur during the operational phase when pipeline maintenance and monitoring is undertaken. Although compacted soils could be ripped after decommissioning of the site, the soils will never regain their original structure. This impact is therefore assessed to be high during the construction phase, however, it is anticipated that the implementation of appropriate mitigation measures could minimise the effect of the impact.

6.4.4 Surface Water

Construction Phase Assessment

The main construction phase activities that would impact the water resources will be the clearing of the RoW to excavate the trench for installation of the pipeline, where the pipeline crosses water courses, the diversion, and the compaction and rehabilitation thereafter. If inadequately done, erosion will occur, and sediments will be washed into water courses increasing the turbidity of the water for downstream users.

In addition, the banks and the bed of the river will be impacted due to the diversion of the streams and removal of vegetation, and instream habitat.

Diversion of the water course:

The process of diverting the water course where flowing water is present will reduce the flow for a short time where the interception method is used and where the two-cofferdam method is used, the reduction of flow will be limited. Without mitigation, the magnitude of the impact may be moderate. However, the duration is expected

to be short-term, and the reduced flow will be local. By implementing the interception method, the degree of the impact from the construction activities will likely be minor.

Disturbance of the surface drainage system – bed and banks of the water courses crossed:

Disturbance of the banks and beds of water courses from trench construction, laying of the pipeline, backfilling and compaction. Poor rehabilitation could lead to erosion and associated downstream sedimentation and loss of riparian habitats. The magnitude of this impact is moderate because of the area to be impacted, the impact is short-term and local. Overall, the impact is anticipated to be medium.

Contamination due to hydrocarbon spills from mechanical equipment:

The use of machines and equipment for excavation could result in the contamination of the soil and this has the potential to be washed downstream into water bodies from runoff. The magnitude of the impact is low with the duration being short term and limited to only the site. Therefore, the overall impact is low.

Operational Phase Assessment

During the operation of the pipeline, it is not expected that there could be further impacts. However, any maintenance on the pipelines could require excavation and should this be necessary, the identified impacts for the construction phase are anticipated, and the mitigation measures recommended could be relevant.

6.4.5 Biodiversity

Construction Phase Assessment

Loss/disturbance of ecosystems of concern:

The clearing of vegetation during the construction of the pipeline will result in a reduction in extent of remaining natural habitats in the LSA. Although these habitats may be slightly-moderately degraded, they support several flora species of conservation concern, and have potential to support fauna species such as Grey Parrot, Hooded Vulture, Bosman's Potto.

The impact of the development on vegetation would be of local extent, with a moderate magnitude given the high sensitivity of nearby protected areas, and Freshwater Swamp sites (presence of species of global and national conservation concern such as *Cussonia bancoensis* and *Schumaniophyton problematicum*). The impact prior to implementation of mitigation measures will be low both before and after the implementation of recommended mitigation measures.

Loss of flora of Species of Conservation Concern:

The clearing of vegetation for roads and pipeline construction will lead to disturbance of the area and loss of biological diversity, including the potential loss of globally/locally rare species. Increased human presence can lead to poaching, illegal plant harvesting and other forms of disturbance such as fire. The impact of the development on vegetation/flora SoCC would however be of a local extent, with a moderate magnitude given the presence of species of global and national conservation concern such as *C. bancoensis* and *S. problematicum*.

The impact is assessed to be long-term as most cleared areas are required for the pipeline and other infrastructure and some areas expected to be rehabilitated. Hence, the loss of vegetation and flora Species of Conservation Concern (SoCC) due to the clearing of vegetation, is anticipated to be of moderate without

mitigation measures as the loss of vegetation is definite during construction. However, with the successful implementation of the required mitigation measures the impact to flora SoCC can be reduced.

Disturbance/contamination of aquatic ecosystems during pipeline construction:

Buried pipelines crossing rivers and wetlands could obstruct surface water flow during construction if trench and/or temporary river/stream diversions are necessary. The impact to these systems is mainly due to the disruption of vegetation and soils by heavy machinery, particularly when tracked vehicles are used that have greater impact on soil structure and from earthworks. Disruption of flows and ecosystem composition may also occur if backfill material imported into the rivers or wetland areas being crossed, to provide stability for excavators and pipe layers, are not completely removed and replaced with the natural soils after construction.

The geographical extent of the impact will be local, and the impact duration will be short-term, because impacts are expected to last as long as it takes the pipeline crossing to be constructed. The magnitude of the impact will be low because, although temporary changes to riparian habitat structure in areas crossed by the pipeline are likely, which could result in edge effects, changed flow regimes, and erosion and sedimentation of affected wetlands, the extent of the area affected will be relatively small. Therefore, a moderate impact on aquatic ecosystems is expected, pre-mitigation.

Erosion due to vegetation clearance:

Vegetation clearing and soil disturbance will lead to an increase in exposed soils, which may leave the disturbed areas vulnerable to erosion. This may impact downstream wetland and riparian habitats if a lot of fine particulate matter or sediment enter the environment. In addition, the construction of many hard surface areas for roads, laydowns, etc. will generate runoffs which could also increase erosion potential of surrounding areas. Although most parts of the site contain a high proportion of grass within the vegetation and grasses which should in most instances help to prevent erosion in areas receiving runoff, the impact of erosion, particularly during heavy rains, remains.

Given the above, impacts associated with erosion will be of local extent, short term duration and of a medium magnitude. The overall impact is anticipated to be low before and after the implementation of recommended mitigation measures. Although the impact is low without mitigation, it is still highly recommended that mitigation measures are implemented successfully as construction of the pipeline could have indirect and cumulative impacts on the surrounding environment.

Increased dust deposition into the receiving environment:

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

However, this is a temporal impact which could be reversed by rainfall if excavation activities cease, therefore, the impact is assessed to have a short-term duration, with local extent and moderate magnitude. The overall impact is low before and after the implementation of mitigation measures.

Introduction of alien and invasive species:

During the construction phase, the introduction of exotic vegetation or the invasion of disturbed areas by exotic vegetation through either a physical vector (e.g., machinery, vehicles etc.) or dispersion vectors (e.g., wind, birds) could occur.

For ecosystems of concern and associated flora SoCC, the impact magnitude could be moderate prior to mitigation, potentially extending beyond the site into the local extent and would likely persist for the duration of the construction and operation activities. The impact is anticipated to be high prior to the implementation of mitigation measures. With the application of recommended mitigation measures, the magnitude of the potential impacts could be reduced, ensuring a residual impact of low environmental significance.

Loss and disturbance of fauna of SoCC:

Vegetation clearance for construction of the project infrastructure could result in the loss of habitat for species of conservation concern and could cause fatalities to individual species of concern, particularly mammals and herpetofauna; injuries or mortalities of fauna species could also be sustained from collisions with vehicles travelling in the construction area. In addition, indirect effects due to the presence of people and heavy machinery, associated noise and vibration, and site lighting at night, could impact faunal SoCC in unaffected habitats adjacent to the LSA. The direct construction activities as well as the indirect disturbance by people and machinery could create a barrier to movement and dispersal of faunal SoCC, particularly (ground-dwelling) mammals and herpetofauna.

The magnitude of the loss and disturbance of SoCC could be moderate. Although there is a significant fauna biodiversity along the pipeline landscape, the conservation significance was rather low, as the fauna species recorded were primarily species of least concern on the IUCN Red List with just two species making the IUCN Red list. However, care should still be taken during construction as any loss or disturbance of the few SoCC could result in impacts of moderate magnitude that would be at least long-term.

The overall impact is high given the extent of loss of species of national and international SoCC is assessed on a regional scale prior to mitigation, and the potential losses would be at least long-term. With the application of the recommended mitigation measures for employee management and prevention of hunting, the duration of the impact could be confined to the construction phase, or short-term only, and the magnitude reduced to a medium due to the regional extent of the impact.

Habitat fragmentation and barriers to movement:

The construction of the pipeline with its RoW could potentially affect biodiversity through fragmentation during the construction phase. The pipeline habitat is already fragmented and degraded but construction of pipeline could cause further degradation. Although the pipeline and the RoW may not directly affect fauna biodiversity, consequential impacts such as edge effect could potentially affect vertebrate fauna as well as flora.

Loss of ecological connectivity is one of the likely impacts of the pipeline construction and maintenance. Disruption of ecological connectivity may adversely affect ground-moving herpetofauna species. Reptiles and amphibians are the species likely to be affected. The presence of the pipeline route may also cause some ground-moving species to change their movement patterns, which may increase their vulnerability to predation (Laurance, *et al.*, 2000, Laurance, *et al.*, 2006).

The construction of the pipeline and maintenance of the RoW could also affect the microclimatic conditions at some sections of the pipeline route, particularly the sections passing through relatively good conditions of the forest reserves. Adverse alteration in microclimatic conditions could affect vertebrate fauna species that are sensitive to changes in microclimatic conditions, especially amphibians (Hillers *et al.*, 2008, Laurance, *et al.*, 2006).

The magnitude of this impact on fauna SoCC during construction is assessed as being moderate, as potential changes in their natural movement patterns as a result avoidance of the pipeline RoW during construction activities is considered likely. The extent of impacts would be regional, and short-term, persisting for the construction phase of the project. With the application of the recommended mitigation measures, the magnitude and extent of the impact may be reduced, resulting in a low residual impact.

Operational Phase Assessment

Increased human presence and activity:

Indirect effects due to the increased presence of people and increased access to forested areas for bush meat hunting along the RoW and access tracks are expected to affect faunal species of conservation concern occurring in the area, particularly mammal SoCC which may be targets for hunting, and SoCC that are targeted for trade, for example the Endangered African Grey Parrot (*Psittacus erithacus*). There is also a potential for increased human encroachment into the ecosystems of concern (Forest Reserves) being traversed by the pipeline, as a factor of ease of access via the cleared RoW.

The magnitude of loss and disturbance of species of conservation concern is assessed as being moderate as the current and future intensity at which bush meat hunting takes place is unknown. The extent of impacts during operation could be regional, extending beyond the LSA and into adjacent forested areas – potentially in to the Anhwiaso East Forest Reserve. Impacts may be long-term, particularly increased human presence associated with population influx, which could persist beyond decommissioning. The impact prior to mitigation is therefore considered to be of high. Implementation of the required mitigation measures may reduce the intensity of the impact to moderate; however, the impact would still occur at a regional extent, and at best the duration of the impact could be limited to the operation phase only (medium-term), resulting in a medium impact after the implementation of mitigation measures.

Presence of the pipeline and barriers to movement:

The presence of the pipeline and the associated transformation of intact vegetation, particularly in forest reserves, is not considered likely to pose a threat to the connectivity of the landscape and the ability of fauna and flora to respond to environmental change, since the pipeline will be buried. Assuming that the pipeline RoW will not be fenced to prevent human/faunal access, the magnitude of potential effects on species of conservation concern during operation is assessed as being low. The extent of impacts would be local, and impact will be long-term, persisting for the operational lifetime of the project. The impact is therefore considered to be low before and after mitigation.

Impact on flora during maintenance activities:

Maintenance activities such as vegetation clearing will impact the biodiversity of the site if not conducted in a sensitive manner. This is a site-specific impact with long-term duration and a moderate magnitude. The intensity is rated as medium before mitigation since it involves the possible loss of species and habitats. The impact can be reduced to a low given that the mitigation measures are implemented and the fact that the lost species can be replaced through replanting.

6.4.6 Socio-Economic

The socio-economic impacts anticipated for the project phases are as described below.

Change in land use:

The proposed pipeline will lead to a change in land-use within the local area. Land-use changes refer to actual or perceived changes in land-use, whether temporary or permanent. The assessment of a land-use change process from a social perspective considers how the proposed pipeline might affect the behaviour or livelihood of landowners and or land users.

Change in land use has the potential to affect access to environmental resources such as wood, water, medicinal plants, and forest resources. This impact is high as it expected to be for the entire duration of the project life.

There is also the issue of food insecurity because livelihood assets will be reduced through the reduction in access to lands, food production by the farmers will reduced and this is likely to threaten the food system in the project area. The impact will be short-lived if the appropriate livelihood interventions are implemented.

The project will also result in limited access to farm-based activities. Land resources that could have been used to undertake other developmental projects may be limited. Community members may also be denied the right their lands. This impact is expected to be high as it is permanent loss and will persist for the entire project lite. It is anticipated that all compensation processes would be completed by GEGL prior to project implementation.

Demographic changes:

Already, there is pressure on the available infrastructure, public facilities, housing stock, and other amenities in the project area. Additionally, construction activities of the pipeline project could lead to a change in the number, and composition of the population within the affected local area, which in turn could lead to economic, land-use, and socio-cultural change processes. The anticipated population growth may be influenced by the following:

- Speculative migration of labour by job seekers
- GEGL camps to be established along the pipeline route
- Some temporary construction workers may opt to stay in the communities after the expiry of their contracts with GEGL

Land Acquisition and Compensation:

The immediate geographical area of influence of the project is about 6.5km long and 12m wide of land area. The minimum working belt required for construction activities is 12m. As a result, the pipeline will be built using a 12m working belt. Accordingly, only crops within a 12m belt will be destroyed and compensated for. However, we are engaging farmers with farmlands beyond the 12m working belt up to 25m to ensure that only shallow-rooted crops are cultivated in order to avoid future interference of these crops with the buried pipeline. Thus, the RoW width for the pipeline will be 12m.

- The most likely impact of acquiring the proposed RoW width is an agreement on the compensation amount for the demarcated areas for pipeline installation because some farmers will be deprived of farming on part of their agricultural lands, thereby deprived of livelihoods from the crops to be destroyed. The project is expected to pay special attention to issues of livelihood. In light of this, GEGL, with the assistance of the Land Valuation Board, would ensure that the appropriate people are identified and adequately engaged in the process in order to ensure that compensation is paid to the appropriate people. As part of this EIS, GEGL's Compensation Plan and details of Project Affected Persons are provided as APPENDIX D.

Economic impacts:

Economic change processes relate to the changes brought about through employment, local businesses and general economic profiling of the area. For example, job opportunities might be created because of the

construction and operation of the proposed development. Employment creates a source of income, increase household assets, help boost the local economy, and reduce the rate of social vices. Details of the economic impacts are outlined in Table 42.

Table 42: Economic impacts of the project

Key issue	Impact details	Significance
Increase in employment opportunities	Unskilled labour may be needed during preconstruction and construction related activities such as bush clearance, trenching, road flagging and traffic assessment. These human efforts may be sourced from the local communities.	These are short term positive impacts and are not likely to be sustainable in the medium to long term. However, the income generated increase purchasing power and may have spill-over impact on the local economy in the long term.
	Most of the employment opportunities would be restricted to the construction phase. However, the operational phase may also generate a few employment opportunities in areas such as security, and even other supervisory, and managerial positions	These are positive impacts and are likely to be sustainable in the medium to long term.
Cost of living and local inflation	There may be a high cost of living and local inflation due to the in-migration of job seekers and workers. Local inflation may also be increased through the reduction in food baskets because of the reduction in farm-produced due to the land taken. Additionally, increase in disposable income may create a demand-pull inflation.	This impact may be severe in the short term, especially during the construction phase
Change in the commercial/ industrial focus of the community	In areas where the pipeline facilities such as gas stations and camps are located, community members who may have the required skills, life experiences, and contextual understanding of the project may benefit from the project. Also, some community members may be exposed to non-farm-based opportunities which can change their focus.	Impacts are expected to be long term, and positive
Change in access to resources that sustain livelihoods	The project will result in limited access to farm-based activities. Also, land resources that could have been used to undertake other developmental projects may be limited. Community members may also be denied the right to their lands	This impact is expected to be significant, and permanent across the entire project life

Access to basic social services:

- Increase in social amenities and other development opportunities through GEGL's corporate social responsibility interventions
- The development would create economic growth through the availability of services such as electricity
- The construction and operation will enhance more equal opportunities to resources because additional services will be provided in the energy sector. Also, opportunities will become available, and these will create the platform for diversified and equitable opportunities.

Socio-cultural impacts:

Socio-cultural change processes that are associated with the construction and operation of the proposed project include the following.

- Culture dilution by “external community members or in-migrants” due to differences in social and cultural practices.
- Impacts on social and cultural history, especially in communities with a deep sense of traditional values and customs which are interlinked with forest, and water resources, cemeteries, and other sacred places where the pipeline route and auxiliary infrastructure is likely to interfere.
- There could be conflict between community members, community members, and in-migrants, and even community members, and GEGL because of conflicting interests and developments.
- Changes in psychological, health, and safety aspects and sense of place can be a source of mental and social health.
- Incidence of accidents, crime, and insecurity. Criminal opportunists are also likely to move into the pipeline areas. This is because, considering the location of the proposed project in farmlands, it is likely that theft cases in the farmlands (such as stealing of cocoa beans and plantain) may increase.
- The proposed development route can easily facilitate access due to the unique demarcation and identification of the pipeline route. It will also ease the access to protected farmlands, forests, and natural resources which may not have been originally accessed.
- These changes can occur in relation to health and safety because of the presence of construction workers and job seekers during construction. However, they are likely to be minimal in the medium to long term, especially during the operational phase.

During construction, many trucks, cars, and equipment such as forklifts, cranes, and excavators will be in use along the pipeline route. Because the pipeline will cross major roads, construction activities may result in road diversion. This can result in increased travelling time and other traffic challenges for road users. An increase in the movement of heavy trucks may also worsen these traffic conditions in the area. Other impacts include the following:

- Decreased safety of pedestrians and other road users
- Increase in dusty and noisy conditions

Health and social wellbeing:

- Any development which causes the migration of people has the potential to result in the spread of diseases such as HIV and AIDS, and Covid 19.
- The presence of migrant construction workers may lead to an increase in activities such as prostitution and promiscuous behaviour.
- There will be pressure on the available health facilities, especially during the construction stage, due to the likelihood of injuries and other diseases. This may worsen the already deteriorating health care delivery system, especially in the underserved communities.

Socio-environmental impacts:

- Fire and explosions - During the construction process, there could be uncontrolled fires, particularly when construction activities are undertaken in the dry season. Such fire explosions may be because of the following:
 - Poor management of highly inflammable liquids and other materials along the pipeline route. This could result in situations where for instance, bush burning is undertaken at farms closer to the pipeline route or a construction worker or even a nearby farmer smoking cigarette recklessly without much regard to fire outbreak. Other activities such as rat chasing, and alcohol breweries can also result in fire outbreaks if not well regulated and monitored.
 - Construction and digging activities can result in situations where frictional contacts of metallic objects with rocks and other materials can spark a fire, and this could explode with nearby explosives if they are available.
- Waste management - The project could result in a relatively high generation of waste discharges which may affect public health. Various types and quantities of wastes are expected to be generated during pipeline construction and operations. Solid waste generation at the project site is expected to consist mainly of office waste, domestic waste, and other waste such as plastic packaging. Leftover refuse has the potential to attract rodents, flies, and vermin, which are vectors of diseases. If not well managed, waste generated could have serious health and safety implications for the populace. This impact without the implementation of mitigation measures is high as the magnitude is moderate and will occur throughout the life of the project. It is anticipated that appropriate waste management strategies will be instituted during project implementation.

6.4.7 Traffic

Construction traffic impacts were assessed in two contexts:

- The affect the construction traffic would have on the existing public road network and
- The affect pipeline road crossings would have on traffic using the road when road traverses the road right-of-way

Traffic impacts during construction will result from the delivery and use of the by construction equipment to prepare the pipeline right-of-way, delivery of material and the commuting of construction employees to the active construction zone. At the peak of construction, approximately 100 workers will need to access the constriction zoned from a camp. Trip generation is estimated at 4 vehicle trips, (30 workers for bus assumed) and 4 construction related trucks (equipment and materials) during the start and end of the construction day. Additional trips are anticipated, including deliveries of equipment and materials during the day.

While the capacity of the roads is limited due to the number of lanes and surface conditions, the number of trips can be accommodated on the roads that provide access to the site due to the number of background trips that currently use the road network. Road use and resulting level of service will be limited due to the potential for construction workers and equipment to be coming from either the port or camp and the fact that the use of roads will be temporary since construction activity and related trip generation will migrate onto other roads as the construction activity moves along the 6.5 km route over a 6-month timeframe.

Limited degradation of the road surface may occur due to increased use. Assuming grading occurs prior to and during construction if needed, the surface conditions can be maintained for both project and construction use.

Access to the pipeline right-of-way and back to the public right-of way has the potential to cause vehicle and pedestrian accidents due to turning movements. The construction zone signage placed in both directions along

the road will reduce the potential for accidents. Similarly, the use of signage along the approaches to the camps will warn the public right-of-way users of additional traffic and turning movements into and out of the camps.

Pipeline construction across public road right-of-way crossings also has the potential to adversely affect public right-of-way users as they approach the construction zone.

6.5 Impacts from Operations

It is expected that the impacts will be minor during the operation of the proposed pipeline to the Prestea GCP and Liquefaction Facility. This 6.5km pipeline, which is buried underground, is the most efficient way to deliver natural gas to the Facility in an environmentally friendly manner.

Because pipelines deteriorate over time, it is expected that proper maintenance activities on the pipeline and gas stations will be carried out to ensure the complete elimination of the risk of leakage, cracking, splitting, or rupturing, which will eliminate the risk of explosion and disruption in power supply to the Prestea GCP. Measurable impacts, on the other hand, may be recorded in cases where the ground where buried pipes must be accessed in order to repair a leak or ruptured section of the pipe.

Sections of the pipeline that remain above ground may be vulnerable to vandalism and accidents, raising community health and safety concerns. Furthermore, areas of the pipeline, particularly those near mining communities, may be degraded as a result of illegal mining known colloquially as galamsey. In light of this, emergency measures to address pipeline safety concerns and illegal mining encroachment will be completed and implemented to ensure adequate preparedness for all such emergency situations.

Decommissioning and closure will have little impact on the study area roadways. Construction-type equipment and trucks to haul decommissioned material will be required. Regulating and metering stations and block valves do not comprise a lot of equipment, so the numbers of construction equipment and trucks are considered minimal. The same precautions and mitigation recommended during construction are also recommended during decommissioning within and adjacent to public road right-of-way. Decommissioning of the pipeline will not incur significant impacts since almost all of the pipeline is located on an independent right-of-way and not parallel and adjacent to public road right-of-way. Decommissioning vehicles will need to exercise care when entering and exiting the pipeline-public road right-of-way intersections. Construction camps are likely to be repurposed.

6.6 Cumulative Impacts

Cumulative impacts are those that will occur due to a combination of the project and other projects and activities that may result in the total impacts being greater than with the project alone. For each impact identified for the project, an analysis was performed to consider if other projects or activities ongoing in the region will contribute to the same effects present within the spatial and temporal extent associated with the project itself.

Surface water determined to potentially be subjected to cumulative impacts (currently or in the future).

6.6.1 Surface Water

The cumulative impacts to the water resources where crossings will take place, are related to increased sedimentation if erosion occurs. However, the water resources are mostly within extensively developed areas and the cumulative impacts are unlikely to be significant.

7.0 IMPACT MITIGATION

GEGL has developed several internal standards that address the measures the company intends to take to promote and manage environmental stewardship and social well-being. These standards, along with a variety of mitigation measures described herein, will guide GEGL's efforts to minimise, control, and where practicable, avoid adverse impacts during the construction, and operational phases of the project. The mitigation measures will also be implemented to maximise, where possible, the benefits associated with the project implementation. For each phase of the project, several factors were considered by GEGL in developing mitigation measures:

- What design techniques can be used to avoid the impact (e.g., interception method for river crossings)?
- What alternative methods can be used to avoid the impact?
- What methods can be used to minimise the impact (e.g., use dust suppression during construction during drier days)?
- What methods can be used to rehabilitate/repair an impact (e.g., reclaim an area after disturbance)?
- What actions can be undertaken to compensate for unavoidable impacts?
- What actions can be undertaken to ensure a positive, lasting long-term effect is realised?
- What can be done to ensure sustainable development occurs (e.g., while GEGL benefits from the project, measures will be put in place to ensure continued environmental stewardship and community well-being)?

The mitigation measures developed for the identified impacts in Chapter **Error! Reference source not found.**

7.1 Air Quality

Dust and particulate emissions to the atmosphere will be mitigated during the construction phase by the application of the following:

- Wet suppression (wet misting during material handling activities):
 - Covering or keeping construction material / stockpile heights as low as practicable to reduce their exposure to wind erosion and thus dust generation
 - Progressive rehabilitation and re-vegetation of areas when available
 - Reduction in unnecessary traffic volumes
- There will be routine inspections to identify areas of unpaved roads that are increasingly dusty. Maintenance work to be undertaken on these areas including watering, application of dust suppressants, compaction, dust removal and/or utilisation of soil aggregate
- Rigorous speed control and the institution of traffic calming measures to reduce vehicle entrainment of dust. A maximum speed limit will be set on all unpaved roads
- All equipment will be well maintained and in good working order to ensure that emissions are kept to a minimum
- The area to be disturbed will be minimised

During the operational phase, VOC emissions will be managed by:

- The pipeline and all associated fixtures will be well maintained to ensure that emissions are kept to a minimum

- A fiber optic cable will be provided beside the underground pipeline to detect leakage and rupture should they occur

No additional mitigation is proposed during the operational phase other than GIIP, which may include the mitigation measures provided for the construction phase impact.

7.2 Noise

To minimise potential noise impacts arising from the construction and operational phases of the project, the following mitigation measures will be implemented:

- The number of simultaneous activities will be minimised to as far as possible when working near a potential sensitive receptor
- Communication channels will be established between GEGL management and potential sensitive receptors, including the following information but not limited to:
 - Proposed working times
 - How long the activity is anticipated to take place
 - What is being done, or why the activity is taking place
 - Contact details of a responsible person where any complaints can be lodged should there be an issue of concern.
- A drop height policy will be implemented onsite to reduce the level of noise generation when handling materials. All equipment operators will be trained in the policy
- A maximum speed limit will be set on all unpaved roads
- A traffic management plan will be developed to optimize vehicle usage and movement
- The receipt of materials will occur during non-peak traffic hours to avoid traffic build-up and associated noise
- Equipment with the lowest possible sound power levels will be selected for the project
- Equipment will be is well maintained and fitted with the correct and appropriate noise abatement measures
- All vehicles and other equipment will be maintained and serviced regularly to ensure that the noise levels are reduced
- Vehicles will not be allowed to idle for more than 5 minutes when not in use
- A berm and/or tree screens will be provided by SR11 to minimize noise at SR11 from the source

7.3 Soil and Land Use

Degradation of soil quality and loss of soil as resource and land use change will be mitigated as follows:

- The project footprint will be minimised and areas to be disturbed will be clearly marked.
- The surface footprints will be minimised to the extent possible and heavy machinery and heavy truck access to sensitive soil areas will be restricted. Lighter machinery will be used during soil handling. Here, lighter machinery refers to machinery typically used in the agricultural industry for soil handling.

- Soil conservation measures will be implemented (e.g., segregation, proper placement and stockpiling of clean soils and overburden material for site remediation)
- Disturbed areas (other than permanent disturbances such as the pipeline trench) will be restored where possible to original contours and drainage lines.
- Inform relevant personnel regarding the handling of soils and consider demarcating and indicating areas intended for stockpiling of topsoil with signage or noticeboard.
- Stockpile side slopes will be limited to 1 in 4 (or gentler where practically possible), and the top edges will be rounded.
- A runoff containment berm will be placed down-gradient of the stockpile to capture runoff, the transported soil will be allowed to settle and subsequently recovered.
- Topsoil stripped from the site will be managed as follows:
 - Stockpiled for rehabilitation
 - Irrespective of where topsoil is stockpiled, it will be reused or kept moist and vegetated as soon as possible.
 - Topsoil stockpiles will be kept low (between 3 and 5 meters tall). It is recommended that the top 50cm of soil be stripped, where the soils are deep enough, and relocated by truck along set removal paths.
 - Stripping will not occur in wet conditions.

Soil contamination by hydrocarbons and other chemical spills and improper waste disposal will be mitigated as follows:

- GEGL will observe proper handling and storage of hazardous chemicals and materials (e.g., fuel, oil, cement, concrete, etc.) as per their corresponding Safety Data Sheets.
- Vehicles and equipment will be maintained regularly, and maintenance activities will be carried out in designated facilities fitted with spillage containment, floors, and sumps to capture any fugitive oils and greases.
- Regular site inspections will be carried out for materials handling and storage.
- Detailed procedures for spills containment and soils clean-up will be developed for implementation on-site.
- Environmental inspections and auditing will be carried out.
- Wastes will be classified into streams to enable appropriate segregation, handling, transport, disposal and recycling/ reused in a manner appropriate to the waste.

Soil erosion mitigation measures include:

- Land clearance activities will be stopped during heavy rainfall.
- Access road gradients will be limited to reduce run-off-induced erosion.
- Vegetation cover will be increased upwind of cleared and exposed areas such as the RoW area.
- Closed areas such as access roads and lay down areas will be ripped, replaced with soil, and revegetated following completion of construction works.

While all development involves some soil compaction, moist soils have less resistance to compaction than dry soils do. The best approach to prevention of soil compaction is thus the avoidance of all unnecessary pressure-inducing operations, limiting the areas of necessary pressure-inducing operations and undertaking these actions when the soil is dry.

The soil compaction mitigation measures include:

- Essential road routes will be pre-defined and clearly demarcated and adhered-to during all phases of the project to restrict soil compaction.
- Vehicles will not drive on soil when it is wet to avoid further soil compaction.
- Soils will not be stripped when they are wet.

7.4 Surface Water

Reduced flow diversion of the water courses will be mitigated by the following:

- Downstream users will be informed that river flow may be limited/changed for a short time
- Diversion of water resources will be done only once relevant authorisations have been received, climatic conditions for the proposed construction period are known, and construction materials and the pipe are at the site and ready for installation.
- The diversion will be undertaken outside of a rain event, and this will involve assessing the climatic conditions for the period of construction

Sedimentation of surface water bodies will be mitigated by the following:

- Construction will be undertaken outside a rain event as far as possible to limit erosion
- Riverbanks and bed will be rehabilitated as soon as the trench is backfilled and compacted by introducing the natural vegetation on the banks, or including gabions as needed, and replace instream habitat such as rocks and vegetation that was removed
- The trench line will be maintained to ensure erosion is limited until vegetation is re-established

Changes to the water chemistry will be mitigated by the implementation of the following measures:

- Machinery will be maintained in good working order
- Good housekeeping will be maintained at the site to ensure that any hydrocarbon spills are dealt with adequately to ensure that run-off or river flow is not contaminated, and if necessary, contaminated soil is removed for disposal at an authorised disposal site or remediated to regulatory requirement

7.5 Biodiversity

Loss/disturbance of ecosystems of concern will be mitigated by the following:

- Micro-routing of the final pipeline alignment will be undertaken to minimise its footprint as it traverses across areas of Freshwater Swamp and protected areas i.e., forest reserves; and avoid mature specimens of tree species of conservation concern.
- Protected plant species search, and rescue surveys will be done in advance of clearance of the final pipeline footprint. Where possible, protected plant specimens will be dug out and maintained in a nursery, for use in rehabilitation activities, particularly in protected areas. In addition, seeds or propagules will be

harvested from indigenous species for generation of new plants in the nursery for rehabilitation activities. The nursery will be established in proximity to the construction camp to avail of water resources for the duration of plant maintenance prior to rehabilitation.

- Areas to be cleared will be demarcated prior to the commencement of vegetation clearing and keep cleared areas to a minimum.
- All construction staff will be provided with environmental awareness training to ensure that basic environmental principles are adhered to.
- The construction campsites, lay-down and other temporary storage areas will be in already disturbed habitats, such as cultivated or fallow fields and these will be clearly demarcated.
- The construction of new vehicle access tracks will be kept to the barest minimum and the use of existing roads/tracks will be encouraged. Track routes will be selected in such a way as to minimize any damage to natural habitats.
- Vegetation clearance will be done via mechanical means and the use of herbicides will be restricted.
- Removal of stream bank vegetation will be avoided as much as possible.
- Cutting of trees will be done by a certified timber contractor, and strictly in line with the prescribed safety guidelines. The landing area of falling trees will be carefully selected to minimize damage to farms. Adequate warning will be given to ensure that public safety is not compromised.
- Active revegetation of freshwater swamp areas and other areas of natural habitat will be undertaken to rehabilitate the vegetation cover in areas where construction activity have taken place (i.e., pipeline footprint, laydown areas, temporary access routes).
- Direct and indirect losses of natural and critical habitats will be quantified once the final pipeline alignment is determined, and offsetting via compensation or other conservation actions that ensure that no net loss is sustained, in accordance with lender's requirements.
- Rehabilitation of affected vegetation communities/bare areas following completion of construction work will be implemented.
- A Biodiversity Management Plan will be developed for project implementation.

Loss of flora of SoCC will be mitigated by the following:

- Wherever possible, micro-routing of the final pipeline alignment will be undertaken to minimise impact on SoCC.
- A pre-construction walk-down of planned clearing/development footprints will be undertaken to identify species of concern that can be translocated if necessary.
- Flora SoCC within the development footprint that require relocation will be demarcated and labelled .
- No flora SoCC will be translocated or disturbed without the permission of the Environmental Manager, and appropriate permits in place.
- Collection of propagules including seeds, cuttings and seedlings of species identified for specific conservation actions will be conducted to preserve genetic diversity of SoCC. These will be cultivated in a nursery and replanted in areas of the Study Area that are proposed for rehabilitation

- The nursery will be established in proximity to the construction camp to avail of water resources for the duration of plant maintenance prior to rehabilitation. It will include suitable shaded areas for growth of seedling plants and will be built and run under the supervision of an appropriately experienced horticulturalist.
- Rehabilitation of affected vegetation communities/bare areas following completion of construction work will be implemented.
- A Biodiversity Management Plan will be developed for project implementation

Disturbance/contamination of aquatic ecosystems during pipeline construction will be mitigated by the following:

- An aquatic ecosystem baseline assessment will be undertaken prior to construction, for use as a baseline to monitor any construction impacts on aquatic communities downstream of the pipeline crossing
- A detailed construction method statement will be developed for river and wetland crossings, defining the requirements to contain construction equipment within the construction footprint, to minimise compaction of wetland soils, to reinstate any clay layers and replace soils in the correct order and to return the wetland to the same profile that existed before construction
- The construction footprint across aquatic ecosystems will be demarcated to prevent inadvertent damage outside of this footprint
- Riparian/wetland vegetation clearance will be minimised for the pipeline crossing to the smallest possible footprint
- If possible, directional drilling will be used beneath aquatic ecosystems for the construction of pipelines
- Access to personnel outside of the defined project work sites and access roads will be prohibited. Personnel will be trained to understand the sensitivity of the local environment in induction and during toolbox meetings
- Erosion protection measures will be in place during construction to minimise runoff from disturbed areas into aquatic ecosystems
- Ensure that All vehicles and machinery will be maintained in sound mechanical order, do not have any oil leaks and are fitted with appropriate mufflers to minimise nuisance affecting wildlife
- Pumps, generators, or other equipment containing oil used to manage water at the aquatic ecosystem crossings will be located on impervious plastic sheeting or drip trays
- Refueling of equipment within 100 m of an aquatic ecosystem will be prohibited
- The use of backfill intended to provide firm footing for vehicles in wetlands will be minimized. Measures to ensure that diffuse flow of water in aquatic ecosystem being crossed is maintained will be implemented.
- Mechanical weed control will be used instead of chemical weed control wherever possible
- The use of chemicals in the control of pests, rodents, snakes etc. around the project site and settlement areas will be avoided
- In situations where chemical control is inevitable, spot application strategy in chemical application will be adopted instead of the broadcast method in order to minimize exposure to non-targeted plants and animals.
- A Biodiversity Management Plan will be developed for project implementation

Erosion due to vegetation clearance will be mitigated by the following:

- A rehabilitation and re-vegetation plan will be developed prior to construction, and will include provision for monitoring for and managing incidences of erosion
- Regular monitoring of the site during construction for issues with erosion will be undertaken
- Construction activities will be undertaken during the dry season, when the soil moisture is low, and the risk of damaging/compacting soils is lowest
- Topsoil should be removed and stored separately and will be reapplied in the pipeline construction footprint as soon as possible to encourage and facilitate rapid regeneration of the natural vegetation on cleared areas
- Revegetation of exposed areas will be undertaken following completion of construction activities.
- Dust suppression methods such as use of the water bowser should be implemented in and around the construction site regularly, particularly during the dry season

Introduction of alien and invasive species will be mitigated by the following measures:

- A project-specific alien invasive management plan will be developed and implemented on-site during all phases of the project. The plan will include provision for:
 - Identification of all alien invasive species observed on-site with emphasis on particularly aggressive species
 - Identification of priority areas of alien invasive species control
 - Species specific control methods
 - Alien invasive species monitoring and roll-out of follow-up treatments
- Only plants and seeds collected on-site from locally occurring indigenous flora species will be used for revegetation/rehabilitation of construction-affected areas.

Loss and disturbance of fauna of SoCC will be mitigated by the following:

- Undertaking targeted surveys of the Anhwiaso East Forest Reserve as well as Afram headwaters, Apamprama Forest Reserve and lake Bosomtwe to confirm the presence and abundance of the globally and nationally protected species. Based on these surveys, it will be determined whether these forest reserves will be categorized as critical habitat
- Access to personnel outside of the defined project work sites and access roads will be prohibited. This will reduce disturbance associated with construction activity (presence of people and heavy machinery), to faunal species of conservation concern – particularly in the protected areas
- Personnel will be trained to understand the sensitivity of the local environment in induction and during toolbox meetings. Hunting activity by construction staff will be prohibited
- Targeted searches for less mobile fauna species of conservation concern confirmed or with high probability of occurring within the Project footprint (e.g., Bosman's potto) will be conducted prior to commencement of clearance activities to allow conservation trapping and relocation to take place and avoid mortalities of these species

- Conservation trapping and relocation of fauna will only take place under the guidance of the national nature conservation authority, and with the appropriate permits in place. This process will be initiated timeously to avoid construction schedule delays, should the presence of fauna species requiring conservation/relocation become apparent.
- Measures to minimise impacts arising from sensory disturbance caused by human presence and mechanical noise generated during construction activity will be implemented, particularly for the highway diversion works. These will include restrictions in operating hours for heavy machinery, use of low-pitched reverse alerts, and restriction of access for road construction workers to areas beyond the road upgrade right of way.
- Speed limit within the construction footprint will be restricted, particularly in areas adjacent or within protected area (i.e., Anhwiaso East Forest Reserve, Afram headwaters Forest Reserve, Apamprama Forest Reserve, and lake Basomtwe).
- An ecological clerk of works should be employed by GEGL to supervise clearance and construction works and stop work where necessary (e.g., a breeding/nesting site of a species of conservation concern is discovered) so that the appropriate conservation measures can be undertaken.
- A Biodiversity Management Plan will be developed for project implementation

Habitat fragmentation and barriers to movement will be mitigated by the following:

- Habitat restoration through active revegetation will be undertaken to restore habitat connectivity
- Reduced impact clearing and construction techniques will be adopted and where possible such areas will be avoided
- Rehabilitation through planting of appropriate plant community will enhance connectivity and prevent potential invasion of pioneer invasive species
- Rehabilitation of such areas will emphasize the use of species of the characteristic flora community
- A Biodiversity Management Plan will be developed for project implementation

Increased human presence and activity will be mitigated as follows:

- GEGL will enforce a complete ban on wildlife harvesting (hunting/trapping/fishing) for all project personnel, including any such activities by any person with access to the pipeline servitude during operation
- Worker and community education programs, which focus on the impacts and risks of bush meat hunting and consumption (e.g., diseases like Ebola and the current novel COVID-19) will be developed to contribute to the alleviation of hunting pressure on fauna species and reduce local people's reliance on consumption of bush meat, and the associated health risks
- An Influx Management Plan for the project will be considered to manage access control, prevent unplanned growth in housing development near the pipeline route, at the same time reducing pressure on ecosystems of concern and associated species for provision of natural resources
- There will be awareness creation and sensitization notices of existing statutory access restrictions for forest reserves

- To restrict use of the servitude as an access corridor into forested areas, a physical barrier (trench or earthen berm) will be placed across the pipeline servitude at the points at which it enters/exits the protected areas.

The RoW will not be fenced-off during operation to minimize hindrances to the movement of fauna and flora species within the RoW.

Impact on flora during maintenance activities will be mitigated as follows:

- The use of chemical herbicides during vegetation clearance will be avoided
- Invasive alien species will be uprooted and burnt once spotted
- Native rare plants will be replanted in buffer zones to prevent extinction
- All vegetation clearance will be done manually/mechanically

7.6 Socio-Economic

Based on the social impacts which have been identified and assessed, the following measures are proposed to be implemented to mitigate the negative impacts identified and maximise the positive impacts.

- Operations to be limited within the limits of the RoW.
- Community infrastructure and sustainable livelihood will be improved through CSR, and other interventions.
- As much as possible some community members will be employed to build their capacity which will ultimately boost the local economy.
- People from the neighbouring communities will be employed during the construction activities to avoid/minimise influx of external job seeker.
- A mechanism will be put in place to ensure that there is food supply to the construction workers to reduce food shortages in the local markets.
- GEGL will consider non-cash compensation schemes such as negotiating for increased land sizes, especially for food crop farmers who will be affected.
- There will also be prompt payment of compensations schemes.
- GEGL will honour the payment of taxes, royalties, ground rents, and other financial obligations to individuals, traditional councils, and mandated statutory bodies.
- The movement of workers between the site and the camps will be controlled to minimise loitering around the project facility by providing scheduled transportation services.
- Adequate signages will be provided along the roads to warn motorists of the construction activities taking place on site.
- All key stakeholders such as community representatives and leadership will be engaged in the planning and implementation of the project to ensure that all likely concerns, risks, and inputs are factored throughout the project cycle.

Potential fires and explosions will be mitigated by the implementation of the following measures:

- Fire extinguishers will be provided at strategic locations along the pipeline route.

- There will be frequent inspections of the pipeline route and associated facilities.
- Community members, employees, and visitors will be educated and trained on fire hazards, prevention, and use of fire equipment.
- A pipeline leak detection system will be installed on the pipeline to identify gas leaks while continuous monitoring will be undertaken in the control rooms.
- There will be clear demarcation, frequent clearing of the RoW and sensitisation of residents on the potential risk of hunting with fire within the RoW.

7.6.1 Customary Rites for Sacred Areas

GEGL's Policy Statement ensures that all customary and religious rites are performed as tradition demands before any activity is carried out by the company or its contractors within an affected community. Rites to pacify the gods will be performed solely by traditional leaders, in the presence of representatives from the company, its contractors, and other community members. Items typically required for the performance of these rituals include crates of eggs, sacrificial animals, schnapps and other drinks, cash, and other items as demanded by the traditional authorities for the ritual. It is believed that non-observance of rituals would thwart any activity in the area, and in some rare cases, cause retribution on workers evoked by the gods.

7.7 Traffic

Traffic impact mitigation is largely comprised of safety-related activities since the pipeline route is almost exclusively located within an independent right-of-way in rural areas. Since trip generation related to construction operations, maintenance, and decommissioning vehicles is modest, mitigation is mostly associated with the locations where the pipeline will cross public right-of-way.

- The condition of unimproved and improved unpaved roads will be assessed prior to construction commencement and grade the roads if required to ensure safe transit of construction workers, equipment, and material deliveries
- A Maintenance of Traffic Plans will be prepared for each public road crossing. Plans will be in accordance with Ghana regulations and guidelines and any other commitments made by project stakeholders
- Once the Plans are approved, a signage will be installed in accordance with the Plans prior to construction
- Flagmen will be used to control traffic where open cut of the road is planned or when line of sight is limited
- Public notice to affected communities will be provided if pipeline constriction across a road is open cut and maintenance of one lane of traffic is not possible
- For open cut crossings, steel plates will be used if construction cannot be completed in one day and flagmen and not present
- Access (ingress and egress) of the pipeline right-of-way will be located where line of sight is sufficient to minimize accident potential between construction vehicles and public right-of-way users
- Access (ingress and egress) to construction camps and construction staging areas will be located where line of sight is sufficient to minimize accident potential between construction vehicles and public right-of-way users
- Signs will be posted along public road right-of-way prior to construction camps and construction staging area access drives to warn the public of project related vehicle movements

8.0 IMPACT MITIGATION

GEGL has developed several internal standards and measures the company intends to take to promote and manage environmental stewardship and social well-being. These standards, along with a variety of mitigation measures described herein, will guide GEGL's efforts to control environmental and social impacts associated with the project through reducing, rectifying, minimising and where practicable, avoiding adverse impacts during the construction, and operational phases of the project. The mitigation measures will also be implemented to maximise, where possible, the benefits associated with the project implementation. For each phase of the project, several factors were considered by GEGL in developing mitigation measures:

- What design techniques can be used to avoid the impact (e.g., reducing the number of generators to minimise emissions)?
- What alternative methods can be used to avoid the impact?
- What methods can be used to minimise the impact (e.g., use dust suppression during construction during drier days)?
- What methods can be used to rehabilitate/repair an impact (e.g., reclaim an area after disturbance)?
- What actions can be undertaken to compensate for unavoidable impacts?
- What actions can be undertaken to ensure a positive, lasting long-term effect is realised?
- What can be done to ensure sustainable development occurs (e.g., while GEGL benefits from the project, measures will be put in place to ensure continued environmental stewardship and community well-being)?

The mitigation measures developed for the identified impacts in Chapter 6.0.

8.1 Soil and Land Use

Degradation of soil quality and loss of soil as resource and land use change will be mitigated as follows:

- The project footprint will be minimised and areas to be disturbed will be clearly marked.
- The surface footprints will be minimised to the extent possible and heavy machinery and heavy truck access to sensitive soil areas will be restricted. Lighter machinery will be used during soil handling. Here, lighter machinery refers to machinery typically used in the agricultural industry for soil handling.
- Soil conservation measures will be implemented (e.g., segregation, proper placement and stockpiling of clean soils and overburden material for site remediation).
- Disturbed areas (other than permanent disturbances such as the pipeline trench) will be restored where possible to original contours and drainage lines.
- Inform relevant personnel regarding the handling of soils and consider demarcating and indicating areas intended for stockpiling of topsoil with signage or noticeboard.
- Regular inspections will be undertaken to assess erosion and sediment migration from stockpiles. Where unacceptable rates of erosion are identified, remedial works will be undertaken, or the stockpile will be relocated.
- A runoff containment berm will be placed down-gradient of the stockpile to capture runoff, the transported soil will be allowed to settle and subsequently recovered.

- Access roads will have gradients or surface treatment to limit erosion and road drainage systems will be provided
- Topsoil stripped from the site will be managed as follows:
 - Topsoil stripped will be stockpiled for rehabilitation
 - Irrespective of where topsoil is stockpiled, it will be reused or kept moist and vegetated as soon as possible.
 - The area to be stripped will be clearly demarcated to prevent stripping beyond the demarcated boundary.
 - Topsoil stockpiles will be kept low (between 3 and 5 meters tall). The top 30cm of soil will be stripped, where the soils are deep enough, and relocated by truck along set removal paths.
 - Stripping will not occur in wet conditions.
 - Within each stripping unit, segments will be stripped progressively to ensure that the haul truck used to move the soil does not drive over the area to be stripped, but rather behind it on the basal layer, to avoid compaction and degradation of the topsoil properties (Humphries Rowell Associates, 2000).

Soil contamination by hydrocarbons and other chemical spills and improper waste disposal will be mitigated as follows:

- GEGL will observe proper handling and storage of hazardous chemicals and materials (e.g., fuel, oil, cement, concrete, etc.) as per their corresponding Safety Data Sheets (SDS).
- Vehicles and equipment will be maintained regularly, and maintenance activities will be carried out in designated facilities fitted with spillage containment, floors, and sumps to capture any fugitive oils and greases.
- Regular site inspections will be carried out for materials handling and storage.
- Detailed procedures for spills containment and soils clean-up will be developed for implementation on-site.
- Environmental inspections and auditing will be carried out.
- Adequate waste disposal facilities will be provided, and wastes will be classified into streams to enable appropriate segregation, handling, transport, disposal and recycling/ reused in a manner appropriate to the waste.

Soil erosion mitigation measures include:

- Land clearance activities will be stopped during heavy rainfall.
- Access road gradients will be limited to reduce run-off-induced erosion.
- Vegetation cover will be increased upwind of cleared and exposed areas.
- Closed areas such as access roads and lay down areas will be ripped, replaced with soil, and revegetated following completion of construction works.

While all development involves some soil compaction, moist soils have less resistance to compaction than dry soils do. The best approach to prevention of soil compaction is thus the avoidance of all unnecessary pressure-

inducing operations, limiting the areas of necessary pressure-inducing operations and undertaking these actions when the soil is dry.

The soil compaction mitigation measures include:

- Essential road routes will be pre-defined and clearly demarcated and adhered-to during all phases of the project to restrict soil compaction.
- Vehicles will not drive on soil when it is wet to avoid further soil compaction.
- Soils will not be stripped when they are wet.

8.2 Air Quality

Dust fallout, PM₁₀ and PM_{2.5} emissions to the atmosphere will be mitigated during the construction phase by the application of the following:

- Wet suppression (wet misting during material handling activities):
 - Covering or keeping construction material / stockpile heights as low as practicable to reduce their exposure to wind erosion and thus dust generation.
 - Progressive rehabilitation and re-vegetation of areas when available.
 - Reduction in unnecessary traffic volumes.
- There will be routine inspections to identify areas of unpaved roads that are increasingly dusty. Maintenance work to be undertaken on these areas including watering, application of dust suppressants, compaction, dust removal and/or utilisation of soil aggregate.
- Rigorous speed control and the institution of traffic calming measures to reduce vehicle entrainment of dust. A maximum speed will be set on all unpaved roads.
- All equipment will be well maintained and in good working order to ensure that emissions are kept to a minimum.
- The area to be disturbed will be minimised.

Dust fallout (PM₁₀ and PM_{2.5}) and gaseous emissions (SO₂, NO₂, CO and VOC) from gas engines and hot oil system will be mitigated during the operational phase by application of the following:

- All engines will be maintained and serviced regularly to ensure that emissions are kept to a minimum.
- Engines will be switched off when not in use.

VOC emissions from storage tanks and during loading and offloading of tanks will be mitigated during the operational phase by the following:

- A stable tank pressure and vapour space will be maintained.
- Tanks will be cleaned periodically.

8.3 Noise

Noise during the construction phase is predicted to be negligible at most sensitive receptors. However, to further minimise noise, noise controls must be implemented during construction activities. To minimise potential noise

impacts arising from the construction and operational phases of the project, the following mitigation measures will be implemented:

- When working near a potential sensitive receptor, the number of simultaneous activities will be limited to a minimum as far as possible.
- Communication channels will be established between construction management and potential sensitive receptors, including the following information but not limited to:
 - Proposed working times.
 - How long the activity is anticipated to take place.
 - What is being done, or why the activity is taking place.
 - Contact details of a responsible person where any complaints can be lodged should there be an issue of concern.
- A drop height policy will be implemented onsite to reduce the level of noise generation when handling materials. All equipment operators will be trained in the policy such that drop height reduction is implemented onsite.
- A maximum speed will be set on all unpaved roads.
- Plans will be developed to optimise vehicle usage and movement, which will ensure a reduction in unnecessary traffic volumes.
- Construction materials will be received during non-peak traffic hours to avoid traffic build-up and associated noise.
- The smallest/quietest equipment will be used for the particular purpose.
- Equipment will be well maintained and fitted with the correct and appropriate noise abatement measures.
- All vehicles and other equipment will be maintained and serviced regularly to ensure that the noise levels are reduced.
- Vehicles will not be allowed to idle for more than 5 minutes when not in use.

8.4 Surface

Sedimentation of water bodies will be mitigated by the following:

- Site clearance will be undertaken only a short time before construction materials arrive at the site and construction starts, so that the time of leaving the land unvegetated is kept to a minimum.
- Berms will be constructed around the site to minimise the occurrence of sediments in run-off from the site.
- Site clearance, as far as practicable will be undertaken during the dry season.
- Areas not required for infrastructure development will be rehabilitated (revegetation) as soon as possible once construction is complete.

Water contamination from hydrocarbon spills will be mitigated by the following:

- Good housekeeping will be maintained at the site to ensure that any hydrocarbon spills are dealt with adequately to ensure that run-off or river flow is not contaminated, and if necessary, contaminated soil is removed for disposal at an authorised disposal site or remediated to regulatory requirement.
- Machinery and equipment will be maintained in good working order.
- Spill kits will be maintained on site.
- Personal will be trained in spill response to enable prompt response and the implementation of appropriate actions should this occur.
- There will be adequate sloping and berm construction around the site to ensure that clean stormwater is routed away from the site, allowing uncontaminated natural flow to the Ankobra River.
- Well maintained bunded areas for hydrocarbon storage.

8.5 Groundwater

Contamination of groundwater due to leakages and spillages of hydrocarbons from vehicles and equipment will be mitigated by the following:

- Equipment and machinery will be inspected to be in good condition prior to use on site.
- Well-maintained construction vehicles and machinery will be used to avoid and/or minimize chemical leaks/spills that may cause contamination of groundwater resources.
- Vegetation clearance will be minimised or limited during construction to minimise the occurrence of pathways for seepages to groundwater.
- Pipeline excavation will be limited to depths above the groundwater table.
- Hazardous substances and materials will be contained in bunded areas.
- The installation of automated meters to measure the volume of products received and dispatched. Reconcile to identify product losses through leaks.
- Spill response procedure will be prepared, documented and the resources be readily available to control any spillage on site.

Acidification of groundwater and dissolution of trace metals will be mitigated by the following:

- Continuously monitoring the pipeline for prompt actions to be implemented.
- The pipeline will be regularly maintained in line with specifications from manufacturers to prevent the occurrence of spillages.
- The installation of automated meters to measure the volume of products received and dispatched. Reconcile to identify product losses through leaks.

8.6 Visual Amenity

The scope to visually mitigate the appearance of the project site during the construction phase and the infrastructure itself during operations is limited, given practical and technological/functionality constraints. However, the following measures will be implemented for project related buildings:

- Offices and workshop buildings will be painted in colours that are complementary to the surrounding landscape and areas around offices and camp facilities will be vegetated.

- Trees will be planted in all landscaped areas as far as practicable, as well as around plant infrastructure to break structural form and provide visual screens. Existing trees will be retained wherever possible.
- Construction sites will be maintained in a neat and orderly condition.
- Designated areas for material storage, waste sorting and temporary storage, batching and other potentially intrusive activities will be demarcated.

Formation of dust plumes will be mitigated by:

- Access roads and any large bare areas where dust is generated will be watered down during construction
- Speed limit on-site for all vehicles will be enforced especially on unpaved roads.
- GEGL will monitor air quality as per Chapter 9.0 to ascertain the effectiveness of the mitigation measure

Light pollution at night will be managed by the following:

- Security lighting (if feasible) that is movement activated will be used rather than permanently switched on, to prevent unnecessary constant illumination.
- Lighting requirements of the facilities will be planned to ensure that lighting meets the need to keep the site secure and safe, without resulting in excessive illumination.
- The height and angle of illumination from which floodlights are fixed will be reduced as much possible while still maintaining the required levels of illumination.
- Zones of high and low lighting requirements will be identified, focusing on only illuminating areas to the minimum extent possible to allow safe operations at night and/or for security surveillance.
- Up-lighting of structures will be avoided by rather directing lighting downwards and focused on the area to be illuminated.
- All security lighting will be fitted with 'blinkers' or specifically designed fixtures, to ensure light is directed downwards while preventing side spill. Light fixtures of this description are commonly available for a variety of uses and should be used to the greatest extent possible.

8.7 Biodiversity

Loss/disturbance of ecosystems of concern will be mitigated by the implementation of the following:

- Areas that will need to be cleared prior to the commencement of vegetation clearing will be demarcated and areas to be cleared will be kept to a minimum.
- Areas within the project area that are not intended for placement of project infrastructure will not be cleared.
- Environmental training will be incorporated into the induction training provided to staff before commencement of work and it will be ensured that all construction staff members are aware of, and adhere to, basic environmental principles.
- The construction campsites, lay-down and other temporary storage areas will be sited in already disturbed habitats, such as cultivated or fallow fields, and areas of natural habitat will be avoided.
- The construction of new vehicle access tracks will be kept to the minimum and the use of existing roads/tracks will be encouraged. Track routes will be selected in such a way as to minimize any damage to natural habitats.

- Vegetation clearance will be done via mechanical means and the use of herbicides will be restricted.
- Cutting of trees will be done by a certified timber contractor, and strictly in line with the prescribed safety guidelines. The landing area of falling trees will be carefully selected to minimize damage to farms. Adequate warning will be given to ensure that public safety is not compromised.
- Active revegetation of degraded or disturbed areas, including tree planting with indigenous species, will be undertaken to mitigate the reduction of vegetation cover in the project footprint.
- Direct losses of natural habitats will be compensated for via offsetting or other conservation actions that ensure that no net loss is sustained, in accordance with lender's requirements.
- Rehabilitation of affected vegetation communities/bare areas will be implemented following completion of construction work.

Loss of flora species of national conservation concern will be mitigated by the implementation of the following:

- A qualified botanist will be appointed to mark out those species that are suitable for translocation, which can be used in rehabilitation/re-vegetation activities.
- Flora SoCC will only be translocated or disturbed with the permission of the Environmental Manager, and with the appropriate permits in place.
- Collection of propagules including seeds, cuttings and seedlings of species identified for specific conservation actions will be conducted to preserve genetic diversity of SoCC. Where possible, these will be cultivated in a nursery and replanted in areas of the project area outside of the project footprint, that are likely candidates for rehabilitation activities.
- Rehabilitation of affected vegetation communities/bare areas will take place immediately following completion of construction work.

Disturbance/contamination of aquatic ecosystems will be mitigated by the implementation of the following:

- A pre-construction assessment of the aquatic ecosystem will be conducted prior to construction, for use as the status quo against which any construction impacts on aquatic communities downstream of the project site can be monitored.
- A stormwater management plan for the separation of clean and dirty water during construction will be implemented. Only clean water discharges will enter the environment.
- Access to personnel outside of the defined project work sites and access roads will be prohibited. Personnel will be trained to understand the sensitivity of the local environment in induction and during toolbox meetings.
- Erosion protection measures will be put in place during construction to minimise runoff from disturbed areas into aquatic ecosystems.

Erosion by will be mitigated by the implementation of the following:

- Removal of vegetation and construction activities will be limited to areas used for construction laydown, access roads and associated GCP infrastructure. Areas within the project footprint that will not be used for construction will not be cleared.
- A rehabilitation and re-vegetation plan will be developed prior to construction and will include provision for monitoring for and managing incidences of erosion.

- Regular monitoring of the site during construction will be undertaken to detect erosion problems.
- Topsoil will be removed from areas that need to be cleared and stored separately. These soils will be reapplied in areas requiring rehabilitation/revegetation as soon as possible to facilitate rapid regeneration of the natural vegetation on cleared areas.
- Rehabilitation and re-vegetation of disturbed areas will be undertaken following completion of construction activities.

Use of herbicides and pesticides will be mitigated by the implementation of the following:

- Mechanical weed control will be used instead of chemical weed control wherever possible.
- The use of chemicals in the control of pests, rodents, snakes etc. around the project site will be avoided.
- In situations where chemical control is inevitable, spot application strategy in chemical application will be adopted instead of the broadcast method in order to minimize exposure to non-target plants and animals.

Introduction of alien and invasive species will be mitigated by the implementation of the following:

- An alien invasive species management plan will be developed and implemented on-site during all phases of the project. The plan will include provision for:
 - Identification of all alien invasive species observed on-site with emphasis on particularly aggressive species.
 - Identification of priority areas for alien invasive species control.
 - Species-specific control methods.
 - Alien invasive species monitoring and roll-out of follow-up treatments.
- Only plants and seeds collected on-site from locally occurring indigenous flora species will be used for rehabilitation and re-vegetation activities.
- Unnecessary movement of vehicles and machinery within the project area will be limited.
- Regular washing and cleaning of vehicles and machinery in designated areas to prevent the spread of AIS seeds/propagules will be implemented.

Loss and disturbance of fauna SoCC will be mitigated by the implementation of the following:

- Access to personnel outside of the defined Project work sites and access roads will be prohibited. This will reduce disturbance associated with construction activity (presence of people and heavy machinery), to faunal species of conservation concern.
- Training will be provided to personnel to understand the sensitivity of the local environment in induction and ongoing toolbox talks. Any hunting activity by construction staff will be prohibited.
- Measures will be implemented to minimise impacts arising from sensory disturbance caused by human presence and mechanical noise generated during construction activity. These will include:
 - Restrictions in operating hours for heavy machinery.
 - Use of low-pitched reverse alerts.
 - Implementing speed limit onsite.

- An ecological clerk of works (EcoW) will be employed by GEGL to supervise clearance and construction works and stop works where necessary (e.g., a breeding/nesting site of a species of conservation concern is discovered) so that the appropriate conservation measures can be undertaken.

Increased human presence and activity will be mitigated by the implementation of the following:

- GEGL will enforce a complete ban on wildlife harvesting (hunting/trapping/fishing) for all project personnel, including any such activities by any contractor or visitors to the GCP project site.
- The development of worker and community education programs, which focus on the impacts and risks of bush meat hunting and consumption (e.g., diseases like Ebola), can contribute to the alleviation of hunting pressure on fauna species and reduce local people's reliance on consumption of bush meat, and the associated health risks.
- There will be awareness creation and sensitization notices of statutory access restrictions for forest reserves.

8.8 Socio-Economic

Employment opportunities will be enhanced by the implementation of the following measures:

- More than 90% of construction workers will be sourced from the local communities. Particularly, GEGL will take keen interest in ensuring that most of the labour are recruited from Heman, Brumasi and Ankobra.
- The employment processes will be fair, transparent, and non-discriminatory.
- The use of local labour as far as possible for contractual obligations will be maintained.
- Existing skills levels in the workforce will be recognised and individuals will be placed on formal career paths.

Increase in local economic activities will be enhanced by the implementation of following measures:

- Education and sensitization of local traders on the need to exploit local opportunities from the project by increasing production to meet the increasing demands.
- Measures will be put in place to ensure that, where possible, sub-consultant are employed or engaged from the local area.

Cost of living and local inflation will be mitigated by the following:

- Food, water, and other consumable needs of workers will be supplied by GEGL. These lines of items will be supplied by wholesale traders and the products will not be directly purchased from the local market where there is the possibility of increasing competing demands for the local people.
- Education and sensitization of local traders on the need to exploit local opportunities from the project by increasing production to meet the increasing demands.
- There will be a canteen facility at the plant site.

Livelihood changes will be mitigated by the implementation of the following measures:

- Education and sensitization of farmers and local labour on the need to exploit other positive opportunities associated with the project.

- Measures will be put in place to ensure that households members whose livelihoods will be affected are given priority in the employment opportunities.
- Education and sensitization of farmers and local people about opportunities surrounding the project (such as increasing production to meet the increasing demands).
- Sustainable livelihood through CSR, and other interventions.
- Prompt payment of compensations schemes.
- Royalties, ground rents, and other financial obligations to individuals, traditional councils, and mandated statutory bodies will be paid promptly.
- All key stakeholders will be constantly engaged on all community issues and concerns.

Population influx and demographic changes will be mitigated by the following:

- Community members will be employed during construction activities to avoid an influx of external job seekers.
- All key stakeholders will be constantly engaged on all issues relating to community influx.
- There will be education and sensitisation of community members in the PACs, and neighbouring communities.

Infrastructure and social amenities impacts will be mitigated by the following:

- GEGL will collaborate with local development partners and invest in key community infrastructure such as schools, roads, water and toilet facilities.
- GEGL will ensure that facilities such as boreholes and toilet facilities are constructed or available at the plant site during construction.
- There will be concrete steps to ensure that workers are housed in a separate camp with all the needed facilities to reduce the likelihood of workers competing with communities with the use of existing infrastructure.
- Workers will be educated and sensitised on the implications of their presence on community infrastructure.

Conflicts will be mitigated by the following:

- All key stakeholders on all will be constantly engaged on issues of community concerns, especially with employment.
- Some community members will be employed, build their capacity, and ultimately boost the local economy.
- Local traders will be educated and sensitized on the need to exploit local opportunities from the project by increasing production to meet the increasing demands.
- Measures will be put in place to ensure that, where possible, sub-consultant are employed or engaged from the local area.
- All relevant community stakeholders such as chiefs, assembly members and youth leaders will be involved on employment processes.
- Ensure that employment processes are free, fair, and transparent.

- GEGL will liaise with key stakeholders such as the municipal assembly and other industry players to explore opportunities which are likely to emerge from the GCP's value chain.

Psycho-social and sense of risk exposure will be mitigated by the following.

- All relevant health and safety measures will be strictly enforced during construction.
- Education and sensitization of workers, visitors, and community members on all likely social impacts of the project.
- Proper warning signs, notices and relevant communication mediums will be properly installed at all relevant places and machines with high-risk potentials.

Social vices will be mitigated by the following:

- Education and sensitisation of community members on potential social vices which are likely to emerge and the need for community members to be aware and take precautions.
- GEGL will liaise with the security and law enforcement agencies, other firms and stakeholders to strengthen the security system in the area. Emphasis will be placed on preventive mechanisms.
- Construction activities will be strategically planned to minimise overcrowding of workers at a particular area or community at a particular point in time.
- There will be concrete steps to ensure that workers are housed in a separate camp with all the needed facilities to reduce workers interactions with community members especially during the evenings

Cultural heritage impacts will be mitigated by the following:

- All key stakeholders will be constantly engaged on all issues of community concerns.
- There will be effective and continuous sensitisation of community members.

Vulnerable groups and PwDs impacts will be mitigated by the following:

- An appreciable quota will be reserved for identifiable vulnerable groups such as females. A careful consideration will be given to the nature of the job within the context of socio-physical and cultural conditions.
- As much as possible, special considerations will be given to PwDs in respect of interventions, compensations, and voluntary social support schemes.
- It will be ensured that thorough health and physical checks are undertaken before recruitment process to avoid the likelihood of selecting desperate job seekers who may have certain underlying conditions which has the likelihood of creating disability problems to them.
- There will be continuous sensitisation, awareness creation and capacity building for identifiable PwDs.

Food insecurity and access to resources will be mitigated by the following:

- Operations will be within the limits of the GCP project lease.
- Sustainable livelihood options will be improved through CSR, and other interventions.
- Community members will be employed during construction activities to avoid an influx of external job seekers.

- A mechanism will be put in place to ensure that foods are provided for the construction workers to reduce food shortages in the local market.
- GEGL will consider non-cash compensation schemes such as negotiating for increased land sizes, especially for food crop farmers affected by the project.

Diseases and infections will be mitigated by the following:

- There will be strict adherence to Covid- 19 protocols among all GEGL staff, contractors, and visitors.
- Stakeholders will be educated and sensitised about Covid- 19, and other sexually transmitted diseases

Health infrastructure impacts will be mitigated by the following:

- GEGL will consider adopting a private hospital within Prestea or Bogoso.
- GEGL will liaise with the municipal health directorate to designate more health workers into the area, especially at Prestea and Heman.
- GEGL will designate health personnel exclusively for workers and visitors of the facility in order to discourage resorting to the facilities in the communities.

Pollution and public health:

- There will be strict adherence to health, safety and environmental standards and protocols.
- GEGL will implement the mitigation measures for air quality, noise, water quality, soil, waste management strategies and other environmental management systems.
- Waste receptacles will be provided at vantage points of the site to minimise littering of nearby farms.
- There will be continuous sensitisation of communities, visitors, workers, and other stakeholders on waste management strategies.
- GEGL will liaise with other stakeholders such as the BML to ensure that the Brumase-Ankobra-Heman community roads are watered frequently.

Accidents and injuries will be mitigated by the following:

- Speed control measures will be developed and there will be strict implementation of the measures.
- There will be flagmen at strategic locations on the roads to control vehicular movements when heavy machines and trucks are moving to site.
- Innovative devices such as speed detectors will be fixed on all machines and cars to detect speeding and other irresponsible driving behaviours by drivers.
- Emergency lines will be boldly displayed on all GEGL vehicles and machines to enable whistle blowing and prompt complains.
- A traffic study will be undertaken for the project and a traffic management plan will be developed for the project.

Explosions will be mitigated by the implementation of the following measures:

- Fire extinguishers will be installed at strategic locations around the plant facility.

- Education and training will be provided to community members, employees, and visitors on fire hazards, prevention, and use of fire equipment and inflammable.
- Materials will be managed according to measures provided by manufacturers.
- There will be sensitisation of residents on the potential risk of hunting, with fire, within the plant area, and the site will be clearly demarcated to minimise unauthorised entry.

8.8.1 Customary Rites for Sacred Areas

Prior to project execution, other forms of rites will be performed occasionally at each stage especially when certain unforeseen or unexplainable circumstances occur that may be associated to spiritual or supernatural underpinnings. For instance, in a recent report of an increasing rate of machine breakdown on-site during the EIA studies, traditional leaders set aside a day known as 'Adiim Afiada' to offer sacrifices and pour libations "for the pacification of gods" to prevent future hindrances at the said area. Items for this special ritual included a cow, schnapps and drinks, yams, eggs, fowls, white clothes, and cash.

8.9 Mitigation for Impacts from Operations of the 6.5km Pipeline

As the proposed pipeline is constructed, operated, and maintained in accordance with its design, it will achieve the goal of zero significant incidents. As a result, the 6.5km pipeline will be built without posing a significant risk to the public's safety. The proposed pipeline has sufficient strength and wall thickness to withstand the maximum operating pressure specified in the design. This will be confirmed during the Hydrotest phase when the pipeline's strength will be tested.

To ensure that these conditions are not violated, GEGL will implement corrective, preventive, predictive and proactive maintenance practices to troubleshoot and/or repair issues from the operation of the pipeline including leakage or rapture as soon as possible in order to prevent the occurrence of a major incident. In addition, GEGL will only use trained personnel to operate and properly carry out periodic monitoring and inspection on the pipeline RoW.

To prevent accidental damage from encroachment by farmers and galamsey operators, as well as pipeline vandalism, GEGL Operations and Maintenance team stationed in some communities will partner up with community leaders, particularly youth leaders, to patrol the pipeline on a regular basis and report any intrusion detected on the pipeline right of way. The Ghana Police Service will be called in to provide security in areas where galamsey is prevalent.

GEGL will also ensure that no farming is carried out on the pipeline's 12m width RoW and that no deep-rooted crops are planted at least 25m away from the pipeline RoW.

9.0 MONITORING PROGRAMMES

One tool that will be applied by GEGL to determine the effectiveness of its EMP is an Environmental Monitoring Programme that quantifies trends and exceedances and provides basis from which the need for further mitigation actions could be determined. The monitoring programme to be implemented for the project will adhere to sampling processes that are supported by accepted scientific methods and international standards. The programme will be designed to complement GEGL's ongoing environmental monitoring programme currently in place for the various operations.

The general objective is to determine the interaction occurring between the project activity and the environmental receptors. Specifically, the environmental monitoring programme will:

- Assist in detecting the development of impacts and thus provide a basis for determining the need for implementing appropriate mitigation measures and control measures.
- Assess the performance of the control measures implemented by GEGL and the development of appropriate corrective actions.
- Identify situations requiring intervention or additional mitigation measures.
- Provide management with information on the effectiveness of environmental management programmes.
- Demonstrate conformance to regulatory standards and international best practice.

9.1 Monitoring Assessment Criteria

The monitoring programme will establish appropriate levels of environmental protection, identify applicable criteria, establish appropriate monitoring compliance points and apportion responsibilities for implementing the programme. The programme will be assessed in accordance with the following guidelines and standards:

- Ghana Standards Authority Standards for Environment and Health Protection – Requirements for Ambient Air Quality and Point Source/Stack Emissions (GS 1236:2019).
- Ghana Standards Authority Standards for Health Protection – Requirements for Ambient Noise Control (GS 1222:2018).
- The IFC EHS Guidelines for noise management (IFC, 2007).

9.2 Categories of Monitoring

The general monitoring categories include:

- **Surveillance monitoring:** Internal monitoring will be undertaken for early assessment of the performance of mitigation measures.
- **Compliance monitoring:** Environmental parameters (air quality and noise (during construction)) will be monitored to adhere to regulatory requirements.
- **Investigative monitoring:** Monitoring will be undertaken as part of a specific investigation, typically to determine the occurrence, nature and extent of possible impacts following an incident or the lodging of a grievance/complaint.

9.3 Environmental Monitoring Programme

The project monitoring programme will comprise new monitoring elements to complement the existing monitoring activities GEGL has planned for the project. The monitoring programme sets out the monitoring locations, parameters, sampling, or observation frequencies, and reporting requirements for the following aspects:

9.3.1 Air Quality Monitoring Programme

Monitoring of air quality will be carried out to ensure that any unacceptable air quality impacts can be readily detected, and timely and appropriate action can be undertaken to rectify the situation. Table 44 outlines the monitoring requirements for the project.

9.3.2 Noise Monitoring Programme

Monitoring of noise levels will be carried out in line with the IFC Noise Regulations to ensure that any unacceptable noise impacts can be readily detected, and timely and appropriate action be undertaken to rectify the situation. Noise monitoring requirements for the project are outlined in Table 44.

9.3.3 Surface Water Monitoring Programme

Pre-construction surface water monitoring

It will be important to get a better understanding of the water quality baseline over a broader spectrum of parameters and time period. It is therefore proposed that monthly samples be taken for at least 6 months prior to construction at the three monitoring sites for laboratory analysis of a broader suite of chemicals including at least the following to understand the existing water chemistry considering the extensive existing artisanal mining operations in the area, and existing impacts from upstream mines and industries.

- | | |
|-------------------------------|-------------------------------------------------|
| ■ Total Dissolved Solids | ■ Mercury as Hg |
| ■ Total Suspended Solids | ■ Nickel as Ni |
| ■ pH | ■ Aluminium as Al |
| ■ Total Alkalinity | ■ Cobalt as Co |
| ■ Turbidity (NTU) | ■ Total Cyanide |
| ■ Nitrate & Nitrite as N | ■ Mercury |
| ■ Orthophosphate as P | ■ Free & Saline Ammonia as N (NH ₃) |
| ■ Fluoride as F | ■ Arsenic as As |
| ■ Sulphate as SO ₄ | ■ Chromium as Cr ³⁺ |
| ■ Cadmium as Cd | ■ Zinc as Zn |
| ■ Iron as Fe | ■ Copper as Cu |
| ■ Manganese as Mn | ■ Lead as Pb |

Construction Monitoring

During construction the following inspection will be undertaken:

- Daily visual inspections will be undertaken to assess areas of erosion potential to allow timeous remediation.
- Visual inspection of areas that may experience hydrocarbon spills to assess need for removal of soils, and/or remediation.

Operational Monitoring

It is proposed that operational monitoring be undertaken on a quarterly basis for the parameters listed above at the three surface water sites set out in Table 43.

Table 43: Surface water monitoring sites

ID	Description	Longitude	Latitude
SW1	Upstream of the proposed site on the Ankobra River and approximately 200m north of the of the proposed site boundary in an area of extensive artisanal mining where abstraction of water from the river was noted.	5°28'42.07"N	2° 7'9.04"W
SW2	On the Ankobra River approximately 420m from the western boundary of the proposed site.	5°28'31.30"N	2° 7'28.36"W
SW3	Downstream on the Ankobra River in an area where extensive artisanal mining is occurring on the west bank of the river.	5°27'56.69"N	2° 7'6.03"W

9.3.4 Groundwater Monitoring Programme

A monthly groundwater monitoring plan is proposed in Table 44. This monitoring will be carried in the six piezometers that were installed during the geotechnical drilling campaign. These piezometers were located around the downstream and upstream of key installations. The quality parameters to be monitored will include metals and trace metals as well as associated petroleum hydrocarbons.

9.3.5 Biodiversity Monitoring Programme

The first required action of monitoring is to determine whether the recommended mitigations measures have been implemented, and in the manner prescribed. It is therefore required that the monitoring mechanism is implemented at the commencement of the Prestea GCP and 6.5km pipeline project. Impact mitigating protocols will be adhered to at all stages of the project, thus, pre-clearing, during clearing and operation. This is important as some of the mitigation measures must be implemented during the pre-clearing and clearing stages of the project – e.g., selection of suitable starred tree species for translocation.

The responsibility of the monitoring rests with GEGL and it is therefore incumbent on the company to appoint qualified personnel with the requisite knowledge of the ecological conditions within the project site, who can make the appropriate recommendations.

Table 44: Environmental Monitoring Programme

Aspect	Objective	Detailed Actions	Monitoring Locations	Timeframe / Frequency	Roles and Responsibilities
Air Quality					
NO ₂ , SO ₂ and VOCs	To monitor air quality levels during the construction and operational phases to ensure emissions are within acceptable limits	<p>Baseline/Construction/Closure phase:</p> <p>A once off bi-annual (i.e., a campaign during the wet and dry season each) campaign to be deployed for a two-week period at each location, then collected after two weeks</p> <p>Operational phase:</p> <p>Bi-annually (i.e., a campaign during the wet and dry season each) campaign to be deployed for a two-week period at each location, then collect, over a period of two years. If concentrations are low, then monitoring can stop or continue if not</p>	Locations can include fence line monitoring/ neighbouring sensitive receptors such as nearby residential areas away from obstructions such as trees	Bi-annual reporting	Environmental Officer / Environmental Specialist
PM ₁₀ and PM _{2.5}		<p>Baseline/Construction/Closure phase:</p> <p>A once off bi-annual (i.e. a campaign during the wet and dry season each) campaign to undertake particulate measurements over three months during each season</p> <p>Operational phase:</p> <p>Bi-annual (i.e. a campaign during the wet and dry season each) campaign to undertake particulate measurements over three months during each season for a total period of two years. If concentrations are low then monitoring can stop or continue if not</p>	Location can include a neighbouring sensitive receptor such as a nearby residential area away from obstructions such as trees, etc	Bi-annual reporting	Environmental Officer / Environmental Specialist

Aspect	Objective	Detailed Actions	Monitoring Locations	Timeframe / Frequency	Roles and Responsibilities
Noise					
Increase in noise levels	To monitor noise levels during the construction and operational phases to ensure that project noise levels are within acceptable limits	<p>Construction/closure phase: A once off annual (i.e., a campaign during the dry season) campaign for 24 hours at each location</p> <p>Operational phase: Not deemed necessary as a result of the negligible noise levels. However, should complaints arise, an annual (i.e., a campaign during the dry season) for 24 hours at each location for two years will be undertaken, thereafter if noise is not a problem, monitoring will stop</p>	Locations can include fenceline monitoring/ neighbouring sensitive receptors such as nearby residential areas away from obstructions such as trees, etc	Annual reporting	Environmental Officer / Environmental Specialist
Groundwater					
Groundwater quality	To identify the quality of groundwater in the project footprint	Sampling of all piezometers within the project footprint	Installed piezometer locations: S5B S7B S8B S9B S10B S11B S12B	Monthly	Environmental Officer

10.0 PROVISIONAL ENVIRONMENTAL MANAGEMENT PLAN

This chapter presents the provisional Environmental Management Plan (EMP) which will guide GEGL's activities to reduce potential impacts on the environment during the implementation of the project. Regulation 24 (1) of LI 1652 stipulates that a person responsible for an undertaking in respect of which a preliminary environmental report or an environmental impact statement has been approved shall submit to the Agency an environmental management plan in respect of his operations within 18 months of commencement of operations and thereafter every three years. The periodic update of the EMP enables GEGL and regulatory agencies to review project activities, strategies, and systems and thereby ensure that appropriate amendments and modifications are made such that intended outcomes are realized.

The objectives of this provisional EMP are to provide management and mitigation measures that will be implemented to control the potential impacts of the project as identified in Chapter 6.0 The provisional EMP will also inform the EMP for the project. Specifically, the provisional EMP:

- Describes the environmental management measures designed to meet environmental objectives and outcomes.
- Provides a framework for impact management.
- Defines roles and responsibilities for environmental management.

10.1 Corporate Commitments and HSE Policies

GEGL has a Mission Vision and Health, Safety and Environmental Policy to guide their operations. The policy statement is as shown in Figure 28.

	GENSER ENERGY - GHANA OCCUPATIONAL HEALTH AND SAFETY PIPELINE PROJECT HSE MANAGEMENT PLAN	Ref. No:	GE-GHA-HSE-PRO-002
		Date	08/10/2020
		Rev.	1

ANNEX A: MISSION, VISION AND HEALTH, SAFETY AND ENVIRONMENTAL POLICY

HSE MISSION

Prevent injuries, ill health and environmental impacts by means of recognized techniques of hazard identification, assessment and control of industrial risks in the Genser Power Plants.

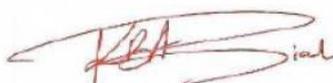
HSE VISION

To be leading sustainable energy solution provider in Africa with best safety, health and Environment records.

HSE POLICY:

We at Genser Energy Africa Incorporated believe that our main responsibility to provide sustainable and cost-effective energy to numerous sectors in Africa is based on the protection of the environment, health and safety of employees, contractors, clients and the community in which we operate.

In this regard, we promote a daily practiced culture in which HSE (Health, Safety and Environment) is recognized as an imperative value that forms the basis of all decision making activities. As such, we aim to fully comply with all applicable laws and relevant industry standards of practice to protect the health and safety of all who are associated with our business activities, while minimizing any adverse impact on the environment.



Baafour Asiamah-Adjei
President / CEO

Figure 28: Mission, Vision and Health, Safety and Environmental Policy

10.2 Environmental Management Structure

This section includes the structure of the team of professionals who will be responsible for the successful implementation of the provisional EMP. The HSE Department of GEGL will be responsible for implementing this plan. The organisational structure of the Pipeline Project Team is presented in Figure 29.

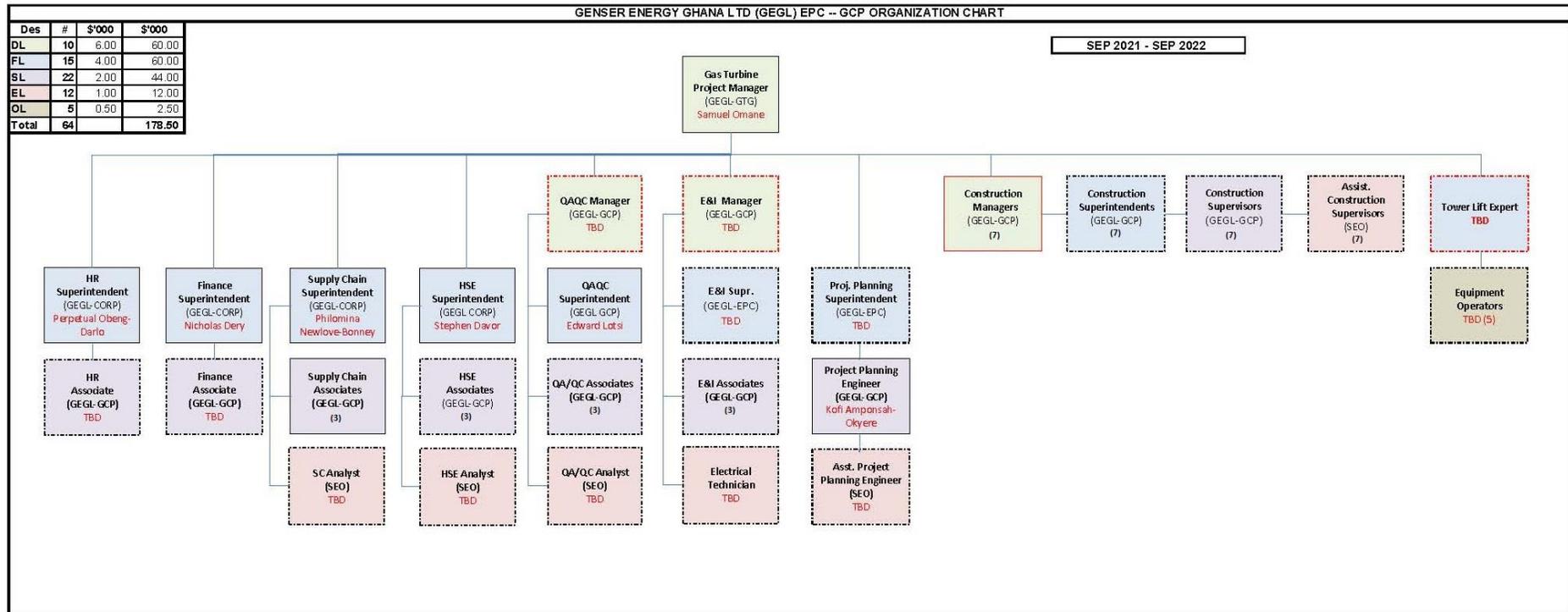


Figure 29: GEGL GCP Organisational Structure

10.3 Financial Allocations

GEGL recognises that the successful implementation of the provisional EMP requires the allocation of sufficient and appropriate financial resources. GEGL will ensure that sufficient funds are allocated to support the implementation of this plan as well as potential liabilities the Company may incur associated with planned activities. The resources for the implementation of the provisional EMP will be incorporated into GEGL's annual budget and operating costs for the project.

10.4 Project Overview

Details of the project infrastructure and components are provided in Chapter 3.0 of this report.

10.5 Existing Natural and Socio-Economic Environments

Details on the biophysical and socio-economic environment are provided in Chapter 4.0 of this report.

10.6 Environmental and Social Impacts and Mitigation Measures

Chapter 6.0 of this document presents the list of impacts likely to occur as a result of the Prestea GCP project and Chapter 8.0 provides recommended mitigation measures to minimise the impacts and in the case of a positive impact, to enhance the benefits.

10.7 Environmental Action Plans

Based on the potential environmental and socio-economic impacts identified in Chapter 6.0, environmental action plans have been formulated to reduce the impacts and enhance the benefits of the project. A summary of the environmental action plan is presented in Table 45.

Table 46 presents a summary of the social management plan that will be implemented by GEGL for the project.

Table 45: Environmental Management Plan

Impact	Source(s) and Activity	Action	Timeframe/Frequency	Responsibility
Soil and land use				
Degradation of soil quality	Soil stripping for the construction of project infrastructure	<ul style="list-style-type: none"> ■ The project footprint will be minimised and areas to be disturbed will be clearly marked. ■ The surface footprints will be minimised to the extent possible and heavy machinery and heavy truck access to sensitive soil areas will be restricted. Lighter machinery will be used during soil handling. Here, lighter machinery refers to machinery typically used in the agricultural industry for soil handling. 	Throughout the construction phase	Construction Manager / Operations Manager / Environmental Officer
Loss of soil as a resource		<ul style="list-style-type: none"> ■ Soil conservation measures will be implemented (e.g., segregation, proper placement and stockpiling of clean soils and overburden material for site remediation) ■ Disturbed areas (other than permanent disturbances such as the pipeline trench) will be restored where possible to original contours and drainage lines. ■ Inform relevant personnel regarding the handling of soils and consider demarcating and indicating areas intended for stockpiling of topsoil with signage or noticeboard. ■ Regular inspections will be undertaken to assess erosion and sediment migration from stockpiles. Where unacceptable rates of erosion are identified, remedial works will be undertaken, or the stockpile will be relocated. ■ Access roads will have gradients or surface treatment to limit erosion and road drainage systems will be provided. 	During the construction phase when soil is stripped	Construction Manager / Operations Manager / Environmental Officer

Impact	Source(s) and Activity	Action	Timeframe/ Frequency	Responsibility
		<ul style="list-style-type: none"> ■ A runoff containment berm will be placed down-gradient of the stockpile to capture runoff, the transported soil will be allowed to settle and subsequently recovered. ■ Soil stripping will not occur in wet conditions ■ Topsoil stripped from the site will be stockpiled for rehabilitation ■ Irrespective of where topsoil is stockpiled, it will be reused or kept moist and vegetated as soon as possible. ■ Topsoil stockpiles will be kept low (between 3 and 5 meters tall). It is recommended that the top 50cm of soil be stripped, where the soils are deep enough, and relocated by truck along set removal paths. ■ Within each stripping unit, segments will be stripped progressively to ensure that the haul truck used to move the soil does not drive over the area to be stripped to prevent soil compaction and degradation. 		
Soil contamination	Hydrocarbon spillages associated with machinery used for earthworks and vehicles. Improper disposal of waste	<ul style="list-style-type: none"> ■ GEGL will observe proper handling and storage of hazardous chemicals and materials (e.g., fuel, oil, cement, concrete, etc.) as per their corresponding Safety Data Sheets (SDS). ■ Vehicles and equipment will be maintained regularly, and maintenance activities will be carried out in designated facilities fitted with spillage containment, floors, and sumps to capture any fugitive oils and greases. 	Throughout the construction and operational phases	Construction Manager / Operations Manager / Environmental Officer

Impact	Source(s) and Activity	Action	Timeframe/ Frequency	Responsibility
		<ul style="list-style-type: none"> ■ Regular site inspections will be carried out for materials handling and storage. ■ Detailed procedures for spills containment and soils clean-up will be developed for implementation on-site. ■ Environmental inspections and auditing will be carried out. ■ Adequate waste disposal facilities will be provided, and wastes will be classified into streams to enable appropriate segregation, handling, transport, disposal and recycling/ reused in a manner appropriate to the waste. 		
Soil erosion	Vegetation clearance Temporary soil stockpiles and bare areas (unvegetated)	<ul style="list-style-type: none"> ■ Land clearance activities will be stopped during heavy rainfall. ■ Access road gradients will be limited to reduce run-off-induced erosion. ■ Vegetation cover will be increased upwind of cleared and exposed areas. ■ Closed areas such as access roads and lay down areas will be ripped, replaced with soil, and revegetated following completion of construction works. 	Throughout the construction phase	Construction Manager / Operations Manager / Environmental Officer

Impact	Source(s) and Activity	Action	Timeframe/ Frequency	Responsibility
Soil compaction	Through movement of equipment and vehicles	<ul style="list-style-type: none"> ■ Essential road routes will be pre-defined and clearly demarcated and adhered-to during all phases of the project to restrict soil compaction. ■ Vehicles will not drive on soil when it is wet to avoid further soil compaction. ■ Soils will not be stripped when they are wet. 	Throughout the construction and operational phases	Construction Manager / Operations Manager / Environmental Officer
Air quality				
Dust fallout, PM ₁₀ and PM _{2.5}	Site clearance Earthworks Storage of construction aggregates	<ul style="list-style-type: none"> ■ Wet suppression (wet misting during material handling activities): <ul style="list-style-type: none"> ■ Covering or keeping construction material / stockpile heights as low as practicable to reduce their exposure to wind erosion and thus dust generation ■ Progressive rehabilitation and re-vegetation of areas when available ■ Reduction in unnecessary traffic volumes ■ There will be routine inspections to identify areas of unpaved roads that are increasingly dusty. Maintenance work to be undertaken on these areas including watering, application of dust suppressants, compaction, dust removal and/or utilisation of soil aggregate ■ Rigorous speed control and the institution of traffic calming measures to reduce vehicle entrainment of dust. A maximum speed will be set on all unpaved roads 	Throughout the construction phase	Construction Manager / Community Coordinator – Community and Stakeholder Affairs / Community Coordinator

Impact	Source(s) and Activity	Action	Timeframe/Frequency	Responsibility
		<ul style="list-style-type: none"> ■ All equipment will be well maintained and in good working order to ensure that emissions are kept to a minimum ■ The area to be disturbed will be minimised 		
Dust fallout, PM ₁₀ and PM _{2.5} and gaseous emissions (SO ₂ , NO ₂ , CO and VOC)	Gas engines and hot oil system	<ul style="list-style-type: none"> ■ All engines will be maintained and serviced regularly to ensure that emissions are kept to a minimum ■ Engines will be switched off when not in use ■ A stable tank pressure and vapour space will be maintained ■ Tanks will be cleaned periodically 	Throughout the operational phase of the project	Operations Manager / Community Coordinator – Community and Stakeholder Affairs / Community Coordinator
Noise				
Increased noise level at sensitive receptors	Earthworks, construction and installation project infrastructure. Operations of the project facilities	<ul style="list-style-type: none"> ■ When working near a potential sensitive receptor, the number of simultaneous activities will be limited to a minimum as far as possible ■ Communication channels will be established between construction management and potential sensitive receptors, including the following information but not limited to: <ul style="list-style-type: none"> ■ Proposed working times ■ How long the activity is anticipated to take place ■ What is being done, or why the activity is taking place 	Throughout the construction and operational phases	Construction Manager / Operations Manager / Community Coordinator – Community and Stakeholder Affairs / Community Coordinator

Impact	Source(s) and Activity	Action	Timeframe/ Frequency	Responsibility
		<ul style="list-style-type: none"> ■ Contact details of a responsible person where any complaints can be lodged should there be an issue of concern. ■ A drop height policy will be implemented onsite to reduce the level of noise generation when handling materials. All equipment operators will be trained in the policy such that drop height reduction is implemented onsite ■ A maximum speed will be set on all unpaved roads ■ Plans will be developed to optimise vehicle usage and movement, which will ensure a reduction in unnecessary traffic volumes ■ Construction materials will be received during non-peak traffic hours to avoid traffic build-up and associated noise ■ The smallest/quietest equipment will be used for the particular purpose ■ Equipment will be well maintained and fitted with the correct and appropriate noise abatement measures ■ All vehicles and other equipment will be maintained and serviced regularly to ensure that the noise levels are reduced ■ Vehicles will not be allowed to idle for more than 5 minutes when not in use 		
Surface Water				

Impact	Source(s) and Activity	Action	Timeframe/ Frequency	Responsibility
Sedimentation of surface water bodies	Erosion due to excavation and compaction activities prior to constructing the facility.	<ul style="list-style-type: none"> ■ Site clearance will be undertaken only a short time before construction materials arrive at the site and construction starts, so that the time of leaving the land unvegetated is kept to a minimum ■ Berms will be constructed around the site to minimise the occurrence of sediments in run-off from the site ■ Site clearance, as far as practicable will be undertaken during the dry season ■ Areas not required for infrastructure development will be rehabilitated (revegetation) as soon as possible once construction is complete 	During construction and operational phases	Environmental Manager / Construction Manager
Water contamination	Contaminated runoff from the site due to hydrocarbon spills from equipment.	<ul style="list-style-type: none"> ■ Good housekeeping will be maintained at the site to ensure that any hydrocarbon spills are dealt with adequately to ensure that run-off or river flow is not contaminated, and if necessary, contaminated soil is removed for disposal at an authorised disposal site or remediated to regulatory requirement ■ Machinery and equipment will be maintained in good working order ■ Spill kits will be maintained on site ■ Personal will be trained in spill response to enable prompt response and the implementation of appropriate actions should this occur 	During construction and operational phases	Environmental Manager / Construction Manager

Impact	Source(s) and Activity	Action	Timeframe/Frequency	Responsibility
		<ul style="list-style-type: none"> ■ There will be adequate sloping and berm construction around the site to ensure that clean stormwater is routed away from the site, allowing uncontaminated natural flow to the Ankobra River ■ Well maintained bunded areas for hydrocarbon storage ■ Ad hoc visual inspection of areas that may experience hydrocarbon spills to assess need for removal of soils, and/ or remediation 		
Groundwater				
Contamination of groundwater	Leakages and spillages from vehicles and equipment, and	<ul style="list-style-type: none"> ■ Equipment and machinery will be inspected to be in good condition prior to use on site ■ Well-maintained construction vehicles and machinery will be used to avoid and/or minimize chemical leaks/spills that may cause contamination of groundwater resources ■ Vegetation clearance will be minimised or limited during construction to minimise the occurrence of pathways for seepages to groundwater ■ Pipeline excavation will be limited to depths above the groundwater table ■ Hazardous substances and materials will be contained in bunded areas ■ Spill response procedure will be prepared, documented and the resources be readily available to control any spillage on site 	Throughout the construction and operational phases	Environmental Officer

Impact	Source(s) and Activity	Action	Timeframe/Frequency	Responsibility
Acidification of groundwater and dissolution of trace metals	Leakage or spillage of CO ₂ or methane and other petroleum hydrocarbons	<ul style="list-style-type: none"> Continuously monitoring the pipeline for prompt actions to be implemented The pipeline will be regularly maintained in line with specifications from manufacturers to prevent the occurrence of spillages The installation of automated meters to measure the volume of products received and dispatched. Reconcile to identify product losses through leaks 	Daily	Environmental Officer
Visual Amenity				
Visual intrusion	Pretea GCP, construction machinery, laydown areas, etc.	<ul style="list-style-type: none"> Offices and workshop buildings will be painted in colours that are complementary to the surrounding landscape and areas around offices and camp facilities will be vegetated Trees will be planted in all landscaped areas as far as practicable, as well as around plant infrastructure to break structural form and provide visual screens. Existing trees will be retained wherever possible Construction sites will be maintained in a neat and orderly condition Designated areas for material storage, waste sorting and temporary storage, batching and other potentially intrusive activities will be demarcated 	Throughout the construction and operational phases	Construction Manager / Operations Manager
Formation of dust plumes	Site clearance, vehicular movement,	<ul style="list-style-type: none"> Access roads and any large bare areas where dust is generated will be watered down during construction 	Throughout the construction	Construction Manager / Operations

Impact	Source(s) and Activity	Action	Timeframe/ Frequency	Responsibility
	unsealed roads, earthworks, soil stockpiles	<ul style="list-style-type: none"> ■ Speed limit on-site for all vehicles will be enforced especially on unpaved roads ■ GEGL will monitor air quality to ascertain the effectiveness of the mitigation measure 	and operational phases	Manager / Environmental Officer
Light pollution at night	Fixed/permanent lighting from the Prestea GCP and other project infrastructure	<ul style="list-style-type: none"> ■ Security lighting (if feasible) that is movement activated will be used rather than permanently switched on, to prevent unnecessary constant illumination ■ Lighting requirements of the facilities will be planned to ensure that lighting meets the need to keep the site secure and safe, without resulting in excessive illumination ■ The height and angle of illumination from which floodlights are fixed will be reduced as much possible while still maintaining the required levels of illumination ■ Zones of high and low lighting requirements will be identified, focusing on only illuminating areas to the minimum extent possible to allow safe operations at night and/or for security surveillance. ■ Up-lighting of structures will be avoided by rather directing lighting downwards and focused on the area to be illuminated. ■ All security lighting will be fitted with 'blinkers' or specifically designed fixtures, to ensure light is directed downwards while preventing side spill. Light fixtures of this description are commonly available for a variety of uses and should be used to the greatest extent possible 	Throughout the construction and operational phases	Construction Manager / Operations Manager / Environmental Officer

Impact	Source(s) and Activity	Action	Timeframe/Frequency	Responsibility
Biodiversity				
Loss/disturbance of ecosystems of concern	Vegetation clearance and earthworks during construction Clearing for housekeeping purposes during operations	<ul style="list-style-type: none"> ■ Areas that will need to be cleared prior to the commencement of vegetation clearing will be demarcated and areas to be cleared will be kept to a minimum ■ Areas within the project area that are not intended for placement of project infrastructure will not be cleared ■ Environmental training will be incorporated into the induction training provided to staff before commencement of work and it will be ensured that all construction staff members are aware of, and adhere to, basic environmental principles ■ The construction campsites, lay-down and other temporary storage areas will be sited in already disturbed habitats, such as cultivated or fallow fields, and areas of natural habitat will be avoided ■ The construction of new vehicle access tracks will be kept to the minimum and the use of existing roads/tracks will be encouraged. Track routes will be selected in such a way as to minimize any damage to natural habitats ■ Vegetation clearance will be done via mechanical means and the use of herbicides will be restricted ■ Cutting of trees will be done by a certified timber contractor, and strictly in line with the prescribed safety guidelines. The landing area of falling trees will be carefully selected to minimize 	Daily during construction	EcoW/ Environmental Officer

Impact	Source(s) and Activity	Action	Timeframe/ Frequency	Responsibility
		<p>damage to farms. Adequate warning will be given to ensure that public safety is not compromised</p> <ul style="list-style-type: none"> ■ Active revegetation of degraded or disturbed areas, including tree planting with indigenous species, will be undertaken to mitigate the reduction of vegetation cover in the project footprint ■ Direct losses of natural habitats will be compensated for via offsetting or other conservation actions that ensure that no net loss is sustained, in accordance with lender's requirements ■ Rehabilitation of affected vegetation communities/bare areas will be implemented following completion of construction work 		
<p>Loss of flora species of national conservation concern</p>	<p>Vegetation clearance and earthworks</p>	<ul style="list-style-type: none"> ■ A qualified botanist will be appointed to mark out those species that are suitable for translocation, which can be used in rehabilitation/re-vegetation activities ■ Flora SoCC will only be translocated or disturbed with the permission of the Environmental Manager, and with the appropriate permits in place ■ Collection of propagules including seeds, cuttings and seedlings of species identified for specific conservation actions will be conducted to preserve genetic diversity of SoCC. Where possible, these will be cultivated in a nursery and replanted in areas of the project area outside of the project footprint, that are likely candidates for rehabilitation activities 	<p>In advance of any clearing activities</p>	<p>EcoW/ Environmental Officer</p>

Impact	Source(s) and Activity	Action	Timeframe/Frequency	Responsibility
		<ul style="list-style-type: none"> Rehabilitation of affected vegetation communities/bare areas will take place immediately following completion of construction work 		
Disturbance/contamination of aquatic ecosystems	<p>Runoff from the site being contaminated with hydrocarbons due to spillage from equipment and vehicles</p> <p>Improper waste disposal</p> <p>Use of chemical herbicides/pesticides</p>	<ul style="list-style-type: none"> A pre-construction assessment of the aquatic ecosystem will be conducted prior to construction, for use as the status quo against which any construction impacts on aquatic communities downstream of the project site can be monitored A stormwater management plan for the separation of clean and dirty water during construction will be implemented. Only clean water discharges will enter the environment Access to personnel outside of the defined project work sites and access roads will be prohibited. Personnel will be trained to understand the sensitivity of the local environment in induction and during toolbox meetings Erosion protection measures will be put in place during construction to minimise runoff from disturbed areas into aquatic ecosystems 	Monthly	EcoW/ Environmental Officer
Erosion	Vegetation clearance	<ul style="list-style-type: none"> Removal of vegetation and construction activities will be limited to areas used for construction laydown, access roads and associated GCP infrastructure. Areas within the project footprint that will not be used for construction will not be cleared A rehabilitation and re-vegetation plan will be developed prior to construction, and will include provision for monitoring for and managing incidences of erosion 	Weekly during construction	EcoW/ Environmental Officer / Construction Contractors

Impact	Source(s) and Activity	Action	Timeframe/ Frequency	Responsibility
		<ul style="list-style-type: none"> ■ Regular monitoring of the site during construction will be undertaken to detect erosion problems ■ Topsoil will be removed from areas that need to be cleared and stored separately. These soils will be reapplied in areas requiring rehabilitation/revegetation as soon as possible to facilitate rapid regeneration of the natural vegetation on cleared areas ■ Rehabilitation and re-vegetation of disturbed areas will be undertaken following completion of construction activities 		
Use of herbicides and pesticides		<ul style="list-style-type: none"> ■ Mechanical weed control will be used instead of chemical weed control wherever possible ■ The use of chemicals in the control of pests, rodents, snakes etc. around the project site will be avoided ■ In situations where chemical control is inevitable, spot application strategy in chemical application will be adopted instead of the broadcast method in order to minimize exposure to non-target plants and animals 	Daily during construction	EcoW/ Environmental Officer / Construction Contractors
Introduction of alien and invasive species	Tyres of equipment and machines for construction, plant species used for revegetation	<ul style="list-style-type: none"> ■ An alien invasive species management plan will be developed and implemented on-site during all phases of the project. The plan will include provision for: <ul style="list-style-type: none"> ■ Identification of all alien invasive species observed on-site with emphasis on particularly aggressive species 	Weekly during construction Annually during operations	EcoW/ Environmental Officer / Construction Contractors

Impact	Source(s) and Activity	Action	Timeframe/Frequency	Responsibility
		<ul style="list-style-type: none"> ■ Identification of priority areas for alien invasive species control ■ Species-specific control methods ■ Alien invasive species monitoring and roll-out of follow-up treatments ■ Only plants and seeds collected on-site from locally occurring indigenous flora species will be used for rehabilitation and re-vegetation activities ■ Unnecessary movement of vehicles and machinery within the project area will be limited ■ Regular washing and cleaning of vehicles and machinery in designated areas to prevent the spread of AIS seeds/propagules will be implemented 		
Loss and disturbance of fauna SoCC	Vegetation clearance	<ul style="list-style-type: none"> ■ Access to personnel outside of the defined Project work sites and access roads will be prohibited. This will reduce disturbance associated with construction activity (presence of people and heavy machinery), to faunal species of conservation concern ■ Training will be provided to personnel to understand the sensitivity of the local environment in induction and ongoing toolbox talks. Any hunting activity by construction staff will be prohibited ■ Measures will be implemented to minimise impacts arising from sensory disturbance caused by human presence and 	Daily during construction	EcoW/ Environmental Officer

Impact	Source(s) and Activity	Action	Timeframe/Frequency	Responsibility
		<p>mechanical noise generated during construction activity. These will include:</p> <ul style="list-style-type: none"> ■ Restrictions in operating hours for heavy machinery ■ Use of low-pitched reverse alerts ■ Implementing speed limit onsite ■ An ecological clerk of works will be employed by GEGL to supervise clearance and construction works and stop works where necessary (e.g., a breeding/nesting site of a species of conservation concern is discovered) so that the appropriate conservation measures can be undertaken 		
Increased human presence and activity	Influx of people into the project area	<ul style="list-style-type: none"> ■ GEGL will enforce a complete ban on wildlife harvesting (hunting/trapping/fishing) for all project personnel, including any such activities by any contractor or visitors to the GCP project site ■ The development of worker and community education programs, which focus on the impacts and risks of bush meat hunting and consumption (e.g., diseases like Ebola), can contribute to the alleviation of hunting pressure on fauna species and reduce local people's reliance on consumption of bush meat, and the associated health risks ■ There will be awareness creation and sensitization notices of statutory access restrictions for forest reserves 	N/A	EcoW/ Environmental Officer / HR Manager / Construction Manager

Table 46: Social Management Plan

Impact	Affected Groups	Action	Timeframe/ Frequency	Responsibility
Employment opportunities	Community members and Youth	<ul style="list-style-type: none"> ■ More than 90% of construction workers will be sourced from the local communities. Particularly, GEGL will take keen interest in ensuring that most of the labour are recruited from Heman, Brumase and Ankobra ■ The employment processes will be fair, transparent, and non-discriminatory ■ The use of local labour as far as possible for contractual obligations will be maintained ■ Existing skills levels in the workforce will be recognised and individuals will be placed on formal career paths 	Throughout the construction and operational phases	Human Resource Department / Community Coordinator – Community and Stakeholder Affairs
Increase in local economic activities	Petty traders, local entrepreneurs Youth groups, unemployed, community leaders, farmers and small-scale miners	<ul style="list-style-type: none"> ■ Education and sensitization of local traders on the need to exploit local opportunities from the project by increasing production to meet the increasing demands ■ Measures will be put in place to ensure that, where possible, sub-consultant are employed or engaged from the local area 	Throughout the construction and operational phases	Community Coordinator – Community and Stakeholder Affairs
Cost of living and local inflation	Community members	<ul style="list-style-type: none"> ■ Food, water, and other consumable needs of workers will be supplied by GEGL. These lines of items will be supplied by wholesale traders and the products will not be directly purchased from the local market where there is the possibility of increasing competing demands for the local people 	Throughout the construction and operational phases	Community Coordinator – Community and Stakeholder Affairs

Impact	Affected Groups	Action	Timeframe/ Frequency	Responsibility
		<ul style="list-style-type: none"> Education and sensitization of local traders on the need to exploit local opportunities from the project by increasing production to meet the increasing demands There will be a canteen facility at the plant site 		
Livelihood changes	Farmers, estate developers, community members, traditional authorities, and landowners	<ul style="list-style-type: none"> Education and sensitization of farmers and local labour on the need to exploit other positive opportunities associated with the project Measures will be put in place to ensure that households members whose livelihoods will be affected are given priority in the employment opportunities Education and sensitization of farmers and local people about opportunities surrounding the project (such as increasing production to meet the increasing demands) Sustainable livelihood through CSR, and other interventions Prompt payment of compensations schemes Royalties, ground rents, and other financial obligations to individuals, traditional councils, and mandated statutory bodies will be paid promptly. All key stakeholders will be constantly engaged on all community issues and concerns 	Throughout the construction and operational phases	Community Coordinator – Community and Stakeholder Affairs
Population influx and demographic changes	Community members	<ul style="list-style-type: none"> Community members will be employed during construction activities to avoid an influx of external job seekers. 	Throughout the construction and operational phases	Community Coordinator – Community and Stakeholder Affairs

Impact	Affected Groups	Action	Timeframe/ Frequency	Responsibility
		<ul style="list-style-type: none"> ■ All key stakeholders will be constantly engaged on all issues relating to community influx. ■ There will be education and sensitisation of community members in the PACs, and neighbouring communities 		Stakeholder Affairs
Infrastructure and social amenities impacts	Community members	<ul style="list-style-type: none"> ■ GEGL will collaborate with local development partners and invest in key community infrastructure such as schools, roads, water and toilet facilities ■ GEGL will ensure that facilities such as boreholes and toilet facilities are constructed or available at the plant site during construction ■ There will be concrete steps to ensure that workers are housed in a separate camp with all the needed facilities to reduce the likelihood of workers competing with communities with the use of existing infrastructure ■ Workers will be educated and sensitised on the implications of their presence on community infrastructure 	Throughout the construction and operational phases	Community Coordinator – Community and Stakeholder Affairs
Conflicts	Youth groups, unemployed, community leaders, farmers and small-scale miners	<ul style="list-style-type: none"> ■ All key stakeholders on all will be constantly engaged on issues of community concerns, especially with employment. ■ Some community members will be employed, build their capacity, and ultimately boost the local economy. ■ Local traders will be educated and sensitized on the need to exploit local opportunities from the project by increasing production to meet the increasing demands 	Throughout the construction and operational phases	Community Coordinator – Community and Stakeholder Affairs

Impact	Affected Groups	Action	Timeframe/ Frequency	Responsibility
		<ul style="list-style-type: none"> ■ Measures will be put in place to ensure that, where possible, sub-consultant are employed or engaged from the local area. ■ All relevant community stakeholders such as chiefs, assembly members and youth leaders will be involved on employment processes ■ Ensure that employment processes are free, fair, and transparent ■ GEGL will liaise with key stakeholders such as the municipal assembly and other industry players to explore opportunities which are likely to emerge from the GCP's value chain 		
Psycho-social and sense of risk exposure	Community members living near roadside, roadside vendors	<ul style="list-style-type: none"> ■ All relevant health and safety measures will be strictly enforced during construction ■ Education and sensitization of workers, visitors, and community members on all likely social impacts of the project ■ Proper warning signs, notices and relevant communication mediums will be properly installed at all relevant places and machines with high-risk potentials 	Throughout the construction and operational phases	Community Coordinator – Community and Stakeholder Affairs
Social vices	Youths, women, and children	<ul style="list-style-type: none"> ■ Education and sensitisation of community members on potential social vices which are likely to emerge and the need for community members to be aware and take precautions ■ GEGL will liaise with the security and law enforcement agencies, other firms and stakeholders to strengthen the security system in the area. Emphasis will be placed on preventive mechanisms 	Throughout the construction and operational phases	Community Coordinator – Community and Stakeholder Affairs

Impact	Affected Groups	Action	Timeframe/ Frequency	Responsibility
		<ul style="list-style-type: none"> ■ Construction activities will be strategically planned to minimise overcrowding of workers at a particular area or community at a particular point in time ■ There will be concrete steps to ensure that workers are housed in a separate camp with all the needed facilities to reduce workers interactions with community members especially during the evenings 		
Cultural heritage impacts	Traditional authorities, religious groups, vulnerable groups, and community members	<ul style="list-style-type: none"> ■ All key stakeholders will be constantly engaged on all issues of community concerns ■ There will be effective and continuous sensitisation of community members 	Throughout the construction and operational phases	Community Coordinator – Community and Stakeholder Affairs
Vulnerable groups and PwDs impacts	Unemployed women, underemployed women, youth, girls, and PwDs	<ul style="list-style-type: none"> ■ An appreciable quota will be reserved for identifiable vulnerable groups such as females. A careful consideration will be given to the nature of the job within the context of socio-physical and cultural conditions ■ As much as possible, special considerations will be given to PwDs in respect of interventions, compensations, and voluntary social support schemes ■ It will be ensured that thorough health and physical checks are undertaken before recruitment process to avoid the likelihood of selecting desperate job seekers who may have certain underlying conditions which has the likelihood of creating disability problems to them 	Throughout the construction and operational phases	Community Coordinator – Community and Stakeholder Affairs

Impact	Affected Groups	Action	Timeframe/ Frequency	Responsibility
		<ul style="list-style-type: none"> There will be continuous sensitisation, awareness creation and capacity building for identifiable PwDs 		
Food insecurity and access to resources	Farmers, hunters, herbalists, community members	<ul style="list-style-type: none"> Operations will be within the limits of the GCP project lease Sustainable livelihood options will be improved through CSR, and other interventions Community members will be employed during construction activities to avoid an influx of external job seekers A mechanism will be put in place to ensure that foods are provided for the construction workers to reduce food shortages in the local market GEGL will consider non-cash compensation schemes such as negotiating for increased land sizes, especially for food crop farmers affected by the project 	Throughout the construction and operational phases	Community Coordinator – Community and Stakeholder Affairs
Diseases and infections	Community members and vulnerable groups such as Women, Children, and PwDs	<ul style="list-style-type: none"> There will be strict adherence to Covid- 19 protocols among all GEGL staff, contractors, and visitors Stakeholders will be educated and sensitised about Covid- 19, and other sexually transmitted diseases 	Throughout the construction and operational phases	Health and Safety Coordinator / Community Coordinator – Community and Stakeholder Affairs
Health infrastructure	Community members and health workers	<ul style="list-style-type: none"> GEGL will consider adopting a private hospital within Prestea or Bogoso 	Throughout the construction and operational phases	Community Coordinator – Community and Stakeholder Affairs

Impact	Affected Groups	Action	Timeframe/ Frequency	Responsibility
		<ul style="list-style-type: none"> ■ GEGL will liaise with the municipal health directorate to designate more health workers into the area, especially at Prestea and Heman ■ GEGL will designate health personnel exclusively for workers and visitors of the facility in order to discourage resorting to the facilities in the communities 		
Pollution and public health	Community members and health workers women, aged and children	<ul style="list-style-type: none"> ■ There will be strict adherence to health, safety and environmental standards and protocols ■ GEGL will implement the mitigation measures for air quality, noise, water quality, soil, waste management strategies and other environmental management systems ■ Waste receptacles will be provided at vantage points of the site to minimise littering of nearby farms ■ There will be continuous sensitisation of communities, visitors, workers, and other stakeholders on waste management strategies ■ GEGL will liaise with other stakeholders such as the BML to ensure that the Brumase-Ankobra-Heman community roads are watered frequently 	Throughout the construction and operational phases	Health and Safety Coordinator / Community Coordinator – Community and Stakeholder Affairs
Accidents and injuries	Road users and community members	<ul style="list-style-type: none"> ■ Speed control measures will be developed and there will be strict implementation of the measures ■ There will be flagmen at strategic locations on the roads to control vehicular movements when heavy machines and trucks are moving to site 	Throughout the construction and operational phases	Health and Safety Coordinator

Impact	Affected Groups	Action	Timeframe/ Frequency	Responsibility
		<ul style="list-style-type: none"> ■ Innovative devices such as speed detectors will be fixed on all machines and cars to detect speeding and other irresponsible driving behaviours by drivers ■ Emergency lines will be boldly displayed on all GEGL vehicles and machines to enable whistle blowing and prompt complains ■ A traffic study will be undertaken for the project and a traffic management plan will be developed for the project 		
Explosions	Farmers, hunters, community members	<ul style="list-style-type: none"> ■ Fire extinguishers will be installed at strategic locations around the plant facility ■ Education and training will be provided to community members, employees, and visitors on fire hazards, prevention, and use of fire equipment and inflammable ■ Materials will be managed according to measures provided by manufacturers ■ There will be sensitisation of residents on the potential risk of hunting, with fire, within the plant area, and the site will be clearly demarcated to minimise unauthorised entry 	Throughout the construction and operational phases	Health and Safety Coordinator / Environmental Officer

10.8 Monitoring Programmes

Details of the monitoring programmes to be implemented as part of the provisional EMP are provided in Chapter 9.0.

10.9 Reclamation and Decommissioning

Details of the decommissioning and closure plan to be implemented are provided in Chapter 11.0.

10.10 Contingency Plans

A detailed contingency plan outlining procedure will be employed during the project implementation. The plan will provide the basis for prevention of and response to environmental incidents. The plan includes:

- Identification of emergency situations.
- Understanding the environmental risks presented by these situations.
- Establishing preventive measures.
- Preparation and implementation of effective notification and response systems.

GEGL has an Emergency Preparedness and Response Plan for the project, and this is attached in xxx.

10.11 Auditing and Review

GEGL will undertake internal and external audits as a means of establishing the effectiveness of the provisional EMP, the accuracy of the predicted impacts and mitigations, and whether the project is compliant with all legal requirements. The audits will provide insight into mitigation measures and programmes which are effective for and those which are not. It will enable the development of appropriate corrective actions and actions to further achieve the objectives of being protective of the environment and social conditions in the project area. Internal audits will be undertaken quarterly, and external audits will be undertaken annually.

11.0 RECLAMATION AND DECOMMISSIONING

The end of the construction phase will result in the demobilisation of machines and equipment from site.

During decommissioning and closure, the demolition and removal of the infrastructure and associated demolition waste from site would effectively reverse the operational phase impacts, as the site would essentially be returned to a pre-project state. The following measures will be implemented at project closure:

- Dismantling of the various components of the Prestea GCP and /or the 6.5km natural gas pipeline including steel stands and concrete bases.
- Dismantling/demolition of related support infrastructure including gate house/access controls, storage and loading terminals and fencing.
- Decontamination, cleaning and degassing of tanks prior to their removal from site or the transportation of the tanks to a contractor specialised in the decontamination, cleaning and degassing of tanks.
- Establishing a salvage yard and sorting and screening of demolition waste to recover reusable components and recyclable scrap steel.
- Crushing of concrete plinths and transport of concrete and other demolition waste to a suitable landfill or waste disposal facility.
- Collection of hazardous waste elements by an EPA approved contractor for safe disposal or be disposed of at hazardous waste site.

The assumptions and qualifications related to the closure scenario and measures described above are as follows:

- During dismantling and demolition specialist supervision would be required to ensure that the components are safely dismantled and disposed.
- All facilities which cannot be transferred to communities for beneficial reuse will be demolished.
- Rehabilitation of other areas that may be disturbed as part of the project will be rehabilitated during operations

A Detailed Decommissioning Plan will be developed prior to the end of the service life of the Prestea GCP and/or the pipeline infrastructure, where all these measures and end uses of all project infrastructure will be firmed up. During decommissioning, GEGL will develop a programme that will satisfy its obligations and complement EPA's Environment, Health and Safety procedures associated with gas pipeline and gas conditioning plant decommissioning.

In accordance with the Environmental Assessment Regulations, GEGL will submit the Decommissioning Plan to the EPA at least two years before any planned closure of the Prestea GCP, associated components and/or the 6.5km natural gas pipeline. There will be engagements with key stakeholders for their input into the plan. GEGL will honour all commitments made in the detailed Decommissioning Plan upon receipt of written permission from the EPA.

12.0 CONCLUSION

GEGL intends to build a Liquefaction and Gas Conditioning Facility and a 6.5km natural pipeline to interconnect the Facility to the existing Gas Regulating and Metering Station in Prestea. The Facility is expected to commence operations with a processing capacity of 135mmscfd to supply LNG and NGL (in the form of butane, propane, ethane) to diverse consumers both within and outside Ghana for various manufacturing processes including power generation and mining processes that rely heavily on the usage of diesel/HFO. The development of the Liquefaction and Gas Conditioning Facility will include gas pre-treatment station, cryogenic separation station, fractioning and separation station, gas compression station, NGL storage and loading terminal and ancillary facilities. The pipe sizing for the 6.5km natural gas pipeline will be 24-inches.

In compliance with the requirements of the LI 1652, GEGL is applying for an environmental permit from the EPA for the development of the pipeline and associated facilities. This EIS has been completed in consideration of various technical reports including engineering designs, and environmental and social baseline data collected within the project area.

The impact assessment methodology employed subject matter specialist assessment, existing baseline condition reviews, and interpretation of data collected to inform the assessment. The assessment is presented as a narrative and combined magnitude, duration and extent of the specific impact occurring, for the project construction and operational phases. Importance was placed on social values during the impact assessment. The specialist studies focused on soil and land use, air quality, noise, surface water, groundwater, visual amenity, biodiversity, and socio-economic. The impact assessment showed that the construction and operation of the Facility will have impacts that are generally site-specific and can be readily addressed through the implementation of the recommended mitigation measures.

The mitigation measures have been incorporated into the project plan to reduce or eliminate negative potential impacts on the physical, biological, and socio-economic environments. Furthermore, an EMP has been developed for project implementation. A monitoring programme also proposed to be undertaken as part of the existing monitoring programme implemented by GEGL for their operations.

In consideration of the information, data, and analysis presented in this document, GEGL requests that EPA deems this EIS acceptable as one component of the EIA process, ultimately leading to the issuance of an environmental permit for the Liquefaction and Gas Conditioning Facility and the 6.5km natural gas pipeline.

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APPENDIX A

EPA letter requesting and EIA for
the project

Detailed PIP

EIA Project Team

Table 1 – Prestea GCP PROJECT EIA TEAM

Name	Contact Details	Experience	Role
Elizabeth Sarpey	Golder Associates Ghana Limited, Ghana Email: esarpey@golder.com Cell: +233 244 422 483	Environmental and social impact assessment, project management, environmental permitting and compliance	Project Manager / EIA Specialist
Brent Baxter	Golder Associates (Pty) Limited, South Africa Email: bbaxter@golder.co.za Cell:+27 11 254 4861	Environmental impact assessment, environmental management, compliance and due diligence, auditing and lender advice against international standards.	Project Director / Reviewer
Clement Abaidoo	Golder Associates Ghana Limited, Ghana Email: cabaidoo@golder.com Cell: +233 243 001 234 / +233 270 231 000	Social impact assessment, data collection and interpretations, social management, and stakeholder engagement	Project Coordinator / Social Scientist
Gladys Anaman	Golder Associates Ghana Limited, Ghana Email: ganaman@golder.com Cell: +233 242 279 010	Geo-environmental, planning, field investigations, data collection and interpretations	EIA Specialist
Ben Asiedu	Golder Associates Ghana Limited, Ghana Email: basiedu@golder.com Cell: +233266839266	Environmental impact assessments and environmental compliance	Ecologist
Stephen Essel	Golder Associates Ghana Limited, Ghana Email: sessel@golder.com Cell: +233244755699	Hydrogeology, geophysics, water management	Hydrogeologist
Lee Boyd	Golder Associates (Pty) Limited, South Africa Email: lboyd@golder.co.za Cell: +27 828 851 799	Hydrology, hydraulics, and water management systems	Hydrologist
Aisling Dower	Golder Associates (Pty) Limited, South Africa	Designing, costing and conducting baseline	Ecologist

	Email: adower@golder.co.za Cell: +27 79 465 0504	flora and fauna surveys, ecosystem services assessments, and development of mitigation, compensation and offsetting measures for projects	
Novania Reddy	Golder Associates (Pty) Limited, South Africa Email: nreddy@golder.co.za Cell: +27 79 497 3460	Data collection, inventory development, compilation of air emission licence and scientific modelling (of air quality and noise) and reporting	Air Quality and Noise Specialist
Karen King	WSP (Africa), South Africa Email: Karen.king@wsp.com Cell: +27 74 129 8488	Soil and land use changes, rainfall patterns, wetlands, soils applications and trans-boundary water.	Pedologist
David de Waal	Golder Associates (Pty) Limited, South Africa Email: ddewaal@golder.co.za Cell: + 27 83 227 8681	Social due diligence for international lenders, implementation and review of social impact assessment and social baseline and related surveys, human rights assessments, integrated environmental governance and institutional conflict management	Socio-economic and stakeholder Specialist
James Adomako	Independent Consultant, Ghana Email: jadamako@yahoo.com Cell: +233 544 340 346	Floral surveys using the quadrat sample, identification and ecosystem ecology	Flora Ecologist
Augustus Asamoah	Independent Consultant, Ghana Email: aasamoah@mail.com Cell: +233 244 519 719	Biodiversity, environmental conservation and tropical forest ecology and management	Fauna Ecologist

APPENDIX B

Biodiversity Baseline and Impact
Assessment Report

Construction Plan for River
Crossing

Alternative Route Analysis Report
for the 6.5km Pipeline

APPENDIX C

**Stakeholder Engagement Report
Project Equipment List**

Project Equipment List

Equipment Item	No. in operation	PWL per unit (dB(A))	Reference for Sound Levels
Construction Phase (all equipment)			
Heavy machinery	5	109	Client Data
Electric gensets	6	103	Client Data
Motorcycle welders	10	119	Client Data
Lighting equipment	4	123	Client Data
Polishing machines	10	113	Client Data
Manual assembly activities	Various	113	Client Data
Telescopic cranes	3	119	Client Data
Personnel vehicles	6	119	Client Data
Trucks	2	123	Client Data
Water pumps	3	116	Client Data

APPENDIX D

**Compensation Action Plan
Compensation Details for Project
Affected Persons**



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