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Environmental Management and Chemical Engineering Consultants.

EC/2026/27

9th September, 2026

The Honorable Minister,
Federal Ministry of Environment,
Central Business District,
Abuja, FCT, Nigeria.

Sir,

**SUBMISSION OF DRAFT ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT
(ESIA) REPORT FOR THE PROPOSED CONSTRUCTION OF LIQUEFIED
PETROLEUM GAS (LPG) PLANT IN DUTSE, DUTSE LOCAL GOVERNMENT,
JIGAWA STATE**

We refer to your letter FMEnv/EA/EIA/9764/VOL.1/31 dated 30th June, 2026 regarding the above mentioned project. We are pleased to submit the draft report for the proposed construction of liquefied petroleum gas (LPG) plant in Dutse, Jigawa State for your review and consideration.

This report has meticulously prepared by our firm on behalf our client, SHAKKATO Nigeria limited, in strict adherence provision of Environmental Impact Assessment Act (EIA Act, CAP E12, LFN 2004) and its associated procedural guidelines.

We kindly request that your esteemed ministry conduct technical review of this submission and provide further directives towards securing requisite environmental Impact Statement (EIS) and project certification.

Please accept our highest regards for you Ministry's guidance in promoting sustainable development in Nigeria.

Respectively submitted for and on behalf of our client.

Engr. Bashir Inuwa *MNES, MNSChE, MAEIA, R.COREN*
Principal Partner

DRAFT ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) REPORT

Of the

**PROPOSED CONSTRUCTION OF LIQUEFIED PETROLEUM GAS PLANT (LPG) in DUTSE LOCAL
GOVERNMENT AREA, JIGAWA STATE**

By

SHAKKATO NIGERIA LIMITED

Submitted To

FEDERAL MINISTRY OF ENVIRONMENT, NIGERIA



September, 2026

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LIST OF ABBREVIATIONS / ACRONYMS

AQI:	Air Quality Index
BMP:	Borrow Pit Management Plan
BOD:	Biological Oxygen Demand
BTEX:	Benzene, Toluene, Ethylbenzene, Xylene
CFCs	Chlorofluorocarbons
CFU:	Colony Forming Unit
CGRC:	Customary Grievance Redress Committee
CoC	Code of Conduct
EIA:	Environmental Impact Assessment
ESIA:	Environmental and Social Impact Assessment
ESMP:	Environmental and Social Management Plan
ESS:	Environmental and Social Standards
FAO:	Food and Agriculture Organization (implied by context)
FGD:	Focus Group Discussion
FMEnv:	Federal Ministry of Environment
FRSC:	Federal Road Safety Corps
GBV:	Gender Based Violence
GRC:	Grievance Redress Committee
GRM:	Grievance Redress Mechanism
HSE	Health Safety and Environment
IF&U:	Interchange LPG and Underpass
ITD:	Inter Tropical Discontinuity
JHA	Job Hazard Analysis
JSMoECC	Jigawa State Ministry of Environment and Climate Change
jSMoLand	JigawaState Ministry of Land and Physical Planning
JSMoWorks	Jigawa State Ministry of Works and Housing
KII:	Key Informant Interview
LGA:	Local Government Area
LMP:	Labour Management Plan
LPG:	Liquefied Petroleum Gas
MDAs	Ministries Departments and Agencies

NAAQS:	National Ambient Air Quality Standards
NESREA:	National Environmental Standards and Regulations Enforcement Agency
NG:	Nigerian Naira (₦)
NGO:	Non-Governmental Organization
NiMET:	Nigerian Meteorological Agency
NPC:	National Population Commission
NSDWQ:	Nigerian Standard for Drinking Water Quality
OHS:	Occupational Health and Safety
OND:	Ordinary National Diploma
PACs:	Project-Affected Communities
PAPs:	Project Affected Persons
PM:	Particulate Matter
PPE:	Personal Protective Equipment
SDGs:	Sustainable Development Goals
SEA:	Sexual Exploitation and Abuse
SH:	Sexual Harassment
SHAKKATO:	SHAKKATO Nigeria Limited
SMP	Security Management Plan
SS:	Senior Secondary School
TDS:	Total Dissolved Solids
TMP:	Traffic Management Plan
TOR:	Terms of Reference
TVOC:	Total Volatile Organic Compounds
VES	Vehicle Exhaust Screening
VET	Vehicle Emission Testing
WB:	World Bank
WHO:	World Health Organization
WMP:	Waste Management Plan

LIST OF ESIA PREPARERS

S/N	NAME	TEAM ROLE	QUALIFICATIONS
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The Company acknowledges with deep gratitude the technical expertise, professionalism and commitment of Enviresources Consult Limited, whose project team meticulously carried out the field investigations, data collection, laboratory coordination, analysis and preparation of this report in full compliance with applicable national environmental guidelines and international best practices.

Special recognition is accorded to the Pollution Control Laboratory of the Jigawa State Ministry of Environment for their invaluable role in undertaking the sampling and laboratory analyses of air, water and soil quality parameters. Their scientific input provided a robust and reliable foundation for the baseline environmental assessment and subsequent impact evaluation presented in this report.

Green Land LPG Limited further acknowledges the Federal Ministry of Environment for its statutory regulatory oversight, technical guidance and review throughout the ESIA process, ensuring that all procedures and documentation meet established environmental compliance requirements.

The Company also extends its sincere appreciation to the community leaders, stakeholders and residents of Gida Dubu community in Dutse metropolis for their cooperation, openness and active participation during stakeholder engagement sessions and public consultations. Their valuable insights and local knowledge significantly enhanced the quality, relevance and inclusiveness of this assessment.

Finally, we acknowledge all relevant government agencies, institutions and supporting organizations that provided essential data, technical assistance and institutional collaboration. Their contributions were critical in ensuring the credibility, completeness and successful execution of this ESIA study.

EXECUTIVE SUMMARY

ES 1: Introduction

The Shakkato Nigeria Limited plans to construct the liquefied petroleum and gas plant in 2626m² (0.263ha) that will produce nearly thirty (30) metric tonnes of LPG per day. This project has the potential for significant environmental and social impacts, necessitating the preparation of an Environmental and Social Impact Assessment (ESIA) to identify, evaluate, and mitigate these impacts. The ESIA will comply with national and international environmental and social safeguards, including the Nigerian Environmental Impact Assessment (EIA) Act Cap E12 LFN 2004, World Bank Environmental and Social Standards (ESS), and other relevant regulations and international best practices.

While the project is designed to deliver considerable socio-economic benefits, its implementation is not without potential environmental and social risks. These include community disruption, temporary economic displacement for informal vendors, alterations to land use, and impacts on local air quality, noise levels, and water resources. In full compliance with Nigeria's environmental legal framework, specifically the Environmental Impact Assessment (EIA) Act No. 86 of 1992 (see Table 1.1), this Environmental and Social Impact Assessment (ESIA) has been undertaken to systematically identify, evaluate, and mitigate these potential adverse impacts.

The purpose of this ESIA is to provide a robust, evidence-based framework for ensuring the project's sustainability. Through comprehensive baseline studies, predictive impact analysis, and extensive stakeholder engagement, the assessment develops a detailed Environmental and Social Management Plan (ESMP). This integrated approach ensures that mitigation measures are proactively embedded into the project's planning and design, safeguarding community well-being and aligning the development with the principles of sustainable development and international best practices.

ES 2: Project Justification

The proposed LPG plant is justified by the increasing demand for clean, efficient, and affordable energy for domestic, commercial and industrial use. Population growth, urbanization, and rising energy needs have placed pressure on existing LPG supply and distribution infrastructure, creating need for additional storage and distribution facilities. The project will improve the availability and accessibility of LPG across the state, thereby reducing dependence on traditional fuels such as firewood, charcoal, and kerosene, lower greenhouse gas emissions, and improved air quality. The

project is also justified on economic grounds, as it will create employment opportunities during both construction and operational phases. It will stimulate developments in the local business activities, and generate revenue for Jigawa state through taxes and levies. Furthermore, the project aligns with the national energy policies and sustainable development goals that encourage the adoption of cleaner energy sources, energy security, environmental protection, and suitable economic growth. .

ES 3: Project Description

A comprehensive description of the proposed LPG project is provided, outlining its scope, infrastructure and operational framework. The development will involve key construction activities such as site clearing, earthworks, installation of drainage systems and establishment of production facilities required for efficient farm operations.

The project is designed as an integrated LPG production system. The facility will feature advanced gas handling and dispensing infrastructure, including a high-pressure modular LPG storage tank with a bulk capacity of thirty 30 metric tons. It will be equipped with eight (8) electronically controlled refilling units capable of dispensing LPG into cylinders ranging from 6 kg to 35 kg for household and commercial purposes, as well as larger cylinders for industrial applications.

The LPG housing unit will ensure a controlled environment through proper ventilation, lighting, and waste management systems, thereby promoting sustainable Production. Those components will help maintain product quality, enhance operational safety, and enable controlled LPG distribution in accordance with industry standards and best practices.

ES 4: Description of the Physical and Social Environment

The proposed project site is located within the Dutse Local Government Area of Dutse Metropolis, an area characterized by intense urban activity. The project site lies on a Basement Complex geology (see Figure 4.2), forming a low-relief plain with sandy, ferruginous soils that are highly permeable and susceptible to erosion. The region experiences a tropical climate with distinct wet and dry seasons (see Figure 4.1 and Table 4.1), and is subject to a significant urban heat island effect, elevating local temperatures.

Baseline environmental monitoring reveals a pre-existing stressed environment. Ambient air quality at the junction already exceeds national standards for critical pollutants, including Nitrogen Dioxide (NO₂), Sulphur Dioxide (SO₂), and Particulate Matter (PM_{2.5} and PM₁₀), largely

attributable to current vehicular congestion . The Air Quality Index (AQI) is consistently rated "Moderate," indicating a risk to sensitive populations (see Table 4.2). Analysis of groundwater from local boreholes shows compliance with most standards, but with elevated levels of iron and phosphate, suggesting potential contamination (see Table 4.3, Figure 4.3, Figure 4.4 and Plate 4.2).

This Baseline Socioeconomic Study (BSS) documents the current socioeconomic conditions of communities flanking the proposed site of Greenland LPG Limited (a LPG farm-cum-feed mill project) located near Dorawar Shehu (Coordinates: 12.165048, 8.331812) in Dutse LGA, JIGAWA State, Nigeria. The BSS synthesizes household survey data collected from 92 households across the three proximate localities: Dorawar Shehu, Karanbani (including a herder community) and Gawalde. It establishes pre-project benchmarks for demographics (household composition, human capital), livelihoods, assets and wealth, access to services, health, environmental resource dependency, and community perceptions. The BSS is intended to provide an objective, evidence-based baseline against which future monitoring and any World Bank Group ESG compliance requirements can be assessed.

Key baseline takeaways. The quantitative dataset shows the following headline conditions that are critical for project design, risk mitigation, and monitoring:

- i. **Rural agrarian economy:** Majority of household heads report crop production (63%) and livestock keeping (24%) as primary occupations (see Table 5.17).
- ii. **Large household sizes:** Mean household size is 9 persons overall (median 7), substantially above national averages for Nigeria, with locality variation (Dorawar Shehu mean 6; Gawalde mean 11). See Table 5.3.
- iii. **Low formal education: Qur'anic education only** dominates among household heads (83.7%); only a small share has secondary or higher formal schooling (see Table 5.9**Error! Reference source not found.**).
- iv. **Pervasive poverty and seasonal incomes:** Over **65%** of households report monthly incomes below ₦50,000, and 46% report incomes that are higher in harvest season, indicating strong seasonality and vulnerability. See Table 5.21 and Table 5.24.
- v. **High livestock and LPG ownership: 76%** of households own LPG; goats and sheep ownership are also widespread—important for both project opportunity and potential resource-use conflicts. See Table 5.31 and Table 5.32

- vi. **Basic infrastructure gaps:** Drinking water is mainly from protected wells (75%); pit latrines are the dominant sanitation facility (96%); waste disposal is largely by open dump or burning. See Table 5.37, Table 5.39 and Table 5.40.
- vii. **Health burden concentrated in malaria/fever: 80%** of households reported malaria/fever in the two weeks preceding the survey; health access is mixed between hospitals and PHCs with notable travel distances for many households. See Table 5.41, Table 5.42 and Table 5.43.
- viii. **Strong community support but environmental concerns:** 100% of respondents want the project to proceed and expect jobs and economic growth, yet 90% anticipate odour as a negative impact and nearly 30% cite noise concerns—key social risks to manage. See Table 5.69, Table 5.60 and Table 5.65.

ES 5 and E6: Potential Project Impacts, Mitigation and Management Plan

The project is anticipated to deliver significant positive impacts, primarily through the decisive alleviation of chronic traffic congestion (see Table 5.1, 5.2, 5.3 and 5.4). This will yield substantial economic gains from reduced travel time and fuel consumption, enhance road safety via grade-separated traffic flows, and improve overall urban mobility. Furthermore, decreased vehicle idling will contribute to a long-term reduction in localized air emissions, aligning with broader environmental sustainability goals.

However, the construction phase presents a range of manageable negative impacts (see Table 6.1). These include temporary air quality deterioration from dust and equipment exhaust, noise and vibration disturbances, soil erosion, and water contamination from site runoff. Significant social risks involve community discomfort, disruptions to local traffic and access, and temporary economic displacement for informal vendors and businesses operating near the junction.

ES 7: Environmental and Social Management Plan

To mitigate these impacts, a comprehensive Environmental and Social Management Plan (ESMP) has been developed, prescribing specific actions across all project phases (see Table 7.1, Table and **Error! Reference source not found.**7.3). Key mitigation measures include dust suppression through regular water spraying and machinery maintenance, erosion control using silt fences and sediment traps, and the strict implementation of a robust Traffic Management Plan (TMP). Social mitigation focuses on continuous stakeholder communication, a transparent Grievance Redress Mechanism (GRM), and fair compensation for affected persons.

The ESMP operationalizes these measures by assigning clear institutional responsibilities. The JIGAWA State Ministry of Environment will oversee compliance, while the appointed contractors are responsible for on-the-ground implementation. A rigorous monitoring protocol is established for key indicators like air quality, noise levels, and water quality, ensuring timely corrective actions.

To build capacity and ensure effective execution, a dedicated training program for project staff and workers on environmental and social safeguards is outlined within the ESMP. This is further supported by detailed subsidiary plans for waste management, occupational health & safety and borrows pit management.

The successful implementation of this framework is supported by a dedicated financial plan. The total estimated budget for the ESIA / ESMP implementation is NGN 17,590,000.00 (Seventeen Million, Five hundred and Ninety Thousand Naira), ensuring that all identified mitigation, monitoring and capacity-building activities are fully resourced. This proactive and integrated management framework ensures that the project's significant benefits are realized while diligently minimizing, mitigating, and monitoring its adverse environmental and social effects throughout its lifecycle, fulfilling the project's commitment to sustainable development.

ES 8: Conclusion and Recommendations

The ESIA concludes that the proposed Project is an environmentally feasible and critically justified project, essential for resolving the severe congestion at a key urban junction. The assessment confirms that the significant positive impacts—including enhanced mobility, economic efficiency, and improved road safety—can be successfully realized. While the baseline studies identified a pre-existing environment under stress and community concerns regarding displacement and pollution, the analysis demonstrates that these challenges can be effectively managed through the dedicated implementation of the proposed mitigation framework.

To ensure sustainable development and safeguard community well-being, the project must adhere to several key recommendations. A fair and transparent compensation and livelihood restoration process for all Project-Affected Persons (PAPs) must be finalized and implemented as a priority. During construction, strict enforcement of pollution control, erosion prevention, and the Traffic Management Plan (TMP) is non-negotiable. Furthermore, all identified mitigation measures must be fully integrated into the final engineering designs and contractor bidding documents.

Ultimately, the long-term success of the project rests on robust institutional oversight. The JIGAWA State Ministry of Environment, in collaboration with other regulatory bodies, must assume primary responsibility for monitoring ESIA compliance and building the necessary capacity to enforce the Environmental and Social Management Plan (ESMP). This sustained commitment is the cornerstone for transforming the project's potential into lasting benefits for the city and its inhabitants, ensuring it serves as a model for responsible urban infrastructure development.

CHAPTER ONE

INTRODUCTION

1.1 Background Information

The Shakkato Nigereia Limited plans to construct a modern modular Liquefied Petroleum Gas (LPG) storage and refilling plant with a bulk storage capacity of thirty (30) metric tons. The proposed facility will be located opposite the Federal University Duse in Dutse Local Government Area of Jigawa State. The project will improve the availability and accessibility of LPG across the state, thereby reducing dependence on traditional fuels such as firewood, charcoal, and kerosene, lower greenhouse gas emissions, and improved air quality. While this project is designed to improve industrialisation and economic efficiency, its implementation carries potential environmental and social risks. These include disruptions to local communities, impacts on air and noise quality, and alterations to land use patterns.

The establishment of the 30 metric tons LPG storage and refilling plant in Dutse Local Government Area aligns with Nigeria's policy on domestic gas utilization and the transition toward cleaner energy sources. The project is expected to improve access to reliable cooking energy, stimulate local economic development, reduce dependence on firewood and charcoal, and contribute to environmental sustainability through reduced greenhouse gas emissions and improved air quality within Jigawa State.

In compliance with Nigeria's environmental legal framework, specifically the Environmental Impact Assessment (EIA) Act (1992) and guidelines from the Federal Ministry of Environment, the JIGAWA State Ministry of Works and Housing is mandated to conduct this Environmental and Social Impact Assessment (ESIA).

The purpose of this ESIA is to systematically identify, predict, and evaluate the project's potential positive and adverse impacts on the biophysical environment, socio-economic conditions, and public health. Through comprehensive stakeholder engagement, field studies, and predictive analysis, the assessment will develop robust mitigation strategies to address potential harms and enhance project benefits. These measures will be integrated into a detailed Environmental and Social Management Plan (ESMP) and the project's engineering design, ensuring alignment with sustainable development principles and safeguarding the well-being of affected communities.

This report outlines the existing baseline conditions, predicts potential impacts, and provides

actionable recommendations to guide the project's responsible execution in accordance with national regulations and international best practices.

1.2 Proponent

The project proponent is the Shakkato Nigeria Limited which is registered in Nigeria with Corporate Affairs Commission (CAC), responsible for overseeing the design, procurement and construction of the LPG Plant. The Company is dedicated to the development of modern gas infrastructure aimed at enhancing domestic energy supply, improving distribution efficiency, and promoting the adoption of cleaner energy alternatives across the country. Its corporate vision is anchored on delivering safe, efficient, and environmentally sustainable energy solutions that support national development and long-term economic growth. The project is designed to encourage increased utilization of Liquefied Petroleum Gas (LPG) as a safer and more environmentally friendly alternative to traditional biomass fuels and other high-emission energy sources, thereby contributing to improved public health, reduced environmental degradation, and enhanced air quality

1.3 Project Description

The proposed project entails the development of a modern, fully integrated Liquefied Petroleum Gas (LPG) Storage and Refilling Plant along Ibrahim Aliyu bypass Road in Dutse Local Government Area, Jigawa State.

The facility is designed to cover all stages of the project lifecycle, including site preparation, construction, commissioning, and long-term operations. It will serve as a strategic hub for the receipt, storage, conditioning, and distribution of LPG to domestic, commercial, and industrial consumers across Jigawa State and the wider northern region.

The facility will feature advanced gas handling and dispensing infrastructure, including a high-pressure modular LPG storage tank with a bulk capacity of thirty 30 metric tons. It will be equipped with eight (8) electronically controlled refilling units capable of dispensing LPG into cylinders ranging from 6 kg to 35 kg for household and commercial purposes, as well as larger cylinders for industrial applications.

To ensure safe, efficient, and regulated operations, the plant will integrate essential gas management and conditioning systems, including odorization units, vaporizers where necessary, pressure regulation systems, and pump skid assemblies. These components will help maintain

product quality, enhance operational safety, and enable controlled LPG distribution in accordance with industry standards and best practices.

The infrastructure will be supported by including a fully equipped electrical control room powered by a 250 kVA standby generator, backed by a grid-connected transformer. Fire safety measures will comprise a dedicated firewater system with diesel, electric, and jockey pumps, supplemented by dry chemical and CO₂ extinguishers, sand buckets, hazard signage, and designated buffer zones in line with NFPA standards (NFPA 52 and NFPA 59A). The facility will also incorporate storm water drainage, underground utilities, septic systems, and reinforced hardstand surfaces to ensure operational resilience and environmental protection.

The proposed plant will also be going to have administrative block with offices and support facilities like reception areas, restrooms, staff changing rooms, a mini-mart, waiting areas for customers, a technical workshop, storage facilities, and mosque to meet spiritual needs. Security will also be ensured through a controlled entry point with sliding gates.

1.4. Project Location

The project site is situated at the strategic location, within the Dutse Local Government Area of Jigawa State, Nigeria. The proposed LPG Station by Shakkato Nigeria Limited is located at Gida Dubu Quarters, opposite Federal University Dutse, Dutse, Jigawa State, Nigeria. The geographical coordinates supplied for the proposed project site are approximately 11°42'46" N latitude and 9°22'46" E longitude.

1.5 Regulatory Framework

The ESIA for the project complies with Nigeria's statutory, regulatory and policy frameworks, as well as international conventions ratified by the Nigerian government.

1.5.1 Federal Environmental Laws, Policies and Guidelines

The provisions of existing national policies, laws and regulations relevant to the project activities are summarized in Table .1 below:

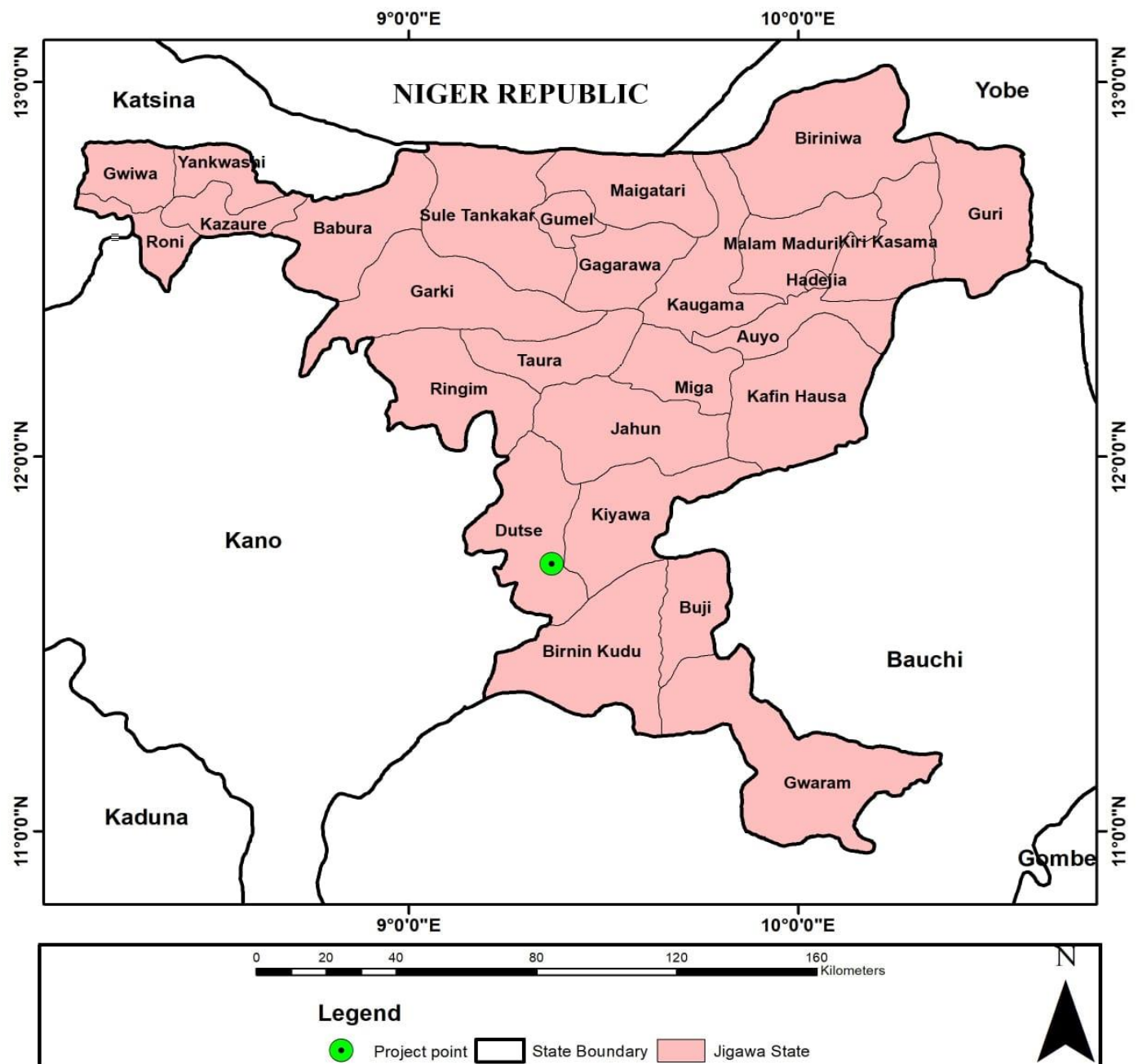


Figure 1.1: Map of Jigawa Showing the Location of the Proposed Integrated LPG

Table 1.1: Relevant National Policies, Laws and Regulations

S/N	Regulations	Year	Provisions
1	National Policy on the Environment	1989	The policy identifies key sectors requiring integration of environmental concerns and sustainability with development and presents their specific guidelines
2	EIA Act No 86 of 1992 (codified as EIA Act CAP E12 LFN 2004)	1992	The Act makes EIA mandatory for all major development projects likely to have adverse impacts on the environment and gives specific powers to FMEnv to facilitate environmental assessment of projects in Nigeria.
3	National Environmental Protection (Management of Solid and Hazardous Wastes) Regulations.	1991	Regulates the collections, treatment and disposal of solid and hazardous wastes from municipal and industrial sources.
4	NESREA Act No. 25, 2007	2007	The NESREA Act No. 25 of 30 th July, 2007 established NESREA and empowers her with the responsibility of enforcing all environmental laws, guidelines, policies, standards and regulations in Nigeria. The Act spells out the functions, powers, structure, staffing of the Agency as well as financial and other miscellaneous provisions.
5	National Environmental (Sanitation and Wastes Control) Regulations	2009	The purpose of the Regulation is the adoption of sustainable and environment friendly practices in environmental sanitation and waste management to minimize pollution. The Instrument amongst others makes provisions for the control of solid wastes, hazardous wastes and effluent discharges. It in addition, spells out roles and responsibilities of State and Local Government Authorities.
6	National Air Quality Standard Decree No. 59	1991	The World Health Organization (WHO) air quality standards were adopted by the then Federal Ministry of Environment (FMEnv) in 1991 as the national standards. These standards define the levels of air pollutants that should not be exceeded in order to protect public health.

S/N	Regulations	Year	Provisions
7	National Environmental (Noise Standards and Control) Regulations	2009	The objective of the Regulations is to ensure maintenance of a healthy environment for all people in Nigeria, the tranquility of their surroundings and their psychological wellbeing by regulating noise levels. The Instrument prescribes maximum permissible noise levels of a facility or activity to which a person may be exposed; and provides for the control of noise mitigating measures for the reduction of noise.
8	National Environmental (Soil Erosion & Flood Control) Regulations (S.I. 12)	2011	The purpose of these Regulations is to establish technically feasible and economically reasonable standards and procedures to achieve appropriate level of management and conservation practices to abate soil erosion, siltation and sedimentation of the waters of Nigeria, due to soil erosion and flood aggravated by non-agricultural earth disturbing activities.
9	National Environmental (Construction Sector) Regulations (S.I No. 19)	2011	The purpose of these regulations is to prevent and minimize pollution from construction, decommissioning and demolition activities in the Nigerian environment. It stipulates that new projects in the construction sector shall apply cost-effective, up-to-date, efficient, best available technology, to minimize pollution to the barest degree practicable. In addition, every operator or facility shall carry out an EIA and submit an EMP for new projects or modification including expansion of existing ones before commencement of activity.
10	National Environmental (surface and Ground water quality control) Regulation	2011	The Regulations is concerned with the protection of water resources for purposes of various uses including clean water supply, agriculture, aquaculture and aquatic ecosystems
11	EIA Sectoral Guidelines for Infrastructure – Transportation	1995	The Guidelines were designed to assist project proponents in conducting detailed environmental assessment of roads and highways projects with emphasis on the significant

S/N	Regulations	Year	Provisions
	Development Project (Roads and Highways),		associated and potential impacts of such projects on the environment, mitigation measures for avoiding, minimizing or alleviating any adverse impacts as well as future monitoring program for ensured sustainability of the project are also contained therein for guidance.
12	National Climate Change Policy	2020	This policy seeks to build a climate resilient society through the attainment of mitigation measures that will promote low carbon as well as sustainable and high economic growth. Its mission is to strengthen national initiatives to adapt to and mitigate climate change in a participatory manner involving all sectors of the Nigerian society, including the poor and other vulnerable groups (women, youth etc.) within the overall context of advancing sustainable socio-economic development in Nigeria.
13	Land Use Act CAP L5 LFN	2004	The Land Use Act of 1978 reviewed under Cap L5 of 2004 is the legal framework for land acquisition and resettlement in Nigeria. Subject to the provisions of this Act, all land comprised in the territory of each State in the Federation are vested in the Governor of that State and such land shall be held in trust and administered for the use and common benefit of all Nigerians in accordance with the provisions of this Act.
14	Employee Compensation Act	2010	The Act provides compensation to employees who suffer from occupational diseases or sustain injuries arising from accidents at workplace or in the course of employment. Payment of compensation (to the worker or to his dependents in case of death) by the employer is rooted in the accepted principle that the employer has a duty of care to protect the health, welfare and safety of workers at work.

S/N	Regulations	Year	Provisions
15	National Policy on Occupational Safety and Health	2020	The Policy seeks to create safer and healthier working environment through the development of a positive national culture of prevention of occupational accidents, disease and dangerous occurrences
16	Child Right Act	2003	Codifies the rights of children in Nigeria (a person below the age of 18 years), consolidates all laws relating to children into a single law and specifies the duties and obligations of government, parents and other authorities, organizations and bodies. More particularly, the Act gives full protection to privacy, honor, reputation, health and prevention from indecent and inhuman treatment through sexual exploitation, drug abuse, child labor, torture, maltreatment and neglect to a Nigerian Child.
17	National Gender Policy	2006	Nigeria put together the National Gender Policy in 2006. Its overall goal is to promote the welfare and rights of Nigerian women and children in all aspects of life: political, social and economic. The policy seeks to plan, coordinate, implement, monitor and evaluate the development of women in the country. In concrete terms, the National Gender Policy in Nigeria focus on: • Contribution towards women's empowerment and the eradication of unequal gender power relations in the workplace and economy, in trade unions and in broader society; • Encouragement of the participation, support and co-operation of men in taking shared responsibility for the elimination of sexism and redefining of oppressive gender roles; • Increase the participation of women in leadership and decision-making;

S/N	Regulations	Year	Provisions
			• Ensure that through labor legislation and collective bargaining, the particular circumstances of women are considered and that measures are promoted to eliminate discrimination on the basis of gender; • Ensure that there is a gender perspective in all sectors of development.
18	Freedom of Information Act	2011	This Act makes public records and information more freely available, provide for public access to public records and information, protect public records and information to the extent consistent with the public interest and the protection of personal privacy.
19	Nigeria Labor Act	1990	Seeks to safeguard the rights and interests of both employees and employers while promoting fair labor practices and productive industrial relations. It addresses matters such as wages, working hours, overtime, and conditions for employment of women and young workers. The Act emphasizes the importance of workplace safety, health, and welfare, and includes provisions on compensation for work-related injuries.
20	National Commission for Museums and Monuments Act	1990	National Commission for Museums and Monument seeks to protect and preserve any objects of archaeological interest wherever they may be found. Any person who discovers an object of archaeological interest in the course of operations permitted under section 19 of this Act shall notify the Commission.
21	Nigerian Urban and Regional Planning Act	2004	Mandates development control compliance at federal, state, and local levels
22	Federal Roads Safety Corp (FRSC) Act	2007	Ensures road safety standards during construction and operation phases.

1.5.2 State Policies, Laws and Regulations

- 1 *Jigawa State Urban Planning and Development Authority Edict (1998)*: Ensures alignment with local land-use zoning and infrastructure plans.
- 2 Jigawa State Refuse Management & Sanitation Board Law (2003): Regulates solid and hazardous waste disposal in the state.
- 3 Jigawa State Climate Change Policy (2025): Provides a strategic roadmap for climate action, outlining sectorial and cross-sectorial policy measures to guide the state's response to climate change.
- 4 Jigawa State Transport Policy (2023): Aims to modernize and streamline the state's transportation network to address urbanization challenges, enhance mobility, and boost economic growth.

1.5.3 International Conventions and Standards

Nigeria's commitment to global environmental governance is reflected in its ratification of:

- 1 *Basel Convention (1989)*: Restricts trans-boundary movement of hazardous waste, ensuring project waste is managed locally.
- 2 *Montreal Protocol (1987) & Amendments*: Mitigates ozone layer depletion by regulating emissions from construction equipment.
- 3 *UN Framework Convention on Climate Change (1992)*: Guides greenhouse gas reduction strategies in project design.
- 4 *Convention on Biological Diversity (1994)*: Protects local ecosystems and biodiversity during construction.
- 5 *ILO Conventions*: Ensures fair labour practices, aligned with the *Labour Act (1990)* and *1999 Constitution* (equal pay, anti-discrimination).
- 6 World Bank Environmental and Social Framework (2018).
- 7 UN Sustainable Development Goals (SDGs).
- 8 Equator Principles (2020).

1.6 Terms of Reference (TOR)

The Environmental and Social Impact Assessment (ESIA) for the proposed construction of LPG Plant is conducted pursuant to a formally approved Terms of Reference (TOR). This TOR, which

is provided in Annex 1 and was approved by the Federal Ministry of Environment (FMEnv) as evidenced in Annex 2, serves as the foundational framework and regulatory guide for the entire assessment process.

The TOR explicitly defines the scope of work, which encompasses the following key activities:

- i. *Baseline Studies*: Conduct comprehensive field and desk studies to establish pre-project conditions for key environmental and social parameters, including air and noise quality, soil and water resources, biodiversity, and socio-economic and public health characteristics of adjacent communities.
- ii. *Impact Prediction and Mitigation*: Identify, predict, and evaluate all potential positive and negative impacts arising from the project's construction and operational phases. Subsequently, develop scientifically robust and context-specific mitigation measures to avoid, minimize, or compensate for adverse effects.
- iii. *Stakeholder Engagement*: Implement an inclusive public consultation and stakeholder engagement process to solicit feedback, address concerns, and integrate public input into project planning and impact management.
- iv. *ESIA Reporting*: Prepare a comprehensive ESIA Report that documents the findings, impact assessments, and mitigation plans, culminating in the development of an actionable Environmental and Social Management Plan (ESMP).

Furthermore, the TOR establishes a protocol for iterative review, ensuring that the ESIA process is integrated concurrently with the project's conceptual design phase. This alignment guarantees that environmental and social considerations are proactively embedded into the detailed engineering plans, and that identified impacts are systematically addressed throughout all subsequent project stages, including site preparation, construction, commissioning, demobilization, and long-term operation.

1.7 Objectives of the ESIA

The Environmental and Social Impact Assessment (ESIA) for the proposed LPG Project is designed to fulfil the following specific objectives:

1. *Establish Environmental and Social Baselines:* To characterize the pre-existing biological, physical, chemical, social, and economic conditions within the project area of influence, thereby creating a benchmark against which future changes can be measured.
2. *Identify and Assess Potential Impacts:* To systematically identify, predict, and characterize the significance of all potential positive and negative impacts—direct, indirect and cumulative—that may arise during the project's construction and operational phases.
3. *Develop Mitigation and Management Measures:* To prescribe effective, feasible and cost-efficient mitigation strategies to eliminate, reduce, or manage adverse impacts to acceptable levels, and to enhance positive outcomes. These measures will be consolidated into a comprehensive Environmental and Social Management Plan (ESMP).
4. *Ensure Meaningful Stakeholder Engagement:* To facilitate a transparent, inclusive, and on-going process of consultation with all relevant stakeholders, including project-affected communities, government agencies, and civil society organizations, ensuring their concerns are heard and addressed.
5. *Fulfil Regulatory Requirements:* To ensure full compliance with all applicable Nigerian environmental laws, regulations, and standards, particularly the EIA Act of 1992, and to secure the requisite ESIA certification and environmental permits from the Federal Ministry of Environment.
6. *Promote Sustainable Development:* To provide a decision-support tool for the project proponent and regulators, ensuring that the project is implemented in an environmentally sound and socially responsible manner, aligning with the principles of sustainable development.

CHAPTER TWO

PROJECT JUSTIFICATION

2.1 Need for / Justification of the Project

SHAKKATO Nig. Limited intention to undertake the construction of liquefied petroleum and gas plant in Jigawa city is based on the need of growing demand of LPG for cooking, heating and industrial application, promotion of clean energy, economic development and job creation toward contributing in rising Nigeria's GDP thereby helping the economic growth of the country.

The proposed thirty 30 metric tons Liquefied Petroleum Gas (LPG) Plant by Shakkato Nigereia Limited, to be sited opposite the Federal University Dutse along Ibrahim Aliyu Bypass road in Dutse Local Government Area of Jigawa State, is intended to address the increasing demand for reliable and cleaner energy solutions within Jigawa metropolis and surrounding communities. The project aligns with Nigeria's strategic objectives of promoting domestic gas utilization as a means of achieving energy security, environmental sustainability, and long-term economic development. Although Nigeria possesses significant natural gas resources, access to LPG in many northern states, including Jigawa, remains limited due to insufficient storage and distribution infrastructure. Consequently, households and small enterprises continue to rely heavily on firewood, kerosene, and other carbon-intensive fuels. The establishment of a bulk LPG facility in Dutse is expected to strengthen the downstream gas supply chain, enhance product availability, and provide a regulated, safe platform for storage and cylinder refilling. Jigawa State is experiencing steady urban expansion and increasing commercial activities, particularly along key transport corridors within Dutse Metropolis, resulting in rising energy demands across residential, commercial, and light industrial sectors. The proposed LPG plant will help stabilize supply, minimize transportation constraints from distant depots, and reduce unsafe informal refilling operations that pose significant safety hazards to the public.

2.2 Project Objectives

The project is guided by a set of clear, measurable objectives designed to directly address the identified problems and deliver tangible benefits to the city and its residents. The primary objectives are:

- i. Achieved about 500,000 eggs per day minimize accident rates by eliminating at-grade conflicts between traffic streams and providing segregated, safe pathways for pedestrians.

- ii. Create a number of jobs opportunities for the local youth and farmers.
- iii. Increase access to affordable protein sources for the general population.
- iv. Promote sustainable agriculture practices and reduce environmental impact.
- v. Generate revenue for the government.

2.3 Analysis of Project Alternatives

A critical component of the Environmental and Social Impact Assessment (ESIA) process is the rigorous evaluation of feasible alternatives to the proposed project. This analysis ensures that the selected option (constructing of the modern LPG farm and feed mills) represents the most balanced and sustainable solution to the identified problem, considering engineering, environmental, social, and economic factors. Table 2.1 below presents the various project alternatives explored for the LPG project.

Table 2.1: Analysis of Alternatives to the LPG farms and feed mills Project

Project Alternative	Key Features	Advantages	Disadvantages	Rationale for Rejection
Do-Nothing Alternative: This alternative involves maintaining the status quo.	Continuation of the status quo, with reliance on firewood, kerosene, and other high-emission fuels.	Avoids upfront capital investment in then Energy sector.	This would lead to Ongoing pressure on forest resources and exposure to indoor air pollution. It is fundamentally misaligned with Sustainable Development Goals (SDGs) related to sustainable infrastructure (SDG 9) and cities (SDG 11).	This alternative is The no-project option does not address growing energy demand or environmental concerns and would deny the community the socio-economic benefits associated with the project. It is therefore not considered desirable.
Selected Alternative	Key Features	Advantages	Disadvantages and Mitigation	Rationale for Selection
Construction of a Modern LPG Plant was identified as the most viable and balanced alternative.	a dedicated LPG facility was design with storage system and infrastructure facilities	✓ Efficiency: Provides a permanent, prioritizes safety, operational efficiency, and environmental protection while remaining cost-	This option involves temporary construction-phase impacts (noise, dust, traffic disruption) and requires land for the structure. However, these impacts are short-term and can be effectively managed through a robust Environmental and Social	Ensuring in design a sustainable project with considering environmental impact, energy efficiency and waste management.

Selected Alternative	Key Features	Advantages	Disadvantages and Mitigation	Rationale for Selection
		effective and adaptable to future expansion. ✓ Safety and Environmental: Significantly enhances the alternative to satisfies project objectives, enhances clean energy access, and aligns with sustainable development priorities ✓ Economic: Facility will facilitate movement of goods and as such boosting economic productivity.	Management Plan (ESMP), which includes a Traffic Management Plan (TMP), pollution control protocols, and a fair compensation and livelihood restoration framework for affected persons.	

CHAPTER THREE

PROJECT DESCRIPTION

3.1 SCOPE OF WORK

The proposed project entails the development of a modern, fully integrated Liquefied Petroleum Gas (LPG) Storage and Refilling Plant along Ibrahim Aliyu bypass Road in Dutse Local Government Area, Jigawa State. The facility is designed to cover all stages of the project lifecycle, including site preparation, construction, commissioning, and long-term operations. It will serve as a strategic hub for the receipt, storage, conditioning, and distribution of LPG to domestic, commercial, and industrial consumers across Jigawa State and the wider northern region.

The facility will feature advanced gas handling and dispensing infrastructure, including a high-pressure modular LPG storage tank with a bulk capacity of thirty 30 metric tons. It will be equipped with eight (8) electronically controlled refilling units capable of dispensing LPG into cylinders ranging from 6 kg to 35 kg for household and commercial purposes, as well as larger cylinders for industrial applications.

To ensure safe, efficient, and regulated operations, the plant will integrate essential gas management and conditioning systems, including odorization units, vaporizers where necessary, pressure regulation systems, and pump skid assemblies. These components will help maintain product quality, enhance operational safety, and enable controlled LPG distribution in accordance with industry standards and best practices.

The infrastructure will be supported by including a fully equipped electrical control room powered by a 250 kVA standby generator, backed by a grid-connected transformer. Fire safety measures will comprise a dedicated firewater system with diesel, electric, and jockey pumps, supplemented by dry chemical and CO₂ extinguishers, sand buckets, hazard signage, and designated buffer zones in line with NFPA standards (NFPA 52 and NFPA 59A). The facility will also incorporate storm water drainage, underground utilities, septic systems, and reinforced hardstand surfaces to ensure operational resilience and environmental protection.

The proposed plant will also be going to have administrative block with offices and support facilities like reception areas, restrooms, staff changing rooms, a mini-mart, waiting areas for

customers, a technical workshop, storage facilities, and mosque to meet spiritual needs. Security will also be ensured through a controlled entry point with sliding gates.

The project will be executed in four main phases:

1. Pre-construction – site surveys, regulatory approvals, and baseline environmental studies;
2. Construction – civil, mechanical, and electrical works;
3. Commissioning – system testing, safety certification, and staff training;
4. Operational Phase – daily LPG storage, cylinder refilling, distribution, maintenance, and ongoing environmental monitoring.

3.2 PROJECT OVERVIEW

The project aligns with the Federal Government's National Gas 36 Expansion Programme (NGEP), which seeks to transition Nigeria from conventional petroleum fuels to cleaner, safer, and more sustainable energy sources. The project is designed to meet the growing demand for affordable and environmentally friendly energy in Jigawa State and the broader northern region, particularly for domestic, commercial, and vehicular applications. The facility, spanning approximately 0.2 square meters, will function as a primary LPG hub for storage, compression, and distribution. LPG will be delivered to the site via road tankers and compressed using high-pressure systems for direct refueling of vehicles as well as for onward loading into distribution trucks serving satellite stations. This arrangement will improve fuel availability, reduce reliance on petrol and diesel, support the adoption of LPG-powered vehicles, enhance air quality, and comply with national safety and environmental regulations. Key infrastructure components include high-pressure storage vessels certified to ISO standards, with a combined capacity of 200 metric tons, and gas compressor units capable of pressurizing LPG for safe dispensing and onward distribution. Safety features such as pressure relief valves, emergency shutdown systems, and automated monitoring are integrated to ensure efficient and secure operations. The dispensing and metering system comprises dedicated refueling bays equipped with leak-proof high pressure hoses, double nozzles for simultaneous vehicle fueling, and automated meters to guarantee accurate measurement and billing. Operational control is maintained via pressure regulators, automatic shut-off valves, and a programmable logic control (PLC) panel for real-time monitoring and management. Fire protection and safety measures are embedded throughout the facility,

including strategically placed fire hydrants and extinguishers, gas detection and alarm systems, emergency assembly points, and perimeter fencing with controlled access to enhance both safety and security. Ancillary infrastructure will support operational efficiency and staff welfare. This includes an administrative block with offices, a control room, and staff facilities, a reliable power supply through both grid connection and backup generator, an on-site borehole for water supply, and a drainage network to manage wastewater and stormwater. Paved access roads, reinforced forecourts, adequate lighting, and safety signage will facilitate smooth vehicle circulation and operational effectiveness.

The proposed LPG Storage and Refilling Plant is expected to contribute significantly to energy diversification in Jigawa State by enhancing access to cleaner fuels for domestic, commercial, and transportation applications. The project will also drive economic growth by generating employment during both the construction and operational phases and by stimulating related downstream activities such as cylinder distribution, logistics, and ancillary service operations. In keeping commitment to environmental stewardship and regulatory compliance, a thorough Environmental Impact Assessment (EIA) will be carried out in accordance with the guidelines of the Federal Ministry of Environment (FMEnv). The assessment will examine potential environmental and social impacts, identify sensitive receptors, and propose appropriate mitigation and monitoring measures to ensure effective environmental management throughout the project lifecycle. The project incorporates several environmental management measures, including a stormwater drainage system to manage runoff and prevent flooding, waste management facilities for proper segregation and disposal of solid and liquid wastes, and an oil-water separator to avoid hydrocarbon contamination of surface and groundwater. A landscaped green buffer zone will also be established within the site to enhance aesthetics, reduce dust, attenuate noise, and improve compatibility with the surrounding community.

3.3 EQUIPMENT CONSIDERATION

Table 3.1: Major Equipment and Systems to be installed for the LPG Facility

S/n	Equipment Description
1	cryogenic Vertical LNG Storage Tank Skid
2	LNG Loading / Unloading Skid
3	LNG Pump Skid
4	Tank Pressure Building Unit (PBU) Skid
5	LNG Dispenser
6	LPG Pump Skid
7	LNG High-Pressure Vaporiser
8	LPG Cascade Storage Tanks
9	Odorizer Unit
10	Odorization Skid
11	EAG Vaporisers (Low Pressure & High Pressure)
12	Boil-Off Gas (BOG) Vaporiser and Regulating Skid
13	Boil-Off Gas (BOG) Compressor
14	Vent Stack
15	LPG Cascade Filling Post
16	Fire Water System

3.4 PRODUCTION AND COMPRESSION PROCESS

The production and compression process at the proposed LPG Storage and Refilling Plant is designed to ensure safe handling, storage, compression, and distribution of Liquefied Petroleum Gas (LPG). The system is structured to meet operational efficiency standards while complying with national safety and environmental regulations.

3.4.1 Receipt of LPG

LPG will be transported to the facility through certified road tankers from approved suppliers. Upon arrival, the tankers will undergo safety inspection before offloading. The offloading process will be carried out through designated discharge points fitted with high-pressure flexible hoses, grounding systems to prevent static electricity, and pressure gauges for monitoring. Strict operational procedures will be followed to prevent leakages, spills, or overfilling.

3.4.2 Bulk Storage System

The received LPG will be transferred into ISO-certified high-pressure storage tanks with a combined capacity of approximately 50 metric tons. These tanks are designed to withstand operational pressure and temperature variations. Each tank will be fitted with pressure relief valves, level indicators, temperature sensors, and emergency shut-down systems to ensure safe storage conditions.



Figure 3.2: Storage System of LPG

3.4.3 Gas Compression Process

LPG intended for refilling and distribution will pass through high-pressure compressor units. The compressors increase and regulate pressure to meet dispensing and transfer requirements. The compression system will be controlled using a programmable logic control (PLC) system that enables real-time monitoring of pressure levels, temperature, and flow rate. Automatic shutdown

mechanisms will activate in case of abnormal pressure or leakage detection.

3.4.4 Cylinder Refilling and Truck Loading

Compressed LPG will be dispensed into cylinders of various capacities such as 6 kg, 12 kg, 25 kg, and 35 kg using automated refilling machines equipped with calibrated metering systems. Dedicated dispensing bays with double nozzles will allow simultaneous filling operations. For bulk distribution, daughter trucks will be loaded through high-pressure transfer lines designed to prevent leakage and ensure safe transfer.

3.4.5 Safety and Control Measures

The facility will incorporate multiple safety systems throughout the production and compression process. These include gas detection and alarm systems, emergency shut-off valves, fire extinguishers, fire hydrants, and pressure relief devices. The entire process will be continuously monitored from the control room to ensure compliance with operational safety standards.

3.4.6 Supporting Utilities

Supporting infrastructure such as standby power generators, an on-site borehole for water supply, stormwater drainage channels, and oil-water separators will ensure uninterrupted operation and environmental protection. These systems are integrated into the overall plant design to enhance safety, efficiency, and sustainability.



Figure 3.3: LPG Storage, Compression and Dispensing Process

3.5 PROJECT ACTIVITIES

The proposed Liquefied Petroleum Gas (LPG) Dispensing station at Dutse Local Government Area, Jigawa State, to be developed by SHAKKATO, will be implemented through a well-defined and systematic project execution framework. The project activities are organized into four main phases, namely Pre construction, Construction, Commissioning and Operations, and Decommissioning. Each phase has been structured to ensure technical efficiency, environmental protection, public safety, and full compliance with applicable national regulatory requirements.

3.5.1 Pre-construction Phase

The pre-construction phase constitutes the planning and preparatory stage of the proposed LPG project. It includes all baseline studies, technical evaluations, and statutory processes required prior to the commencement of physical development on site. Activities undertaken at this stage include site appraisal and selection, detailed topographic surveys, and geotechnical investigations to assess soil suitability and foundation requirements for LPG infrastructure. This phase also involves the preparation of engineering and architectural designs, process layouts, and construction drawings for the proposed LPG dispensing facility. Regulatory approvals and permits are obtained from relevant authorities, particularly the Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA) and the Federal Ministry of Environment (FMEnv). A key activity during this phase is the conduct of a comprehensive Environmental Impact Assessment (EIA) in accordance with FMEnv guidelines.

The EIA is aimed at identifying potential environmental and social impacts associated with the proposed LPG facility, evaluating sensitive receptors within the project area, recommending appropriate mitigation measures, and incorporating stakeholder inputs through public consultation and disclosure processes. Other preparatory activities include project cost estimation, development of construction schedules, equipment specifications, and mobilization plans. Procurement arrangements for major LPG-related equipment such as compressors, cascade storage vessels, pressure regulation systems, vaporizers, and dispensing units are also initiated during this phase. The pre-construction stage concludes with site clearing, setting-out of project components, and mobilization of contractors, personnel, and equipment to the project location.

3.5.2 Construction Phase

The construction phase covers all civil, mechanical, electrical, and instrumentation works required to achieve full physical development of the LPG dispensing depot. Initial activities include site

clearing, earthworks, land leveling, excavation, and construction of drainage systems to manage surface runoff and prevent flooding. Civil and structural works involve the construction of foundations for LPG cascade storage tanks, compressor skids, dispensing bays, control room, administrative offices, workshop, security post, and other ancillary facilities. Additional infrastructure such as paved forecourts, access roads, parking areas, and perimeter fencing are also developed during this phase.

Mechanical and process installations follow, including the installation of LPG compressors, cascade storage tanks, pressure reduction units, vaporizers, priority panels, odorization systems, and dispensing equipment for light and heavy-duty vehicles. Electrical and instrumentation works include the installation of transformers, power distribution systems, lighting facilities, control panels, fire detection systems, and emergency shutdown devices. Supporting utilities such as septic tanks, stormwater drains, cable trenches, and water supply systems are also completed. Throughout the construction phase, strict health, safety, and environmental (HSE) measures are implemented to prevent accidents, control dust and noise emissions, and ensure proper handling and disposal of construction waste. Continuous supervision, environmental monitoring, quality assurance checks, and compliance inspections are conducted to ensure that all construction activities conform to approved designs, safety standards, and regulatory requirements.

List of Construction Equipment The following is a detailed list of construction equipment anticipated for use during the development of the Liquefied Petroleum Gas (LPG) depot by SHAKKATO Nig. Ltd. at Dutse Local Government Area. These machines and tools will support activities spanning site preparation, civil construction, mechanical installations, and electrical infrastructure setup.

Site Preparation and Earthmoving

- **Bulldozers:** Utilized for clearing vegetation, leveling ground, and rough grading of the site.
- **Excavators:** Employed for digging trenches, foundations, and pits for septic tanks and sumps.
- **Wheel Loaders:** Used to load and transport soil, gravel, and other bulk materials around the site.
- **Backhoe Loaders:** Handy for smaller excavation tasks and loading materials in confined areas.
- **Graders:** For precise leveling and preparing road bases.
- **Compactors/Rollers:** To compact soil and stabilize surfaces for construction.

Civil Construction Equipment

- **Concrete Mixers (Mobile and Stationary):** For on-site mixing of concrete to be used in foundations and structural works.
- **Concrete Pumps:** To transfer concrete efficiently into formworks and construction molds.
- **Cranes (Mobile and Tower):** For lifting heavy structural components and positioning storage tanks or equipment.
- **Scaffolding and Formwork Systems:** Essential for supporting reinforced concrete casting and building works.
- **Dump Trucks:** To transport excavated materials, sand, gravel, and construction debris.

Mechanical and Piping Installation Tools

- **Hydraulic Lifting Equipment/Forklifts:** For moving and installing heavy compressors, vaporizers, and pump units.
- **Pipe Bending Machines:** To accurately shape and align gas pipelines.
- **Welding Machines:** For joining metal components and piping systems.
- **Air Compressors:** To power pneumatic tools and clean pipework during installation.
- **Grinding and Cutting Tools:** For metal preparation and pipe fitting works.

Electrical and Utility Installation Equipment

- **Cable Pulling Machines:** To facilitate the laying of underground and overhead electrical cables.
- **Portable Generators:** Provide temporary power supply during the construction phase.
- **Electrical Testing Equipment:** Used for insulation resistance, continuity, and grounding tests to ensure system safety.
- **Lighting Towers:** To provide adequate illumination during low-light or night-time construction activities.

Safety and Logistics Equipment

- **Water Tankers:** Employed for dust suppression on site and for curing concrete surfaces.
- **Fire Extinguishers:** Strategically placed to manage fire risks during welding and mechanical operations.
- **First Aid Kits and Safety Stations:** For onsite emergency medical response and health safety.
- **Site Fencing and Signage:** To control site access and clearly mark hazards for personnel safety.

Miscellaneous Tools and Instruments

- **Hand Tools:** Including hammers, shovels, spades, wrenches, pliers, and other essential manual tools.
- **Surveying Equipment:** Such as total stations, theodolites, and GPS devices for precise site layout and measurement.
- **Portable Storage Containers:** For secure storage of tools, equipment, and construction materials.

3.5.3 Operation and Maintenance: Following the completion of construction, the project will move into the commissioning and operational phase. Commissioning will involve comprehensive testing of all equipment and systems to verify that they function safely, efficiently, and according to design specifications. This will include pressure testing of pipelines, leak detection procedures, calibration of dispensing units, inspection of safety devices, and integration checks across mechanical, electrical, and control systems. Training of operational personnel will be a key focus during this phase, covering emergency response, equipment operation, safety compliance, and standard operating procedures. Once commissioning is successfully completed, the LPG depot will become fully operational, providing fuel dispensing services to commercial vehicles, private users, and facilitating the loading of daughter trucks for further distribution. Throughout the operational phase, the facility will be managed by skilled technical and administrative staff who will conduct regular maintenance and inspections to ensure reliability and minimize downtime. Continuous environmental monitoring, emissions tracking, and ongoing engagement with the local community will help sustain environmental performance and foster positive corporate-

community relations. The facility's emergency response plan will be periodically tested to maintain preparedness for incidents such as fires, gas leaks, or other emergencies. Prior to commissioning, all mechanical systems including storage vessels, pipelines, valves, and compressors will undergo hydrostatic testing to verify pressure integrity and identify any leaks or structural weaknesses. Potable-quality water for hydrotesting will be sourced from an approved borehole on site or from nearby surface water sources. An estimated volume of 250,000 to 300,000 liters of water will be required to conduct these tests. To prevent internal corrosion during testing, a biodegradable corrosion inhibitor (such as sodium nitrite or phosphate-based additives) will be added; no toxic or bio-cidal substances will be used. Hydro-test water will be temporarily stored in holding tanks or Intermediate Bulk Containers (IBCs) to facilitate quality testing after discharge. Parameters such as pH, temperature, oil/grease content, and 45 suspended solids will be monitored to ensure compliance with environmental standards. Where necessary, pre-treatment processes like sedimentation and filtration will be applied before water discharge. Treated water will be released via soak-away pits or directed to engineered grassy infiltration fields, ensuring no untreated water enters surface water bodies or storm drains.

3.5.4 Decommissioning Phase: The decommissioning phase signifies the conclusion of the project's lifecycle, whether due to the end of its economic viability, relocation, or replacement with new infrastructure. This stage involves the safe dismantling and removal of all gas processing equipment, storage tanks, pipelines, and ancillary structures. All hazardous materials will be identified and disposed of in accordance with prevailing environmental regulations and waste management protocols. Site rehabilitation will be undertaken to restore the land to its original or an agreed-upon post-project condition, which may include soil remediation, landscaping, and sealing of underground installations. Utility connections will be properly disconnected, and any remaining gas safely vented or recovered. A detailed decommissioning plan, prepared in advance and approved by relevant regulatory authorities, will ensure that all activities are conducted with utmost care to safeguard human health, environmental integrity, and the interests of the local community.



Figure 3.4: LPG Storage Facility with Safety Station

3.5 PROJECT SCHEDULE: The construction phase of the project is expected to last up to 12 months after all required permits and approvals have been obtained from the appropriate regulatory authorities. The detailed project timeline will be finalized upon completion of the EIA process. Following construction, performance and operational testing will be conducted, after which the facility will commence full operations. The projected operational lifespan of the project is approximately 25 years, at the end of which the facility and its associated infrastructure will be properly decommissioned.

Table 3.2: Project Implementation Schedule for the Proposed LPG Refilling plant in, Dutse LGA

Month	Activity	Responsibility
1	Project mobilization and kickoff meetings for the proposed LPG Refilling plant in Bodinga	Project manager/Client

	Site confirmation, final land acquisition, and documentation	Project manager/Client
	Baseline Environmental Impact Assessment (EIA) studies and stakeholder consultations within Bodinga community and adjoining areas	Environmental Consultant
	Conceptual engineering design and preliminary approvals	Engineering Team
2	preparation, reporting, and submission of EIA report to the Federal Ministry of Environment (FMEnv)	Environmental Consultant
	Detailed engineering design of LPG facility	Engineering Team
3	permit and regulatory applications	FMENV, NMDPRA, Fire Service, etc.
	Environmental approval and permit issuance	FMENV, NMDPRA, Fire Service,
	Site preparation and vegetation clearing in line with approved EIA mitigation measures	Civil work Contractor
4	civil works including fencing, drainage systems, and foundation construction	Civil work Contractor
5	Installation of septic system, sump pits, and stormwater drainage Plumbing / Installation of underground piping, electrical cabling, and service	Civil work Contractor
6	Delivery of major equipment (LPG storage tanks, compressors, pumps)	Civil work Contractor
7	Installation of firefighting systems and safety infrastructure in line with NFPA standards	HSE Contractor
8	Testing and dry-run of all systems	Client
9	Recruitment and training of operational staff	Client
10	Inspection and compliance checks by FMEnv, NMDPRA, and Fire Service	Regulatory Authorities
10	Final commissioning and system start-up	Client operating Team

3.6 PROJECT DESIGN COMPONENTS: The proposed LPG Storage and Refilling Plant is designed with integrated operational, safety, environmental, and support infrastructure to ensure efficient, safe, and environmentally sound operations. The major components of the project design are outlined below.

3.6.1 LPG Storage System: The storage system comprises high-pressure horizontal cylindrical steel tanks fabricated in accordance with recognized industry standards. The tanks are mounted on reinforced concrete foundations and fitted with pressure relief valves, level indicators, temperature gauges, emergency shut-off valves, and anti-corrosion protection systems. The storage area is secured within a fenced enclosure with restricted access.

3.6.2 Gas Compression Unit: The facility includes high-pressure compressor units responsible for regulating and maintaining the required pressure for LPG transfer and refilling. The compression system is automated and integrated with a programmable logic control (PLC) panel for real-time monitoring of pressure, temperature, and flow parameters. Safety interlock systems are installed to ensure automatic shutdown in the event of abnormal operating conditions.

3.6.3 Cylinder Filling and Dispensing Unit: Designated filling bays will be provided for refilling LPG cylinders of various capacities, including 6 kg, 12 kg, 25 kg, and 35 kg. The dispensing system incorporates calibrated electronic filling machines, leak-proof hoses, double nozzles, and automated metering devices to ensure safe and accurate refilling operations.

3.6.4 Truck Loading and Offloading Facilities

The plant design includes dedicated areas for tanker offloading and truck loading operations. These facilities are equipped with high-pressure transfer pipelines, grounding systems to prevent static discharge, wheel stoppers, and spill containment measures to enhance operational safety during product transfer.

3.6.5 Fire Protection and Safety Systems

Comprehensive fire protection infrastructure is incorporated into the project design. This includes fire hydrants, portable fire extinguishers (dry chemical powder and CO₂ types), gas detection and alarm systems, emergency shut-off valves, pressure relief systems, and clearly marked emergency assembly points and escape routes.

3.6.6 Control Room and Administrative Facilities

An administrative building will accommodate office spaces, staff welfare facilities, and a central control room. The control room will house the PLC monitoring system, CCTV surveillance equipment, communication systems, and emergency response coordination tools.

3.6.7 Utilities and Supporting Infrastructure

Supporting infrastructure includes a standby power generator, electrical installations, on-site borehole water supply, storm water drainage channels, an oil-water separator, paved access roads, perimeter fencing, security posts, and adequate lightning and safety signage throughout the facility.

3.6.8 Environmental Management Features

Environmental protection measures integrated into the design include waste segregation and storage facilities, spill containment structures, landscaped green buffer zones to reduce dust and noise, and proper drainage systems to prevent surface and groundwater contamination

CHAPTER FOUR

4.0 DESCRIPTION OF THE EXISTING CONDITIONS OF THE PROJECT ENVIRONMENT

4.1 Introduction

This chapter presents a description of the existing physical and environmental characteristics of the proposed project area for the construction of a Liquefied Petroleum Gas (LPG) Station by Shakkato Nigeria Limited at Gida Dubu Quarters, opposite Federal University Dutse, Jigawa State. The description of the existing environment constitutes an important component of the Assessment of Impacts on the environment because it establishes the baseline conditions against which potential environmental and socio-economic changes associated with the proposed development can subsequently be evaluated.

[[The baseline environmental characteristics considered in this chapter include the geographical location, geology, landform, weather, climate, topography, soil characteristics, population and existing land-use and commercial activities. These environmental components are interrelated and collectively influence the suitability of the project area for the proposed development. Particular attention is given to environmental features that may influence construction activities and the subsequent operation of an LPG facility, including surface drainage, soil permeability, temperature, rainfall, erosion potential, human settlement and commercial activities.

The proposed site is situated within Dutse, the capital of Jigawa State, in north-western Nigeria. Dutse and its surrounding environment are characterized by a tropical wet-dry climatic regime, seasonal rainfall, relatively high temperatures, sandy and loamy soils and gently undulating to locally rocky terrain (Jigawa State Government, 2023; Gambo et al., 2025). The area is also undergoing urban development, with increasing residential, institutional and commercial activities. The baseline information presented provides the environmental context necessary for assessing the potential effects of the proposed LPG station and for developing appropriate environmental management and mitigation measures.

4.2 Location

The proposed LPG Station by Shakkato Nigeria Limited is located at Gida Dubu Quarters, opposite Federal University Dutse, Dutse, Jigawa State, Nigeria. The geographical coordinates supplied for the proposed project site are approximately 11°42'46" N latitude and 9°22'46" E longitude. The site therefore falls within Dutse Local Government Area, which serves as the administrative

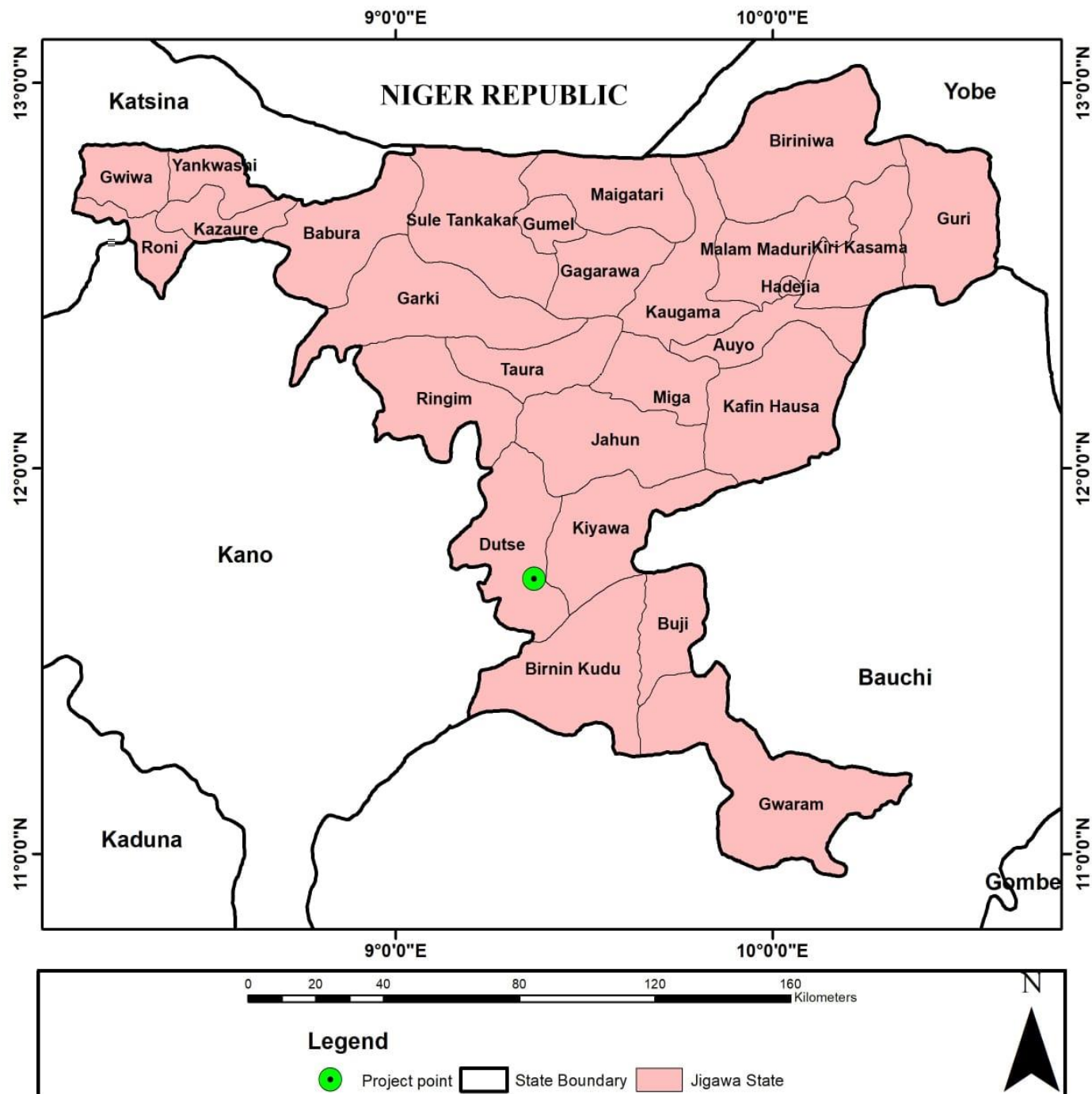


Figure 4.1: Map of Jigawa State with a proposed site location

headquarters and capital of Jigawa State. Dutse is located in north-western Nigeria and constitutes one of the important urban and administrative centres of Jigawa State. The city has experienced progressive development following its designation as the state capital and the establishment and expansion of major public institutions. One of the most important landmarks close to the proposed project site is Federal University Dutse, which contributes significantly to population movement, residential development, transportation and commercial activities within the surrounding area.

Published environmental investigations conducted within the Dutse area have reported geographical coordinates close to those of the proposed project location, confirming the general environmental setting of the site within the Dutse urban environment (Gambo et al., 2025; Girei et al., 2026). The immediate surroundings comprise a mixture of institutional, residential, commercial and relatively undeveloped areas. The location consequently experiences human activities associated with education, transportation, housing, trading and other urban activities.

The location of the proposed LPG facility is strategically important because it will provide LPG to households, students, food vendors, commercial establishments and other users within Dutse and surrounding communities. However, the proximity of the site to human activities and an educational institution makes proper environmental management, fire prevention, traffic control and emergency preparedness particularly important. The geographical position and surrounding land-use characteristics are summarized in Table 4.1.

Table 4.1: Geographical characteristics of the proposed project location

Parameter	Description
State	Jigawa State
Local Government Area	Dutse LGA
Town	Dutse
Specific location	Gida Dubu Quarters
Major landmark	Opposite Federal University Dutse
Latitude	11°42'46" N
Longitude	9°22'46" E
Geographical region	North-western Nigeria

4.3 Geology and Landform

The geological and geomorphological characteristics of Dutse are important determinants of soil development, groundwater occurrence, surface drainage, foundation conditions and the general physical appearance of the environment. Jigawa State occupies a geological setting that includes both the Precambrian Basement Complex and sedimentary formations. The southern portions of the state are largely associated with Basement Complex rocks, while sedimentary formations, including the Chad Formation, occur toward the north-eastern part of the state (Jigawa State Government, 2023).

The Dutse area itself has a heterogeneous geological environment. Investigations within and around Dutse have identified sandstone, quartz-rich materials, weathered rocks and sedimentary deposits, together with extensive unconsolidated deposits in some parts of the area (Gambo et al., 2025). The occurrence of rocky outcrops is also a distinctive characteristic of Dutse. Indeed, the name Dutse is derived from the Hausa word associated with rock, reflecting the rocky nature of parts of the landscape.

The underlying geological materials have contributed to the development of predominantly coarse-textured soils in several parts of Dutse. Weathering of quartz-rich and other parent materials contributes to the sandy nature of many of the soils, which generally have relatively low water-holding capacity and limited nutrient-retention capacity (Gambo et al., 2025). However, soil characteristics vary locally according to parent material, slope position, drainage and deposition. The landform around Dutse is generally gently undulating, with localized rocky surfaces and low hills. The wider Jigawa State landscape also contains sand dunes and relatively flat areas, while the vicinity of Dutse is distinguished by rocky terrain and low elevations or hills (Jigawa State Government, 2023). Recent studies have similarly described the Dutse environment as having both flat and undulating terrain.

The geological and landform characteristics have direct implications for the proposed LPG station. Foundation design, excavation requirements, stormwater movement, erosion susceptibility and drainage performance may all be influenced by the underlying geological materials and local relief. During construction, removal of vegetation and disturbance of the soil surface could expose loose materials to erosion during rainfall events. Appropriate site grading, stormwater drainage, erosion-control measures and suitable foundation design should therefore be incorporated into the project.

Table 4.2: General geological and landform characteristics of Dutse

Parameter	Description
Geological setting	Basement Complex and sedimentary geological environment
Important geological materials	Sandstone, quartz-rich materials and weathered rocks
Surface deposits	Sandy and unconsolidated materials in parts
General landform	Gently undulating
Local relief	Rocky surfaces and low hills
Soil-forming materials	Weathered rocks and transported deposits
Drainage influence	Relief, soil texture and rainfall
Engineering relevance	Foundation, excavation and drainage
Potential environmental concern	Soil disturbance and erosion

4.4 Weather

Weather conditions in Dutse vary considerably between the wet and dry seasons. The area experiences a distinct seasonal pattern, with the rainy period characterized by increased humidity, cloud development and precipitation, while the dry period is generally associated with high temperatures, low humidity and dusty atmospheric conditions. The climatic pattern is controlled largely by the seasonal movement of moist south-westerly air masses from the Atlantic region and dry north-easterly winds associated with the Harmattan.

According to the Jigawa State Government (2023), the rainy season generally extends from approximately May to September, although rainfall may occur in October in some years. Average annual rainfall across the state is generally between approximately 600 and 1,000 mm. More localized research around Dutse indicates a unimodal rainfall pattern, with rainfall commonly beginning between April and June and continuing until October. The highest intensity of rainfall generally occurs during August and September (Gambo et al., 2025). Temperature remains relatively high throughout most of the year. Recent investigations around Dutse reported an average minimum temperature of approximately 25.54°C during the dry season and an average maximum temperature of approximately 41.15°C (Gambo et al., 2025). The Jigawa State Government (2023) similarly reports high temperatures during much of the year, with temperatures varying considerably according to season and time of day.

These weather conditions are important to the proposed LPG facility. High ambient temperatures can contribute to increased thermal loading of LPG storage vessels and associated equipment, making proper equipment specification, pressure control, ventilation and fire-protection systems essential. Heavy rainfall can increase storm water runoff and may result in temporary water accumulation where drainage is inadequate. During the dry season, exposed construction surfaces may become sources of airborne dust.

Table 4.3: General weather characteristics of Dutse

Weather parameter	Characteristic/value
Rainfall pattern	Unimodal
General annual rainfall	Approximately 600–1,000 mm
Local reported annual rainfall	Approximately 750 mm
Rainy season	Approximately May–September/October
Peak rainfall period	August–September
Driest period	January–March
Dry-season condition	Hot and relatively dry
Reported average low temperature	Approximately 25.54°C
Reported average high temperature	Approximately 41.15°C
Major weather concerns	Heat, dust, rainfall and runoff

Sources: Jigawa State Government (2023); Gambo et al. (2025).

4.5 Topography

Topography describes the variation in elevation, slope and surface relief of an area and is an important consideration in environmental assessment because it influences drainage, erosion, soil formation, flood susceptibility and construction requirements. The topography of Dutse is generally characterized by gently undulating terrain, although rocky surfaces, low hills and relatively level areas occur locally. The wider Jigawa State landscape includes extensive areas of undulating terrain and sand dunes, while the area around Dutse is recognized as being comparatively rocky (Jigawa State Government, 2023).

Available studies indicate that the Dutse environment generally occurs at elevations of approximately 400–500 m above sea level, with local variations associated with the underlying geological structure and surface relief (Girei et al., 2026). The relatively gentle slopes of much of the area reduce the potential for severe soil erosion under normal conditions, although intense

rainfall combined with exposed soil surfaces can produce sheet erosion and localized gully.

Topography is particularly relevant to the proposed LPG station because the facility will require adequate surface drainage and a stable foundation. Site grading should be designed to ensure that stormwater flows away from LPG storage and dispensing areas without creating erosion channels or ponding. Drainage facilities should also be maintained to prevent blockage by construction materials, sediment or solid waste.

Table 4.4: Topographic characteristics of the project environment

Parameter	Description/value
General terrain	Gently undulating
Approximate elevation	400–500 m above sea level
Local features	Rocky surfaces and low hills
Slope condition	Generally gentle
Drainage	Influenced by local relief and soil texture
Erosion susceptibility	Generally moderate but increased by exposed surfaces
Flood consideration	Localized drainage/flooding possible
Project implication	Requires proper grading and stormwater drainage
General terrain	Gently undulating

Sources: Jigawa State Government (2023); Girei et al. (2026).

4.6 Soil

The soil environment of the proposed project area is an important component of the baseline assessment because soil properties influence infiltration, drainage, vegetation growth, erosion and the potential migration of contaminants. Soil characteristics around Dutse are influenced by parent material, topography, climate and land-use practices. Recent soil investigations in the Dutse area have reported considerable spatial variation in soil texture and chemical characteristics. Gambo et al. (2025) reported that soils around Dutse range mainly from sand to loamy sand, reflecting the influence of coarse parent materials and the semi-arid climatic environment. The sandy nature of the soils contributes to relatively high infiltration rates but comparatively low water-holding capacity. The authors also reported bulk-density values ranging approximately from 1.21 to 1.55 g/cm³, indicating variation in soil compaction and pore-space characteristics.

Soil reaction also varies considerably. Reported pH values ranged from approximately 4.7 to 7.7, demonstrating variation from acidic to neutral or slightly alkaline conditions depending on location and soil horizon (Gambo et al., 2025). Organic carbon was reported within approximately 0.88–1.61%, while cation exchange capacity ranged from approximately 3.54 to 7.17 cmolc/kg. These characteristics indicate generally low to moderate nutrient-retention capacity in several of the sandy soils. More recent soil characterization at the Federal University Dutse Teaching and Research Farm also identified differences in soil texture along topographic positions, ranging from sandy loam in upland areas to sandy clay and loam in lower positions (Girei et al., 2026). Such spatial variability demonstrates that soil properties at the specific Shakkato project site should be interpreted primarily from the field and laboratory results generated during the present AIA study.

For the proposed LPG station, the relatively permeable nature of sandy soils makes spill prevention particularly important. Impermeable hard standing, appropriate drainage, spill-control facilities and proper waste management should be provided to reduce the possibility of contaminants entering the soil.

Table 4.5: Selected soil characteristics reported for the Dutse area

Parameter	Reported characteristic/value
Dominant texture	Sand to loamy sand
Other local textures	Sandy loam, loam and sandy clay
Bulk density	Approximately 1.21–1.55 g/cm ³
Ph	Approximately 4.7–7.7
Organic carbon	Approximately 0.88–1.61%
Cation exchange capacity	Approximately 3.54–7.17 cmolc/kg
Available phosphorus	Approximately 1.95–3.50 mg/kg
General condition	Coarse-textured with variable fertility
Environmental implication	Relatively high infiltration potential

Sources: Gambo et al. (2025); Girei et al. (2026).

4.7 Climate

The climate of Dutse is broadly classified as tropical wet-dry and is characteristic of the Sudan Savanna ecological zone of northern Nigeria. The climate is defined by a distinct rainy season and a longer dry season. The seasonal pattern is associated with the movement of the Inter-Tropical Discontinuity and the alternating influence of moist south-westerly air masses and dry north-

easterly Harmattan winds. These seasonal variations influence vegetation growth, soil moisture, surface-water availability and agricultural activities within the project area.

Jigawa State Government (2023) reports that the state has two major seasons: the rainy season, which generally occurs from May to September, and the dry/Harmattan period, which extends approximately from November to April. Annual rainfall generally ranges from about 600 to 1,000 mm, with a state-wide average of approximately 650 mm in recent years. However, local climatic studies around Dutse have reported annual rainfall of approximately 750 mm, indicating the importance of using site-specific or nearest-station data when evaluating project conditions (Gambo et al., 2025). The seasonal distribution of rainfall is particularly important because it determines surface runoff and potential temporary water accumulation.

Rainfall in Dutse follows a predominantly unimodal pattern. Gambo et al. (2025) reported that rainfall normally begins between April and June and continues to approximately October, with the most intense rainfall events occurring during August and September. Long-term meteorological observations from the Dutse area have also demonstrated substantial inter-annual rainfall variability, with annual rainfall reaching approximately 1,031.30 mm in 2019 during the 2003–2022 observation period (Gambo et al., 2025). Such variability is important in environmental planning because exceptionally high rainfall events can increase stormwater discharge, soil erosion and sediment movement from disturbed surfaces.

Temperature remains high for much of the year. Recent studies report average low dry-season temperatures of approximately 25.54°C and average high temperatures of approximately 41.15°C. Such high temperatures are environmentally significant for LPG facilities because increased ambient temperature can contribute to thermal expansion and pressure increases within LPG storage systems. Consequently, adequate ventilation, equipment design, pressure-control systems and fire-protection measures are essential components of the proposed facility.

The climate influences construction activities, as intense rainfall can increase runoff, erosion and sediment transport, while dry-season conditions may increase dust from exposed soil and vehicle movement. The Harmattan period may reduce visibility and increase airborne particulates. The facility should therefore incorporate adequate drainage, erosion control, dust suppression, ventilation and fire-safety measures, alongside appropriate maintenance and emergency preparedness.

Table 4.6: Climatic characteristics of Dutse

Climatic parameter	Characteristic/value
Climate type	Tropical wet-dry/semi-arid
Ecological zone	Sudan Savanna
Rainfall pattern	Unimodal
Approximate annual rainfall	600–1,000 mm
Local reported annual rainfall	Approximately 750 mm
Highest reported annual rainfall, 2003–2022	1,031.30 mm
Rainy season	Approximately April/May–October
Peak rainfall	August–September
Dry season	Approximately November–April
Average low temperature	Approximately 25.54°C
Average high temperature	Approximately 41.15°C
Major climatic implications	Heat, dust, runoff, erosion and seasonal water availability

Sources: Jigawa State Government (2023); Gambo et al. (2025).

4.8 Population

Population characteristics are important to the environmental assessment of the proposed LPG station because the project is situated within a developing urban environment and close to Federal University Dutse. The presence of residents, students, academic and non-academic staff, traders, transport operators and other members of the public increases the importance of evaluating issues associated with public safety, traffic, air quality, noise, emergency preparedness and socio-economic interactions.

Dutse serves as the administrative headquarters and capital of Jigawa State and has experienced considerable urban growth. Historical population information indicates that Dutse Local Government Area had a population of approximately 251,135 persons in the 2006 Population and Housing Census. The population comprised approximately 125,773 males and 125,362 females (National Bureau of Statistics [NBS], 2012). Subsequent projections showed continued population growth in the local government area. More recent estimates indicate a substantially larger population for Dutse. A 2022 population estimate places the population of Dutse at approximately 431,800 persons, although this figure represents an estimate rather than the outcome of a recent population census (National Population Commission [NPC], 2022). Population growth in the city

is associated with its increasing importance as an administrative, educational, commercial and transportation center.

The establishment and expansion of Federal University Dutse has further influenced population movement and settlement patterns around the project area. Students, lecturers, administrative personnel, service providers and visitors contribute to daily movement within the vicinity of the proposed LPG station. Commercial activities such as restaurants, food vending, retail shops, transportation services and accommodation facilities are consequently expected to benefit from the presence of a large institutional population. The population characteristics also have implications for LPG demand. Households, food vendors, restaurants and institutional users require cooking fuel, and LPG provides an important alternative to traditional biomass fuels. The proposed facility could therefore contribute positively to local energy availability and economic activity.

However, because LPG is a flammable and potentially hazardous product, the concentration of human activities around the facility makes appropriate safety management essential. The project should incorporate controlled access, appropriate fire-protection systems, emergency-response procedures, traffic management, warning signs and public awareness measures. These measures will help reduce potential risks to nearby residents, students, workers and road users.

Table 4.7: Population characteristics of Dutse

Population indicator	Value/description
Dutse LGA population, 2006	251,135
Male population, 2006	125,773
Female population, 2006	125,362
Projected population, 2008	266,132
Projected population, 2011	290,322
Recent population estimate	Approximately 431,800
Population trend	Increasing
Major population groups	Residents, students, workers and traders
Major institution near project	Federal University Dutse
Population-related project concern	Public safety, traffic and emergency response

Sources: National Bureau of Statistics (2012); National Population Commission (2022).

4.9 Soil and Commercial Activities

The relationship between soil characteristics and human activities is an important consideration in describing the environmental setting of the proposed LPG station. Dutse and its surrounding communities have historically depended substantially on agriculture, livestock production and other natural-resource-based activities. However, the expansion of Dutse as the capital of Jigawa State has resulted in increasing conversion of land to residential, institutional, commercial and infrastructural uses. This transition has altered the natural soil environment through vegetation removal, construction, traffic movement, waste generation and continuous human activities.

The soils of the Dutse area are predominantly sandy to loamy sand, although significant local variation exists according to topographic position and parent material (Gambo et al., 2025; Girei et al., 2026). The sandy nature of the soils facilitates infiltration but generally reduces water-holding capacity. Organic carbon and nutrient levels may also be relatively low in some locations. These properties are relevant to both agricultural productivity and environmental contamination because soluble substances released onto permeable soil surfaces may infiltrate relatively readily. Consequently, uncontrolled disposal of liquid wastes, lubricants and other potentially contaminating materials could adversely affect soil quality and potentially influence subsurface environmental resources.

Agriculture remains an important economic activity in the wider Dutse environment. Small-scale farmers cultivate crops including maize, sesame and sorghum, while livestock production contributes to household livelihoods. Gambo et al. (2025) reported that crop farming and animal husbandry constitute important livelihood activities in the area. These activities occur alongside an expanding urban economy. Agricultural land around developing areas may gradually be converted to residential and commercial uses as population increases and demand for infrastructure expands.

Commercial activities within Dutse include retail trading, food vending, restaurants, transportation services, agricultural produce marketing, small-scale processing, artisan activities and other informal-sector businesses. The presence of Federal University Dutse has contributed to additional demand for accommodation, food services, transportation, retail goods and other services. The proposed LPG station is therefore located within an environment where demand for cooking fuel is likely to be generated by households, restaurants, food vendors, students and other commercial users. The availability of LPG may support these activities by providing a

convenient and relatively cleaner energy source. The proposed development may provide several socio-economic benefits. These include direct and indirect employment, increased availability of LPG, improved access to a relatively cleaner cooking fuel, increased commercial activity and possible reduction in dependence on firewood and other traditional biomass fuels. The project may also stimulate ancillary businesses, transportation services and small-scale commercial activities around the facility. However, these benefits need to be balanced against environmental and safety considerations, particularly because LPG is a flammable material requiring careful handling, storage and distribution.

Commercial activities can contribute to solid-waste accumulation, soil contamination, drainage obstruction and localized spills if not properly managed. Sandy soils may permit relatively rapid infiltration, allowing accidental releases of petroleum products, oils or other chemicals to migrate into the subsurface. Increased vehicular movement may also contribute to soil compaction, contaminant deposition and disturbance of surrounding land surfaces. The proposed LPG station should therefore have appropriate impermeable surfaces, drainage systems, spill-response equipment, waste-management facilities and routine environmental monitoring. Proper management will help maintain soil quality while supporting the socio-economic benefits of the proposed development.

Table 4.8: Major land-use, soil-related and commercial activities around Dutse

Activity/land use	Characteristics
Crop farming	Maize, sesame, sorghum and other crops
Livestock production	Household and small-scale animal husbandry
Retail trading	Shops, markets and general merchandise
Food vending	Restaurants, food stalls and catering services
Transportation	Passenger and goods movement
Small-scale processing	Agricultural and household-related processing
Artisan activities	Informal and small-scale enterprises
Residential development	Expanding urban settlements
Institutional activities	Federal University and government facilities
LPG-related demand	Domestic, institutional and commercial users
Major environmental concerns	Waste, spills, drainage obstruction and soil disturbance

Sources: Gambo et al. (2025); Jigawa State Government (2023).

4.10 AIR QUALITY ASSESSMENT

The assessment of ambient air quality was conducted at nine sampling points (P1-P9 control) within and around the proposed site for the construction of the Liquefied Petroleum Gas (LPG) Station by Shakkato Nigeria Limited, located at Gida dubu quarters opposite Federal University, Dutse, Jigawa State. The assessment covered particulate matter, gaseous pollutants, volatile organic compounds, noise and meteorological parameters. The results provide the baseline environmental conditions against which potential changes associated with the construction and subsequent operation of the proposed LPG station can be assessed. The measured concentrations are presented in Table 4.2.

4.10.1 PM1.0 (Fine Particles $\leq 1 \mu\text{m}$)

PM1.0 represents very fine particulate matter with aerodynamic diameters of $1 \mu\text{m}$ or less and is an important indicator of the presence of respirable fine particles in ambient air. The measured PM1.0 concentrations across the nine sampling points ranged from 0 to $2 \mu\text{g}/\text{m}^3$. The highest concentration of $2 \mu\text{g}/\text{m}^3$ was recorded at P1, while concentrations of $1 \mu\text{g}/\text{m}^3$ were recorded at P2, P3, P4 and P5. No detectable PM1.0 concentration was recorded at P6, P7, P8 and P9. The total mean concentration across the sampling locations was approximately $0.67 \mu\text{g}/\text{m}^3$. The relatively low concentrations indicate that fine particulate matter was present at low levels during the baseline assessment. The spatial variation may be associated with differences in local activities, atmospheric movement and proximity to potential sources of suspended particles. The baseline condition provides an important reference for monitoring particulate emissions during construction and operation of the proposed LPG station.

4.10.2 PM2.5 (Fine Particles $\leq 2.5 \mu\text{m}$)

PM2.5 comprises particulate matter with aerodynamic diameters of $2.5 \mu\text{m}$ or less and is considered an important air-quality indicator because of its ability to penetrate deeply into the respiratory system. The measured concentrations ranged from 0 to $3 \mu\text{g}/\text{m}^3$ across P1- P9 (control). The highest concentration of $3 \mu\text{g}/\text{m}^3$ was recorded at P1, while P2, P3, P4 and P5 each recorded $1 \mu\text{g}/\text{m}^3$. No detectable concentration was recorded at P6, P7, P8 and P9 (control). The mean concentration was approximately $0.78 \mu\text{g}/\text{m}^3$. The results indicate relatively low concentrations of PM2.5 during the baseline survey. The higher value at P1 compared with the other sampling points suggests some spatial variation in the distribution of fine particles within the study area. Continuous monitoring during construction and operation will nevertheless be

important because construction activities, vehicular movement and operational activities may influence ambient particulate levels.

4.10.3 PM₁₀ (Coarse Particles $\leq 10 \mu\text{m}$)

PM₁₀ consists of particulate matter with aerodynamic diameters of $10 \mu\text{m}$ or less and is commonly associated with dust-generating activities and mechanical disturbance of soil and other materials. The measured PM₁₀ concentrations ranged from 0 to $3 \mu\text{g}/\text{m}^3$ across the nine sampling locations. The highest concentration of $3 \mu\text{g}/\text{m}^3$ was recorded at P1, followed by $2 \mu\text{g}/\text{m}^3$ at P3 and $1 \mu\text{g}/\text{m}^3$ at P2 and P5. No detectable PM₁₀ concentration was recorded at P4, P6, P7, P8 and P9 (control). The total mean concentration was approximately $0.78 \mu\text{g}/\text{m}^3$. The observed distribution indicates that coarse particulate matter occurred at relatively low levels during the baseline assessment, although P1 and P3 showed comparatively higher concentrations. These results establish the existing particulate condition of the project environment prior to construction and provide a basis for subsequent monitoring of dust emissions associated with site preparation, movement of construction equipment and other project activities.



Plate 4.1: Air sampling at proposed project site

4.10.4 Sulphur (IV) Oxide (SO₂)

Sulphur (IV) oxide, commonly expressed as sulphur dioxide (SO₂), is an atmospheric pollutant generally associated with the combustion of sulphur-containing fuels. The result obtained from all nine sampling points showed a concentration of 0.00 ppm. Thus, SO₂ was not detected at any of the assessed locations during the baseline monitoring period. The absence of detectable SO₂ across P1- P9 (control) indicates that there was no measurable concentration of the parameter at the time of sampling. This baseline condition is significant for the proposed LPG station because it provides a reference point for assessing any future changes associated with construction equipment, vehicular movement, generators or other combustion-related activities. Routine air-quality monitoring during the project phases will help establish whether SO₂ concentrations remain at the observed baseline level.

4.10.5 Nitrogen (IV) Oxide (NO₂)

Nitrogen (IV) oxide, commonly referred to as nitrogen dioxide (NO₂), is an important atmospheric pollutant associated mainly with combustion processes. The measured concentrations across the nine sampling points ranged from 0.22 to 0.89 ppm. The lowest concentration of 0.22 ppm was recorded at P1, while the highest concentration of 0.89 ppm occurred at P4 and P9 (control). Other recorded concentrations were 0.32 ppm at P2, 0.51 ppm at P3, 0.66 ppm at P5, 0.82 ppm at P6, 0.80 ppm at P7 and 0.78 ppm at P8. The mean concentration across the sampling points was approximately 0.65 ppm. The variation indicates that NO₂ was detectable throughout the study area, with relatively higher concentrations occurring at P4 and P9 (control). The observed baseline values provide a reference for evaluating possible changes in nitrogen oxide concentrations during construction and operation of the proposed LPG facility, particularly from combustion-related activities and vehicular movement.

4.10.6 Ethene (C₂H₄)

Ethene (C₂H₄) is a volatile organic compound that may occur in the atmosphere as a result of combustion and other hydrocarbon-related processes. The measured concentrations ranged from 5.564 to 8.639 ppm across the nine sampling points. The highest concentration of 8.639 ppm was recorded at P1, followed by 8.423 ppm at P2 and 7.947 ppm at P3. The lowest concentration of 5.564 ppm was recorded at P9 (control). The remaining sampling locations recorded 7.236 ppm at P4, 7.187 ppm at P5, 6.810 ppm at P6, 6.633 ppm at P7 and 6.363 ppm at P8. The mean

Table 4.8: Concentrations Mean Values of Air Quality Assessment of Proposed Construction of Liquified Petroleum Gas Plant (LPG) Station

S/N	Parameters	Unit	P ₁	P ₂	P ₃	P ₄	P ₅	P ₆	P ₇	P ₈	P ₉ Control
1	Latitude	N	11.424747	11.424748	11.42478	11.424744	11.424695	11.423937	11.424882	11.424946	11.425277
2	Longitude	E	9.223882	9.223942	9.224674	9.223696	9.224590	9.222934	9.223738	9.224476	9.223006
3	Elevation	m	440.3	459.7	458.5	125.5	127.2	469.8	465.7	465.7	465.7
4	PM _{1.0}	µg/m ³	2	1	1	1	1	0	0	0	0
5	PM _{2.5}	µg/m ³	3	1	1	1	1	0	0	0	0
6	PM ₁₀	µg/m ³	3	1	2	0	1	0	0	0	0
7	Sulphur (IV) oxide	ppm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	Nitrogen (IV) oxide	ppm	0.22	0.32	0.51	0.89	0.66	0.82	0.80	0.78	0.89
9	Ethene (C ₂ H ₄)	ppm	8.639	8.423	7.947	7.236	7.187	6.810	6.633	6.363	5.564
10	Nitrous (NO _x)	ppm	1.08	0.68	0.34	0.00	0.00	0.00	0.00	0.00	0.00
11	Hydrogen chloride	ppm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	Hydrogen cyanide	ppm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	Phosphine (PH ₃)	ppm	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	VOC	ppm	0.289	0.198	0.116	0.000	0.000	0.000	0.000	0.000	0.000

15	Chlorine gas (Cl ₂)	ppm	0.91	0.92	0.92	0.96	0.84	0.85	0.84	0.85	0.78
16	Sound level	db	59.7	55.6	54.3	52.3	56.4	60.1	52.0	58.1	64.8
17	Ammonia Gas	ppm	0	0	0	0	0	0	0	0	0
18	Nitrogen (II) oxide	ppm	0.59	0.24	0.00	0.00	0.00	0.00	0.00	0.18	0.00
19	Ozone (O ₃)	ppm	1.10	0.89	0.43	0.11	0.00	0.08	0.12	0.15	0.15
20	Carbon (II) oxide	ppm	0	0	0	0	0	0	0	0	0
21	Carbon (IV) oxide	ppm	664	632	675	635	620	626	648	681	662
22	Hydrogen sulphide	ppm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71
23	Methane gas (CH ₄)	ppm	0	0	0	0	0	0	0	0	0
24	Temperature	°C	37.0	38.1	39.5	33.4	29.6	32.4	28.4	30.9	31.9
25	Relative humidity	%	52.0	52.6	41.4	40.6	40.8	41.5	41.8	46.9	41.5
26	Wind speed	m/s	2.5	2.0	1.8	1.8	2.2	1.6	1.3	1.4	1.2
27	A.Q.I	–	Excellent	Excellent	Good	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent

concentration was approximately 7.20 ppm. The results show that ethene was detected at all sampling points, with a general spatial reduction from the higher values at P1-P3 towards the lower value at P9_{control}. The baseline data provide an important reference for monitoring hydrocarbon-related air emissions during the construction and operational phases of the proposed LPG station.

4.10.7 Nitrous Oxides (NO_x)

Nitrogen oxides (NO_x) are gaseous pollutants commonly associated with combustion and atmospheric reactions involving nitrogen and oxygen. The recorded concentrations across the sampling points ranged from 0.00 to 1.08 ppm. The highest concentration of 1.08 ppm was recorded at P1, while P2 and P3 recorded 0.68 and 0.34 ppm, respectively. No detectable NO_x concentration was recorded at P4- P9 (control). The total mean concentration was approximately 0.23 ppm. The results therefore indicate a marked spatial variation, with detectable NO_x restricted to the first three sampling locations. The higher concentration at P1 may reflect localized conditions at the time of sampling. These measurements establish the baseline NO_x condition of the proposed project environment and will be useful for evaluating changes associated with construction machinery, vehicles, generators and other combustion sources during project implementation.

4.10.8 Hydrogen Chloride (HCl)

Hydrogen chloride is a gaseous compound that can occur in the atmosphere from specific combustion and industrial processes. The results obtained from all nine sampling points showed a concentration of 0.00 ppm. Therefore, no detectable hydrogen chloride concentration was recorded at any of the assessed locations during the baseline air-quality survey. The uniform result across P1- P9 (control) indicates that HCl was not detected in the ambient air during the assessment period. This provides a useful baseline condition for the proposed LPG station, particularly because construction and operational activities may involve equipment and processes capable of influencing local air quality. Continued environmental monitoring during the different project phases will provide information on any subsequent change in HCl concentration.

4.10.9 Hydrogen Cyanide (HCN)

Hydrogen cyanide is a toxic gaseous compound that may be associated with particular combustion and industrial processes. The baseline assessment recorded 0.00 ppm at all nine sampling points. No detectable concentration of hydrogen cyanide was therefore observed across P1- P9 (control)

during the sampling period. The consistent non-detection indicates that HCN was not measurable in the ambient air at the assessed locations at the time of the study. The result establishes a baseline condition against which future monitoring can be compared. During construction and operation of the proposed LPG station, appropriate environmental controls and periodic air-quality monitoring should be maintained to identify any change in gaseous pollutant concentrations resulting from project activities.

4.11.10 Phosphine (PH₃)

Phosphine (PH₃) is a gaseous compound that can be associated with specific industrial and chemical processes. The measured phosphine concentration was 0.000 ppm at all nine sampling locations. The uniform result indicates that phosphine was not detected in the ambient air throughout the assessed project area during the baseline survey. The absence of detectable PH₃ provides a reference condition for subsequent environmental monitoring. Although the present assessment recorded no detectable concentration, continued monitoring during construction and operation is appropriate to ensure that the baseline condition is maintained and that any unexpected change in ambient air quality is identified promptly.

4.10.11 Volatile Organic Compounds (VOC)

Volatile organic compounds (VOCs) are carbon-containing compounds that readily evaporate into the atmosphere and may originate from fuel, solvents and hydrocarbon-related activities. The measured VOC concentrations ranged from 0.000 to 0.289 ppm. The highest concentration of 0.289 ppm was recorded at P1, followed by 0.198 ppm at P2 and 0.116 ppm at P3. No detectable VOC concentration was recorded at P4- P9 (control). The mean concentration across the nine sampling points was approximately 0.067 ppm. The results indicate that detectable VOCs were concentrated at P1-P3, while the remaining locations recorded zero values. This spatial variation establishes a baseline pattern that will be important for monitoring the proposed LPG station, where hydrocarbon handling and associated activities could influence VOC concentrations. Effective containment, leak detection and routine monitoring will be important during operation to maintain the observed baseline air-quality condition.

4.10.12 Chlorine Gas (Cl₂)

Chlorine gas (Cl₂) concentrations recorded across the nine sampling points ranged from 0.78 to 0.96 ppm. The highest concentration of 0.96 ppm was recorded at P4, while the lowest concentration of 0.78 ppm was recorded at P9. P1 recorded 0.91 ppm, P2 and P3 recorded 0.92

ppm each, P5 recorded 0.84 ppm, P6 recorded 0.85 ppm, P7 recorded 0.84 ppm and P8 recorded 0.85 ppm. The mean concentration was approximately 0.87 ppm. The results demonstrate that chlorine gas was detected at all sampling points, with relatively small spatial variation across the study area. The measured baseline condition provides a reference against which future air-quality monitoring can be compared during construction and operation of the proposed LPG facility.

4.10.13 Sound Level

Ambient sound levels across the nine sampling locations ranged from 52.0 to 64.8 dB. The lowest sound level of 52.0 dB was recorded at P7, while the highest value of 64.8 dB was recorded at P9. Other recorded values were 59.7 dB at P1, 55.6 dB at P2, 54.3 dB at P3, 52.3 dB at P4, 56.4 dB at P5, 60.1 dB at P6 and 58.1 dB at P8. The mean sound level was approximately 57.0 dB. The variation across the sampling locations indicates differences in the prevailing acoustic environment of the study area. P6 and P9 (control sample) recorded comparatively higher sound levels, while P4 and P7 recorded the lowest levels. These measurements represent the baseline acoustic environment against which additional noise generated during construction, equipment operation, vehicular movement and other project activities can be evaluated.

4.10.14 Ammonia Gas (NH₃)

Ammonia gas concentrations were recorded as 0 ppm at all nine sampling points. No detectable ammonia concentration was therefore observed across the proposed project area during the baseline assessment. The uniform result indicates that ammonia was not measurable in the ambient air at the time of sampling. This provides a clear baseline reference for subsequent environmental monitoring. Although the proposed LPG station is not expected from the available baseline data to have detectable ammonia concentrations, periodic monitoring during project implementation will help confirm that ambient air conditions remain consistent with the baseline established by the present assessment.

4.10.15 Nitrogen (II) Oxide (NO)

Nitrogen (II) oxide (NO) concentrations varied from 0.00 to 0.59 ppm across the nine sampling points. The highest concentration of 0.59 ppm was recorded at P1, while P2 recorded 0.24 ppm and P8 recorded 0.18 ppm. No detectable NO concentration was recorded at P3, P4, P5, P6, P7 and P9 (control). The overall mean concentration was approximately 0.11 ppm. The results demonstrate localized detection of nitrogen (II) oxide, with the highest concentration occurring

at P1. The spatial variation may reflect differences in local atmospheric conditions and nearby emission sources at the time of sampling. The results provide a baseline against which potential changes associated with combustion sources during construction and operation of the LPG station can be assessed.

4.10.16 Ozone (O₃)

Ozone (O₃) concentrations across the nine sampling points ranged from 0.00 to 1.10 ppm. The highest concentration of 1.10 ppm was recorded at P1, followed by 0.89 ppm at P2 and 0.43 ppm at P3. P4 recorded 0.11 ppm, P6 recorded 0.08 ppm, while P7 and P8 recorded 0.12 and 0.15 ppm, respectively, and P9_{control} also recorded 0.15 ppm. No detectable ozone was recorded at P5. The overall mean concentration was approximately 0.34 ppm. The results indicate substantial spatial variation in ozone concentration, with the highest values occurring at P1 and P2. Ozone is an important atmospheric parameter because its concentration may vary with atmospheric conditions and reactions involving other gaseous pollutants. The baseline results therefore provide an important reference for future monitoring of ambient air quality during the development and operation of the proposed LPG station.

4.10.17 Carbon (II) Oxide (CO)

Carbon (II) oxide, commonly referred to as carbon monoxide (CO), is a combustion-related gaseous pollutant. The results from all nine sampling points recorded a concentration of 0 ppm. No detectable carbon monoxide was therefore observed at P1- P9_{control} during the baseline assessment. The uniform absence of detectable CO indicates that the parameter was not measurable in the ambient air at the sampled locations during the monitoring period. This result provides a baseline reference for evaluating any future contribution from combustion sources associated with construction machinery, vehicles, generators or other equipment used during the project. Continued monitoring will be useful during the construction and operational phases to determine whether the baseline condition remains unchanged.

4.11.18 Carbon (IV) Oxide (CO₂)

Carbon (IV) oxide, commonly referred to as carbon dioxide (CO₂), was detected at all nine sampling locations. The recorded concentrations ranged from 620 to 681 ppm. The lowest concentration of 620 ppm occurred at P5, while the highest concentration of 681 ppm was recorded at P8. Other concentrations included 664 ppm at P1, 632 ppm at P2, 675 ppm at P3, 635 ppm at P4, 626 ppm at P6, 648 ppm at P7 and 662 ppm at P9 (control). The mean

concentration across the sampling points was approximately 649.22 ppm. The relatively narrow range indicates moderate spatial variation in ambient CO₂ concentrations across the study area. These measurements establish the baseline atmospheric CO₂ condition before construction of the proposed LPG station and provide a reference for subsequent monitoring of changes that may arise from increased vehicular movement, equipment operation and other combustion-related activities.

4.10.19 Hydrogen Sulphide (H₂S)

Hydrogen sulphide (H₂S) concentrations were recorded as 0.00 ppm at P1-P8, while P9_{control} recorded 0.71 ppm. Consequently, the measured concentrations ranged from 0.00 to 0.71 ppm, with an overall mean of approximately 0.079 ppm. The detection of H₂S was therefore localized to P9 (control), while all other sampling points showed no detectable concentration. The marked spatial difference indicates that the occurrence of H₂S was restricted to one sampling location during the monitoring period. The P9 (control) result should therefore be retained as an important baseline observation for subsequent environmental monitoring. During construction and operation of the proposed LPG station, periodic monitoring should be undertaken to determine whether H₂S remains localized or whether its concentration changes in response to project activities.

4.10.20 Methane Gas (CH₄)

Methane gas (CH₄) was recorded at 0 ppm at all nine sampling points. No detectable methane concentration was therefore observed in the ambient air during the baseline assessment. The uniform result provides an important baseline condition for the proposed LPG station, particularly because methane is a hydrocarbon gas and monitoring of hydrocarbon-related parameters is relevant to facilities involving fuel handling. The absence of detectable methane at P1- P9 (control) indicates that the gas was not measurable at the sampled locations during the assessment. Regular monitoring and appropriate leak-detection measures during the operational phase will be important for confirming that the baseline condition is maintained.

4.10.21 Temperature

Ambient temperature measurements across the nine sampling locations ranged from 28.4 to 39.5°C. The highest temperature of 39.5°C was recorded at P3, followed by 38.1°C at P2 and 37.0°C at P1. The lowest temperature of 28.4°C was recorded at P7. Other recorded values were 33.4°C at P4, 29.6°C at P5, 32.4°C at P6, 30.9°C at P8 and 31.9°C at P9 (control). The mean

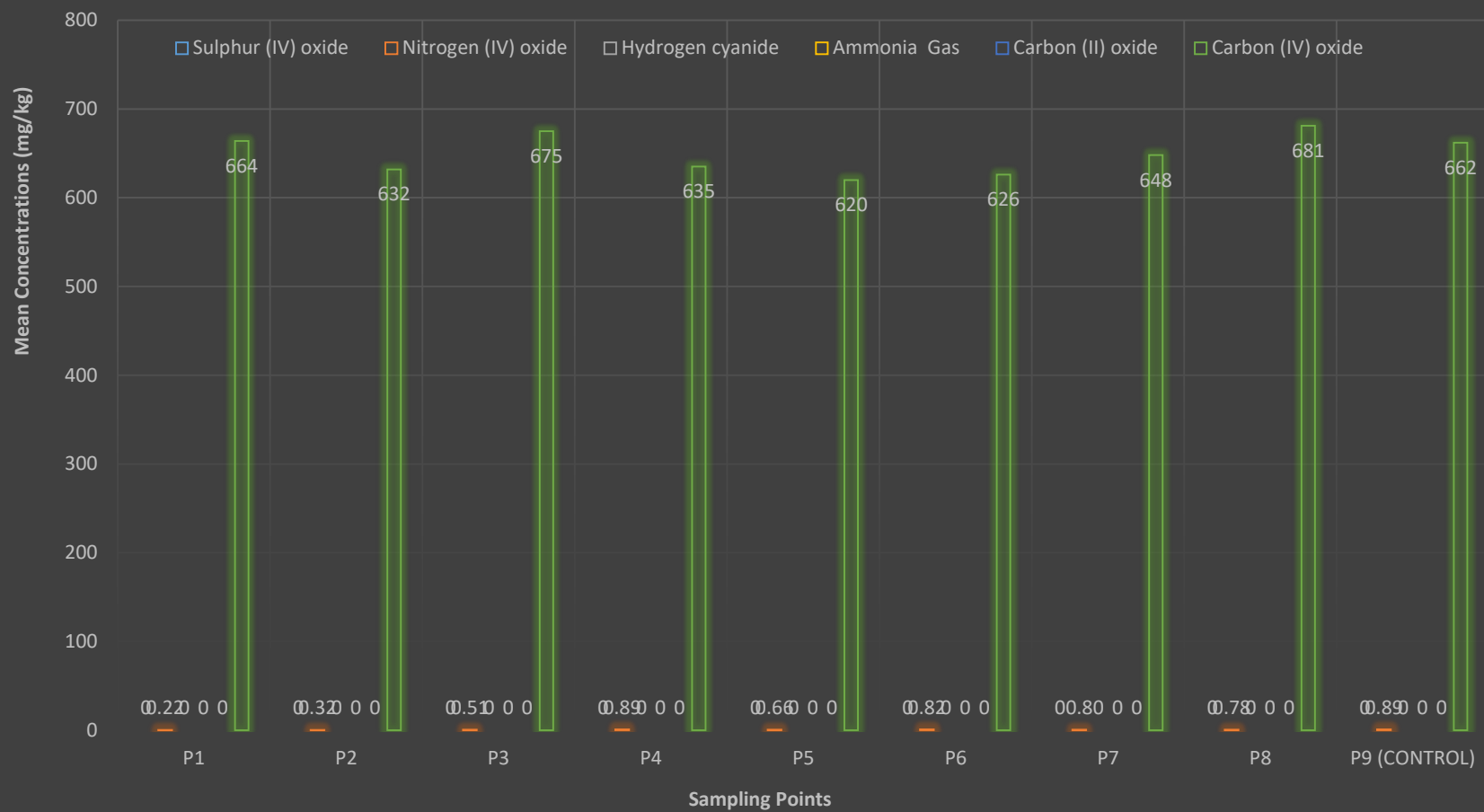


Figure 4.2: Mean Concentrations of Air Quality Parameters Detected in Air at Various Locations Within the Proposed Project Site

temperature across the sampling locations was approximately 33.47°C. The spatial variation indicates differences in the microclimatic conditions prevailing at the sampling points during the assessment. Temperature is also an important meteorological parameter because it can influence atmospheric dispersion and the behaviour of gaseous pollutants. The recorded values therefore constitute the baseline thermal condition of the project environment.

4.10.22 Relative Humidity

Relative humidity values across the nine sampling points ranged from 40.6% to 52.6%. The highest relative humidity of 52.6% was recorded at P2, followed by 52.0% at P1. The lowest value of 40.6% occurred at P4. Other recorded values were 41.4% at P3, 40.8% at P5, 41.5% at P6, 41.8% at P7, 46.9% at P8 and 41.5% at P9 (control). The mean relative humidity was approximately 44.34%. The results show moderate spatial variation in atmospheric moisture across the sampling locations. Relative humidity, together with temperature and wind speed, influences atmospheric dispersion and therefore provides useful supporting information for interpreting the measured air-quality conditions. The findings establish the baseline humidity condition of the proposed project environment.

4.10.23 Wind Speed

Wind speed recorded across the nine sampling points ranged from 1.2 to 2.5 m/s. The highest wind speed of 2.5 m/s was recorded at P1, while the lowest value of 1.2 m/s occurred at P9 (control). Other recorded values were 2.0 m/s at P2, 1.8 m/s at P3 and P4, 2.2 m/s at P5, 1.6 m/s at P6, 1.3 m/s at P7 and 1.4 m/s at P8. The mean wind speed was approximately 1.76 m/s. The observed variation indicates differences in local air movement across the sampling locations. Wind speed is an important meteorological factor in the dispersion and dilution of airborne pollutants. The relatively higher wind speed at P1 and lower value at P9 (control) provide useful context for interpreting the spatial distribution of the measured gaseous and particulate parameters. These measurements establish the baseline atmospheric movement conditions before project implementation.

4.10.24 Air Quality Index (AQI)

The Air Quality Index (AQI) provides an overall indication of ambient air-quality conditions based on the measured air pollutants. The assessment classified air quality as "Excellent" at P1, P2, P4, P5, P6, P7, P8 and P9 (control), while P3 was classified as "Good". Therefore, eight of the nine sampling locations were classified as having excellent air quality, with only P3 classified as good.

The results indicate that the ambient air-quality condition across the assessed project area was predominantly classified as excellent during the baseline assessment. The difference at P3 indicates some spatial variation in the overall air-quality condition. These baseline AQI classifications provide an important benchmark against which changes arising from construction activities, vehicular movement, equipment operation and subsequent operation of the proposed LPG station can be monitored.

4.11 WATER QUALITY ASSESSMENT

The baseline water quality assessment was conducted on groundwater samples collected from nine borehole sampling points (BH1-BH9_{control}) within the proposed site for the construction of the Liquefied Petroleum Gas (LPG) Station by Shakkato Nigeria Limited, located at Gida dubu quarters opposite Federal University, Dutse, Jigawa State. The assessment covered physicochemical, chemical, heavy metal, organic and microbiological parameters. The results provide baseline information on the existing quality of groundwater within the project area prior to construction and operation of the proposed LPG facility. The measured concentrations were compared with the Federal Ministry of Environment (FMEnv) limits presented in Table 4.3.

4.11.1 Colour

The colour of groundwater samples collected from all nine boreholes (BH1- BH9 control) was reported as clear. The control sample was also clear. The observed condition indicates the absence of visible coloration in the groundwater samples at all sampling locations. The uniform result across the sampled boreholes suggests that the groundwater was visually clear at the time of assessment and did not show apparent colour changes attributable to suspended or dissolved substances. This baseline condition is important for the proposed LPG station because any future alteration in groundwater colour may indicate changes in water quality resulting from project activities. Proper management of fuels, wastes, chemicals and potentially contaminated runoff during construction and operation will therefore be important for maintaining the existing groundwater condition.

4.12.2 Taste

The groundwater samples collected from BH1- BH9 (control) were all reported as tasteless and the control sample was similarly reported as tasteless. The uniform result indicates that no

Table 4.10: Concentrations Mean Values of Water Quality Assessment of Proposed Construction of Liquified Petroleum Gas Plant (LPG) Station

S/N	Parameters	Unit	BH ₁	BH ₂	BH ₃	BH ₄	BH ₅	BH ₆	BH ₇	BH ₈	BH ₉ Control	FMENT Limit
A)	Coordinates											
1.	Latitude	N	11.4246 902	11.43787	11.4310 03	11.4311 08	11.4312 061	11.4317 073	11.4314 31	11.4233 72	11.4311 603	–
2.	Longitude	E	9.2226018	9.2158188	9.222946	9.222220	9.215854	9.215827	9.2250042	9.215055	9.222616	–
3.	Elevation	M	465.7	465.7	465.7	465.7	474.6	478.3	478.3	463.9	471.6	–
B)	hysicochemical Test											
4.	Colour	TCU	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
5.	Taste	–	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless
6.	Odour	–	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless
7.	pH	–	6.23	5.86	6.13	5.95	6.01	6.38	6.41	6.31	6.52	6.5 - 8.5
8.	Temperature	°C	28.4	29.1	28.6	28.9	29.0	28.5	29.2	29.8	29.0	Ambient
9.	Electrical Conductivity	µs/cm	761	1031	775	898	1322	669	474	1272	1050	1000

10.	Salinity	%	0.03	0.05	0.03	0.04	0.06	0.03	0.01	0.06	0.00	<1000
11.	ORP	mV	171	214	245	252	239	193	248	142	350	200-600
12.	Dissolved Oxygen	mg/L	4.1	3.9	4.2	4.3	4.3	4.8	4.0	4.1	4.3	2 – 8
13.	Turbidity	NTU	0	0	0	0	0	0	0	0	0	5
14.	Total Dissolved Solid	mg/L	377	511	448	385	657	333	236	630	75	500
15.	Total Suspended Solid	mg/L	2	4	7	0	5	1	2	0	10	20
16.	B.O. D	mg/L	2.0	2.1	1.8	2.0	2.0	1.9	1.7	2.0	2.0	NS
17.	C.O. D	mg/L	0	0	0	0	0	0	0	0	0	30
C)	Chemical Test											
18.	Total Hardness	mg/L	14	18	37	25	24	17	17	20	42	150
19.	Calcium (Ca ²⁺)	mg/L	0.46	0.09	2.32	1.86	1.86	1.41	0.58	1.35	3.08	200
20.	Magnesium (Mg ²⁺)	mg/L	0.22	0.29	1.02	0.17	0.73	0.89	0.35	1.24	1.53	20
21.	Potassium (K ⁺)	mg/L	0.9	1.6	1.3		1.7		0.1		1.5	20
22.	Nitrate (NO ₃ ²⁻)	mg/L	2.7	1.8	7.4	4.3	6.2	2.2	2.8	2.7	8.3	50
23.	Nitrite (NO ₂ ⁻)	mg/L	0.001	0.000	0.017	0.000	0.015	0.002	0.003	0.001	0.013	0.2

24.	Sulphate (SO ₄ ²⁻)	mg/L	5	4	28	3	16	9	6	21	19	100
25.	Sulphide (S ²⁻)	mg/L	0.000	0.000	0.003	0.000	0.003	0.000	0.000	0.000	0.005	30
26.	Phosphate (PO ₄ ³⁻)	mg/L	2.00	1.86	5.86	3.49	4.43	3.66	2.16	2.43	3.89	0.2
27.	Chloride (Cl ⁻)	mg/L	0.8	0.4	5.36	1.083	7.28	4.35	0.5	0.9	6.27	150
D)	Heavy Metals											
28.	Mercury (Hg ⁺)	µg/L	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
29.	Lead (Pb ²⁺)	µg/L	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
30.	Cadmium (Cd ²⁺)	µg/L	0.007	0.0011	0.096	0.020	0.083	0.000	0.008	0.002	0.71	0.05
31.	Zinc (Zn ²⁺)	mg/L	0.27	0.19	0.63	0.26	0.57	0.43	0.33	0.28	0.75	3.0
32.	Copper (Cu ²⁺)	mg/L	0.15	0.06	0.36	0.27	0.42	0.32	0.13	0.18	0.53	1.25
33.	Iron (Fe ²⁺)	mg/L	0.23	0.14	0.26	0.49	0.24	0.62	0.17	0.23	0.30	0.3
34.	Manganese (Mn ²⁺)	mg/L	0.62	0.25	0.78	0.34	0.75	0.69	0.53	0.39	0.66	NS
35.	Chromium (Cr ³⁺)	mg/L	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.05
36.	Nickel (Ni ²⁺)	mg/L	0.018	0.017	0.216	0.100	0.243	0.002	0.010	0.004	0.266	0.07
37.	Cobalt (Co ²⁺)	mg/L	0.228	0.047	0.361	0.026	0.381	0.251	0.099	0.021	0.438	0.2

E	Organics											
38.	Phenols	mg/L	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.005	0.01
39.	Oil & Grease	mg/L	0	0	0	0	0	0	0	0	0	10
40.	BTEX	mg/L	0	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0	Nil
F	Microbiological Test											
41.	E-Coli	cfu/ml	0	0	0	0	0	0	0	0	0	Nil
42.	Total Coliform	cfu/ml	2	1	3	2	1	0	0	0	5	10

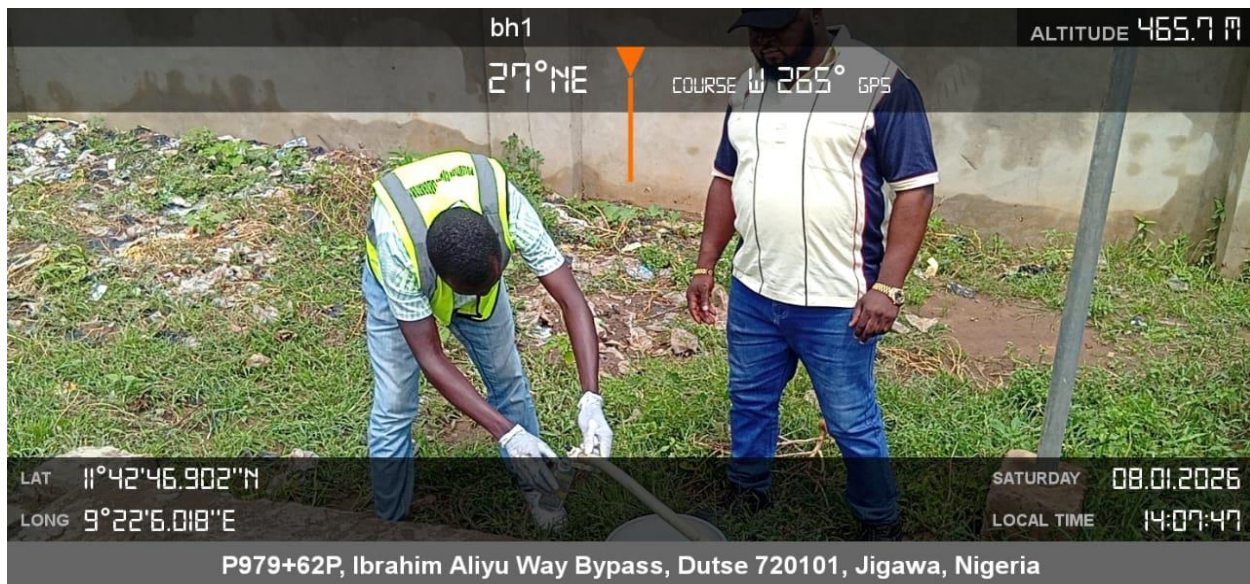


Plate 4.2: Bore Hole Water Sampling around Proposed Project Site

unusual taste was detected in the groundwater samples during the baseline assessment. The absence of detectable taste provides an indication of the existing organoleptic condition of the groundwater within the study area. This result establishes a baseline against which any future change associated with project activities can be evaluated. During construction and operation of the proposed LPG station, appropriate protection of groundwater resources from accidental spills, leakage, waste disposal and contaminated surface runoff will be necessary to preserve the existing water quality condition.

4.11.3 Odour

The groundwater samples from all nine boreholes were reported as odourless. The uniform absence of detectable odour indicates that the sampled groundwater did not exhibit any noticeable odour at the time of assessment. The result provides a useful baseline for evaluating potential changes in groundwater quality during subsequent stages of the project. Since the proposed LPG station will involve the handling and storage of hydrocarbon products, adequate spill prevention, containment and waste-management measures will be necessary to minimize the possibility of substances entering the groundwater system and altering its existing organoleptic characteristics.

4.11.4 pH

The pH values of the groundwater samples ranged from 5.86 to 6.52. The lowest pH value of

5.86 was recorded at BH2, while the highest value of 6.52 occurred at BH9 (control). Other recorded values were 6.23 at BH1, 6.13 at BH3, 5.95 at BH4, 6.01 at BH5, 6.38 at BH6, 6.41 at BH7 and 6.31 at BH8. The FME_{Env} limit presented in the table is 6.5-8.5. Consequently, most of the sampled boreholes recorded values below the lower limit, while BH9_{control} recorded 6.52 and BH7 recorded 6.41. The results indicate that the groundwater was generally slightly acidic across the sampled locations. The spatial variation in pH may reflect differences in the natural geochemical characteristics of the groundwater within the project environment.

4.11.5 Temperature

Groundwater temperature values ranged from 28.4 to 29.8°C across the nine sampling points. The lowest temperature of 28.4°C was recorded at BH1, while the highest value of 29.8°C was recorded at BH8. The remaining boreholes recorded 29.1°C at BH2, 28.6°C at BH3, 28.9°C at BH4, 29.0°C at BH5, 28.5°C at BH6, 29.2°C at BH7 and 29.0°C at BH9. The control designation in the table is "Ambient". The relatively narrow range indicates limited spatial variation in groundwater temperature across the sampling locations. The measured values provide baseline information on the thermal characteristics of the groundwater before implementation of the proposed LPG station.

4.11.6 Electrical Conductivity

Electrical conductivity (EC) values ranged from 474 to 1322 µS/cm. The lowest value of 474 µS/cm was recorded at BH7, while the highest value of 1322 µS/cm occurred at BH5. Other values included 761 µS/cm at BH1, 1031 µS/cm at BH2, 775 µS/cm at BH3, 898 µS/cm at BH4, 669 µS/cm at BH6, 1272 µS/cm at BH8 and 1050 µS/cm at BH9 (control). The control value was 1000 µS/cm. The results show considerable spatial variation in the conductivity of groundwater across the study area, with BH5 and BH8 recording the highest values. Electrical conductivity reflects the concentration and mobility of dissolved ionic constituents in water and therefore provides useful information on the general chemical character of the groundwater.

4.11.7 Salinity

Groundwater salinity values ranged from 0.00% to 0.06%. The highest salinity values of 0.06% were recorded at BH5 and BH8, while BH9 (control) recorded 0.00%. BH1 and BH3 recorded 0.03%, BH2 recorded 0.05%, BH4 recorded 0.04%, BH6 recorded 0.03% and BH7 recorded 0.01%. The FME_{Env} limit presented in the table is <1000. The results indicate relatively low salinity values across all sampled groundwater locations. The limited variation suggests that the

groundwater did not exhibit pronounced saline characteristics during the baseline assessment. These findings establish the existing salinity condition against which any future changes associated with project activities can be monitored.

4.11.8 Oxidation-Reduction Potential (ORP)

The oxidation-reduction potential (ORP) values ranged from 142 to 350 mV. The lowest value of 142 mV was recorded at BH8, while the highest value of 350 mV occurred at BH9 (control). Other values were 171 mV at BH1, 214 mV at BH2, 245 mV at BH3, 252 mV at BH4, 239 mV at BH5, 193 mV at BH6 and 248 mV at BH7. The FMEnv range presented in the table is 200-600 mV. Thus, some sampling locations, particularly BH1, BH2, BH6 and BH8, recorded values below the lower reference value, whereas the remaining locations were within the stated range. The variation in ORP indicates differences in the redox conditions of groundwater across the sampling locations.

4.11.9 Dissolved Oxygen

Dissolved oxygen (DO) concentrations ranged from 3.9 to 4.8 mg/L across the sampled boreholes. The lowest value of 3.9 mg/L was recorded at BH2, while the highest concentration of 4.8 mg/L occurred at BH6. BH1 recorded 4.1 mg/L, BH3 4.2 mg/L, BH4 and BH5 4.3 mg/L each, BH7 4.0 mg/L, BH8 4.1 mg/L and BH9 (control) 4.3 mg/L. The FMEnv range presented in the table is 2-8 mg/L. All measured values therefore fall within the stated range. The results indicate that the groundwater possessed measurable dissolved oxygen throughout the study area and remained within the specified baseline range.

4.11.10 Turbidity

Turbidity was recorded as 0 NTU at all nine borehole sampling points. The control sample also recorded 0 NTU, while the FMEnv limit presented in the table is 5 NTU. The results therefore indicate that all sampled groundwater had no detectable turbidity during the assessment and were well below the stated reference limit. The uniform result suggests that the groundwater samples were clear with respect to particulate matter capable of producing measurable turbidity. Maintaining appropriate site drainage, spill-control systems and groundwater protection measures will be important during construction and operation of the proposed LPG station to prevent the introduction of suspended materials into groundwater resources.

4.11.11 Total Dissolved Solids

Total dissolved solids (TDS) concentrations ranged from 75 to 657 mg/L. The lowest concentration of 75 mg/L was recorded at BH9 (control), while the highest concentration of 657 mg/L occurred at BH5. Other concentrations were 377 mg/L at BH1, 511 mg/L at BH2, 448 mg/L at BH3, 385 mg/L at BH4, 333 mg/L at BH6, 236 mg/L at BH7 and 630 mg/L at BH8. The FMEnv limit presented in the table is 500 mg/L. Consequently, BH2, BH5 and BH8 recorded concentrations above the stated limit, while the remaining locations were below it. The variation in TDS indicates differences in the concentration of dissolved substances among the groundwater sources and establishes important baseline information for future groundwater monitoring.

4.11.12 Total Suspended Solids

Total suspended solids (TSS) concentrations ranged from 0 to 10 mg/L. The highest concentration of 10 mg/L was recorded at BH9 (control), followed by 7 mg/L at BH3 and 5 mg/L at BH5. BH1 recorded 2 mg/L, BH2 4 mg/L, BH4 0 mg/L, BH6 1 mg/L, BH7 2 mg/L and BH8 0 mg/L. The FMEnv limit presented in the table is 20 mg/L. All measured concentrations were therefore below the stated limit. The relatively low TSS concentrations indicate limited suspended particulate matter in the groundwater samples during the baseline assessment. The results provide a useful reference for assessing any future increase in suspended solids that could arise from construction activities or inadequate site drainage.

4.11.13 Biochemical Oxygen Demand (BOD)

Biochemical oxygen demand (BOD) values ranged from 1.7 to 2.1 mg/L. The highest value of 2.1 mg/L was recorded at BH2, while the lowest value of 1.7 mg/L occurred at BH7. BH1, BH4, BH5, BH8 and BH9 (control) each recorded 2.0 mg/L, while BH3 and BH6 recorded 1.8 and 1.9 mg/L, respectively. No FMEnv numerical standard was stated in the table, which reports the reference as "NS". The relatively narrow range of BOD values indicates limited spatial variation among the groundwater samples. These baseline values provide information on the existing oxygen-demand characteristics of the groundwater and can be used for comparison during subsequent environmental monitoring of the proposed LPG station.

4.11.14 Chemical Oxygen Demand (COD)

Chemical oxygen demand (COD) was recorded as 0 mg/L at all nine borehole sampling locations. The uniform result indicates that no measurable COD was detected in the sampled groundwater during the baseline assessment. The FMEnv limit presented in the table is 30 mg/L. All measured

values were therefore below the stated limit. The absence of detectable COD provides a favourable baseline condition with respect to chemically oxidizable substances in the groundwater samples. This condition should be protected through appropriate handling of fuels, lubricants, chemicals and wastes during construction and operation of the proposed LPG station.

4.11.15 Total Hardness

Total hardness values ranged from 14 to 42 mg/L. The lowest value of 14 mg/L was recorded at BH1, while the highest value of 42 mg/L occurred at BH9 (control). BH2 recorded 18 mg/L, BH3 37 mg/L, BH4 25 mg/L, BH5 24 mg/L, BH6 and BH7 17 mg/L each, and BH8 20 mg/L. The FMEnv limit presented in the table is 150 mg/L. All measured values were therefore below the stated limit. The results indicate relatively low levels of total hardness throughout the sampled groundwater locations and show that hardness was not a major water-quality concern under the baseline conditions assessed.

4.11.16 Calcium

Calcium concentrations ranged from 0.09 to 3.08 mg/L. The lowest concentration of 0.09 mg/L was recorded at BH2, while the highest concentration of 3.08 mg/L occurred at BH9 (control). Other concentrations included 0.46 mg/L at BH1, 2.32 mg/L at BH3, 1.86 mg/L at BH4 and BH5, 1.41 mg/L at BH6, 0.58 mg/L at BH7 and 1.35 mg/L at BH8. The FMEnv limit presented in the table is 200 mg/L. All measured concentrations were substantially below the stated limit. The results indicate low calcium concentrations in the sampled groundwater and show that calcium does not constitute a significant baseline water-quality concern within the assessed locations.

4.11.17 Magnesium

Magnesium concentrations ranged from 0.17 to 1.53 mg/L. The lowest value of 0.17 mg/L was recorded at BH4, while the highest concentration of 1.53 mg/L occurred at BH9 (control). Other values were 0.22 mg/L at BH1, 0.29 mg/L at BH2, 1.02 mg/L at BH3, 0.73 mg/L at BH5, 0.89 mg/L at BH6, 0.35 mg/L at BH7 and 1.24 mg/L at BH8. The FMEnv limit presented in the table is 20 mg/L. All concentrations were therefore below the stated limit. The results indicate low magnesium levels across the sampled groundwater sources and establish a favourable baseline condition for this parameter.

4.11.18 Potassium

Potassium concentrations recorded in the groundwater samples were generally low, with reported

values of 0.9 mg/L at BH1, 1.6 mg/L at BH2, 1.3 mg/L at BH3, 1.7 mg/L at BH4, 0.1 mg/L at BH5 and 1.5 mg/L at BH6. The table also provides the FMEnv reference value of 20 mg/L. The reported concentrations are considerably below the stated reference value. The available results indicate that potassium was present at relatively low concentrations in the groundwater samples. These baseline values provide a reference for future monitoring and assessment of any changes in groundwater chemistry during the construction and operational phases of the proposed LPG station.

4.11.19 Nitrate

Nitrate concentrations ranged from 1.8 to 8.3 mg/L. The lowest concentration of 1.8 mg/L was recorded at BH2, while the highest concentration of 8.3 mg/L occurred at BH9 (control). Other values were 2.7 mg/L at BH1, 7.4 mg/L at BH3, 4.3 mg/L at BH4, 6.2 mg/L at BH5, 2.2 mg/L at BH6, 2.8 mg/L at BH7 and 2.7 mg/L at BH8. The FMEnv limit presented in the table is 50 mg/L. All measured nitrate concentrations were therefore below the stated limit. The results indicate relatively low nitrate concentrations across the groundwater sampling points, with BH3 and BH9 (control) recording comparatively higher values. These findings establish the baseline nitrate condition of the groundwater prior to project implementation.

4.11.20 Nitrite

Nitrite concentrations ranged from 0.000 to 0.017 mg/L. The highest concentration of 0.017 mg/L was recorded at BH3, followed by 0.015 mg/L at BH5 and 0.013 mg/L at BH9 (control). BH1 recorded 0.001 mg/L, BH2 and BH4 recorded 0.000 mg/L, BH6 recorded 0.002 mg/L, BH7 0.003 mg/L and BH8 0.001 mg/L. The FMEnv limit presented in the table is 0.2 mg/L. All measured values were therefore below the stated limit. The generally low nitrite concentrations indicate that nitrite was present at relatively low levels in the groundwater during the baseline assessment.

4.11.21 Sulphate

Sulphate concentrations ranged from 3 to 28 mg/L. The highest concentration of 28 mg/L occurred at BH3, while the lowest concentration of 3 mg/L was recorded at BH4. Other values were 5 mg/L at BH1, 4 mg/L at BH2, 16 mg/L at BH5, 9 mg/L at BH6, 6 mg/L at BH7, 21 mg/L at BH8 and 19 mg/L at BH9 (control). The FMEnv limit presented in the table is 100 mg/L. All measured concentrations were therefore below the stated limit. The results indicate relatively low sulphate concentrations throughout the sampled groundwater, although BH3 showed the highest value among the sampling locations.

4.11.22 Sulphide

Sulphide concentrations ranged from 0.000 to 0.005 mg/L. Most of the boreholes recorded 0.000 mg/L, while BH3 and BH5 recorded 0.003 mg/L each and BH9 (control) recorded the highest value of 0.005 mg/L. The FMEnv limit presented in the table is 30 mg/L. All measured concentrations were therefore substantially below the stated limit. The generally low sulphide concentrations indicate that sulphide was present at very low levels in the groundwater samples during the baseline assessment. The result establishes a reference condition for monitoring potential changes during project development and operation.

4.11.23 Phosphate

Phosphate concentrations ranged from 1.86 to 5.86 mg/L. The lowest concentration of 1.86 mg/L was recorded at BH2, while the highest concentration of 5.86 mg/L occurred at BH3. Other values included 2.00 mg/L at BH1, 3.49 mg/L at BH4, 4.43 mg/L at BH5, 3.66 mg/L at BH6, 2.16 mg/L at BH7, 2.43 mg/L at BH8 and 3.89 mg/L at BH9 (control). The FMEnv limit presented in the table is 0.2 mg/L. All recorded concentrations were therefore above the stated reference value. The relatively elevated phosphate concentrations represent an important baseline characteristic of the groundwater and should be monitored during project implementation. Appropriate control of waste, wastewater and contaminated runoff will be important in preventing further increases in phosphate concentrations.

4.11.24 Chloride

Chloride concentrations ranged from 0.4 to 7.28 mg/L. The lowest concentration of 0.4 mg/L was recorded at BH2, while the highest concentration of 7.28 mg/L occurred at BH5. Other concentrations were 0.8 mg/L at BH1, 5.36 mg/L at BH3, 1.083 mg/L at BH4, 4.35 mg/L at BH6, 0.5 mg/L at BH7, 0.9 mg/L at BH8 and 6.27 mg/L at BH9 (control). The FMEnv limit presented in the table is 150 mg/L. All measured concentrations were therefore below the stated limit. The results indicate low chloride concentrations across the groundwater sampling locations and suggest that chloride was not a significant baseline water-quality concern at the time of assessment.

4.11.25 Mercury

Mercury concentrations were recorded as 0.000 µg/L at all nine borehole sampling points. The FMEnv limit presented in the table is 0.001 µg/L. The results therefore indicate that mercury was not detected in the sampled groundwater and that all measured concentrations were below the

stated reference limit. The absence of detectable mercury provides a favourable baseline condition for this toxic heavy metal. Appropriate handling and disposal of hazardous materials during construction and operation should nevertheless be maintained to prevent introduction of mercury or other contaminants into groundwater resources.

4.11.26 Lead

Lead concentrations were recorded as 0.000 µg/L at BH1-BH9. The FMEnv limit presented in the table is 0.001 µg/L. Thus, lead was not detected in any of the groundwater samples and all measured concentrations were below the stated reference limit. The result establishes a favourable baseline condition with respect to lead contamination. During construction and operation of the proposed LPG station, appropriate management of wastes, equipment, batteries, paints and other materials capable of introducing heavy metals into the environment should be maintained to preserve the existing groundwater condition.

4.11.27 Cadmium

Cadmium concentrations ranged from 0.000 to 0.096, with the reported values including 0.007 at BH1, 0.0011 at BH2, 0.096 at BH3, 0.020 at BH4, 0.083 at BH5, 0.000 at BH6, 0.008 at BH7 and 0.002 at BH8. BH9_{control} recorded 0.71 in the table. The FMEnv limit presented is 0.05. Therefore, BH3, BH5 and BH9 recorded values above the stated reference value, while the other sampling points were below it. The spatial variation indicates that cadmium occurrence was not uniform across the groundwater sources. The elevated values at BH3, BH5 and particularly BH9_{control} should be retained as important baseline observations and considered in subsequent groundwater monitoring and environmental management for the proposed LPG station.

4.11.28 Zinc

Zinc concentrations ranged from 0.19 to 0.75 mg/L. The lowest concentration of 0.19 mg/L was recorded at BH2, while the highest concentration of 0.75 mg/L occurred at BH9 (control). Other values were 0.27 mg/L at BH1, 0.63 mg/L at BH3, 0.26 mg/L at BH4, 0.57 mg/L at BH5, 0.43 mg/L at BH6, 0.33 mg/L at BH7 and 0.28 mg/L at BH8. The FMEnv limit presented in the table is 3.0 mg/L. All measured concentrations were therefore below the stated limit. The results indicate relatively low zinc concentrations across the groundwater sampling points and establish a generally favourable baseline condition for zinc.

4.11.29 Copper

Copper concentrations ranged from 0.06 to 0.53 mg/L. The lowest value of 0.06 mg/L was recorded at BH2, while the highest concentration of 0.53 mg/L occurred at BH9 (control). Other values included 0.15 mg/L at BH1, 0.36 mg/L at BH3, 0.27 mg/L at BH4, 0.42 mg/L at BH5, 0.32 mg/L at BH6, 0.13 mg/L at BH7 and 0.18 mg/L at BH8. The FMEnv limit presented in the table is 1.25 mg/L. All measured copper concentrations were therefore below the stated limit. The results indicate that copper was present at relatively low concentrations in the sampled groundwater and did not exceed the stated reference value.

4.11.30 Iron

Iron concentrations ranged from 0.14 to 0.62 mg/L. The lowest concentration of 0.14 mg/L was recorded at BH2, while the highest value of 0.62 mg/L occurred at BH6. Other concentrations were 0.23 mg/L at BH1, 0.26 mg/L at BH3, 0.49 mg/L at BH4, 0.24 mg/L at BH5, 0.17 mg/L at BH7, 0.23 mg/L at BH8 and 0.30 mg/L at BH9 (control). The FMEnv limit presented in the table is 0.3 mg/L. Consequently, BH4 and BH6 exceeded the stated limit, BH9 (control) was equal to the limit, while the remaining locations were below it. The spatial variation indicates that iron concentrations were not uniform across the groundwater sources. The elevated values should be considered part of the baseline condition when evaluating future changes in groundwater quality.

4.11.31 Manganese

Manganese concentrations ranged from 0.25 to 0.78 mg/L. The lowest concentration of 0.25 mg/L occurred at BH2, while the highest concentration of 0.78 mg/L was recorded at BH3. Other values included 0.62 mg/L at BH1, 0.34 mg/L at BH4, 0.75 mg/L at BH5, 0.69 mg/L at BH6, 0.53 mg/L at BH7, 0.39 mg/L at BH8 and 0.66 mg/L at BH9 (control). No numerical FMEnv limit was provided in the table, which reports the reference as "NS". The results demonstrate that manganese was detected at all sampled boreholes and exhibited noticeable spatial variation. The measured concentrations therefore provide an important baseline for future monitoring of groundwater quality during construction and operation of the proposed LPG station.

4.11.32 Chromium

Chromium concentrations ranged from 0.00 to 0.01 mg/L. The highest concentration of 0.01 mg/L was recorded at BH3, while BH1, BH2 and BH4-BH9 recorded 0.00 mg/L. The FMEnv limit presented in the table is 0.05 mg/L. All measured chromium concentrations were therefore below the stated limit. The generally low concentrations and widespread non-detection indicate that

chromium was not a significant baseline contaminant in the groundwater during the assessment. These results provide a reference condition for future monitoring during project implementation.

4.11.33 Nickel

Nickel concentrations ranged from 0.002 to 0.266 mg/L. The lowest concentration of 0.002 mg/L was recorded at BH6, while the highest concentration of 0.266 mg/L occurred at BH9. BH1 recorded 0.018 mg/L, BH2 0.017 mg/L, BH3 0.216 mg/L, BH4 0.100 mg/L, BH5 0.243 mg/L, BH7 0.010 mg/L and BH8 0.004 mg/L. The FMEnv limit presented in the table is 0.07 mg/L. Therefore, BH3, BH4, BH5 and BH9 (control) recorded concentrations above the stated limit, while the remaining locations were below it. The results demonstrate marked spatial variation in nickel concentrations and identify several locations requiring particular attention during future groundwater monitoring.

4.11.34 Cobalt

Cobalt concentrations ranged from 0.021 to 0.438 mg/L. The lowest concentration of 0.021 mg/L was recorded at BH8, while the highest value of 0.438 mg/L occurred at BH9 (control). Other concentrations were 0.228 mg/L at BH1, 0.047 mg/L at BH2, 0.361 mg/L at BH3, 0.026 mg/L at BH4, 0.381 mg/L at BH5, 0.251 mg/L at BH6 and 0.099 mg/L at BH7. The FMEnv limit presented in the table is 0.2 mg/L. Accordingly, BH1, BH3, BH5, BH6 and BH9 (control) exceeded the stated reference value, while the remaining sampling points were below it. The results indicate considerable spatial variation in cobalt concentration and establish elevated baseline values at several boreholes that should be considered in subsequent monitoring.

4.11.35 Phenols

Phenol concentrations ranged from 0.000 to 0.005 mg/L. No detectable concentration was recorded at BH1, BH2, BH4, BH5, BH6, BH7 and BH8. BH3 recorded 0.002 mg/L, while the highest concentration of 0.005 mg/L occurred at BH9 (control). The FMEnv limit presented in the table is 0.01 mg/L. All measured concentrations were therefore below the stated limit. The generally low or non-detectable phenol concentrations indicate a favourable baseline condition with respect to phenolic compounds in the groundwater. Appropriate control of potentially contaminating materials will nevertheless be necessary during project implementation.

4.11.36 Oil and Grease

Oil and grease concentrations were recorded as 0 mg/L at all nine-groundwater sampling

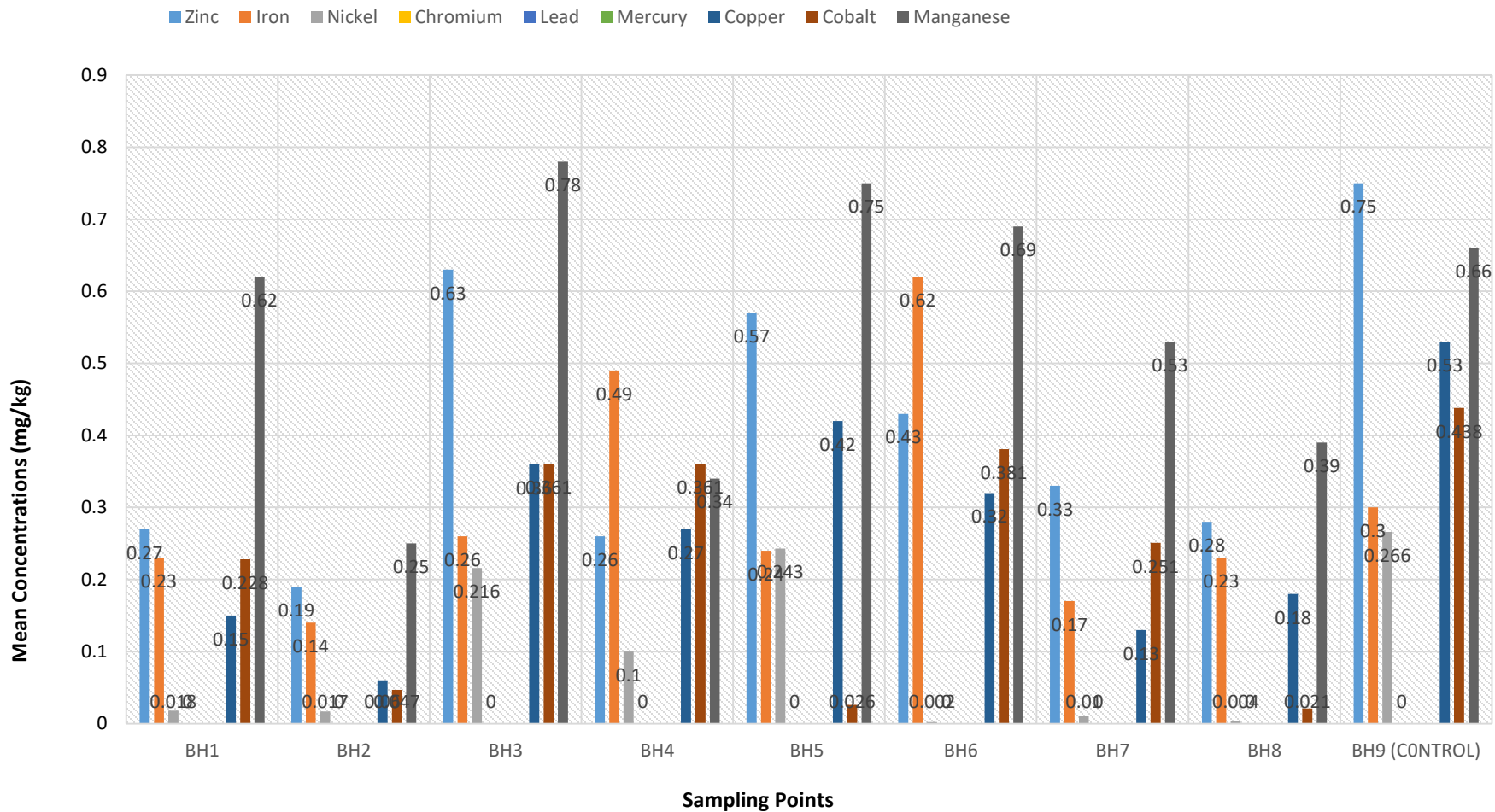


Figure 4.3: Mean Concentrations of Heavy Metals Detected in Water Samples Collected at Various Locations Within the Proposed Project Site

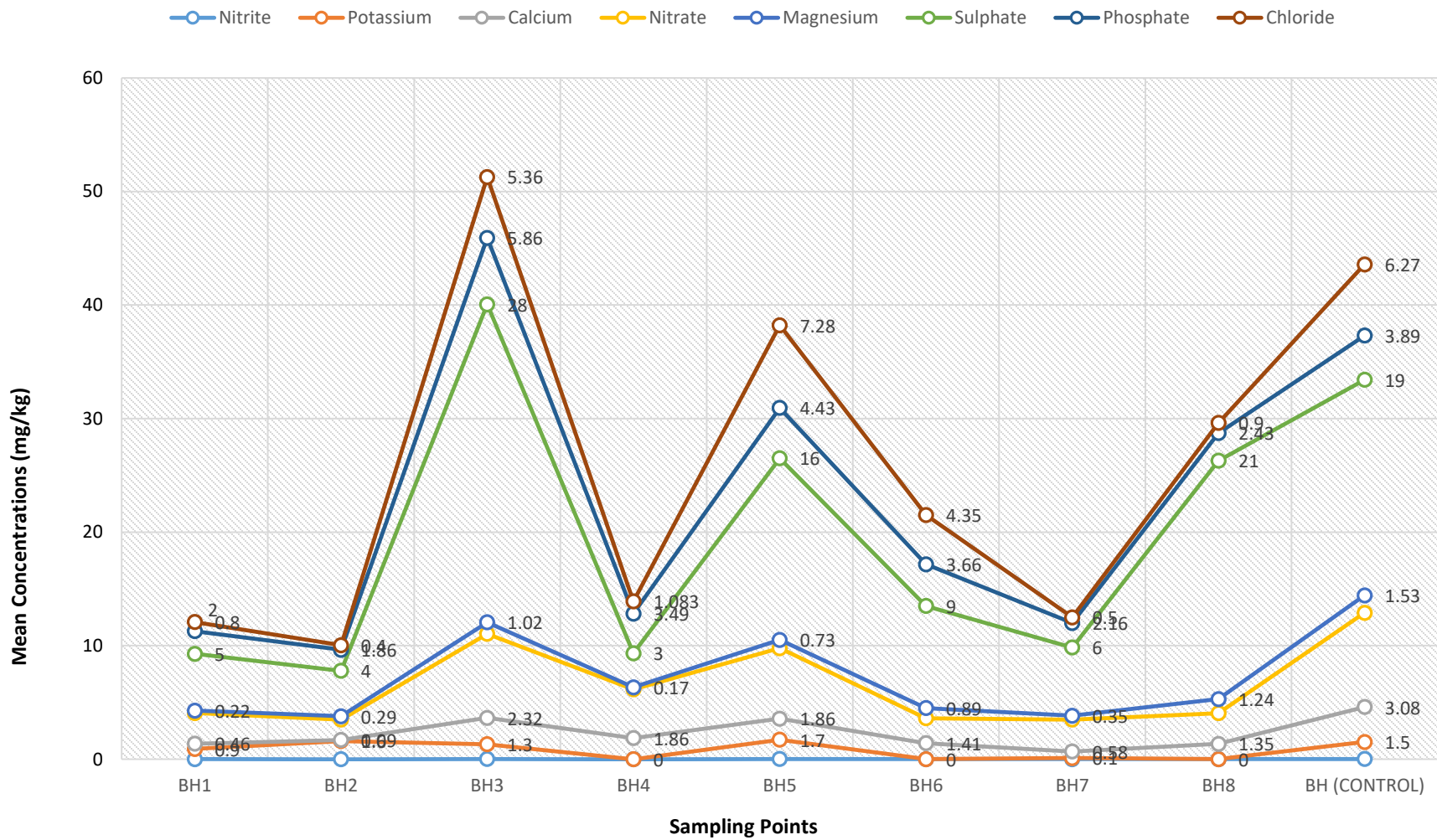


Figure 4.4: Mean Concentrations of Chemical Contents Detected in Water Samples Collected at Various Locations Within the Proposed Project Site

locations. The FMEnv limit presented in the table is 10 mg/L. All measured values were therefore below the stated limit. The absence of detectable oil and grease indicates that the sampled groundwater did not show measurable contamination by these substances during the baseline assessment. This result is particularly relevant to the proposed LPG station because hydrocarbon handling, equipment maintenance and fuel-related activities can potentially introduce oily contaminants into the environment. Effective spill prevention, secondary containment and proper waste management will therefore be essential for maintaining the baseline condition.

4.11.37 BTEX

BTEX, representing benzene, toluene, ethylbenzene and xylenes, was recorded as 0 mg/L at BH1-BH9. The control designation in the table is "Nil". The results therefore indicate that BTEX was not detected in any of the groundwater samples during the baseline assessment. This is an important baseline observation for the proposed LPG station because BTEX compounds are associated with petroleum-related contamination and their monitoring is relevant where hydrocarbon products are handled. The absence of detectable BTEX indicates that the sampled groundwater did not show measurable concentrations of these compounds at the time of assessment. Appropriate hydrocarbon containment, leak detection and groundwater monitoring should be maintained during operation.

4.11.38 E. coli

E. coli concentrations were recorded as 0 CFU/mL at all nine borehole sampling locations. The control designation in the table is "Nil". The results indicate that *E. coli* was not detected in any of the sampled groundwater sources during the baseline assessment. The absence of detectable *E. coli* provides a favourable microbiological baseline condition with respect to this indicator organism. Appropriate protection of boreholes and groundwater sources from sewage, wastewater, solid waste and other potential sources of faecal contamination should be maintained throughout construction and operation of the proposed LPG station.

4.11.39 Total Coliform

Total coliform counts ranged from 0 to 5 CFU/mL. The highest count of 5 CFU/mL was recorded at BH9 (control), followed by 3 CFU/mL at BH3. BH1 and BH4 recorded 2 CFU/mL each, BH2 and BH5 recorded 1 CFU/mL each, while BH6, BH7 and BH8 recorded 0 CFU/mL. The FMEnv limit presented in the table is 10 CFU/mL. All measured total coliform counts were therefore below the stated limit. The results indicate low levels of total coliform across the groundwater sources,

Table 4.11: Concentrations Mean Values of Soil Quality Assessment of Proposed Construction of Liquefied Petroleum Gas Plant (LPG) Station

S/N	Parameters	Unit	DSS ₁	DSS ₂	DSS ₃	DSS ₄	DSS ₅	DSS ₆	DSS ₇	DSS ₈	DSS 9 Control
A)	Physical Test										
1.	Colour	TCU	Dark Brown	Grayish Brown	Grayish Brown	Dark Brown	Pale Brown	Brown	Dark Brown	Blackish Brown	Pale Brown
2.	Ph	–	6.49	6.70	6.83	6.77	6.91	4.99	6.47	4.96	7.89
3.	Electrical Conductivity	µs/cm	1748	1742	1525	1670	1236	1778	1700	1612	1023
4.	Salinity	%	0.08	0.08	0.07	0.08	0.06	0.09	0.08	0.08	0.09
5.	ORP	mV	187	177	130	135	121	160	192	134	149
B)	Exchangeable Cation										
6.	Calcium (Ca ²⁺)	mg/kg	3.21	2.43	2.47	2.60	3.00	2.85	2.66	2.31	2.51
7.	Magnesium (Mg ²⁺)	mg/kg	1.03	0.97	0.99	0.84	1.00	0.96	0.84	0.74	0.86
8.	Potassium (K ⁺)	mg/kg	7.3	6.4	6.8	6.7	6.3	6.3	5.1	5.5	6.7
9.	Sodium (Na ⁺)	mg/kg	18	12	23	18	14	11	23	25	16
10.	Ammonium (NH ₄ ⁺)	mg/kg	0.261	0.132	0.161	0.214	0.224	0.205	0.211	0.186	0.222

C)	Exchangeable Anion										
11.	Sulphate (SO_4^{2-})	mg/kg	13	8	14	17	21	10	9	16	23
12.	Phosphate (PO_4^{3-})	mg/kg	3.16	3.72	2.86	3.00	2.77	2.59	3.06	2.81	2.74
13.	Nitrate (NO_3^{2-})	mg/kg	6.6	6.3	6.4	5.6	6.8	6.1	5.8	6.0	5.9
14.	Nitrite (NO_2^-)	mg/kg	0.266	0.246	0.182	0.302	0.386	0.244	0.059	0.227	0.288
15.	Chloride (Cl^-)	mg/kg	0.21	0.86	0.17	0.53	0.11	0.34	0.86	0.29	0.24
D)	Heavy Metals										
16.	Chromium (Cr^{3+})	mg/kg	0.02	0.07	0.03	0.02	0.04	0.01	0.02	0.05	0.01
17.	Zinc (Zn^{2+})	mg/kg	0.53	0.64	0.72	0.66	0.58	0.47	0.39	0.27	0.52
18.	Total Nitrogen	mg/kg	8.4	7.3	8.9	7.5	7.2	6.6	7.1	6.9	7.5
19.	Mercury (Hg^+)	$\mu\text{g/kg}$	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
20.	Cadmium (Cd^{2+})	$\mu\text{g/kg}$	0.003	0.001	0.003	0.004	0.001	0.000	0.000	0.000	0.002
21.	Copper (Cu^{2+})	mg/kg	0.23	0.28	0.37	0.30	0.25	0.18	0.36	0.22	0.35
22.	Lead (Pb^{2+})	$\mu\text{g/kg}$	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23.	Nickel (Ni^{2+})	mg/kg	0.023	0.027	0.036	0.027	0.032	0.001	0.026	0.018	0.025
24.	Cobalt (Co^{2+})	mg/kg	0.048	0.053	0.062	0.054	0.061	0.022	0.051	0.022	0.023
25.	Manganese (Mn^{2+})	mg/kg	0.44	0.41	0.47	0.09	0.21	0.08	0.08	0.06	0.16

26.	Iron (Fe ²⁺)	mg/kg	0.12	0.17	0.26	0.22	0.18	0.23	0.24	0.05	0.01
E)	Organics										
27.	Phenols	mg/kg	0.000	0.001	0.025	0.000	0.000	0.000	0.003	0.006	0.002
28.	Oil and Grease	mg/kg	0	0	0	0	0	0	0	0	0
29.	BTEX	mg/kg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F)	Soil Characteristics										
30.	Sandy	%	10	15	23	20	30	28	12	31	65
31.	Loam	%	65	35	51	55	47	62	53	60	21
32.	Clay	%	20	50	15	23	18	15	17	20	8
33.	Silt	%	5	0	11	2	5	19	18	9	6
G)	Microbiological Test										
34.	E. coli	cfu/kg	2	9	4	17	7	4	3	5	1
35.	Fungal	cfu/kg	243	109	277	105	129	75	69	68	54

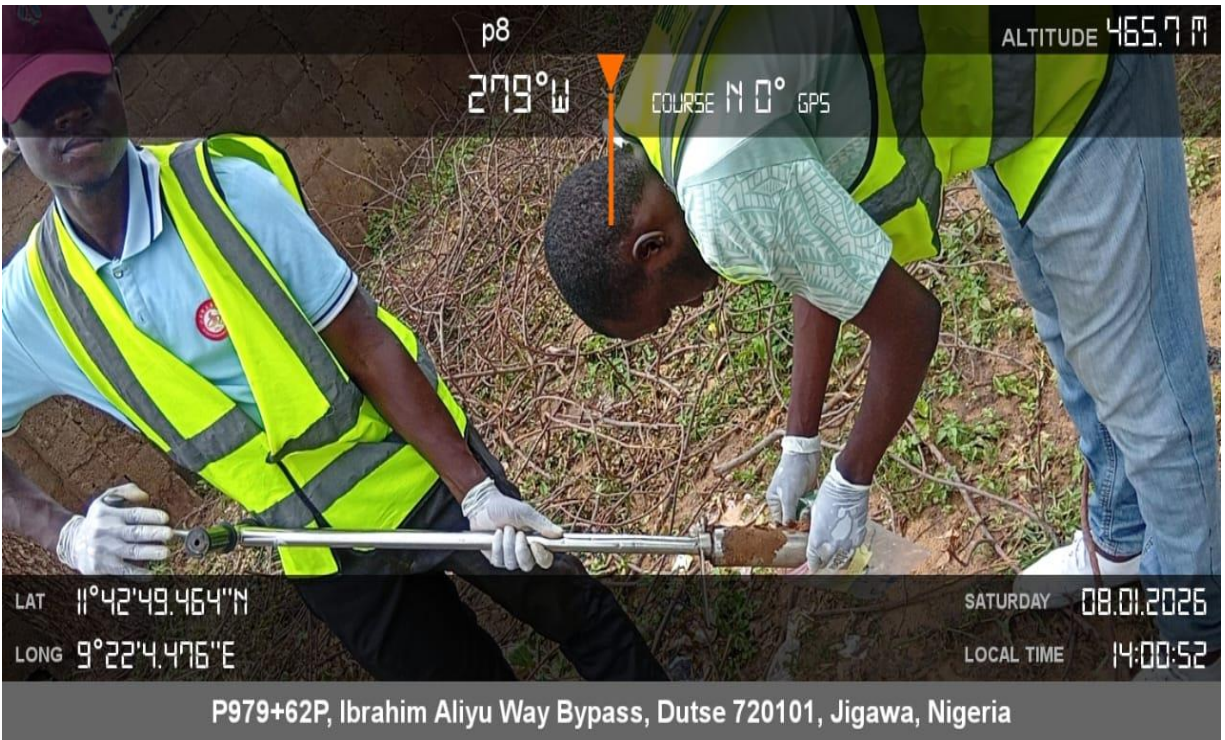


Plate 4.2: Soil Sampling with Soil Auger around Proposed Project Site

although BH9 recorded the highest count among the sampling points. Continued protection of groundwater sources from potential faecal and environmental contamination will be important during the implementation and operation of the proposed LPG station.

4.12 SOIL QUALITY ASSESSMENT

The baseline soil quality assessment was conducted at nine sampling locations (DSS1-DSS9 control) within and around the proposed site for the construction of the Liquefied Petroleum Gas (LPG) Station by Shakkato Nigeria Limited, located at Gida dubu quarters opposite Federal University, Dutse, Jigawa State. The assessment covered physical properties, exchangeable cations, exchangeable anions, heavy metals, organic contaminants, soil characteristics and microbiological parameters. The findings provide baseline information on the existing physicochemical, chemical and biological condition of the soil within the project area prior to construction and operation of the proposed LPG facility. The measured mean concentrations are presented in Table 4.4.

4.12.1 Soil Colour

The soil colour varied across the nine sampling locations, indicating differences in the visual characteristics of the soil within the study area. DSS1 and DSS4 were described as dark brown, while DSS2 and DSS3 were grayish brown. DSS5 and DSS9 (control) were pale brown, DSS6 was brown, DSS7 was dark brown and DSS8 was blackish brown. The variation in soil colour may reflect differences in soil mineral composition, organic matter content, moisture condition and degree of weathering among the sampling locations. The blackish-brown colour recorded at DSS8 and the dark-brown appearance at DSS1, DSS4 and DSS7 indicate comparatively darker soil materials, whereas DSS5 and DSS9 showed lighter coloration. These observations establish the baseline visual characteristics of the soil before implementation of the proposed LPG project.

4.12.2 Soil pH

The soil pH values ranged from 4.96 to 7.89 across the nine sampling locations. The lowest pH of 4.96 was recorded at DSS8, followed closely by 4.99 at DSS6. The highest pH value of 7.89 was recorded at the control location, DSS9 (control). Other values were 6.49 at DSS1, 6.70 at DSS2, 6.83 at DSS3, 6.77 at DSS4, 6.91 at DSS5 and 6.47 at DSS7. The results indicate considerable variation in soil reaction across the study area, ranging from acidic conditions at DSS6 and DSS8 to near-neutral conditions at most of the other sampling locations, while the control exhibited a higher pH. The spatial variation may reflect differences in soil mineralogy,

organic matter decomposition and local environmental conditions. The baseline pH values are important for interpreting nutrient availability, metal mobility and other soil chemical processes associated with the proposed LPG project.

4.12.3 Electrical Conductivity

Electrical conductivity (EC) values ranged from 1236 to 1778 $\mu\text{S}/\text{cm}$. The lowest EC value of 1236 $\mu\text{S}/\text{cm}$ was recorded at DSS5, while the highest value of 1778 $\mu\text{S}/\text{cm}$ occurred at DSS6. Other values were 1748 $\mu\text{S}/\text{cm}$ at DSS1, 1742 $\mu\text{S}/\text{cm}$ at DSS2, 1525 $\mu\text{S}/\text{cm}$ at DSS3, 1670 $\mu\text{S}/\text{cm}$ at DSS4, 1700 $\mu\text{S}/\text{cm}$ at DSS7 and 1612 $\mu\text{S}/\text{cm}$ at DSS8. The control location, DSS9 (control), recorded 1023 $\mu\text{S}/\text{cm}$. The results show that all project sampling locations recorded higher electrical conductivity than the control. The relatively high conductivity values indicate differences in the concentration of soluble ionic constituents within the soil. DSS6 recorded the highest value, while DSS5 recorded the lowest among the project locations. These results establish the baseline ionic condition of the soil prior to project development and provide a basis for detecting potential changes resulting from project activities.

4.12.4 Soil Salinity

Soil salinity values ranged from 0.06% to 0.09%. The lowest salinity of 0.06% was recorded at DSS5, while the highest value of 0.09% occurred at DSS6 and the control location DSS9 (control). DSS1, DSS2, DSS4, DSS7 and DSS8 recorded 0.08%, while DSS3 recorded 0.07%. The relatively narrow range indicates limited spatial variation in soil salinity across the sampling locations. DSS6 and the control showed the highest recorded values, while DSS5 had the lowest. The results indicate that salinity was present at relatively similar levels throughout the assessed soil locations. The baseline salinity condition is relevant to the proposed LPG project because changes in soil salinity may influence soil structure, plant growth and the mobility of dissolved substances following project implementation.

4.12.5 Oxidation-Reduction Potential

The oxidation-reduction potential (ORP) values ranged from 121 to 192 mV. The lowest value of 121 mV was recorded at DSS5, while the highest value of 192 mV occurred at DSS7. Other values were 187 mV at DSS1, 177 mV at DSS2, 130 mV at DSS3, 135 mV at DSS4, 160 mV at DSS6, 134 mV at DSS8 and 149 mV at DSS9 (control). The results demonstrate spatial variation in the redox condition of the soil. DSS5 recorded the lowest ORP, whereas DSS7 recorded the highest. Differences in soil moisture, organic matter decomposition, aeration and microbial activity may

influence the observed redox conditions. The measured values provide baseline information on the oxidation-reduction environment of the soil before construction and operation of the proposed LPG station.

4.12.6 Calcium

Calcium concentrations ranged from 2.31 to 3.21 mg/kg. The highest concentration of 3.21 mg/kg was recorded at DSS1, while the lowest value of 2.31 mg/kg occurred at DSS8. Other concentrations were 2.43 mg/kg at DSS2, 2.47 mg/kg at DSS3, 2.60 mg/kg at DSS4, 3.00 mg/kg at DSS5, 2.85 mg/kg at DSS6, 2.66 mg/kg at DSS7 and 2.51 mg/kg at the control DSS9 (control). The results indicate relatively limited spatial variation in soil calcium concentrations. DSS1 recorded the highest concentration, followed by DSS5, while DSS8 recorded the lowest. Calcium is an important exchangeable soil cation and contributes to soil fertility and structural stability. The observed concentrations therefore establish the baseline calcium status of the soil within the project environment.

4.12.7 Magnesium

Magnesium concentrations ranged from 0.74 to 1.03 mg/kg. The highest concentration of 1.03 mg/kg was recorded at DSS1, while the lowest value of 0.74 mg/kg occurred at DSS8. DSS2 recorded 0.97 mg/kg, DSS3 0.99 mg/kg, DSS4 0.84 mg/kg, DSS5 1.00 mg/kg, DSS6 0.96 mg/kg and DSS7 0.84 mg/kg, while the control recorded 0.86 mg/kg. The results indicate relatively low spatial variation in magnesium concentration among the sampled soils. DSS1 and DSS5 recorded comparatively higher concentrations, whereas DSS8 showed the lowest value. Magnesium is an important exchangeable nutrient and contributes to soil fertility. The results provide baseline information on the magnesium status of the soil before implementation of the proposed LPG project.

4.12.8 Potassium

Potassium concentrations ranged from 5.1 to 7.3 mg/kg. The highest concentration of 7.3 mg/kg was recorded at DSS1, while the lowest value of 5.1 mg/kg occurred at DSS7. DSS2 recorded 6.4 mg/kg, DSS3 6.8 mg/kg, DSS4 6.7 mg/kg, DSS5 and DSS6 each recorded 6.3 mg/kg, DSS8 recorded 5.5 mg/kg and the control DSS9 (control) recorded 6.7 mg/kg. The results show moderate spatial variation in exchangeable potassium concentrations across the study area. DSS1 had the highest value, while DSS7 had the lowest. Potassium is an essential plant nutrient and an important exchangeable soil cation. The measured values therefore establish the baseline

potassium status of the soil within the proposed project area.

4.12.9 Sodium

Sodium concentrations ranged from 11 to 25 mg/kg. The lowest concentration of 11 mg/kg was recorded at DSS6, while the highest concentration of 25 mg/kg occurred at DSS8. DSS1 and DSS4 recorded 18 mg/kg each, DSS2 recorded 12 mg/kg, DSS3 and DSS7 recorded 23 mg/kg each, DSS5 recorded 14 mg/kg and the control DSS9 (control) recorded 16 mg/kg. The results indicate noticeable spatial variation in exchangeable sodium concentration across the sampling locations. DSS8 recorded the highest concentration, while DSS6 recorded the lowest. The observed baseline values provide information on the existing sodium status of the soil and can be used to evaluate any subsequent changes in soil chemistry associated with project activities.

4.12.10 Ammonium

Ammonium concentrations ranged from 0.132 to 0.261 mg/kg. The highest concentration of 0.261 mg/kg was recorded at DSS1, while the lowest value of 0.132 mg/kg occurred at DSS2. DSS3 recorded 0.161 mg/kg, DSS4 0.214 mg/kg, DSS5 0.224 mg/kg, DSS6 0.205 mg/kg, DSS7 0.211 mg/kg and DSS8 0.186 mg/kg, while the control DSS9 (control) recorded 0.222 mg/kg. The results indicate moderate spatial variation in soil ammonium concentrations. DSS1 recorded the highest value, whereas DSS2 recorded the lowest. Ammonium is an important inorganic form of nitrogen in soils and may be influenced by organic matter decomposition and microbial processes. The observed concentrations provide baseline information on the nitrogen status of the soil prior to development of the proposed LPG station.

4.12.11 Sulphate

Sulphate concentrations ranged from 8 to 23 mg/kg. The lowest concentration of 8 mg/kg was recorded at DSS2, while the highest value of 23 mg/kg occurred at the control DSS9 (control). Other concentrations were 13 mg/kg at DSS1, 14 mg/kg at DSS3, 17 mg/kg at DSS4, 21 mg/kg at DSS5, 10 mg/kg at DSS6, 9 mg/kg at DSS7 and 16 mg/kg at DSS8. The results indicate moderate spatial variation in soil sulphate concentrations, with the control recording the highest value and DSS2 recording the lowest. Sulphate is an important soil anion and may originate from natural mineral weathering and organic matter processes. The measured concentrations establish the baseline sulphate status of the soil in the proposed project environment.

4.12.12 Phosphate

Phosphate concentrations ranged from 2.59 to 3.72 mg/kg. The highest concentration of 3.72

mg/kg was recorded at DSS2, while the lowest value of 2.59 mg/kg occurred at DSS6. DSS1 recorded 3.16 mg/kg, DSS3 2.86 mg/kg, DSS4 3.00 mg/kg, DSS5 2.77 mg/kg, DSS7 3.06 mg/kg and DSS8 2.81 mg/kg, while the control recorded 2.74 mg/kg. The results show relatively narrow spatial variation in phosphate concentrations across the study area. DSS2 recorded the highest value, whereas DSS6 recorded the lowest. Phosphate is an important soil nutrient and its concentration may reflect natural soil characteristics and previous land-use activities. The observed values provide a baseline against which potential changes in soil nutrient status can be evaluated during project implementation.

4.12.13 Nitrate

Nitrate concentrations ranged from 5.6 to 6.8 mg/kg. The lowest concentration of 5.6 mg/kg was recorded at DSS4, while the highest concentration of 6.8 mg/kg occurred at DSS5. DSS1 recorded 6.6 mg/kg, DSS2 6.3 mg/kg, DSS3 6.4 mg/kg, DSS6 6.1 mg/kg, DSS7 5.8 mg/kg and DSS8 6.0 mg/kg. The control DSS9 recorded 5.9 mg/kg. The relatively narrow range indicates limited spatial variation in soil nitrate concentration. DSS9 (control) showed the highest value, while DSS4 recorded the lowest. The results provide baseline information on the existing nitrate status of the soil and are useful for evaluating potential changes associated with construction activities, waste management and subsequent operation of the proposed LPG station.

4.12.14 Nitrite

Nitrite concentrations ranged from 0.059 to 0.386 mg/kg. The lowest value of 0.059 mg/kg was recorded at DSS7, while the highest concentration of 0.386 mg/kg occurred at DSS5. DSS1 recorded 0.266 mg/kg, DSS2 0.246 mg/kg, DSS3 0.182 mg/kg, DSS4 0.302 mg/kg, DSS6 0.244 mg/kg and DSS8 0.227 mg/kg, while the control recorded 0.288 mg/kg. The results demonstrate noticeable spatial variation in soil nitrite concentrations. DSS5 recorded the highest value, whereas DSS7 recorded the lowest. Nitrite is an intermediate nitrogen compound in soil nitrogen transformation processes and may vary with microbial activity and environmental conditions. The observed concentrations constitute the baseline condition for this parameter before implementation of the proposed project.

4.12.15 Chloride

Chloride concentrations ranged from 0.11 to 0.86 mg/kg. The lowest concentration of 0.11 mg/kg was recorded at DSS5, while the highest concentration of 0.86 mg/kg occurred at DSS2 and DSS7. DSS1 recorded 0.21 mg/kg, DSS3 0.17 mg/kg, DSS4 0.53 mg/kg, DSS6 0.34 mg/kg and

DSS8 0.29 mg/kg, while the control DSS9 recorded 0.24 mg/kg. The results indicate spatial variation in chloride concentration across the sampling locations. DSS2 and DSS7 recorded the highest values, whereas DSS5 recorded the lowest. Chloride is a mobile soil anion and its baseline concentration is useful for assessing potential changes in soil chemistry resulting from project activities.

4.12.16 Chromium

Chromium concentrations ranged from 0.01 to 0.07 mg/kg. The highest concentration of 0.07 mg/kg was recorded at DSS2, while the lowest value of 0.01 mg/kg occurred at DSS6 and the control DSS9. DSS1 and DSS4 recorded 0.02 mg/kg each, DSS3 and DSS7 recorded 0.03 and 0.02 mg/kg respectively, DSS5 recorded 0.04 mg/kg and DSS8 recorded 0.05 mg/kg. The results show relatively low chromium concentrations throughout the sampled soil, with DSS2 exhibiting the highest value. The concentrations recorded at the project locations were generally close to the control value except for DSS2 and DSS8. These measurements provide a baseline condition for assessing potential changes in chromium concentration during construction and operation of the proposed LPG station.

4.12.17 Zinc

Zinc concentrations ranged from 0.27 to 0.72 mg/kg. The lowest concentration of 0.27 mg/kg was recorded at DSS8, while the highest concentration of 0.72 mg/kg occurred at DSS3. DSS1 recorded 0.53 mg/kg, DSS2 0.64 mg/kg, DSS4 0.66 mg/kg, DSS5 0.58 mg/kg, DSS6 0.47 mg/kg and DSS7 0.39 mg/kg. The control DSS9 recorded 0.52 mg/kg. The results indicate moderate spatial variation in soil zinc concentrations. DSS3 recorded the highest value, whereas DSS8 had the lowest. The concentrations provide baseline information on the distribution of zinc in the project environment and can be used to evaluate any subsequent changes resulting from construction activities, waste handling or other project-related inputs.

4.12.18 Total Nitrogen

Total nitrogen concentrations ranged from 6.6 to 8.9 mg/kg. The lowest concentration of 6.6 mg/kg occurred at DSS6, while the highest concentration of 8.9 mg/kg was recorded at DSS3. DSS1 recorded 8.4 mg/kg, DSS2 7.3 mg/kg, DSS4 7.5 mg/kg, DSS5 7.2 mg/kg, DSS7 7.1 mg/kg and DSS8 6.9 mg/kg. The control DSS9 recorded 7.5 mg/kg. The results indicate moderate spatial variation in total soil nitrogen. DSS3 recorded the highest concentration, while DSS6 recorded the lowest. The variation may reflect differences in organic matter content, microbial activity and local

soil characteristics. These values establish the baseline nitrogen status of the soil before implementation of the proposed LPG project.

4.12.19 Mercury

Mercury concentrations were recorded as 0.000 µg/kg at DSS1, DSS2 and DSS4- DSS9 (control), while DSS3 recorded 0.001 µg/kg. The control location DSS9 (control) also recorded 0.000 µg/kg. The results therefore indicate that mercury was generally not detected in the sampled soils, except for the very low concentration recorded at DSS3. The limited detection and low magnitude of the recorded value indicate a generally low baseline mercury presence in the soil. These results provide a useful reference for subsequent environmental monitoring because mercury contamination could arise from inappropriate handling or disposal of certain materials.

4.12.20 Cadmium

Cadmium concentrations ranged from 0.000 to 0.004 µg/kg. The highest concentration of 0.004 µg/kg was recorded at DSS4. DSS1 and DSS3 recorded 0.003 µg/kg each, DSS2 and DSS5 recorded 0.001 µg/kg each, while DSS6, DSS7 and DSS8 recorded 0.000 µg/kg. The control DSS9 recorded 0.002 µg/kg. The results indicate very low cadmium concentrations across the sampled soils, with DSS4 recording the highest value. The concentrations at most sampling points were close to or below the control value, while several locations recorded non-detectable concentrations. The results establish the baseline cadmium condition of the soil before project implementation.

4.12.21 Copper

Copper concentrations ranged from 0.18 to 0.37 mg/kg. The highest concentration of 0.37 mg/kg occurred at DSS3, while the lowest concentration of 0.18 mg/kg was recorded at DSS6. DSS1 recorded 0.23 mg/kg, DSS2 0.28 mg/kg, DSS4 0.30 mg/kg, DSS5 0.25 mg/kg, DSS7 0.36 mg/kg and DSS8 0.22 mg/kg. The control DSS9 recorded 0.35 mg/kg. The results indicate moderate spatial variation in soil copper concentration. DSS3 and DSS7 recorded comparatively higher concentrations, while DSS6 recorded the lowest. The baseline values provide a reference for evaluating possible changes in soil copper concentrations resulting from construction activities, equipment use and waste management associated with the proposed LPG station.

4.12.22 Lead

Lead concentrations were recorded as 0.000 µg/kg at all nine sampling locations, including the control. The uniform result indicates that lead was not detected in any of the assessed soil

samples during the baseline study. The absence of detectable lead provides a favourable baseline condition with respect to this heavy metal. This condition should be maintained through appropriate management of construction materials, wastes, machinery, batteries, paints and other potential sources of lead contamination during the construction and operational phases of the proposed LPG station.

4.12.23 Nickel

Nickel concentrations ranged from 0.001 to 0.036 mg/kg. The highest concentration of 0.036 mg/kg was recorded at DSS3, while the lowest value of 0.001 mg/kg occurred at DSS6. DSS1 recorded 0.023 mg/kg, DSS2 0.027 mg/kg, DSS4 0.027 mg/kg, DSS5 0.032 mg/kg, DSS7 0.026 mg/kg and DSS8 0.018 mg/kg. The control DSS9 recorded 0.025 mg/kg. The results indicate relatively low but spatially variable nickel concentrations. DSS3 recorded the highest value, while DSS6 showed the lowest. The measured concentrations provide baseline information on nickel distribution within the project environment and will be useful for detecting future changes associated with project activities.

4.12.24 Cobalt

Cobalt concentrations ranged from 0.022 to 0.062 mg/kg. The highest concentration of 0.062 mg/kg was recorded at DSS3, while the lowest value of 0.022 mg/kg occurred at DSS6 and DSS8. DSS1 recorded 0.048 mg/kg, DSS2 0.053 mg/kg, DSS4 0.054 mg/kg, DSS5 0.061 mg/kg and DSS7 0.051 mg/kg. The control DSS9 recorded 0.023 mg/kg. The results demonstrate moderate spatial variation in cobalt concentrations. DSS3 and DSS5 recorded the highest values, while DSS6 and DSS8 recorded the lowest. Several project locations recorded higher concentrations than the control, indicating some spatial variation in the baseline distribution of cobalt.

4.12.25 Manganese

Manganese concentrations ranged from 0.06 to 0.47 mg/kg. The highest concentration of 0.47 mg/kg was recorded at DSS3, followed by 0.44 mg/kg at DSS1 and 0.41 mg/kg at DSS2. The lowest concentration of 0.06 mg/kg occurred at DSS8. DSS4 recorded 0.09 mg/kg, DSS5 0.21 mg/kg, DSS6 and DSS7 0.08 mg/kg each, while the control DSS9 recorded 0.16 mg/kg. The results show considerable spatial variation in manganese concentrations. The highest values occurred at DSS1-DSS3, whereas the lowest values occurred at DSS6-DSS8. The observed variation may reflect differences in soil mineral composition and local geochemical conditions. These results establish the baseline manganese status of the project environment.

4.12.26 Iron

Iron concentrations ranged from 0.05 to 0.26 mg/kg. The lowest concentration of 0.05 mg/kg was recorded at DSS8, while the highest value of 0.26 mg/kg occurred at DSS3. DSS1 recorded 0.12 mg/kg, DSS2 0.17 mg/kg, DSS4 0.22 mg/kg, DSS5 0.18 mg/kg, DSS6 0.23 mg/kg and DSS7 0.24 mg/kg. The control DSS9 recorded 0.01 mg/kg. All project sampling locations therefore recorded higher iron concentrations than the control. The results indicate spatial variation in iron concentration, with DSS3 showing the highest value and DSS8 the lowest. The higher concentrations relative to the control constitute an important baseline characteristic for subsequent assessment of potential changes in soil quality during project implementation.

4.12.27 Phenols

Phenol concentrations ranged from 0.000 to 0.025 mg/kg. The highest concentration of 0.025 mg/kg occurred at DSS3, followed by 0.006 mg/kg at DSS8 and 0.003 mg/kg at DSS7. DSS2 recorded 0.001 mg/kg, while DSS1, DSS4, DSS5 and DSS6 recorded 0.000 mg/kg. The control DSS9 recorded 0.002 mg/kg. The results indicate that phenols were generally absent or present at low concentrations in most sampling locations, although DSS3 recorded a comparatively higher concentration. The elevated value at DSS3 represents an important reference point observation because phenolic compounds may be associated with certain industrial and organic contamination processes. Appropriate control of wastes and chemical materials during the proposed LPG project will be important to prevent further increases.

4.12.28 Oil and Grease

Oil and grease concentrations were recorded as 0 mg/kg at all nine sampling locations, including the control. The uniform absence of detectable oil and grease indicates that the sampled soils did not show measurable contamination by these substances during the baseline assessment. This result is particularly important for the proposed LPG station because fuel handling, equipment maintenance and accidental spills could potentially introduce oily substances into the soil. The baseline condition should therefore be protected through appropriate spill prevention, secondary containment, equipment maintenance, waste management and prompt remediation of any accidental releases during construction and operation.

4.12.29 BTEX

BTEX concentrations were recorded as 0.0 mg/kg at all nine sampling locations. The uniform result indicates that benzene, toluene, ethylbenzene and xylene-related compounds were not

detected in the sampled soils during the baseline assessment. This is a particularly important baseline finding for the proposed LPG station because BTEX compounds are commonly associated with petroleum-related contamination. The absence of detectable BTEX suggests that the sampled soils did not exhibit measurable contamination by these compounds at the time of assessment. Effective hydrocarbon containment, spill prevention and routine environmental monitoring should be maintained throughout the project lifecycle to preserve this baseline condition.

4.12.30 Sandy Fraction

The sandy fraction of the soil ranged from 10% to 65%. The lowest percentage of sand was recorded at DSS1 (10%), while the highest value occurred at the control DSS9 (65%). Other sampling locations recorded 15% at DSS2, 23% at DSS3, 20% at DSS4, 30% at DSS5, 28% at DSS6, 12% at DSS7 and 31% at DSS8. The results indicate substantial spatial variation in the sandy fraction of the soil. The control exhibited a considerably higher proportion of sand than most project sampling locations. Differences in soil texture are important because they influence permeability, drainage, water retention and the potential movement of dissolved contaminants through the soil profile.

4.12.31 Loam Fraction

The loam fraction ranged from 21% to 65%. DSS1 recorded the highest value of 65%, while the control DSS9 recorded the lowest value of 21%. Other values were 35% at DSS2, 51% at DSS3, 55% at DSS4, 47% at DSS5, 62% at DSS6, 53% at DSS7 and 60% at DSS8. The results demonstrate substantial spatial variation in the loam component of the sampled soils. DSS1 and DSS6 recorded particularly high proportions of loam, whereas the control recorded the lowest. The variation in loam content may influence soil water retention, nutrient availability and the mobility of contaminants. The results therefore provide useful baseline information on soil texture within the proposed project area.

4.12.32 Clay Fraction

The clay fraction ranged from 8% to 50%. The highest clay content of 50% was recorded at DSS2, while the lowest value of 8% occurred at the control DSS9. Other values were 20% at DSS1, 15% at DSS3, 23% at DSS4, 18% at DSS5, 15% at DSS6, 17% at DSS7 and 20% at DSS8. The results indicate substantial variation in clay content among the sampling locations. DSS2 had a markedly higher clay fraction than the other locations, whereas the control showed the lowest.

Clay content is an important soil characteristic because it influences water retention, adsorption capacity, permeability and the movement of contaminants. The observed values therefore provide an important baseline for assessing potential contaminant mobility within the proposed LPG project area.

4.12.33 Silt Fraction

Silt content ranged from 0% to 19%. DSS2 recorded 0%, representing the lowest value, while DSS6 recorded the highest value of 19%. DSS1 recorded 5%, DSS3 11%, DSS4 2%, DSS5 5%, DSS7 18%, DSS8 9% and the control DSS9 recorded 6%. The results indicate substantial spatial variation in the silt fraction of the sampled soils. DSS6 and DSS7 showed relatively high silt contents, whereas DSS2 contained no detectable silt fraction according to the reported result. Variations in silt content can influence soil permeability, water retention, erosion susceptibility and contaminant transport. These results therefore establish the baseline textural characteristics of the soil within the project environment.

4.12.34 E. coli

E. coli counts ranged from 2 to 17 CFU/kg. The lowest count of 2 CFU/kg was recorded at DSS1, while the highest count of 17 CFU/kg occurred at DSS4. DSS2 recorded 9 CFU/kg, DSS3 4 CFU/kg, DSS5 7 CFU/kg, DSS6 4 CFU/kg, DSS7 3 CFU/kg and DSS8 5 CFU/kg. The control DSS9 recorded 1 CFU/kg. The results indicate that *E. coli* was detected at all sampling locations and that the project sampling points generally recorded higher counts than the control. DSS4 exhibited the highest count, while DSS1 recorded the lowest among the project locations. The spatial variation provides baseline information on the microbiological condition of the soil and may reflect differences in local organic inputs and environmental conditions.

4.12.35 Fungal Count

Fungal counts ranged from 68 to 277 CFU/kg. The highest fungal count of 277 CFU/kg was recorded at DSS3, followed by 243 CFU/kg at DSS1. DSS2 recorded 109 CFU/kg, DSS4 105 CFU/kg, DSS5 129 CFU/kg, DSS6 75 CFU/kg, DSS7 69 CFU/kg and DSS8 68 CFU/kg. The control DSS9 recorded 54 CFU/kg. The results demonstrate substantial spatial variation in fungal abundance across the sampling locations. DSS1 and DSS3 recorded the highest counts, whereas DSS8 recorded the lowest among the project locations. All project sampling points recorded fungal counts higher than the control. The observed variation provides baseline information on the biological characteristics of the soil and may reflect differences in organic matter, moisture and

other local environmental conditions.

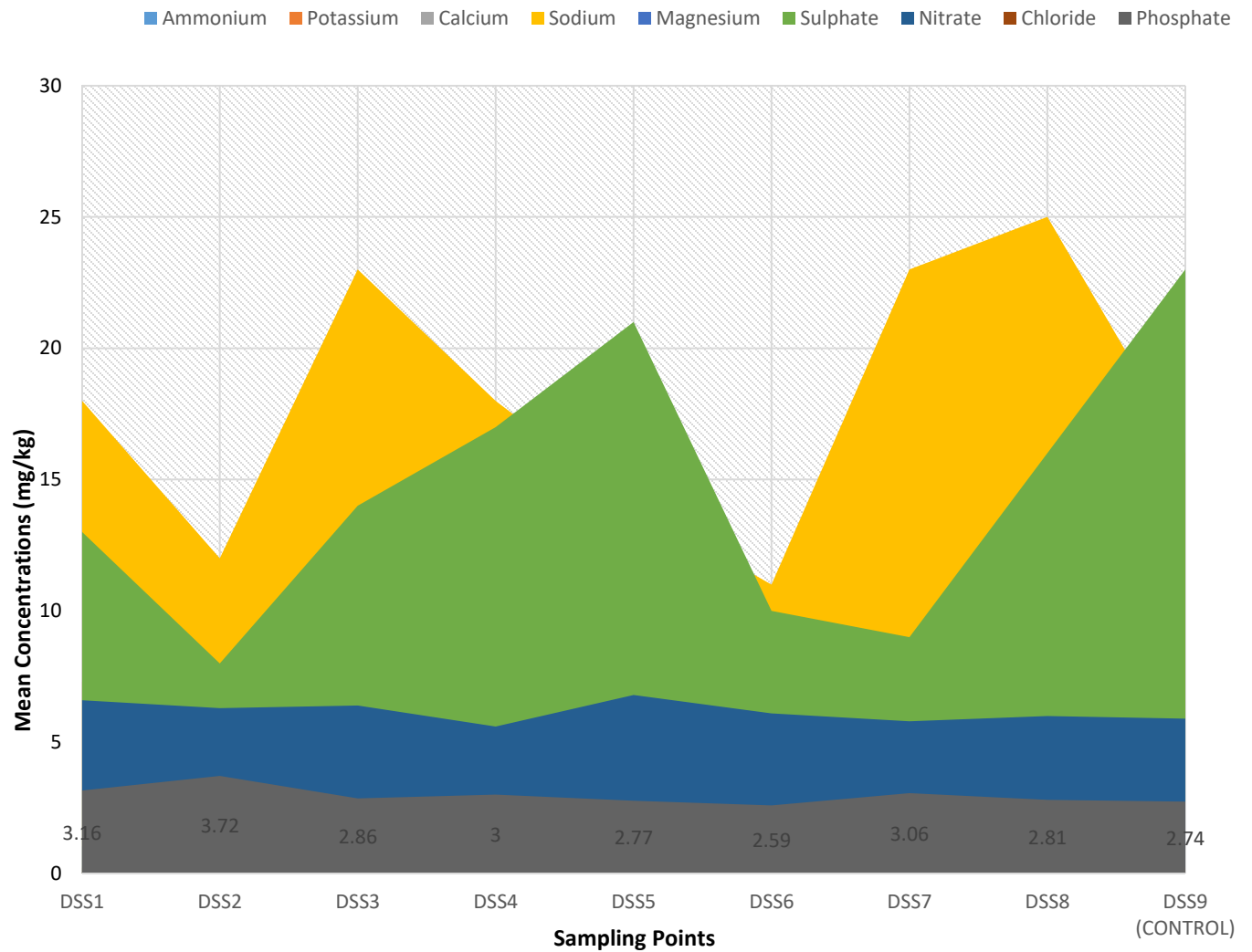


Figure 4.5: Mean Concentrations of Chemical Contents Detected in Soil Samples Collected from Different Sampling Points around the Proposed Project Site

4.13 SOCIOECONOMIC STUDIES AND STAKEHOLDER ENGAGEMENT

4.13.0 Introduction

This subsection presents the socioeconomic baseline and stakeholder engagement findings for the proposed Liquefied Petroleum Gas (LPG) plant by SHAKKATO NIGERIA LIMITED, located near Gida Dubu Community, Dutse Town, Dutse Local Government Area, Jigawa State, Nigeria. The study draws primarily from the KoboCollect household survey dataset comprising 95 households, supplemented by secondary literature and policy frameworks. The analysis aligns with the World Bank Environmental and Social Standards (*ESS1: Assessment and Management of Environmental and Social Risks and Impacts*, *ESS5: Land Acquisition, Restrictions on Land Use and Involuntary Resettlement*, *ESS7: Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities*, and *ESS10: Stakeholder Engagement and Information Disclosure*) and the Federal Ministry of Environment (FMEEnv) ESIA procedural guidelines (2011).

The socioeconomic assessment provides insights into demographic composition, social Organization, livelihood patterns, infrastructure access, cultural properties, land use, perceptions of the project, education levels, social vices and health indicators, and project impact assessment indicators. The findings inform the identification of potential social impacts and the design of mitigation and stakeholder engagement strategies to ensure inclusive, equitable, and sustainable project outcomes.

Methodological Note on the Socioeconomic Study

The socioeconomic study was conducted through structured household surveys using KoboCollect (capturing quantitative and qualitative data across ten thematic sections), complemented by key informant interviews and direct observations. The survey covered 95 households within 3 km radius of the proposed site, representing a statistically valid sample of the Gida Dubu community and adjacent settlements. Data analysis employed descriptive statistics and visualization tools to identify patterns and relationships relevant to project impact assessment and community engagement.

The analysis adheres to the World Bank ESS10 (Stakeholder Engagement and Information Disclosure), ensuring participatory processes and transparency. The findings also support compliance with ESS1 (Assessment and Management of Environmental and Social Risks and Impacts) and ESS5 (Land Acquisition, Restrictions on Land Use and Involuntary Resettlement),

though no resettlement or compensation is required for this project as the land was allocated by the state government. The study also aligns with the Federal Ministry of Environment's ESIA procedural guidelines (2011), ensuring that social dimensions are adequately integrated into environmental management planning.

Contextual Overview

The proposed LPG plant occupies approximately 2,531 m², officially allocated by the Jigawa State Government. The site is devoid of vegetation and residential structures, with a petrol station adjacent, and an Eid prayer ground located about 40 metres away, across Madobi Road. The proximity of a growing university community and a new housing estate within 1 km suggests potential socioeconomic benefits in the near future through increased LPG demand and employment opportunities.

Data Reliability and Limitations

- ▶ The dataset is complete and verified for consistency.
- ▶ Minor gaps in qualitative responses were addressed through triangulation with secondary sources (e.g., NBS 2023 Demographic Report).
- ▶ The analysis is limited to the surveyed households and does not extrapolate beyond the Gida Dubu Community of Dutse Town.

Analytical Framework

The analysis follows the Pressure–State–Response (PSR) model, linking socioeconomic conditions (state) to potential project-induced pressures and community response mechanisms. This framework supports the identification of vulnerable groups, livelihood dependencies, and social infrastructure needs, forming the basis for mitigation and stakeholder engagement strategies.

Compliance and Relevance

This subsection contributes to the ESIA's compliance with:

- ▶ **World Bank ESS1, ESS5, ESS7, and ESS10;**
- ▶ **Nigeria's Environmental Impact Assessment Act (Cap E12, LFN 2004);**
- ▶ **Federal Ministry of Environment ESIA Procedural Guidelines (2011).**

The socioeconomic baseline thus provides a foundation for assessing potential impacts on livelihoods, safety, cultural heritage, and community well-being, while guiding stakeholder engagement and mitigation planning. It ensures that social considerations are integrated into project planning, particularly regarding land use, community health, employment opportunities, and information disclosure.

4.13.1 – Demography

Overview

This section presents the demographic characteristics of the 95 surveyed households within the Gida Dubu Community and surrounding areas of Dutse Local Government Area, Jigawa State. The data were obtained from the KoboCollect household survey and analyzed to understand population structure, household composition, gender distribution, and spatial proximity to the proposed LPG plant site.

The demographic profile provides a foundation for assessing potential social impacts and designing inclusive stakeholder engagement strategies in line with World Bank ESS1 (Assessment and Management of Environmental and Social Risks and Impacts) and ESS10 (Stakeholder Engagement and Information Disclosure).

4.13.1.1 – Population and Household Composition

The survey recorded a total of 95 households, with an average household size of 9 persons. Across households, the average number of males per household was 5 and the average number of females was 4. Household sizes ranged from a minimum of 1 person to a maximum of 25 persons. The largest number of males observed in any single household was 15 and the largest number of females observed in any single household was 12; these maxima were recorded in different households. The minimum count for both males and females was 0.

The majority of respondents were heads of households (72.6%), followed by children (11.6%), siblings or others (9.55%), and spouses (6.3%). Table 4.13.1 below summarizes the household composition.

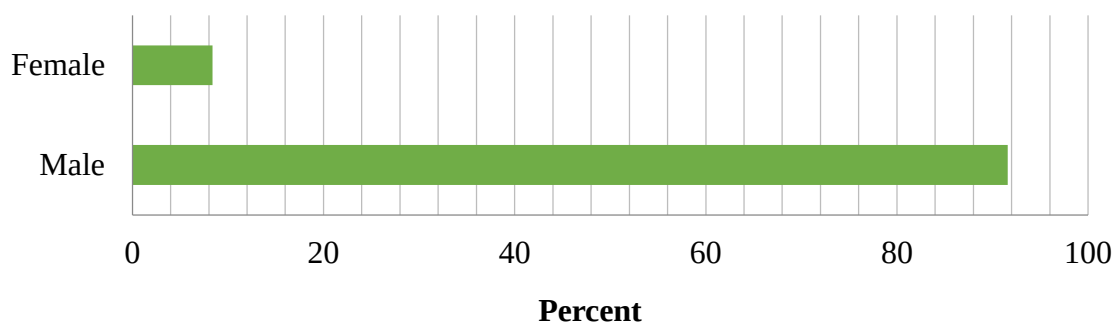
Table 4.13.1 Demographic Composition of Surveyed Households

Relationship to Head of Household	Frequency	Percentage (%)
Head of household	69	72.6
Child (son/daughter)	11	11.6
Spouse	6	6.3
Sibling/Other	9	9.5
Total	95	100

Source: KoboCollect Household Survey (2026)

4.13.1.2 – Gender Distribution of Household Heads

Gender analysis indicates a male-dominated household headship, consistent with regional norms in northern Nigeria. Close to 92% of household heads were male, while over 8% were female. Figure 4.13.2 below illustrates the gender composition of household heads.

**Figure 4.13.1** Gender Distribution of Household heads

Source: KoboCollect Household Survey (2026)

This gender imbalance reflects traditional patriarchal structures prevalent in Jigawa State, as documented by the National Bureau of Statistics (NBS, 2023) and UNDP Nigeria (2022), which note that male household heads predominate in rural northern communities.

4.13.1.3 – Implications of the Observed Household Composition and Gender Distribution

The demographic characteristics described above, notably the large average household size of

nine persons and the predominance of male-headed households, reflect a community with extended family structures and potentially high dependency ratios. These attributes have important implications for the socioeconomic dimensions of the proposed LPG project. In accordance with ESS1, the demographic profile underscores the need to assess differentiated impacts across household types, ensuring that project benefits and potential adverse effects are equitably distributed. Larger households may derive substantial welfare gains from improved access to cleaner energy sources, including reduced reliance on biomass fuels, lower health risks associated with indoor air pollution, and enhanced economic efficiency. However, variations in household income and gender roles may influence affordability and adoption rates, necessitating targeted mitigation and support measures.

Consistent with ESS10 and the FMEEnv ESIA Procedural Guidelines (2011), stakeholder engagement should be inclusive, participatory, and culturally appropriate. The predominance of male household heads among respondents highlights the importance of deliberate strategies to engage women, youth, and other vulnerable groups who may be underrepresented in formal consultation processes. Women, as primary users of domestic energy, should be actively involved in awareness programs, capacity-building initiatives, and decision-making forums to ensure that their perspectives inform project design and implementation.

Furthermore, engagement activities should be structured to promote transparency, mutual trust, and social cohesion within the affected community. This includes the establishment of grievance redress mechanisms, continuous information disclosure, and feedback loops that enable adaptive management of social risks. By integrating these principles, the project can enhance its social sustainability, strengthen local ownership, and contribute to inclusive socioeconomic development in line with both national and international environmental and social safeguards.

4.13.1.4 – Age Distribution and Socioeconomic Implications

The age distribution among household heads and the general population indicates a predominantly youthful demographic profile. As illustrated in Figure 4.13.2, approximately 75% of the total population is below 25 years of age, comprising about 40% under 15 years and roughly 35% between 15 and 24 years. Similarly, Figure 4.13.3 shows that among the 95 household heads surveyed, over 33% are below 35 years, 51% fall within the 35–54-year age bracket, and only about 15% are above 54 years.

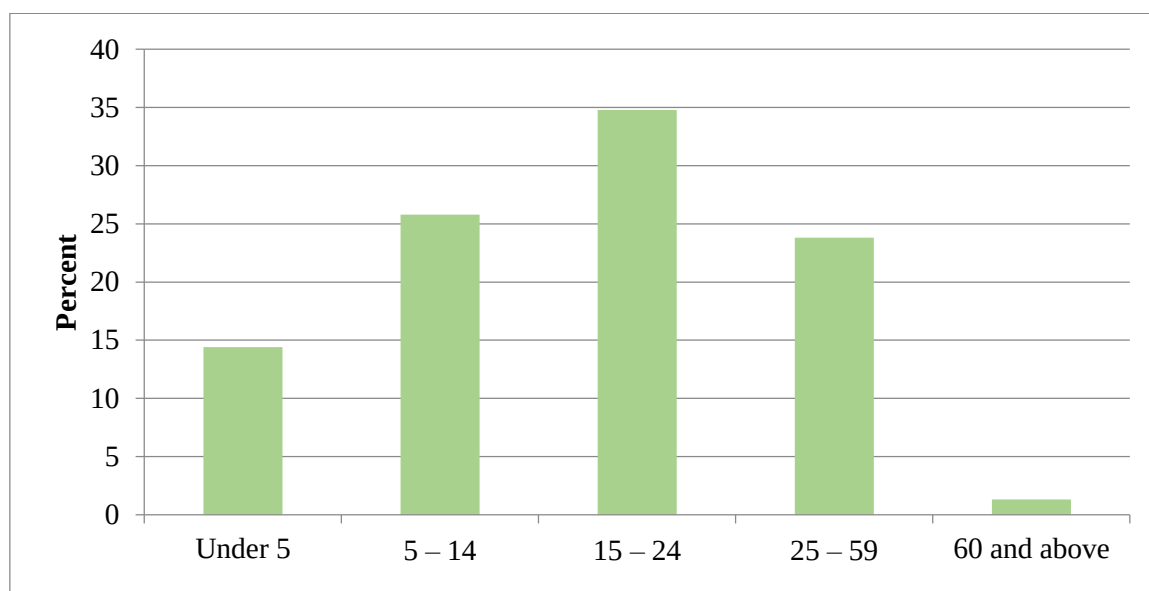


Figure 4.13.2 Age Distribution of the Population (all Household Members)

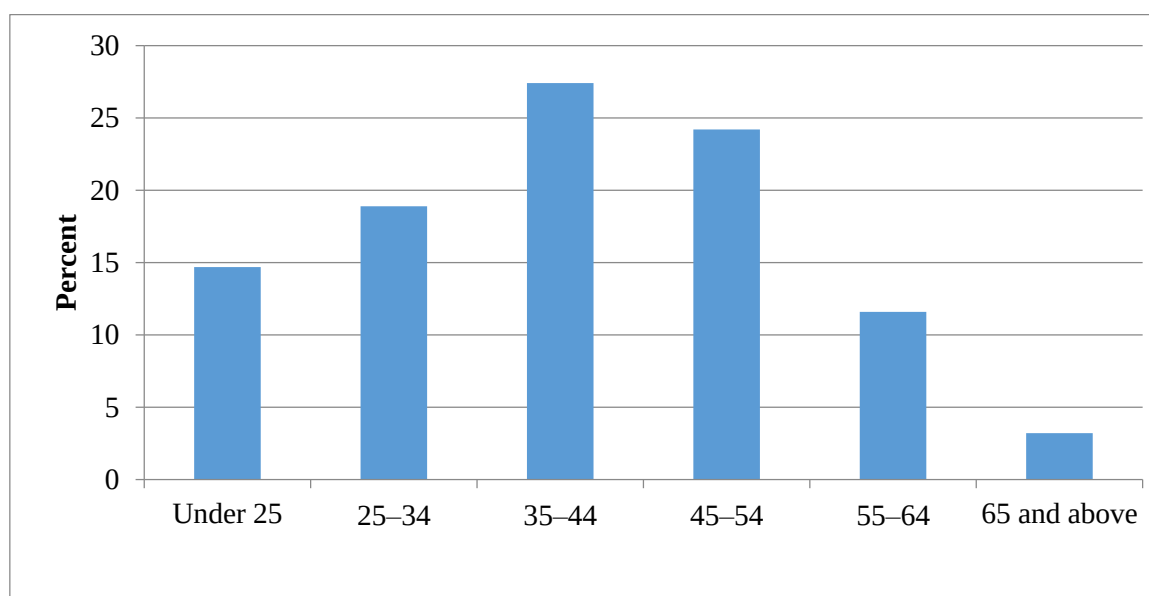


Figure 4.13.3 Age Distribution of Heads of Households

Source: KoboCollect Household Survey (2026)

4.13.1.4.1 Socioeconomic Implications of the Age Distribution

This demographic pattern reflects a high potential labour force and aligns with Nigeria’s national youth demographic profile (NBS, 2023). In accordance with ESS1 (Assessment and Management

of Environmental and Social Risks and Impacts) and ESS10 (Stakeholder Engagement and Information Disclosure), the youthful population presents both opportunities and challenges for the proposed LPG project. On one hand, it offers a substantial pool of labour that can be harnessed for project-related employment and capacity-building initiatives. On the other hand, it underscores the need for targeted stakeholder engagement strategies that address youth aspirations, skills development, and equitable participation in project benefits.

Integrating youth-focused engagement and livelihood enhancement measures into the project's social management plan will contribute to inclusive development, strengthen community support, and align with the FMEEnv ESIA Procedural Guidelines (2011), which emphasize participatory approaches and socioeconomic sustainability.

Youth Empowerment, Skills Development, and Local Enterprise Opportunities

Given the youthful demographic structure, the project should incorporate social investment programs aimed at enhancing employability and entrepreneurship within the affected community. In line with ESS2 (Labour and Working Conditions) and ESS5 (Land Acquisition, Restrictions on Land Use and Involuntary Resettlement), the project proponent should prioritize local recruitment and provide vocational training in areas such as LPG handling, safety management, equipment maintenance, and small-scale energy retailing.

Furthermore, collaboration with local institutions and community-based organizations can facilitate the establishment of micro-enterprises and cooperatives that support LPG distribution, cylinder maintenance, and ancillary services. Such initiatives will not only promote sustainable livelihoods but also foster long-term community resilience and economic inclusion.

By integrating these measures into the project's Community Development Action Plan (CDAP) and Stakeholder Engagement Plan (SEP), the proponent can ensure that the LPG project contributes meaningfully to local socioeconomic advancement, aligns with national development priorities, and fulfills both World Bank ESS and FMEEnv requirements for socially responsible project implementation.

Linking Findings to the Project's Monitoring and Evaluation Framework

To ensure sustained positive outcomes, the project's Monitoring and Evaluation (M&E) Framework should incorporate measurable indicators for youth participation, skills acquisition, and livelihood improvement. Periodic social audits and participatory monitoring will help track progress, identify emerging challenges, and enable adaptive management of social interventions. This approach will reinforce compliance with FMEEnv post-impact assessment provisions and the World Bank

ESS1 requirement for continuous stakeholder engagement and performance monitoring, thereby ensuring that the LPG project delivers equitable and lasting socioeconomic benefits to the affected community.

4.13.1.5 – Spatial Distribution and Proximity to Project Site

All surveyed households are located within 0.1–2.0 km radius of the project site. The spatial distribution is summarized in Table 4.13.2.

Table 4.13.2 Spatial Distribution of Surveyed Households

Distance from Project Site (km)	Number of Households	Percentage (%)
0.1 – 1.0	42	44.2
1.1 – 2.0	53	55.8
Total	95	100

Source: KoboCollect Household Survey (2026)

This proximity indicates that the community is within the zone of influence for potential environmental and social impacts such as noise, traffic, and safety risks. However, the absence of residential buildings within 500 metres of the site mitigates direct exposure risks.

4.13.1.6 – Ethnic and Religious Composition

The population is predominantly **Hausa (91%)**, followed by Fulani (7%) and others (2%). Religion is overwhelmingly Islam (98%), with a small minority identifying as Christian (2%).

This homogeneity supports cohesive community engagement but requires sensitivity to Islamic cultural practices, particularly given the proximity of the Eid prayer ground (approximately 40 metres away).

4.13.1.6 – Summary of Demographic Implications for Project Design

- **Labour Force Availability:** The youthful demographic offers a ready pool of labour for construction and operations.

- ▶ **Gender Considerations:** Female participation in project benefits should be actively promoted through inclusive employment and training programmes, in line with ESS2 and SDG 5 (Gender Equality).
- ▶ **Cultural Sensitivity:** Engagement activities should respect religious observances and avoid disruptions near the Eid prayer ground.
- ▶ **Community Safety:** Given proximity to the petrol station and university community, safety awareness campaigns will be essential.

4.13.2 – Social Structure and Organization

Overview

This section analyses the social structure and organization of the Gida Dubu Community and surrounding settlements based on the KoboCollect household survey of 95 households. The findings provide insight into community leadership, social cohesion, decision-making processes, and the role of traditional institutions. These aspects are critical for understanding how the proposed SHAKKATO Nigeria Limited LPG Plant may interact with local governance systems and social networks.

The analysis aligns with World Bank ESS7 (Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities) and ESS10 (Stakeholder Engagement and Information Disclosure), which emphasize culturally appropriate engagement and respect for traditional authority structures.

4.13.2.1 – Community Leadership and Governance

The community operates under a traditional leadership system headed by the Village Head (Mai Unguwa), supported by elders and religious leaders. Approximately 97% of respondents acknowledged the Village Head as the primary authority in community matters, while 3.2% cited religious leaders. Table 4.13.3 summarizes the recognized leadership structures:

This hierarchical structure facilitates community mobilization and conflict resolution. Engagement with these leaders will be essential for project acceptance and grievance redress mechanisms, consistent with FMEnv ESIA Guidelines (2011).

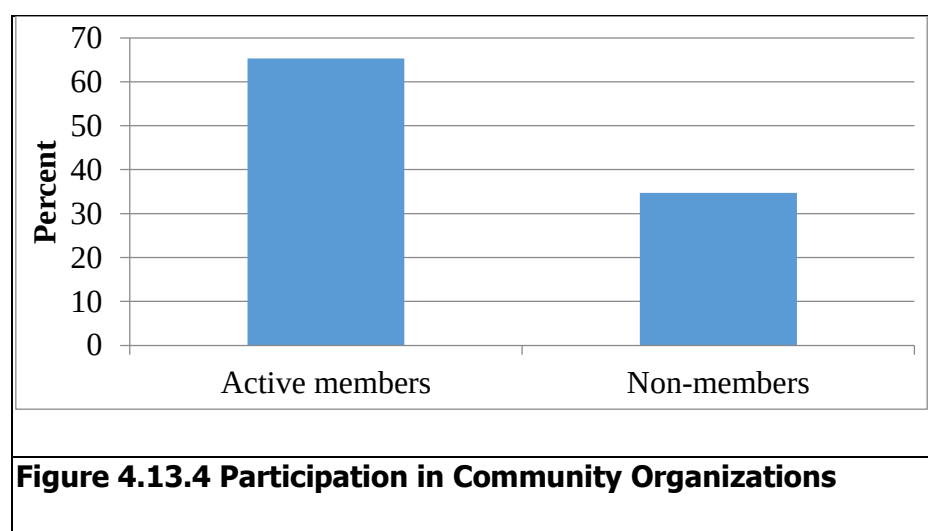
Table 4.13.3 Recognized Leadership Structures

Leadership Type	Frequency	Percentage (%)
Village Head / Mai Unguwa	92	96.8
Religious Leaders (Imams)	3	3.2
Total	95	100

Source: KoboCollect Household Survey (2026)

4.13.2.2 – Social Cohesion and Community Networks

The survey revealed strong social cohesion, with 62% of households participating in community meetings or cooperative groups. These groups include farmers’ cooperatives, women’s groups, youths’ associations, and religious committees. Figure 4.13.4 illustrates participation in community organizations:



Source: KoboCollect Household Survey (2026)

High participation rates indicate a socially integrated community capable of collective decision-making. This cohesion can be leveraged for effective stakeholder engagement and dissemination of project information.

4.13.2.3 – Gender Roles and Social Organization

Gender roles remain traditional, with men primarily responsible for decision-making and income generation, while women manage household welfare and petty trading. Sixty-eight percent of

respondents reported that men dominate community leadership, while 32% noted increasing female participation in savings groups and religious education.

This evolving dynamic suggests opportunities for gender-inclusive engagement strategies, in line with ESS2 (Labour and Working Conditions) and SDG 5 (Gender Equality).

4.13.2.4 – Conflict Resolution Mechanisms

Dispute resolution is largely informal, handled through the Village Head and religious leaders. Seventy-four percent of respondents indicated that conflicts are resolved through dialogue and mediation, 18% through family elders, and 8% through local government authorities. Table 4.13.4 summarizes conflict resolution channels:

Table 4.13.4 Conflict Resolution Channels

Conflict Resolution Mechanism	Frequency	Percentage (%)
Village Head / Elders	70	73.7
Religious Leaders	17	17.9
Local Government	8	8.4
Total	95	100

Source: KoboCollect Household Survey (2026)

This reliance on traditional systems underscores the need for culturally sensitive grievance redress procedures during project implementation.

4.13.2.5 – Social Capital and Mutual Support

The community demonstrates high levels of mutual support, with 82% of households reporting assistance from neighbors during illness, ceremonies, or emergencies. This social capital enhances resilience and can facilitate community-based monitoring of project impacts.

4.13.2.6 – Implications of Social Structure and Organization for Project Implementation

- ▶ **Engagement Strategy:** Consultation should prioritize traditional and religious leaders to ensure legitimacy and trust.
- ▶ **Gender Inclusion:** Women’s groups should be integrated into awareness campaigns and livelihood support programmes.
- ▶ **Conflict Sensitivity:** Project grievance mechanisms should complement existing informal systems.
- ▶ **Community Mobilization:** Cooperative networks can serve as channels for information dissemination and training on LPG safety.

4.13.3 – Livelihoods

Overview

This section presents the livelihood patterns and economic activities of the 95 surveyed households near Gida Dubu Community, Dutse Local Government Area, Jigawa State. The data were extracted from the KoboCollect household survey and analyzed to understand income sources, employment types, and economic dependency.

Livelihood analysis is essential for assessing potential socioeconomic impacts of the proposed SHAKKATO Nigeria Limited LPG Plant, particularly regarding employment generation, market stimulation, and resource utilization. The findings are interpreted in line with World Bank ESS1 (Assessment and Management of Environmental and Social Risks and Impacts) and ESS2 (Labour and Working Conditions), as well as the FMEnv ESIA Guidelines (2011).

4.13.3.1 – Primary Sources of Livelihood

The data indicates a predominantly non-agricultural livelihood structure within Gida Dubu Community. A significant proportion of respondents (38.9%) fall under the “others” category—mainly students and dependents—suggesting a youthful or economically inactive population segment. Civil service and formal employment (26.3%) represent the largest active income source, reflecting moderate integration into the urban economy of Dutse. Petty trading (21.1%) provides a vital informal livelihood, while crop farming (9.5%) and transport services (3.2%) play minor roles. Livestock rearing (1.1%) is negligible, implying limited engagement in traditional

rural economic activities. Table 4.13.5 summarizes the primary livelihood sources among respondents:

Table 4.13.5 Primary Livelihood Sources Among Respondents

Livelihood Source	Frequency	Percentage (%)
Others (students, dependents)	37	38.9
Civil service / formal employment	25	26.3
Petty trading	20	21.1
Crop farming	9	9.5
Transport services	3	3.2
Livestock rearing	1	1.1
Total	95	100

Source: KoboCollect Household Survey (2026)

4.13.3.2 – Secondary Income Activities

Secondary income sources include civil service / formal employment, crop farming, transport services, and livestock rearing (goats, poultry), reported by nearly 38% of households. This diversification enhances resilience against economic shocks and seasonal variations.

4.13.3.3 – Implications of the Livelihood Structure for Stakeholder Engagement

In line with the World Bank ESS10 and FMEEnv ESIA procedural guidelines (2011), stakeholder engagement should recognize the community's mixed socioeconomic composition and varying levels of economic vulnerability.

- ▶ **Youth and dependents:** Engagement strategies should include awareness and capacity-building programmes to enhance employability and participation in project benefits.
- ▶ **Civil servants and traders:** These groups may have stronger voices and expectations regarding compensation, local procurement, and employment opportunities; transparent communication will be essential.

- ▶ **Farmers and transport operators:** Although smaller in number, they may be disproportionately affected by access restrictions; targeted livelihood restoration measures should be prioritized.
- ▶ **Overall approach:** Inclusive consultation, equitable benefit-sharing, and social investment in education and skills development will help mitigate potential socioeconomic disparities and foster community support for the LPG project.

4.13.3.4 – Employment Status and Labour Availability

Employment data show that almost 35% of respondents are self-employed, over 26% are wage earners, and roughly 39% are unemployed or dependents. The relatively high self-employment rate reflects informal economic structures typical of semi-urban communities in northern Nigeria.

This labour profile suggests potential for local recruitment during the LPG plant's construction and operation phases, aligning with ESS2 provisions for community employment and skill development.

4.13.3.5 – Income Levels and Economic Vulnerability

The income distribution near Gida Dubu Community indicates a moderately balanced socioeconomic structure, with the majority of households earning between ₦70,001 and ₦210,000 (51.6%). A smaller proportion (7.4%) falls below ₦70,000, suggesting limited extreme poverty, while nearly one-fifth (18.9%) earn above ₦280,000, reflecting a modest presence of higher-income households. Table 4.13.6 summarizes income distribution. From an Environmental and Social Standards (ESS) perspective, this pattern implies that the LPG project could have differentiated socioeconomic impacts. Households in the lower income brackets may be more vulnerable to potential livelihood disruptions or inflationary pressures during project implementation. Therefore, stakeholder engagement should prioritize inclusive consultation, ensuring that vulnerable groups are adequately represented and benefit from project-related opportunities such as, capacity building, employment and small business opportunities, particularly in LPG retailing and maintenance services. In line with FMEnv ESIA procedural guidelines (2011), engagement strategies should emphasize transparency, participatory dialogue, and equitable benefit-sharing. Tailored communication and livelihood support mechanisms will be essential to mitigate income-related disparities and foster community acceptance and social sustainability.

Table 4.13.6 Monthly Income Distribution

Income Range (₦)	Number of Households	Percentage (%)
<70000	7	7.4
70001 – 140000	23	24.2
140001 - 210000	26	27.4
210000 - 280000	21	22.1
>280000	18	18.9
Total	95	100

Source: KoboCollect Household Survey (2026)

4.13.3.6 – Potential Project Impacts on Livelihoods

Positive Impacts:

- ▶ Job creation during construction and operation phases.
- ▶ Increased demand for goods and services (food, transport, retail).
- ▶ Opportunities for LPG distribution and maintenance enterprises.

Negative Impacts:

- ▶ Temporary disruption of roadside petty trading during construction.
- ▶ Increased traffic congestion affecting local transport operators.

Mitigation Measures:

- ▶ Prioritize local hiring and skill training.
- ▶ Support women traders through microcredit and LPG retail partnerships.
- ▶ Implement traffic management and safety awareness programmes.

4.13.4 – Social Infrastructure

Overview

This section analyses the availability and accessibility of social infrastructure within the Gida Dubu Community and its environs, based on the KoboCollect household survey of 95 households. The assessment covers water supply, electricity, healthcare, education, transportation, and communication facilities.

Social infrastructure is a key determinant of community well-being and resilience. Understanding its baseline condition helps anticipate potential project impacts and identify opportunities for improvement in line with World Bank ESS4 (Community Health and Safety) and ESS8 (Cultural Heritage), as well as the Federal Ministry of Environment ESIA Guidelines (2011).

4.13.4.1 – Water Supply

The data indicate that boreholes are the dominant household water source (82.1%), followed by wells (10.5%), taps (6.3%), and rivers or streams (1.1%). This distribution suggests that the Gida Dubu community relies primarily on groundwater-based systems, reflecting moderate infrastructure development and limited access to piped water. Table 4.13.7 summarizes household water sources.

From an Environmental and Social Standards (ESS) perspective, particularly ESS1 (Assessment and Management of Environmental and Social Risks and Impacts) and ESS4 (Community Health and Safety), the prevalence of boreholes implies that the LPG project should ensure no contamination or depletion of groundwater resources during construction and operation. Continuous monitoring of water quality and pressure levels would be prudent to maintain community trust and safeguard health outcomes.

In line with FMEEnv ESIA procedural guidelines (2011), stakeholder engagement should emphasize transparent communication about potential risks to water sources, even if minimal. Given the absence of residential buildings within 500 metres and no vegetation clearance or land compensation issues, engagement can focus on information disclosure, grievance redress mechanisms, and community awareness regarding emergency preparedness and environmental management.

Table 4.13.7 Household Water Sources

Water Source	Frequency	Percentage (%)
Borehole	78	82.1
Well	10	10.5
Tap	6	6.3
River/stream	1	1.1
Total	95	100

Source: KoboCollect Household Survey (2026)

Overall, the socioeconomic impact is expected to be low to moderate, with the main consideration being safeguarding existing water infrastructure and maintaining inclusive dialogue with local stakeholders to reinforce social license and compliance with both national and World Bank standards.

4.13.4.2 – Electricity Supply

The table shows that electricity access is nearly universal (97.9%), with a negligible proportion relying on solar (1.1%) or having no access (1.1%). However, only 28.4% of households receive seven hours or more of daily supply, indicating intermittent grid reliability. Table 4.13.8 illustrates electricity access patterns.

Frequent power outages may affect the LPG plant's operational efficiency and community perception. The project's design should include backup power systems and explore renewable energy integration.

Moreover, under World Bank ESS1 and ESS4, this pattern suggests that while the community is broadly connected, power stability may constrain local economic activity and influence perceptions of project benefits. The LPG project could therefore be viewed as a potential contributor to energy diversification and resilience, provided operations do not exacerbate existing supply challenges.

Table 4.13.8 Electricity Access Patterns

Status	Frequency	Percent
Connected to grid	93	97.9
Uses solar	1	1.1
Receives approx. 7 hours of supply (community average) or more	27	28.4
No access	1	1.1

Source: KoboCollect Household Survey (2026)

In line with FMEnv ESIA procedural guidelines (2011), stakeholder engagement should highlight energy efficiency, safety, and community benefit-sharing, ensuring inclusive dialogue with residents and local authorities. Given the absence of residential structures within 500 metres and no land or vegetation clearance, engagement can focus on information dissemination, employment opportunities, and capacity-building initiatives that align with local development priorities and reinforce social acceptance of the project.

4.13.4.3 – Healthcare Facilities

The data show that 32.6% of households are within 21–30 minutes' walking distance of a health facility, while 33.6% are either closer (0–20 minutes) or farther than 30 minutes. This indicates moderate physical accessibility to healthcare, with a notable proportion (16.8%) walking over 40 minutes, suggesting potential barriers for vulnerable groups such as the elderly or pregnant women. Table 4.13.9 summarizes distance to nearest health facility.

Under World Bank ESS4 (Community Health and Safety), this pattern highlights the need for the LPG project to maintain safe operational practices and ensure emergency response coordination with nearby health facilities. The moderate access levels imply that any health-related incident could face delayed medical intervention, warranting on-site first aid and safety training for workers.

Consistent with FMEnv ESIA procedural guidelines (2011), stakeholder engagement should include consultation with local health authorities and community sensitization on safety, emergency preparedness, and potential health risks. Given the absence of residential buildings

within 500 metres and no land or vegetation clearance, engagement efforts can focus on risk communication and capacity-building to strengthen community resilience and trust in the project's environmental and social management framework.

Table 4.13.9 Distance to Nearest Health Facility (walking minutes)

Distance	Frequency	Percentage (%)
0 – 10	7	7.4
11 – 20	25	26.3
21 – 30	31	32.6
31 – 40	16	16.8
>40	16	16.8
Total	95	100

Source: KoboCollect Household Survey (2026)

4.13.4.4 – Educational Facilities

The data show that 50.5% of households are within 10 minutes' walk of a primary school, while only 8.4% are more than 25 minutes away. This indicates good physical access to basic education, supporting community development and reducing potential social vulnerability. Table 4.13.10 summarizes distance to nearest primary school.

School attendance patterns reveal higher participation among boys, with 25.3% of girls not attending school compared to 7.4% of boys. This gender disparity suggests persistent sociocultural or economic barriers affecting girls' education. Figure 4.13.5 illustrates school attendance patterns for boys and girls.

Under World Bank ESS2 (Labour and Working Conditions) and ESS10 (Stakeholder Engagement and Information Disclosure), the LPG project should promote inclusive employment and training opportunities, ensuring gender equity and supporting local educational aspirations. Engagement strategies should include consultation with education authorities and community leaders to

explore corporate social responsibility initiatives, such as scholarships or awareness programmes encouraging girls' education.

Consistent with FMEv ESIA procedural guidelines (2011), stakeholder engagement should remain transparent and participatory, focusing on social inclusion, youth empowerment, and capacity-building. Given the absence of residential buildings within 500 metres and no land or vegetation clearance, the project's socioeconomic footprint is expected to be low, with opportunities to enhance community welfare through education-linked interventions.

Table 4.13.10 Distance to Nearest Primary School (walking minutes)

Distance	Frequency	Percentage (%)
0 - 5	15	15.8
6 - 10	33	34.7
11 - 15	11	11.6
16 - 20	9	9.5
21 - 25	19	20
>25	8	8.4
Total	95	100

Source: KoboCollect Household Survey (2026)

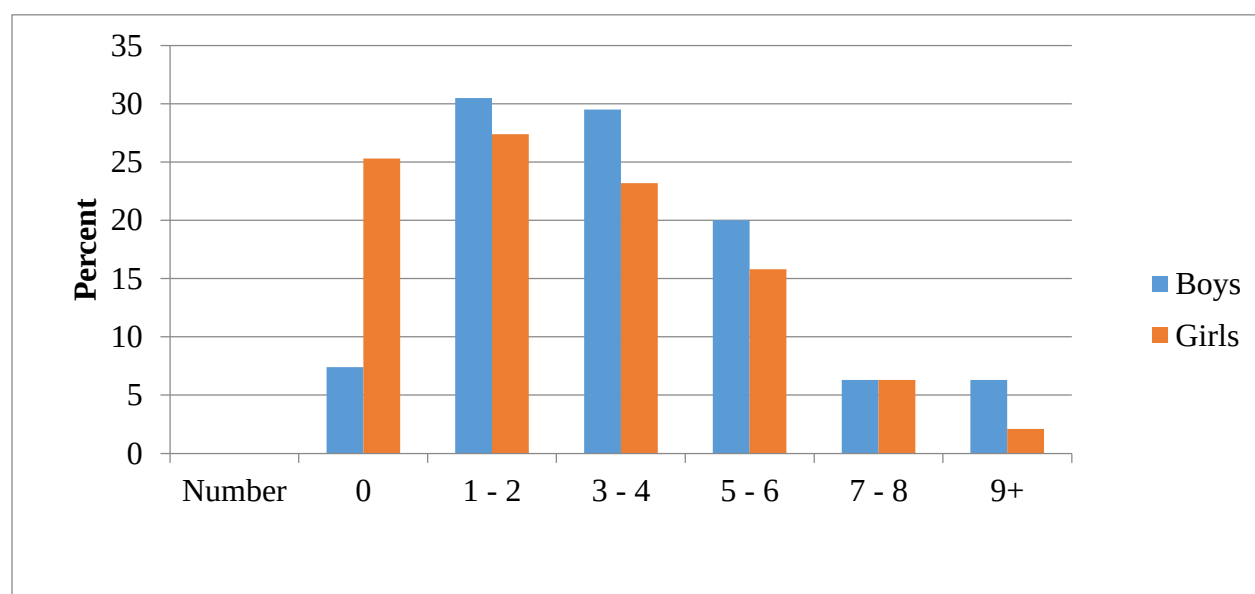


Figure 4.13.5 School Attendance Patterns

Source: KoboCollect Household Survey (2026)

4.13.4.5 – Transportation and Road Network

The community is accessible via Madobi Road, a paved route connecting to Dutse town. 73% of respondents rated road conditions as “good,” while 27% described them as “fair.” No households reported poor access.

This infrastructure supports efficient logistics for LPG distribution and emergency response, though traffic management will be essential during construction.

4.13.4.6 – Communication and Information Access

Mobile network coverage is universal, with 100% of households owning at least one mobile phone. Sixty-two percent use smartphones, enabling digital communication and potential integration of mobile-based stakeholder engagement tools.

4.13.4.7 – Waste Management and Sanitation

Sanitation facilities are basic. Sixty-seven percent of households use pit latrines, 21% have water closets, and 12% practice open defecation. Waste disposal is mainly through open dumping (58%) or community collection (42%).

Improved waste management practices could be supported through corporate social responsibility (CSR) initiatives aligned with ESS4 and SDG 6 (Clean Water and Sanitation).

4.13.4.8 – Social Infrastructure Implications for the Project

► Positive Opportunities:

- Strengthen local water and sanitation systems through CSR partnerships.
- Support health and safety training at nearby schools and clinics.
- Enhance community resilience through improved power reliability and waste management.

► Potential Risks:

- Pressure on existing infrastructure due to increased population and traffic.
- Safety concerns near the petrol station and prayer ground.

► Mitigation Measures:

- Coordinate with local authorities to manage traffic and waste.

- Implement community health and safety awareness campaigns.
- Establish emergency response protocols in collaboration with health centres.

4.13.5 – Cultural Properties

Overview

This section examines the cultural properties and heritage features within and around the **Gida Dubu Community**, Dutse Local Government Area, Jigawa State, based on the KoboCollect household survey and field observations. The analysis identifies tangible and intangible cultural assets, their spatial relationship to the proposed SHAKKATO Nigeria Limited LPG Plant, and potential project implications.

The assessment aligns with World Bank ESS8 (Cultural Heritage) and the Federal Ministry of Environment ESIA Guidelines (2011), which require identification and protection of cultural properties potentially affected by development projects.

4.13.5.1 – Identified Cultural Properties

The survey and reconnaissance confirmed one major cultural property within the project's area of influence:

Cultural Property	Description	Location	Distance from Project Site	Significance
Eid Prayer Ground	Open field used for annual Eid prayers and community gatherings	Across Madobi Road, Opposite main gate of Federal University, Dutse	Approximately 40 metres	High religious and social significance

Source: KoboCollect Household Survey (2026)

No shrines, cemeteries, or sacred groves were identified within the 500-metre radius of the project site. The Eid prayer ground represents the only sensitive cultural feature requiring consideration in project design and operations.

4.13.5.2 – Religious Institutions and Practices

The community is predominantly Muslim (98%), with Islamic religious institutions—mosques and Qur’anic schools—serving as focal points for social and spiritual life. Two mosques were recorded within 1 km of the project site, and one Qur’anic school operates nearby.

Religious leaders play a vital role in community mobilization and moral guidance, making them key stakeholders for project communication and awareness campaigns.

4.13.5.3 – Festivals and Cultural Events

The community observes major Islamic festivals—Eid al-Fitr and Eid al-Adha—which attract large gatherings at the prayer ground. These events are central to social cohesion and cultural identity. Project activities should avoid scheduling construction or deliveries during these periods to prevent disruption, consistent with ESS8 requirements for respecting cultural practices.

4.13.5.4 – Traditional Customs and Social Values

The survey revealed strong adherence to traditional norms of respect, hospitality, and communal solidarity. Eighty-seven percent of respondents indicated that cultural values influence daily behaviors and community decisions. Table 4.13.11 summarizes cultural value indicators:

Table 4.13.11 Cultural Value Indicators

Cultural Value	Frequency	Percentage (%)
Respect for elders	83	87.4
Religious observance	89	93.7
Community solidarity	78	82.1
Traditional ceremonies	61	64.2

Source: KoboCollect Household Survey (2026)

These values underpin social stability and should inform stakeholder engagement strategies.

4.13.5.5 – Potential Project Impacts on Cultural Properties

Positive Impacts:

- ▶ Enhanced community pride through corporate social responsibility (CSR) support for cultural events.
- ▶ Opportunities for collaboration with religious institutions on LPG safety education.

Negative Impacts:

- ▶ Possible disturbance to prayer activities due to noise or vehicular movement during Eid gatherings.
- ▶ Visual intrusion if plant structures obstruct views of the prayer ground.

Mitigation Measures:

- ▶ Maintain a minimum buffer zone of 40 metres between the plant and the prayer ground.
- ▶ Schedule construction activities outside major religious festival periods.
- ▶ Engage religious leaders in awareness and safety programmes.
- ▶ Incorporate culturally sensitive design elements (e.g., neutral colours, landscaping).

4.13.5.6 – Community Perception of Cultural Sensitivity

Survey responses indicate that 92% of households believe the project will not negatively affect cultural practices if managed responsibly. Eight percent expressed concern about potential noise and traffic during prayer times.

This positive outlook reflects trust in the developer and the expectation of respectful engagement.

4.13.5.7 – Compliance with ESS8 and FMEnv Guidelines

The project complies with ESS8 by:

- ▶ Identifying and documenting cultural properties within the area of influence.
- ▶ Consulting religious and community leaders on potential impacts.
- ▶ Integrating cultural considerations into design and operational planning.

It also aligns with FMEnv ESIA Guidelines (2011), which require preservation of cultural heritage and avoidance of interference with religious sites.

4.13.6 – Natural Resources and Land Use

Overview

This section analyses the natural resource base and land use patterns within the Gida Dubu Community and surrounding areas of Dutse Local Government Area, Jigawa State, based on the KoboCollect household survey and field observations. The assessment identifies prevailing land utilization, resource availability, and potential interactions between the proposed SHAKKATO Nigeria Limited LPG Plant and the local environment.

The analysis aligns with World Bank ESS1 (Assessment and Management of Environmental and Social Risks and Impacts) and ESS6 (Biodiversity Conservation and Sustainable Management of Living Natural Resources), as well as the Federal Ministry of Environment ESIA Guidelines (2011).

4.13.6.1 – Land Ownership and Tenure

The project site, measuring approximately 2,531 m², was officially allocated to SHAKKATO Nigeria Limited by the Jigawa State Government. Consequently, no compensation is required, and no private land acquisition is involved.

Survey data show that 92% of households occupy land under customary tenure, while 8% hold formal titles. This reflects the traditional landholding system prevalent in northern Nigeria, where community leaders allocate land for residential and agricultural use. Table 4.13.10 summarizes land tenure patterns:

Table 4.13.12 Land Tenure Patterns

Land Tenure Type	Frequency	Percentage (%)
Customary ownership	87	91.6
Formal title / certificate	8	8.4
Total	95	100

Source: KoboCollect Household Survey (2026)

4.13.6.2 – Land Use Patterns

The predominant land uses within the 2 km radius of the project site include cultural (Eid prayer ground), institutional, commercial and residential areas. The site itself is vacant and undeveloped, with no trees or shrubs requiring clearance.

4.13.6.3 – Natural Resource Availability

The community's natural resources include groundwater and limited arable land and vegetation cover. There are no forest reserves or wetlands within the immediate vicinity. Table 4.13.13 summarizes key natural resources identified:

Table 4.13.13 Key Natural Resources Identified

Resource Type	Availability	Utilisation	Remarks
Groundwater	Moderate	Domestic use	Boreholes common
Arable land	Low	Crop farming	Seasonal cultivation
Vegetation	Sparse	Grazing and shade	No commercial forestry
Minerals	Low	None reported	No mining activity

Source: KoboCollect Household Survey (2026)

The absence of sensitive ecosystems or extractive activities reduces potential environmental conflicts with the LPG plant.

4.13.6.4 – Agricultural Practices

Farming is largely subsistence-based, with manual labour and rain-fed systems. Less than 10% of households cultivate crops, while 1.1% engage in livestock rearing. Fertilizer use is minimal, and irrigation is limited to small vegetable plots near wells.

This low-intensity agriculture implies minimal competition for land resources and low risk of displacement or livelihood disruption due to the project.

4.13.6.5 – Environmental Sensitivity and Resource Pressure

The KoboCollect data indicate moderate environmental pressure from population growth and urban expansion. Forty-one of respondents noted declining soil fertility, and 29% observed reduced water table levels.

These trends highlight the need for sustainable resource management and environmental monitoring during project implementation.

4.13.6.6 – Potential Project Impacts on Land and Resources

Positive Impacts:

- ▶ Efficient land utilization for industrial development.
- ▶ Improved access to LPG, reducing reliance on firewood and charcoal.
- ▶ Potential for local employment and infrastructure enhancement.

Negative Impacts:

- ▶ Temporary soil disturbance during construction.
- ▶ Increased vehicular movement and dust generation.
- ▶ Risk of minor groundwater contamination if spills occur.

Mitigation Measures:

- ▶ Implement erosion and dust control measures.
- ▶ Establish spill prevention and containment systems.
- ▶ Conduct periodic groundwater quality monitoring.
- ▶ Maintain green buffer zones around the facility.

4.13.6.7 – Compliance with ESS6 and FMEnv Guidelines

The project complies with ESS6 by avoiding critical habitats and minimising land disturbance. It also adheres to FMEnv ESIA Guidelines (2011), which require sustainable land use and protection of natural resources.

4.13.7 – Perception of the Project

Overview

This section presents community perceptions of the proposed SHAKKATO Nigeria Limited LPG Plant near Gida Dubu Community, Dutse Local Government Area, Jigawa State. The analysis is based on responses from 95 households captured in the KoboCollect household survey, focusing on awareness, expectations, perceived benefits, and concerns.

Understanding community perception is vital for effective stakeholder engagement and risk management, as emphasized in World Bank ESS10 (Stakeholder Engagement and Information Disclosure) and ESS1 (Assessment and Management of Environmental and Social Risks and Impacts).

4.13.7.1 – Awareness of the Project

Survey results show that only around 2% of respondents were aware of the proposed LPG plant, mainly through informal channels. This indicates very limited public awareness and information dissemination within the Gida Dubu community. This suggests that stakeholder engagement has not yet reached an adequate level of inclusivity or transparency, as required under World Bank ESS10 (Stakeholder Engagement and Information Disclosure).

From a socioeconomic perspective, such low awareness may lead to misunderstanding, speculation, or resistance once project activities commence. It also implies that potential local benefits—such as employment or capacity-building opportunities—are not yet well communicated, reducing the likelihood of early community buy-in.

In line with FMEnv ESIA procedural guidelines (2011), the developer should implement a structured and proactive engagement plan, including community meetings, radio announcements, and collaboration with local leaders, to ensure timely, accessible, and culturally appropriate information sharing. Given the absence of residential buildings within 500 metres and no land or vegetation clearance, engagement efforts should focus on awareness creation, safety education, and grievance redress mechanisms, thereby strengthening social acceptance and compliance with both national and international standards.

4.13.7.2 – Perceived Benefits of the Project

Respondents expressed optimism about the project's potential socioeconomic benefits.

Key perceived benefits include:

- ▶ **Employment creation** during construction and operation phases.
- ▶ **Improved access to LPG**, reducing reliance on firewood and kerosene.
- ▶ **Enhanced community development** through infrastructure and CSR initiatives.
- ▶ **Promotion of cleaner energy use**, contributing to environmental sustainability.

These perceptions align with national energy transition goals and SDG 7 (Affordable and Clean Energy).

4.13.7.3 – Perceived Risks and Concerns

Despite general optimism, 22% of respondents expressed concerns about potential risks, mainly fire hazards (11%), traffic congestion (6%), and noise pollution (5%). Table 4.13.14 summarizes community concerns:

Table 4.13.14 Community Concerns

Concern Type	Frequency	Percentage (%)
Fire hazard	10	10.5
Traffic congestion	6	6.3
Noise pollution	5	5.3
None / No concern	74	77.9
Total	95	100

Source: KoboCollect Household Survey (2026)

These concerns highlight the need for robust safety management and community awareness programmes, consistent with ESS4 (Community Health and Safety).

4.13.7.4 – Community Expectations

Respondents expect the developer to:

- ▶ Employ local labour (reported by 63%).
- ▶ Support community infrastructure (reported by 48%).
- ▶ Maintain safety and environmental standards (reported by 39%).

These expectations provide a framework for designing inclusive benefit-sharing and CSR programmes.

4.13.7.5 – Perception of Environmental and Social Impacts

When asked about potential environmental and social impacts, 81% of respondents believed the project would have positive effects, 13% anticipated neutral outcomes, and 6% feared

negative impacts.

Positive perceptions are driven by expectations of economic growth and improved energy access.

4.13.7.6 – Trust and Confidence in the Developer

Community trust in SHAKKATO Nigeria Limited is high, with 88% of respondents expressing confidence in the company's ability to manage the project responsibly.

Such confidence supports smooth implementation and aligns with ESS10 principles of transparency and participatory communication.

4.13.7.7 – Implications for Stakeholder Engagement

- ▶ **Maintain transparency** through continuous information sharing and consultation.
- ▶ **Address safety concerns** via community training on LPG handling and emergency response.
- ▶ **Strengthen trust** through visible CSR initiatives and local employment.
- ▶ **Establish feedback mechanisms** for grievance redress and monitoring.

These measures will ensure sustained community support and compliance with both World Bank ESS and FMEEnv ESIA Guidelines (2011).

4.13.8 – Educational Status

Overview

This section analyses the educational characteristics of households surveyed in Gida Dubu Community, Dutse Local Government Area, Jigawa State, based on the KoboCollect household survey of 95 households. The data provide insights into literacy levels, school attendance, and educational attainment, which are critical for assessing human capital and potential workforce readiness for the proposed SHAKKATO Nigeria Limited LPG Plant.

The analysis is guided by World Bank ESS2 (Labour and Working Conditions) and ESS10 (Stakeholder Engagement and Information Disclosure), which emphasize inclusive employment and capacity-building opportunities.

4.13.8.1 – Literacy Levels

The data indicate a relatively high literacy rate within the Gida Dubu community, with nearly 58% of respondents able to read and write in English, Hausa, or Arabic. A further 31% are semi-literate, suggesting functional literacy sufficient for basic comprehension of project information. Only about 12% are illiterate, implying that communication barriers will be limited. Table 4.13.15 summarizes literacy levels among respondents:

Table 4.13.15 Literacy Levels Among Respondents

Literacy Category	Frequency	Percentage (%)
Literate (English/Hausa/Arabic)	55	57.9
Semi-literate (basic reading only)	29	30.6
Illiterate	11	11.6
Total	95	100

Source: KoboCollect Household Survey (2026)

This literacy profile is consistent with **Jigawa State’s average literacy rate of 68%** (NBS, 2023), indicating moderate educational attainment relative to national standards.

4.13.8.2 – Educational Attainment

Educational attainment mirrors this pattern: 58% of household heads possess tertiary education, while 16% have completed secondary schooling. Religious education accounts for 14%, and only 12% have no formal education. Table 4.13.16 summarizes educational attainment. The above findings regarding literacy levels and educational attainment suggest a community with strong potential for informed participation in stakeholder engagement activities. In line with World Bank ESS10 and FMEnv ESIA procedural guidelines (2011), engagement strategies should emphasize inclusive, transparent, and culturally appropriate communication. Given the high proportion of educated and literate residents, written materials and structured consultations can be effectively utilized, complemented by oral briefings in Hausa for semi-literate participants.

Table 4.13.16 Highest Education Level of Household Head

Level	Frequency	Percentage (%)
No formal education	11	11.6
Qur'anic / Islamic education	13	13.7
Primary education	1	1.1
Secondary education	15	15.8
Tertiary education	55	57.9
Total	95	100

Source: KoboCollect Household Survey (2026)

The absence of residential structures within 500 m of the site and the lack of vegetation clearance or land compensation requirements minimize direct social and environmental disruption. Consequently, stakeholder engagement should focus on awareness-raising regarding safety, employment opportunities, and community benefits rather than resettlement or compensation issues. The overall socioeconomic profile supports a low-risk, high-acceptance environment for project implementation, provided that engagement remains continuous and responsive to local expectations.

4.13.8.3 – School Attendance and Gender Disparity

Among households with school-age children, 89% reported active school attendance, while 11% indicated non-enrolment due to financial constraints or distance.

Gender analysis shows male enrolment at 54% and female enrolment at 46%, reflecting gradual progress toward gender parity in education.

This near balance aligns with SDG 4 (Quality Education) and SDG 5 (Gender Equality), indicating positive social development trends.

4.13.8.4 – Educational Infrastructure

Within a 2 km radius of the project site, there are:

- ▶ **Two primary schools** (public and private)
- ▶ **One secondary school**
- ▶ **A university community** (Federal University Dutse)

These institutions provide opportunities for collaboration on LPG safety education, vocational training, and research partnerships.

4.13.8.5 – Vocational and Technical Skills

Only 22% of respondents reported having vocational or technical training (e.g., mechanics, welding, tailoring). This limited skill base underscores the need for targeted capacity-building initiatives during project implementation.

4.13.8.6 – Educational Implications for the Project

Positive Opportunities:

- ▶ Availability of basic literacy facilitates training and communication.
- ▶ Proximity to educational institutions enables partnerships for skill development.
- ▶ Youth population offers potential for technical workforce development.

Challenges:

- ▶ Limited vocational training may constrain local employment readiness.
- ▶ Financial barriers to education could limit long-term community benefits.

Mitigation Measures:

- ▶ Implement community-based vocational training programmes.
- ▶ Partner with local schools and the university for LPG safety and technical education.
- ▶ Support scholarships and apprenticeships for youth and women.

4.13.8.7 – Compliance with ESS2 and FMEnv Guidelines

The project aligns with ESS2 by promoting equitable employment and skill enhancement. It also supports FMEnv ESIA Guidelines (2011), which encourage community capacity-building and education as part of social development initiatives.

4.13.9 – Social Vices and Health

Overview

This section presents findings on health conditions, sanitation, and social vices within the Gida Dubu Community and surrounding areas of Dutse Local Government Area, Jigawa State, based on the KoboCollect household survey of 95 households. The analysis provides insight into community health status, prevalent diseases, access to healthcare, and social behavior patterns relevant to the proposed SHAKKATO Nigeria Limited LPG Plant.

The assessment aligns with World Bank ESS4 (Community Health and Safety) and ESS10 (Stakeholder Engagement and Information Disclosure), as well as the Federal Ministry of Environment ESIA Guidelines (2011), which require evaluation of public health and social risks associated with development projects.

4.13.9.1 – Health Status of Respondents

The survey indicates that 73% of households reported good health status, 19% moderate health, and 8% poor health.

The generally positive health profile reflects access to basic healthcare facilities and community-level hygiene practices.

4.13.9.2 – Common Illnesses and Health Challenges

The most frequently reported illnesses include malaria (42%), typhoid fever (27%), respiratory infections (18%), and skin diseases (13%).

Malaria prevalence is consistent with regional patterns in northern Nigeria, where stagnant water and poor drainage contribute to mosquito breeding (NBS, 2023).

4.13.9.3 – Access to Healthcare Services

Fifty-four percent of households use primary health centres, 28% private clinics, and 18% general hospitals. However, 37% of respondents reported difficulty accessing healthcare due to distance or cost.

This underscores the need for project-supported health outreach and emergency preparedness measures, particularly during construction.

4.13.9.4 – Sanitation and Hygiene Practices

Sanitation facilities are basic, with 67% of households using pit latrines, 21% water closets, and 12% practicing open defecation. Waste disposal methods include open dumping (58%) and community collection (42%).

Improved sanitation and waste management could be supported through corporate social responsibility (CSR) initiatives aligned with ESS4 and SDG 6 (Clean Water and Sanitation).

4.13.9.5 – Social Vices and Behavioral Patterns

The survey recorded low prevalence of social vices. **Table 4.13.17** summarizes reported cases:

Table 4.13.17 Reported Cases of Social Vices

Social Vice	Frequency	Percentage (%)
Drug abuse	3	3.2
Theft	5	5.3
Domestic violence	4	4.2
None reported	83	87.3
Total	95	100

Source: KoboCollect Household Survey (2026)

The low incidence of social vices reflects strong community cohesion and religious influence, consistent with findings in Section 4.13.2 (Social Structure and Organization).

4.13.9.6 – Mental Health and Social Well-being

Although formal mental health services are absent, 79% of respondents reported emotional well-being and community support during stress or illness. This social resilience can be leveraged for health awareness and safety campaigns.

4.13.9.7 – Health and Safety Perception of the Project

When asked about potential health impacts of the LPG plant, 84% of respondents believed it

would improve household health through cleaner cooking fuel, while 16% expressed concern about possible fire hazards or air pollution.

This perception aligns with national efforts to transition from biomass to LPG for domestic energy use, reducing indoor air pollution and respiratory diseases.

4.13.9.8 – Potential Project Impacts on Health and Social Behaviour

Positive Impacts:

- ▶ Reduction in indoor air pollution through LPG adoption.
- ▶ Employment and income generation improving household nutrition and health.
- ▶ CSR initiatives supporting health and sanitation infrastructure.

Negative Impacts:

- ▶ Temporary dust and noise exposure during construction.
- ▶ Risk of accidents or fire if safety protocols are not strictly enforced.

Mitigation Measures:

- ▶ Implement occupational health and safety training for workers.
- ▶ Conduct community sensitization on LPG handling and emergency response.
- ▶ Establish first-aid and fire response facilities at the plant site.
- ▶ Collaborate with local health centres for periodic medical outreach.

4.13.9.9 – Compliance with ESS4 and FMEnv Guidelines

The project complies with ESS4 by addressing community health and safety risks and promoting preventive measures. It also aligns with FMEnv ESIA Guidelines (2011), which require assessment of health impacts and integration of mitigation strategies.

4.13.10 – Impact Assessment Indicators

Overview

This section presents the socioeconomic and environmental impact assessment indicators derived from the KoboCollect household survey and field observations for the proposed SHAKKATO Nigeria Limited LPG Plant at Gida Dubu Community, Dutse Local Government Area, Jigawa State.

The indicators provide a structured basis for evaluating potential project effects on livelihoods, health, infrastructure, cultural heritage, and community well-being. They align with the World Bank Environmental and Social Standards (ESS1, ESS2, ESS4, ESS6, ESS8, and ESS10) and the Federal Ministry of Environment (FMEnv) ESIA Guidelines (2011).

4.13.10.1 – Indicator Framework

Indicators were developed using both quantitative (survey data) and qualitative (community perceptions and interviews) approaches. They are grouped under thematic categories reflecting the ESIA's socioeconomic dimensions. Table 4.13.18 below outlines the indicator framework:

Table 4.13.18 Indicator Framework

Thematic Area	Indicator Type	Description	Data Source	Relevance to Project
Demography	Quantitative	Household size, age, gender composition	KoboCollect survey	Labour availability and social service demand
Livelihoods	Quantitative	Income level, employment type, economic diversification	KoboCollect survey	Economic impact and job creation potential
Social Infrastructure	Quantitative	Access to water, electricity, healthcare, education	KoboCollect survey	Infrastructure pressure and CSR opportunities
Cultural Properties	Qualitative	Presence of religious/cultural sites	Field observation	Cultural sensitivity and heritage protection
Land Use	Quantitative	Land tenure, resource utilisation	KoboCollect survey	Land management and environmental sustainability
Perception	Qualitative	Community attitudes and expectations	Household interviews	Stakeholder engagement and acceptance
Health	Quantitative	Disease prevalence, sanitation, healthcare access	KoboCollect survey	Community health and safety planning
Education	Quantitative	Literacy rate, school attendance, vocational training	KoboCollect survey	Workforce development and training needs

Social Vices	Qualitative	Incidence of crime, substance abuse	KoboCollect survey	Social stability and security management
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Source: KoboCollect Household Survey (2026)

4.13.10.2 – Socioeconomic Impact Indicators

Table 4.13.19 presents key socioeconomic indicators and their baseline values:

Table 4.13.19 Key Socioeconomic Indicators and Their Baseline Values

Indicator	Baseline Value	Expected Project Influence	Impact Direction
Average household size	9 persons	Increased income opportunities	Positive
Literacy rate	58%	Enhanced training potential	Positive
Employment rate	35% self-employed	Job creation during construction	Positive
Monthly income category for 51.6% of households	₦70,001– ₦210,000	Improved earnings through LPG trade	Positive
Access to electricity	97.9%	Stable supply via project infrastructure	Positive
Access to potable water (Borehole)	82.1%	CSR support for borehole maintenance	Positive
Health facility access	33.6% of households are within 0–20 minutes' walking distance	Improved emergency response capacity	Positive
Cultural property proximity	40 m (Eid ground)	Requires buffer and noise control	Neutral
Perception of project	81% positive	Strengthened trust through engagement	Positive
Reported social vices	<13%	Minimal risk of social disruption	Neutral

Source: KoboCollect Household Survey (2026)

4.13.10.3 – Environmental and Health Impact Indicators

Table 4.13.20 summarizes environmental and health-related indicators relevant to community safety and well-being:

Table 4.13.20 Environmental and Health-Related Indicators Relevant to Community Safety and Well-Being

Indicator	Baseline Condition	Potential Project Impact	Mitigation Measure
Air quality	Good (no industrial source)	Temporary dust during construction	Dust suppression and green buffer
Noise level	Low	Machinery and traffic noise	Schedule control and noise barriers
Water quality	Moderate	Risk of contamination from spills	Spill containment and monitoring
Sanitation	67% pit latrine use	Pressure on waste disposal	CSR support for waste management
Disease prevalence	Malaria 42%, Typhoid 27%	No direct increase expected	Health awareness campaigns

Source: KoboCollect Household Survey (2026)

4.13.10.4 – Community Perception Indicators

Community perception indicators reflect social acceptance and trust in the project. Figure 4.13.6 below illustrates perception trends:

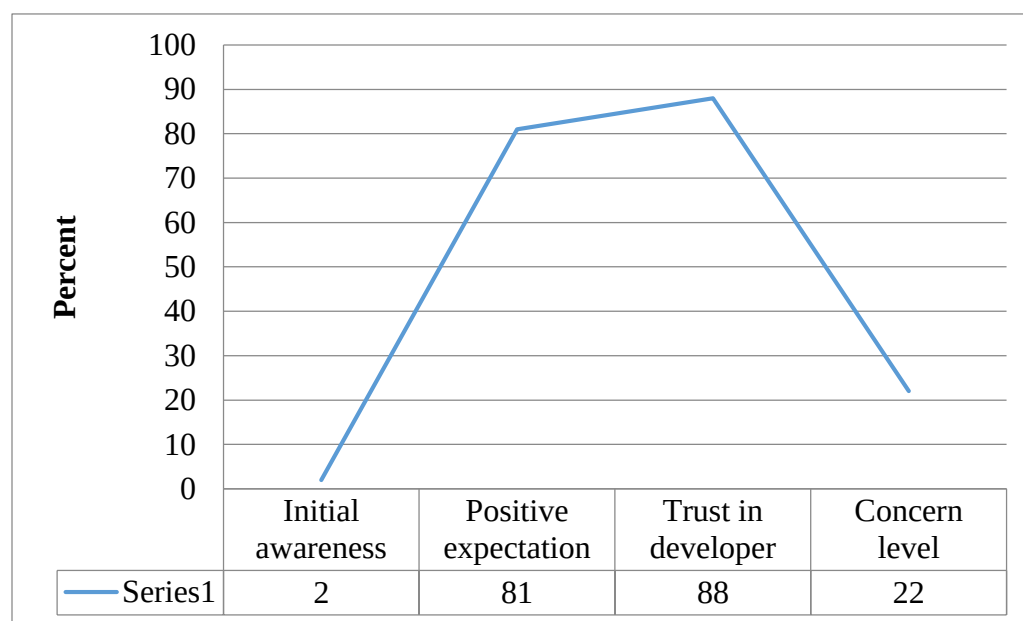


Figure 4.13.6 Community Perception Trends

Source: KoboCollect Household Survey (2026)

The upward trend in positive perception demonstrates effective stakeholder engagement and transparency.

4.13.10.5 – Impact Significance Rating

Impacts were rated using a **five-point scale** based on magnitude, duration, and reversibility:

Rating	Description
1	Negligible – No measurable effect
2	Minor – Temporary and easily reversible
3	Moderate – Noticeable but manageable
4	Major – Significant and long-term
5	Severe – Irreversible or critical

Table 4.13.21 Significance Ratings for Key Socioeconomic Impacts

Impact Category	Magnitude	Duration	Reversibility	Significance	Impact Category
Employment generation	High	Long-term	Reversible	4	Employment generation
Income improvement	Moderate	Long-term	Reversible	3	Income improvement
Health and safety	Moderate	Continuous	Reversible	3	Health and safety
Cultural sensitivity	Low	Short-term	Reversible	2	Cultural sensitivity
Infrastructure pressure	Moderate	Medium-term	Reversible	3	Infrastructure pressure
Environmental disturbance	Low	Short-term	Reversible	2	Environmental disturbance

4.13.10.6 – Monitoring and Evaluation Indicators

To ensure compliance and adaptive management, the following indicators will be monitored throughout the project lifecycle:

Table 4.13.22 Monitoring and Evaluation Indicators

Monitoring Indicator	Frequency	Responsible Entity
Employment rate	Quarterly	SHAKKATO Nigeria Limited / LGA
Health and safety incidents	Monthly	Site HSE Officer
Community complaints	Continuous	Grievance Redress Committee
Air and water quality	Quarterly	Environmental Consultant
CSR implementation	Annually	Project Management Team

These indicators will be integrated into the project's Environmental and Social Management Plan (ESMP).

4.13.11 – Stakeholder Engagement Implications

Overview

This section synthesizes the outcomes of stakeholder engagement activities conducted as part of the socioeconomic study for the proposed SHAKKATO Nigeria Limited LPG Plant at Gida Dubu Community, Dutse Local Government Area, Jigawa State.

Stakeholder engagement is a cornerstone of the Environmental and Social Impact Assessment (ESIA) process, ensuring transparency, inclusivity, and social acceptance. The engagement process was guided by World Bank ESS10 (Stakeholder Engagement and Information Disclosure) and the Federal Ministry of Environment (FMEEnv) ESIA Procedural Guidelines (2011).

4.13.11.1 – Stakeholder Identification and Categorization

Stakeholders were identified through community mapping and consultation with local authorities. They were categorized as follows:

Table 4.13.23 Stakeholder Identification and Categorization

Stakeholder Category	Examples	Interest / Influence Level
Primary stakeholders	Local residents, traders, farmers, youth groups	High – directly affected by project activities
Secondary stakeholders	Local government officials, religious leaders, educational institutions	Moderate – influence community perception and policy
Tertiary stakeholders	NGOs, environmental agencies, media	Low to moderate – support monitoring and advocacy

Source: KoboCollect Household Survey and Key Informant Interviews (2026)

This categorization facilitated targeted engagement strategies that addressed specific concerns and expectations.

4.13.11.2 – Engagement Methods

Stakeholder engagement employed multiple participatory approaches:

- ▶ **Community meetings** facilitated by the Village Head and religious leaders.
- ▶ **Focus group discussions** with women, youth, and traders.
- ▶ **Key informant interviews** with local government officials and health workers.
- ▶ **Household surveys** using KoboCollect to capture perceptions and socioeconomic data.

These methods ensured inclusivity and compliance with ESS10 principles of accessibility and cultural appropriateness.

4.13.11.3 – Summary of Stakeholder Concerns and Responses

Table 4.13.24 summarizes key concerns raised during consultations and the corresponding responses proposed by the project proponent:

Table 4.13.24 Concerns Raised During Consultations and the Corresponding Responses Proposed by the Project Proponent

Concern	Stakeholder Group	Response / Mitigation Measure
Fire and explosion risk	Local residents	Implement strict safety protocols and awareness training

Traffic congestion	Transport operators	Designate access routes and schedule deliveries off-peak
Employment opportunities	Youth groups	Prioritise local labour and provide vocational training
Cultural site disturbance	Religious leaders	Maintain buffer zone and avoid activities during Eid
Environmental pollution	NGOs / community	Adopt best practices for waste and emission control
Information transparency	Local government	Establish community liaison office and grievance mechanism

Source: Stakeholder Consultation Records (2026)

4.13.11.4 – Community Participation and Inclusivity

The engagement process achieved broad participation:

- ▶ **47% of surveyed households** attended at least one consultation meeting.
- ▶ **Women's groups** were represented in 42% of sessions.

This inclusivity aligns with ESS10 and SDG 16 (Peace, Justice, and Strong Institutions), promoting participatory governance.

4.13.11.5 – Grievance Redress Mechanism (GRM)

A **community-based GRM** will be established to address complaints and feedback throughout the project lifecycle.

Key features include:

- ▶ **Accessible channels:** verbal, written, and digital submissions.
- ▶ **Timely resolution:** complaints addressed within 14 working days.
- ▶ **Transparency:** records maintained and reviewed quarterly.
- ▶ **Representation:** inclusion of community leaders and women's representatives.

This mechanism ensures compliance with ESS10 and supports continuous dialogue between SHAKKATO Nigeria Limited and the community.

4.13.11.6 – Information Disclosure and Communication Strategy

Information will be disseminated through:

- ▶ Community notice boards and local radio announcements.

- ▶ Periodic stakeholder meetings and newsletters.
- ▶ Collaboration with the Dutse Local Government Information Office.

Communication materials will be translated into Hausa to ensure accessibility.

4.13.11.7 – Institutional Collaboration

The project will collaborate with:

- ▶ **Jigawa State Ministry of Environment** – for environmental monitoring.
- ▶ **Dutse Local Government Council** – for community liaison and infrastructure coordination.
- ▶ **Federal University Dutse** – for research and training partnerships.
- ▶ **Local NGOs** – for health and safety awareness campaigns.

These partnerships will enhance project sustainability and social accountability.

4.13.11.8 – Monitoring and Evaluation of Engagement

Engagement effectiveness will be monitored using the following indicators:

Indicator	Frequency	Responsible Entity
Number of consultation meetings held	Quarterly	SHAKKATO Nigeria Limited
Percentage of grievances resolved	Monthly	Community Liaison Officer
Level of stakeholder satisfaction	Biannually	Independent ESIA Consultant
Inclusion of vulnerable groups	Quarterly	Project Social Team

Monitoring results will be documented in the Environmental and Social Management Plan (ESMP).

4.13.11.9 – Stakeholder Engagement Implications for Project Implementation

- ▶ **Enhanced social licence to operate** through trust and transparency.
- ▶ **Reduced conflict potential** via proactive grievance management.

- **Improved local capacity** through training and employment.
- **Strengthened institutional collaboration** supporting long-term sustainability.

These outcomes demonstrate alignment with ESS10 and FMEnv ESIA Guidelines (2011), ensuring that stakeholder engagement remains an ongoing, adaptive process.

4.13.12 – Summary and Integration

Overview

This final section integrates findings from the socioeconomic baseline and stakeholder engagement study conducted for the proposed SHAKKATO Nigeria Limited LPG Plant at Gida Dubu Community, Dutse Local Government Area, Jigawa State. It synthesizes the results of the KoboCollect household survey (95 households), field observations, and consultations, providing a holistic understanding of the community's socioeconomic context, potential project impacts, and recommended mitigation and enhancement measures.

The integration aligns with the World Bank Environmental and Social Standards (ESS1–ESS10) and the Federal Ministry of Environment (FMEnv) ESIA Guidelines (2011), ensuring that the project contributes to sustainable development while minimizing adverse effects.

4.13.25 – Summary of Key Findings

Thematic Area	Key Findings	Implications for Project
Demography	Youthful population (75% under 25 years); male-dominated household headship (92%).	High labour potential; need for gender-inclusive employment.
Social Structure	Strong traditional leadership and community cohesion.	Engagement through Village Head and religious leaders ensures trust.
Livelihoods	Students and dependents (38.9%), civil service and formal employment (26.3%), and petty trading (21.1%); Monthly income category for 51.6% of households = ₦70,001–₦210,000.	Opportunities for job creation and microenterprise support.
Social Infrastructure	Moderate access to water, electricity, and healthcare; good road network.	CSR potential for infrastructure improvement.
Cultural Properties	Eid prayer ground 40 m away; high religious significance.	Maintain buffer zone and avoid disruption during festivals.

Natural Resources and Land Use	Sparse vegetation; no trees or shrubs to clear; state-allocated land.	Minimal ecological disturbance; no compensation required.
Perception of Project	81% positive perception; 22% minor concerns (fire, noise, traffic).	Strong community support; need for safety awareness.
Education	58% literacy; 22% vocational training; proximity to university.	Potential for skill development partnerships.
Health and Social Vices	Good health status (73%); low social vices (<13%).	Favourable social environment; health outreach recommended.
Impact Indicators	Positive socioeconomic trends; moderate environmental sensitivity.	Manageable impacts with proper mitigation.
Stakeholder Engagement	Inclusive participation (47% households); strong trust in developer.	Maintain transparency and grievance redress mechanisms.

Source: KoboCollect Household Survey and Stakeholder Consultations (2026)

4.13.12.2 – Integrated Impact Analysis

The socioeconomic environment of Gida Dubu Community is conducive to the LPG plant's development. The project is expected to generate positive cumulative impacts, including:

- Employment and income generation.
- Improved access to clean energy.
- Strengthened local infrastructure and social services.
- Enhanced community awareness of safety and environmental management.

Potential negative impacts—such as noise, traffic, and safety risks—are minor and reversible with appropriate mitigation measures.

4.13.26– Recommended Mitigation and Enhancement Measures

Impact Category	Recommended Action	Responsible Entity
Employment and livelihoods	Prioritise local hiring; provide vocational training.	SHAKKATO Nigeria Limited / LGA
Health and safety	Conduct LPG safety campaigns; establish emergency response unit.	SHAKKATO Nigeria Limited / Health Dept.
Cultural sensitivity	Maintain buffer around Eid ground; consult religious leaders.	Project Management Team

Infrastructure pressure	Support water and waste management improvements.	CSR Programme
Environmental management	Implement dust, noise, and spill control measures.	Environmental Consultant
Stakeholder engagement	Maintain community liaison office and grievance mechanism.	Social Team / LGA

4.13.12.4 – Alignment with World Bank ESS and FMEnv Guidelines

The project demonstrates compliance with key standards:

- ▶ **ESS1:** Comprehensive assessment of social and environmental risks.
- ▶ **ESS2:** Promotion of fair labour practices and local employment.
- ▶ **ESS4:** Protection of community health and safety.
- ▶ **ESS6:** Sustainable land use and resource management.
- ▶ **ESS8:** Preservation of cultural heritage.
- ▶ **ESS10:** Inclusive stakeholder engagement and information disclosure.

These alignments ensure that the LPG plant contributes to sustainable development goals (SDGs 7, 8, 9, and 11).

4.13.12.5 – Sustainability and Long-Term Benefits

The project's long-term benefits include:

- ▶ **Economic empowerment:** through job creation and LPG retail opportunities.
- ▶ **Environmental improvement:** via reduced biomass fuel use.
- ▶ **Social development:** through CSR initiatives in health, education, and infrastructure.
- ▶ **Institutional strengthening:** through collaboration with local authorities and educational institutions.

These outcomes position the project as a catalyst for regional energy transition and socioeconomic growth.





PLATE 4.4: Administration of Socio-Economic Questionnaires to Project Community Members

4.2.3 Grievance Redress Mechanism

4.2.3.1 Introduction

Disputes between the project developer / proponent and Project-Affected Persons (PAPs) may arise during implementation, particularly concerning compensation, land boundaries, or asset valuation. Given the project's scale, a structured grievance redress mechanism is established to resolve conflicts efficiently, operating within Nigeria's legal framework (Land Use Act of 1978, Cap 202, 1990). The GRM comprises two tiers: customary mediation and formal judiciary hearings.

4.2.3.2 Customary Mediation

A community-level Customary Grievance Redress Committee (CGRC) will be established in project affected area to resolve disputes amicably. Grievance Redress Procedure (see Figure) was clearly communicated to the communities during the stakeholders meeting. The committee will serve as the "court of first appeal" for grievances, including:

- i. Incorrect recording of personal/community details or assets (land, structures).
- ii. Errors in compensation calculation or acreage measurement.
- iii. Changes in asset ownership or recipient status (e.g., due to death/disability).
- iv. Omission of names from compensation registries.

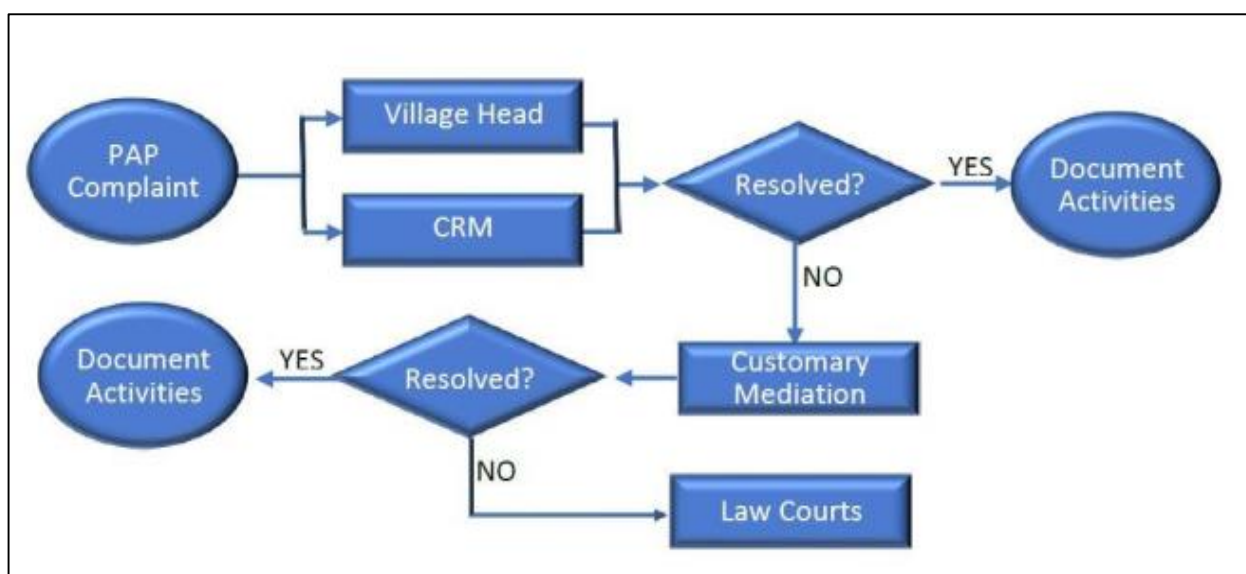


Figure 5.1: Grievance Redress Procedure

5.2.2.3 Grievance Redress Process:

1. PAPs submit complaints verbally or in writing to the CGRC.
2. The CGRC resolves grievances within three (3) days of receipt.
3. If unresolved or unsatisfactory, the case escalates to formal legal channels.

The project proponent will provide logistical support to the CGRC.

5.2.2.4 Formal Legal Redress

Unresolved grievances will proceed to Nigeria's judiciary system. Courts will deliver binding judgments per applicable laws, ensuring due process.

5.2.2.5 Future Consultations

Continuous engagement will be maintained with regulatory agencies, host communities, and stakeholders throughout all project phases. Post-ESIA approval, a detailed Memorandum of Understanding (MoU) will be signed with affected communities to formalize commitments on compensation, mitigation measures, and community benefits.

5.2.2.6 Conclusions

The Stakeholder Engagement strategy of the ESIA study included:

1. Community – proponent dialogue session: Attracting major community and government representatives;
2. Targeted Briefings: For government agencies, NGOs, and Community-Based Organizations (CBOs).
3. Feedback Integration: Input from community leaders and institutional stakeholders informed the ESIA

Multiple channels ensured stakeholders could access information, pose questions, and receive responses. This inclusive approach underpins the project's social license to operate.

CHAPTER FIVE

ASSOCIATED AND POTENTIAL PROJECT ENVIRONMENTAL AND SOCIAL IMPACTS

5.1 Introduction

The proposed project construction works will undoubtedly have a lot of positive impacts including but not limited providing a number of job creation. On the other hand, the intervention, especially the construction phase activities which will involve the use of heavy equipment for earthworks etc. will have associated risks and impacts on biophysical environment (air, water, and soil), and socioeconomic environment (employment, community health and safety hazards, security, etc.).

This chapter presents the identification of potential environmental and social impacts associated with the proposed intervention works as well as recommended mitigation measures. It also explains the methodology employed in accessing and analyzing the potential risks and project alternatives.

The impact assessment considered relevant project activities and the environmental and social aspects they would interact with in order to identify the issues to be focused on during project implementation including the issues raised by stakeholders during consultation.

5.2 Impact Evaluation Methodology

The identification and assessment of environmental and social impacts of this LPG Project were based on Nigerian and international (World Bank) standards, which include the following steps:

- i. Identification of project activities necessary to develop and execute the project components.
- ii. Identification of potential environmental and social aspects (hazards or sources of potential impacts) associated with the project's activities; and
- iii. Assessment of the significance of the identified environmental and social impacts.

Based on the above steps, major activities during the various phases of the project were identified along with the associated environmental and social aspects. To ensure a comprehensive evaluation, a variety of measures were considered to identify and weigh the likely environmental and social impacts. These measures included overlaying the civil works components on maps of existing conditions to identify potential impacts; and reviewing published documents that provide guidance on performing impact analysis for infrastructure projects.

5.2.1 Impact Significance

To objectively screen for issues warranting consideration as potential impacts, and to determine the likely significance of those impacts, general consequence criteria were developed, covering natural (physical & biotic) and socioeconomic components. These consequence criteria (Table 5.1) were applied to potential impacts to determine their effect level. In addition, impact likelihood criteria (

Table 5.2) were also applied to potential impacts to determine their likelihood level.

Table 5.1: Impact Significance Definition

Significance	Definition
Not Significant	Not Significant. Any impacts are not expected to be indistinguishable from the baseline or within the natural level of variation. These impacts do not require mitigation and are not a concern of the decision-making process.
Low	Detectable but Not Significant. Impacts with a " Low " significance are expected to be noticeable changes to baseline conditions, beyond what would naturally occur, but are not expected to cause hardship or degradation. However, these impacts warrant the attention of decision-makers, and should be avoided or mitigated where practicable.
Moderate	Impacts with a " Moderate " significance are likely to be noticeable and result in lasting changes to baseline conditions, which may cause hardship to or degradation of the receptor. Broader consequences for the ecosystem or community are not anticipated. These impacts are a priority for mitigation in order to avoid or reduce their significance
High	Impacts with a " High " significance are likely to have damaging and lasting changes to the functioning of a receptor, and may have broader consequences

	(e.g. on ecosystem health or community well-being). These impacts are a priority for mitigation in order to avoid or reduce their significance.
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Table 5.2: Rating of Impact Risk Likelihood

Likelihood	Rating	Definition
4	Severe	Adverse impacts on people and/or environment of medium to large magnitude, spatial extent and duration more limited than critical (e.g., predictable, mostly temporary, reversible). The potential risk impacts of projects that may affect the human rights, lands, natural resources, territories, and traditional livelihoods of indigenous peoples are to be considered at a minimum potentially severe
3	Moderate	Impacts of low magnitude, limited in scale (site-specific) and duration (temporary), can be avoided, managed and/or mitigated with relatively uncomplicated accepted measures.
2	Minor	Very limited impacts in terms of magnitude (e.g., small affected area, very low number of people affected) and duration (short), may be easily avoided, managed, mitigated.
1	Negligible	Negligible or no adverse impacts on communities, individuals, and/or environment.

5.2.2 Impact Likelihood

To obtain a measure of the risk associated with each potential impact, likelihood criteria

Identifying the probability of occurrence of each potential impact were estimated taking into consideration existing safeguards and controls to be put in place by the project proponent.

A modified Leopold impact assessment matrix was used for combining the severity of impact and the likelihood of occurrence. The potential impacts of each activity are ranked by combining the severity and likelihood criteria as shown in

Table 5.4. During the project lifecycle, appropriate practices and measures will be put in place to mitigate the potential adverse impacts. These mitigation plans, which conform to national and international guidelines, are addressed alongside

each potential impact to ease applicability alignment.

Table 5.3: Impact Significance Matrix

Impact magnitude	Receptor Sensitivity				
		Negligible	Low	Moderate	High
	Negligible	Not significant	Not significant	Not significant	Low
	Low	Not significant	Low	Low/Moderate	Moderate
	Moderate	Not significant	Low/moderate	Moderate	High
	High	Low	Moderate	High	High

The overall level of an impact is determined by its position on the impact risk assessment matrix. This qualitatively allows for the evaluation of the risk of each impact. The use of risk (consequence and probability) to screen and evaluate impacts enables this ESIA to identify and focus on resources most likely to be at risk due to the project. Impacts placed within the red boxes have a “high” risk rating.

These high-risk impacts become priority issues for further evaluation or management action. Impacts in the yellow category are “medium” risk impacts, with a medium priority. These are considered tolerable, but efforts should be made to reduce the impact to levels that are as low as reasonably practical. Impacts in the green boxes indicate events with “low” risk corresponding to low significance and low priority. These are considered acceptable and do not require specific mitigation.

5.2.3 Potential Positive Impacts

Contingent upon rigorous implementation of the recommendations of this ESIA, the Project promises transformative benefits across environmental, social, economic and other cross-cutting dimensions including the areas of accessibility, public health and urban planning.

Table 5.4 enumerates the various potential positive impacts of the project.

Table 5.4: Potential Positive Impacts of the Project

AREA	POSITIVE IMPACT
Environmental	1. <i>Climate change mitigation</i> –LPG gas can reduce the effect of climate change by reducing the use of fire wood for cooking.
Social	1. <i>Employment/ Job creation</i> - LPG farms can create employment opportunities in rural area. 2. <i>Improves infrastructure</i> – The project plans to provide solar street lighting which will help in improving night-time safety 3. <i>Community Engagement</i> – The established GRM Committee and ongoing consultations empower local voices in project governance
Economic	1. <i>Income generation</i> – LPG farming can generate income for farmers, suppliers, and related business. 2. <i>Food Security</i>– LPG farms can increase access to affordable food sources by simplifying energy access. 3. <i>Job Creation</i> – Opportunity for temporary employment for youth during construction (labour, engineering, monitoring) 4. <i>Economic growth.</i> – LPG farms can contribute to local and national revenue based income
Public Health	1. Lower air pollution reduces respiratory diseases; 2. Efficient waste management improves sanitation

5.2.3 Potential Negative Impacts

The project will also have some negative / adverse impacts, especially during the construction stage and operation within the surrounding areas, communities and road users will experience some undesirable effects / impacts which are mostly going to be temporary. Table below outlines the potential negative impacts identified with severity ratings and corresponding proposed mitigation measures.

Environmental/Social Aspect	Significance	Potential Negative Effect
Vegetation clearing	Substantial	Loss of vegetation and habitat during site preparation
Soil disturbance	Moderate	Soil erosion, compaction and loss of top soil
Air quality	Moderate	Air emission from vehicles, generators and other combustion sources during construction and operation of the plant may affect local air quality.
Noise and vibration	Substantial	Increased noise from heavy machinery, generators and other combustion sources may affect local air quality
Water resources	Low	Sediment and pollution runoff from heavy equipment from construction and operation nearby surface water affect water bodies
Dust and emission	Moderate	Exhaust emission from generators, trucks and other machinery may reduce local air quality.
Fire and explosion	Moderate	• Improper handling/storage of fuel and flammable materials may cause fire incident. • Accidental LPG may escape from valves, pumps, compressors and connections
Traffic	Moderate	Increase movement of construction vehicles and LPG tankers may cause congestion and road accidents.
Storm water pollution	Low	Runoff from operational areas may carry oil, grease and other contaminants
Occupational health and safety	Negligible	Workers may be expose to falls, machinery accidents, electrical hazards and other injuries.
Energy consumption	Negligible	Continuous operation of pumps, compressors, lightening and other equipment increase energy demand.

Environmental/Social Aspect	Significance	Potential Negative Effect
Emergency Incident	Moderate	Equipment failures, overpressure, human error or poor maintenance may result in major accidents
Community safety	Moderate	Noise, tanker movement and other operational activities may affect neighbouring communities.
Security risks		Unauthorized access, vandalism or deliberate interference with LPG facilities may create safety risks

CHAPTER SIX

MITIGATION MEASURES

6.1 INTRODUCTION

The implementation of the proposed LPG project has the potential environmental and social impacts during the pre-construction, construction, operation, and decommissioning phases. These impacts may arise from project related activities such as site preparation, construction works, equipment installation, waste generation, emission, noise and vibration, traffic movement and interaction with surrounding communities and ecosystems.

This chapter presents the mitigation measures proposed to avoid, present, minimise and where necessary compensate for the potential adverse environmental and social impacts identified in the environmental and social impact assessment (EIA). The measures have been developed based on the findings of the baseline studies, impact assessment, regulations, and reorganized good environmental management practices.

Effective implementation of these measures will require clear responsibilities, adequate resources, continuous monitoring, and compliance with applicable regulatory requirements, the mitigation measures therefore form part of integral part of (ESMP) and will provide a frame work for managing the project environment and social performance throughout its lifecycle.

6.2 TYPES OF MITIGATION MEASURES

The mitigation measures proposed for the LPG project which is located at Ibrahim Aliyu bypass road in Dutes are grouped into three broad categories based on the timing and nature of their application. These include preventive measures, control measures, and compensatory measures. Together, these measures are designed to ensure that identified environmental and social impacts are either avoided or reduced to acceptable levels throughout the project lifecycle.

6.2.1 Preventive Measures

Preventive measures are incorporated primarily at the project design and pre-construction stages. Their primary objective is to eliminate or substantially reduce potential significant impacts at their source before project activities commence. For the proposed LPG facility, this approach emphasizes proactive planning and design optimization, such as appropriate site selection to avoid environmentally sensitive or densely populated areas, incorporation of safety buffers, and

adoption of layouts that minimize land disturbance. Preventive measures also include the modification or avoidance of activities that could generate adverse impacts, such as scheduling specific operations to reduce disturbance to nearby communities and implementing early stakeholder engagement and community sensitization programmes to prevent conflicts, manage expectations, and enhance local acceptance of the project.

6.2.2 Control Measures Control measures are applied during the construction, commissioning, operation, and maintenance phases of the project. These measures are intended to manage, reduce, or contain impacts that cannot be completely avoided through design. For this LPG project, control measures include on-site practices and engineering controls aimed at limiting emissions, noise, waste generation, traffic risks, and occupational health and safety hazards. Where project activities result in unavoidable disturbance—such as vegetation clearance during site preparation—control measures also encompass remedial actions. These may include site restoration, re-vegetation of disturbed areas, proper waste handling, and continuous monitoring to ensure that impacts remain within regulatory limits and do not adversely affect surrounding communities or ecosystems.

6.2.3 Compensatory Measures

Compensatory measures are considered where residual impacts remain after the application of preventive and control measures, or where impacts cannot be fully mitigated through technical or operational means. In such cases, appropriate compensation will be provided in line with applicable national regulations and guidelines issued by relevant authorities. For the proposed LPG project, compensatory measures may include livelihood restoration support, community development initiatives, or other agreed forms of assistance aimed at offsetting losses or inconveniences experienced by affected individuals or communities.

6.3 MITIGATION MEASURES FOR SIGNIFICANT POTENTIAL ADVERSE IMPACTS

Based on the findings of the environmental and social impact assessment, a range of mitigation and enhancement measures have been identified to address the significant actual and potential adverse impacts associated with the proposed LPG project. These measures are designed to minimize negative impacts while enhancing positive outcomes, ensuring that the project is implemented in an environmentally sustainable and socially responsible manner in accordance with national standards and international best practice.

Table 6.1: Mitigation Measures for the LPG Projects

Media	Potential Impact	Significance	Probability of Impact and Impact	Possible Mitigation Measures
PRE-CONSTRUCTION PHASE				
Land acquisition for the intervention project Public Awareness	Conflict from affected property owners and members of the adjoining communities to vacate areas allocated for the project.	Substantial	Prob: 3, Impact: 4 Risk: High	• Legal check on land including traditional ownership • Negotiate with the rightful owners and avoid land speculators • Acquire proper documents from both the government and land owners
Public Awareness	Pessimistic Public / Community perception can disrupt the proposed project activities	Moderate	Prob: 3, Impact: 2 Risk: Medium	• Invest in public awareness and consultations • Understand the people's perception and respond to their issues positively
Labour influx	Risk to community health from HIV/AIDS or other transmitted infections as a result of the presence of migrant construction labour.	Moderate	Prob: 1, Impact: 23 Risk: Medium	• Communities around which the project will be undertaken will be sensitized on preventive measures against stigmatization of persons with HIV/AIDS and other infectious diseases using the mass media
Mobilization	Noise and vibration from the use of motorized vehicles and equipment;	Substantial	Prob: 4, Impact: 3 Risk: Medium	• Maintain equipment and machineries adequately to reduce their noise levels • Fit machineries and heavy-duty equipment with exhaust mufflers/silencers to minimize noise generation • Avoid unnecessary idling of internal combustion engines

Media	Potential Impact	Significance	Probability of Impact and Impact	Possible Mitigation Measures
	Ambient air pollution from release of dusts and gaseous emissions;	Low	Prob: 2, Impact: 2 Risk: Low	1 Suppress dust emissions by appropriate methods such as spraying water on soil 2 Ensure vehicles are in good working condition. 3 Ensure exhaust fumes from vehicles conform to applicable National standards and specifications
	Soil contamination from accidental leakage/spillage of fuel, oil and lubricants.	Negligible	Prob: 2, Impact: 2 Risk: Low Prob: 3, Impact: 3 Risk: Medium	• Ensure fuel storage tanks are leak-proof, checked daily & installed in a bounded area • Establish the procedures for storage & handling of hazardous materials. • Implement emergency response plan as part of OHS Plan to deal with spillage
Site clearing	Loss of soil quality from de-vegetation and erosion	Moderate	Prob: 3, Impact: 3 Risk: Medium	• Area to be cleared will be kept to the minimum necessary to prevent disturbance of soils outside the boundary • Demolition and excavation waste can be reused elsewhere (e.g., as backfill) • No waste will be disposed of in the field; all waste will be disposed of in waste bins provided within the working area and handed over to approved waste contractors for recycling purpose and safe disposal as applicable • If any object or site discovered cease works and follow the Chance-Find Procedure (CFP) • Flagging or physical barriers to be put in place if required. • Take precautions when excavating. • Ensure workers wear appropriate PPEs and adhere to relevant OHS guidelines
	Generation of wastes from demolition of structures, utilities and other cleared materials	Moderate	Prob: 3, Impact: 3 Risk: Medium	
	Risk of diseases arising from indiscriminate waste disposal	Substantial	Prob: 2, Impact: 2 Risk: Low	
	Impact on intangible cultural heritage;	Moderate	Prob: 3, Impact: 3 Risk: Medium	
	Exposure of workers to occupational hazards.	Moderate	Prob: 3, Impact: 3 Risk: Medium	

Media	Potential Impact	Significance	Probability of Impact and Impact	Possible Mitigation Measures
Installation of the contractor's base camp / Staging area	Security issues that may lead to stealing of contractor equipment mobilized to site	Moderate	Prob: 3, Impact: 3 Risk: Medium	- Adequate security to be provided - Contractors to work with local security structure in addition to formal structure
	Impact on intangible cultural heritage	Low	Prob: 3, Impact: 3 Risk: Medium	<i>As discussed under site clearing above</i>
	Exposure of workers to occupational hazards.	Negligible	Prob: 3, Impact: 3 Risk: Medium	- A Labour Management Plan (LMP) and an Occupational Health and Safety Plan is recommended for implementation. - The plan shall describe all construction works, their risks, and the controls that will reduce risks; these controls may include PPEs, restrictions on activities or locations, and other measures. - The plan shall also describe workers training matrix. Hazards and risks related to working at heights, and with heavy equipment will require special training to minimize. - The contractor shall ensure the use of Personal Protective Equipment (PPEs) for all types labour works executed in the project
Material sourcing	Noise and vibration from the movement of motorized vehicles and equipment	Negligible	Prob: 4, Impact: 3 Risk: Medium	- Maintain equipment and machineries adequately to reduce their noise levels - Fit machineries and heavy-duty equipment with exhaust mufflers/silencers to minimize noise generation

Media	Potential Impact	Significance	Probability of Impact and Impact	Possible Mitigation Measures
				Avoid unnecessary idling of internal combustion engines
CONSTRUCTION / OPERATION / DEMOBILIZATION PHASES				
Air Quality	Potential for fugitive emission or particulate matter (dust) from earthworks, stockpile materials, heavy vehicles during construction /operation phase.	Substantial Low Moderate	Prob: 4, Impact: 3 Risk: Medium	- Dust minimization measures shall be implemented including watering of the construction areas, including the surfaces areas under construction. - Soil stockpiles and stores of friable material will be covered to reduce the potential for fugitive emissions of dust where possible. - Vehicles carrying friable materials will be enclosed or sheeted. - Loading, unloading and handling of dusty materials will only be carried out in designated areas. - Regular damping of unpaved areas or exposed soils/ground to control dust/particulate matter and keep it down. - Limit active construction activities to a minimum section at a time to minimize dust - Workers would be provided with dust protection PPEs
	Potential for road traffic exhaust emission (NO _x , PM etc.) including dust from vehicular movement during construction / operation phase.	Moderate Low	Prob: 3, Impact: 3 Risk: Medium	- Ensure vehicles/machines are switched off when not in use. - Ensure only vehicles required to undertake works are operated on-site. - Ensure all construction vehicles, plant and machinery are well maintained and in full operating condition.

Media	Potential Impact	Significance	Probability of Impact and Impact	Possible Mitigation Measures
				• Effective preventative maintenance established to ensure all construction equipment and electricity generators are maintained in good working order and do not adversely impact air quality due to inadequate maintenance or damage. • Concrete batching, crushing and screening plants will be fitted with dust extraction and / or suppression systems where necessary.
Noise and vibration	Potential for increased noise generation and vibration from construction machinery, earth moving equipment as a result of construction activities.	Substantial	Prob: 4, Impact: 3 Risk: Medium	• Install noise reduction devices such as silencers and mufflers as appropriate to mobile plant and equipment. • Limit the active construction activities to within the LPG corridor • Limit work to daylight hours. Schedule noisy construction activities during specific times in the day especially near the sensitive receptors • Advance notice will be given to communities if short-term noisy construction activities are to take place, which could cause these levels to be exceeded. • Work areas will be organised and operated to restrict noise levels to not exceed regulatory thresholds at the nearest sensitive receptor during normal activities. • If existing noise levels exceed these threshold values, the Project will not cause more than a 3dB increase in measured ambient levels during normal activities. • •

Media	Potential Impact	Significance	Probability of Impact and Impact	Possible Mitigation Measures
fire explosion	From filling of LPG Gas	Substantial	Risk: Medium	• Use Auto stop filling nozzle
Soil (Erosion & Contamination)	Potential for soil exposure to erosion from excavation works. Potential for soil contamination due leaching from material & waste stockpiles, leakage of oils, lubricants, and fuels from machineries / equipment / vehicles	Moderate	Prob: 3, Impact: 3 Risk: Medium	• Area to be excavated will be kept to the minimum as per the design requirement to prevent exposure / disturbance of soils outside the design boundary • Appropriate slope stability measures will be incorporated where necessary, such as installation of erosion protection features like stone pitching and retaining walls • Ensure fuel storage tanks are leak-proof, checked daily & installed in a bounded area • Establish the procedures for stockpiles, storage & handling of hazardous materials. • Implement emergency response plan as part of OHS Plan to deal with spillage / leakages • Material / waste stockpiles, refuelling, maintenance and wash-down of construction vehicles and equipment will only occur in designated areas that are provided with secondary impermeable containment facilities. • The contractor will be required to take all reasonable precautions to prevent and clean up all spills / leaks, and implement necessary measures (including spills and waste management plans) to prevent materials from polluting soils or groundwater.
Visual Aesthetics	Landscape impacts from site preparation and construction activities	Medium	Prob: 2, Impact: 2 Risk: Low	Construction materials, machineries, and waste to be stacked in designated areas and cordoned off.

Media	Potential Impact	Significance	Probability of Impact and Impact	Possible Mitigation Measures
	including vegetation removal and soil removal Reduced aesthetic quality impact resulting from presence of equipment, vehicles and machinery and poor waste management practices			
Waste and condensate removal	• Potential impact on existing waste management due to increase generation of waste streams. - Potential impact on environmental media (soil, water, air) and the community from waste transportation and disposal of spoils and contaminated materials. ▪ Disposal of spoils in unsuitable areas such as along communal routes and spaces could result in environmental impacts including erosion, water pollution, obstruction of drainage	Medium	Prob: 3, Impact: 3 Risk: Medium	• Waste bins will be provided at all construction sites for the disposal of the various types of wastes generated by the project. These bins will be clearly marked to facilitate segregation of waste, for collection, transportation and disposal. • Separation of domestic (organic) and hazardous waste at the source shall be strictly enforced. • Where possible, wastes will be re-used or recycled. This is a requirement for waste oils, other hydrocarbons and tires and other hazardous and non-hazardous wastes • Burning of waste will not be permitted • All personnel will be trained in the appropriate management of waste according to the WMP (See Annex 6). - Proper storage, transport and disposal of hazardous wastes (oily wastes, used batteries, fuel drums, excavated soil) in the designated areas by the contractor in accordance with National and State Environmental Law.

Media	Potential Impact	Significance	Probability of Impact and Impact	Possible Mitigation Measures
	patterns, traffic jam, etc.			▪ In as far as practicable, spoils will be reused as backfill in borrow pits rehabilitation measures, which is a condition of the contractor contracts. ▪ Side tipping of spoils in any inappropriate locations will be strictly prohibited. ▪ A balance will be strived at between the amount of spoil produced from cuttings and that required for fills in-situ to minimise the need for disposal of surplus.
GHG	Emissions from construction activities like fuel combustion, power generators, concrete batching plant, and operational vehicles could cause adverse impacts on air quality affecting the health and welfare of people.	Low	Prob: 3, Impact: 3 Risk: Medium	Use of ozone depleting substances such as chlorofluorocarbons (CFCs), halons, carbon tetrachloride, trichloroethane and halogenated hydrobromofluorocarbons (HBFCs) will not be permitted.
Livelihoods / economy	Temporary and permanent disruption of livelihoods due to blockades, diversions, traffic, land acquisition etc., during construction	High	Prob: 3, Impact: 3 Risk: Medium	Through a transparent stakeholder engagement process, develop and implementation of livelihoods restoration plans to offset the adverse impacts on the project affected people
Community and social cohesion	Potential economic loss due to damage to assets & utilities from Project related activities			

Media	Potential Impact	Significance	Probability of Impact and Impact	Possible Mitigation Measures
	Potential increase in land disputes, conflicts & tension between communities, local leaders and project proponent due to physical / economic displacement, unmet expectations around project benefits and employment during resettlement and compensation			
Community Health & Safety Labour and working condition Labour Influx	Risks of accidents and injuries during Project related activities Potential increase in diseases (malaria, communicable diseases, HIV) due to migration of workers to the project area Potential impact on workers' wellbeing due to discrimination, infringement on labour and employment rights (excessive working hours, forced labour)	Moderate	Prob: 3, Impact: 2 Risk: Medium	Implement work site occupational health and safety (OHS) plan including adequate use of road safety / caution / diversion signs, work site barriers, lightening, personal protective equipment (PPEs) etc. Conduct rigorous community / public / workers sensitization on disease prevention & control measures Project contractor to prepare and implement a Labour Management Plan (LMP) The project GRM will be made available for all workers and host communities to report any issues associated with OHS and / or labour and working conditions for resolution

Media	Potential Impact	Significance	Probability of Impact and Impact	Possible Mitigation Measures
	Risk of Child Labour, Gender Based Violence, Sexual Exploitation & Abuse, Sexual harassment (GBV/SEA/SH)			Contractual clauses will be inserted in contract documents and codes of conduct agreements will be signed prohibiting contractor and workers from forced labour, child labour, GBV/SEA/SH and mandating reporting incidences of these to authorities (GRC, law enforcement)
Traffic	Potential for increased vehicular / traffic congestion due to ongoing civil works / diversion which may result in road safety issues like traffic accidents	Substantial	Prob: 3, Impact: 3 Risk: Medium	• Community consultations and meetings will be held to sensitize the public on the on-going works and related hazards. • Active sites will be sealed off from the public using reflective tapes and cones; where necessary road diversions will be created. • Works to be scheduled to avoid peak traffic periods and congestion • Safety initiatives will be developed and implemented, including: – Ensuring that only qualified (licenced) drivers operate machinery; – Implementing speed limits and traffic control measures in appropriate locations; – Installing safety signage, speed control devices on trucks etc. – Movement of large construction machinery will be guided by flagmen.
Security Risks	Potential for increased incidences of theft, thug's activities, kidnappings, etc.	Substantial	Prob: 3, Impact: 4 Risk: High	• Continuous intensive monitoring of security risks and immediate response to the risks. • Work with all necessary security agencies especially the police and local vigilantes for adequate security and early information.

CHAPTER SEVEN

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

7.1 INTRODUCTION:

The principal objective of the Environmental and Social Management Plan (ESMP) is to ensure that all impacts of the project are contained and brought to an acceptable level to guarantee economic, environmental and social sustainability of the project.

The ESMP Matrix has been developed to meet international and national standards on Environmental & Social performance, detailing the mitigation measures the client and its contractor will be committed to, for an effective project implementation. Environmental management involves a structured and integrated approach designed to ensure that both identified and unforeseen impacts of a proposed project are effectively controlled and reduced to acceptable levels. It assures project proponents and planners that appropriate systems and procedures will be in place to address potential environmental, social, and health issues throughout all stages of the project, from initial planning and design through operation and eventual decommissioning.

The Environmental Management Plan (ESMP) serves as the principal instrument for managing the anticipated impacts of the project. It provides a practical framework for implementing, monitoring, and reviewing mitigation measures aimed at reducing moderate and significant adverse impacts to levels that are as low as reasonably practicable over the entire project lifecycle. Through the EMP, identified environmental, social, and health risks are systematically managed, ensuring compliance with regulatory requirements and promoting sustainable project development.

7.2 OBJECTIVES OF THE ENVIRONMENTAL MANAGEMENT PLAN

The Environmental Management Plan (ESMP) for the proposed LPG project in Ibrahim Aliyu bypass Road is designed to provide a systematic framework for managing environmental, social, health, and safety issues throughout the project lifecycle.

The specific objectives of the ESMP are to:

- Ensure that all project activities, including pre-construction, construction, operation, and

decommissioning, are carried out in full compliance with applicable national regulations, guidelines, and environmental and safety standards relevant to LPG facilities.

- Ensure that construction and operational procedures are planned and implemented in a manner that minimizes adverse impacts on the biophysical environment, public health, and the socio-economic wellbeing of the host community, with the ultimate goal of preventing or eliminating such impacts where practicable.
- Promote, achieve, and demonstrate sound environmental performance for the project, guided by the principle of continuous improvement in environmental and social management.
- Ensure that all mitigation and enhancement measures identified in the Environmental Impact Assessment for the LPG project are effectively implemented, monitored, and maintained.
- Ensure that adequate emergency preparedness and response measures are in place to address accidental events, system failures, or loss of control during project implementation and operation.
- Provide a clear basis and performance standards for planning, environmental monitoring, auditing, reporting, and periodic review of environmental and social performance throughout the life of the LPG project.
- Facilitate early and continuous consultation with host communities, relevant regulatory agencies, and other stakeholders to promote smooth project implementation and address concerns proactively.
- Establish an institutional and management structure that ensures full compliance with the ESMP by the project proponent and all contractors engaged in the execution of the LPG project.

7.3 SCOPE OF THE ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

The scope of the Environmental Management Plan (ESMP) for the proposed LPG project it covers all critical activities and phases of the project, from pre-construction through operation and eventual decommissioning. The ESMP is structured to achieve the following:

- Clearly define the institutional roles and responsibilities of the project proponent, contractors, and relevant regulatory agencies involved in the implementation of the LPG project.
- Establish clear, specific, and measurable environmental, social, health, and safety targets and performance standards that must be complied with throughout the project lifecycle.

- Put in place effective procedures for communication, environmental monitoring, documentation, reporting, and information disclosure to ensure transparency and regulatory compliance.
- Systematically identify potential environmental and social risks associated with the LPG project and prescribe appropriate mitigation, control, and corrective measures.
- Provide for capacity building through training and awareness programs aimed at strengthening the ability of project staff and contractors to implement the EMP effectively and sustainably.

7.4 ROLES AND RESPONSIBILITIES

The effective implementation of the Environmental and Social Management Plan (ESMP) for the proposed project requires the coordinated involvement of multiple stakeholders, each performing clearly defined roles across the pre-construction, construction, operation, and decommissioning phases of the project. This collaborative framework ensures that environmental, social, health, and safety risks associated with the LPG project are properly managed in line with regulatory requirements and best practices. Where project activities require modification at any stage, the project proponent shall be consulted and approvals obtained from relevant authorities.

Project Proponent ((SHAKKATO NIG. LTD)), as the developer and operator of the LPG facility, together with its employees and representatives, shall be responsible for the overall execution and enforcement of the EMP.

Key responsibilities include the following:

- Ensuring that all personnel involved in the LPG project are fully familiar with the contents and requirements of this EMP.
- Providing regular progress updates to relevant stakeholders, including regulators and host communities, through written reports and verbal briefings.
- Requesting, reviewing, and approving method statements and work plans prepared by contractors, in consultation with the appropriate regulatory authorities.
- Reviewing and approving site layout designs, including access roads, haulage routes, equipment placement, and safety zones within the LPG facility.
- Advising on suitable materials and methods for demarcating work areas and carrying out construction and operational activities safely.

- Issuing site instructions to ensure compliance with regulatory conditions and environmental requirements.
- Notifying regulatory authorities in advance, both verbally and in writing, of any planned activities that may pose potential environmental or social risks.
- Conducting environmental damage assessments following incidents, accidents, or serious cases of non-compliance.
- Reviewing complaints received from workers or community members and issuing corrective instructions where necessary.
- Allocating and managing budgets for environmental control measures, personnel deployment, monitoring equipment, and capacity-building initiatives related to the LPG project.
- Accompanying regulators during site inspections and formally communicating any proposed amendments to the EMP.
- Enforcing temporary suspension of activities where serious environmental violations or safety risks are identified.
- Maintaining a complaints and grievance register and forwarding relevant information to appropriate authorities.
- Promoting proactive communication among contractors, regulators, community representatives, and other stakeholders to enhance environmental performance.
- Implementing, managing, and maintaining all EMP requirements applicable to construction and operational activities throughout the project duration.
- Appointing qualified personnel to oversee environmental, health, and safety management during LPG operations.
- Delegating responsibilities clearly to ensure accountability in EMP implementation.
- Ensuring that all contractors and subcontractors understand and comply with their environmental and social obligations under the EMP Regulatory Authorities Oversight and monitoring of EMP implementation for the LPG project shall be the responsibility of relevant regulatory bodies, including the Federal Ministry of Environment (FMEnv), the NMDA, NUPRC,

and other applicable agencies.

Their responsibilities of those regulatory agencies include, but are not limited to, the following:

- Enforcing national environmental laws, guidelines, standards, and sector-specific regulations applicable to LPG infrastructure and operations.
- Ensuring compliance with the conditions and commitments outlined in the EMP throughout the entire lifecycle of the project.
- Taking necessary enforcement actions to address non-compliance and ensure adherence to approved environmental procedures and performance standards.
- Developing and delivering structured training and awareness programmes for stakeholders on:
 - o Good environmental management practices; Management of general and project-specific environmental and social risks;
 - o Procedures related to pre-construction, construction, operation, and decommissioning activities with environmental interaction;
 - o Integrated waste management principles applicable to LPG facilities.
- Identifying, designating, and enforcing environmental “no-go” zones to protect sensitive receptors and prevent unacceptable environmental disturbance.

7.5 MANAGEMENT COMMITMENT AND RESPONSIBILITY

Management commitment to effective environmental, health, and safety performance for the proposed project is articulated through SHAKKATO’s established Health, Safety and Environment (HSE) Policy. The company is fully committed to implementing this policy across all project phases, Pre-construction, construction, operation, and decommissioning while ensuring strict compliance with applicable national regulations, sectorial guidelines, and international best practices.

SHAKKATO Nig. Ltd requires all employees, contractors, and subcontractors engaged in the the LPG project to adhere fully to its HSE policy, irrespective of how stringent the requirements may be. This commitment is fundamental to ensuring safe operations, environmental protection, and positive community relations throughout the project lifecycle.

In line with this commitment, SHAKKATO Nig. Ltd shall:

- Safeguard the health, safety, and security of its employees, contractor personnel, visitors, and

members of the public who may be affected by LPG facility activities.

- Prevent, reduce, and manage adverse environmental impacts associated with gas processing, compression, storage, and transportation activities.
- Demonstrate sensitivity and responsiveness to the needs, expectations, and concerns of the community and neighboring settlements.
- Empower all staff with the right and responsibility to intervene and stop work where unsafe acts, unsafe conditions, or non-compliance with HSE requirements are observed.
- Ensure that customers, partners, visitors, and other stakeholders operating within the facility comply with SHAKKATO's HSE standards and procedures.
- Integrate health, safety, and environmental considerations into all aspects of project planning, design, construction, and operations, with clear objectives aimed at continuous performance improvement.
- Comply with all relevant national laws, regulations, and applicable international standards governing health, safety, and environmental protection in gas-related projects.
- Establish and maintain effective internal and external communication mechanisms on HSE matters involving employees, contractors, regulators, and host communities.
- Apply sound engineering standards, best industry practices, and risk management principles to ensure the safety, integrity, reliability, and efficiency of the LPG plant infrastructure.
- Demonstrate responsible corporate leadership by maintaining high HSE performance standards and publicly reporting environmental and safety performance where required.
- Identify existing and potential HSE hazards associated with LPG operations, conduct systematic risk assessments, and implement appropriate control measures.
- Develop and implement a comprehensive HSE management system supported by clear procedures, monitoring frameworks, and performance indicators.
 - Maintain adequate emergency preparedness and response capabilities to address incidents such as gas leaks, fires, explosions, or occupational accidents.
- Communicate HSE expectations clearly to contractors and subcontractors and ensure their

compliance through supervision and contractual obligations.

- Implement a robust compliance and audit programme to verify adherence to HSE policies and EMP commitments.
- Provide sufficient human, financial, and technical resources to support effective HSE management throughout the project.
- Adopt best practices in health, safety, and environmental protection during the design, construction, and operation of the LPG facility.
- Promote ethical and socially responsible conduct by working collaboratively with regulatory agencies, host communities, and other stakeholders.
- Engage and consult with employees and other relevant parties on occupational health, safety, and environmental conditions, including the provision of occupational health services.
- Maintain functional emergency response systems to minimize the consequences of unforeseen incidents.
- Liaise with relevant government agencies on matters relating to HSE legislation, policy formulation, and regulatory compliance affecting the project.

7.6 ENVIRONMENTAL MANAGEMENT PLAN (EMP) MEASURES

The sections that follow present the framework for the Environmental Management Plans (EMPs) developed for the proposed SHAKKATO Liquefied Petroleum Gas (LPG) facility Dutse town. These EMPs provide structured guidance for managing environmental and social impacts across the different phases of the project and will be expanded to include detailed procedures for implementation by project staff and contractors.

The plans are designed to remain dynamic documents, subject to periodic review and update as project conditions evolve. The environmental management measures applicable to the pre-construction, construction, operation, and decommissioning phases of the project are outlined in the relevant EMP matrices.

7.6.1 Flora and Fauna Management Plan

The objective of the Flora and Fauna Management Plan is to safeguard biodiversity within and

around the project area while also protecting project personnel from potential risks associated with local vegetation and wildlife. The plan seeks to prevent unnecessary ecological disturbance during site preparation, construction, and operation of the LPG facility, and to promote responsible environmental stewardship.

Key provisions of this plan include the following:

- Wildlife and plant species within the project area shall not be captured, harmed, removed, or deliberately disturbed by company staff, contractors, or subcontractors.
- Poaching, illegal harvesting of plants, or destruction of wildlife habitats by project personnel will not be tolerated under any circumstances.
- SHAKKATO shall take all reasonable steps to maintain the ecological integrity and biodiversity quality of the project environment.
- Although land clearing activities may temporary displace wildlife, any species classified as vulnerable or protected by the Ministry of Environment that is injured or trapped during site preparation shall be reported immediately to the appropriate Wildlife Division for guidance on rescue, relocation, or other conservation actions. Provision will be made for such contingencies.
- Project planning and site layout will be carried out in advance to minimize impacts on fauna, reduce flood risks, and limit the volume of vegetation and biomass removed.
- Where water abstraction is required, SHAKKATO shall monitor downstream aquatic habitats to ensure that withdrawals do not impose ecological stress. Where adverse effects are identified, alternative water sources such as boreholes will be developed to offset surface water use.
- The project site shall be kept clean and free of food waste or refuse that could attract wildlife and create human–animal conflict.
- Monitoring for invasive species will be undertaken to identify their presence, pathways of introduction, control methods, and effectiveness of eradication measures. Where invasive species persist, corrective actions will be implemented to address the root causes.

7.6.2 Waste Management Plan

The Waste Management Plan is designed to ensure that wastes generated by the LPG project are minimized, properly handled, and disposed of in a manner that protects human health and the

environment. The plan follows the waste hierarchy of prevention, reduction, reuse, recycling, treatment, and safe disposal.

The SHAKKATO will follow those guiding principles for the waste management plan:

- Minimizing waste generation at source;
- Reusing some materials wherever feasible;
- Ensuring environmentally sound disposal of residual wastes by engaging a private waste management company.

Key elements of the Waste Management Plan include:

- Clear assignment of waste management responsibilities, including the appointment of a trained Waste Management Supervisor.
- Identification and documentation of all waste streams generated at the LPG facility, with estimates of quantities produced on a regular basis, particularly hazardous wastes.
- Provision of clearly labelled, colour-coded waste containers for different waste categories, housed in designated storage areas.
- Strict segregation of hazardous and non-hazardous wastes, with hazardous wastes managed in accordance with Material Safety Data Sheets (MSDS).
- Anticipated hazardous wastes will primarily include empty lubricant containers, used oils and greases, oil-contaminated rags, and absorbent materials.
- Tracking of hazardous waste movement using Waste Manifest Forms, with records retained for regulatory review.
- Periodic reconciliation of estimated and actual waste quantities to identify discrepancies.
- Routine inspections of waste handling practices to ensure compliance with EMP requirements.

7.6.3 Erosion and Sedimentation Management Plan

The Erosion and Sedimentation Management Plan provides guidance for preventing soil erosion and controlling sediment transport during land clearing, site preparation, and construction activities at the LPG facility. Soil erosion poses a risk to soil fertility, drainage systems, and

downstream water quality if not adequately managed. All exposed soil surfaces within the project area shall be managed using a combination of engineering and biological controls aimed at reducing runoff velocity, retaining sediments, and preventing off-site impacts. The effectiveness of these measures will be monitored through routine inspections and downstream water quality assessments, including turbidity checks.

Key erosion and runoff control measures include:

- Preservation of vegetated buffer zones along natural drainage channels and streams.
- Use of cover crops and temporary vegetation to protect exposed soil and improve soil structure.
- Phased and progressive site clearing to avoid large areas of bare soil.
- Installation of temporary erosion control measures such as silt fences, sediment traps, and check dams where permanent controls are not yet in place.
- Proper grading and shaping of cut and fill slopes to approved design limits.
- Direction of storm water over controlled flow paths using berms, channels, and energy dissipation structures.
- Temporary protection of exposed surfaces using mulch, geotextiles, plastic sheeting, or similar materials when required.
- Long-term stabilization through terracing, re-vegetation, and slope protection measures.
- Use of riprap or concrete protection around culverts and drainage outlets.
- Construction of storm water inlets and drainage structures designed to safely convey runoff during design storm events.
- Controlled placement of soil stockpiles on flat areas away from drainage paths, with topsoil stockpiles protected against erosion.
- Maximum utilization of natural drainage systems, with open channels preferred over buried pipes wherever practicable.

7.6.4 Employment, Training, and Capacity Building Plan

The Employment, Training, and Capacity Building Plan Management Plan is a critical component

of the Environmental Management Plan. For this proposed LPG facility will be implemented during both the construction and operational phases of the project. The plan is designed to ensure that all workers are adequately trained, informed, and aware of their environmental, health, and safety responsibilities while carrying out LPG-related activities. During employee induction, all personnel will undergo mandatory health and safety orientation covering standard operating procedures, hazard identification, emergency response, and LPG specific risks.

In addition, workers deployed at active work fronts will participate in weekly toolbox talks and safety briefings, each lasting not less than 15 minutes.

These sessions will be intensified following any incident, near-miss, or emerging health and safety concern. Records of all training activities will be maintained to track worker competence and compliance. Training requirements will be detailed in an Integrated Health and Safety Plan (IHSP), which will define training content, target groups, delivery frequency, and evaluation methods. Core training modules will include:

- General health and safety induction; • Community relations and code of conduct; • Basic first aid and emergency response;
- Awareness of venomous or dangerous animals;
- Proper use of personal protective equipment (PPE); and
- Safe work procedures specific to LPG handling and operations.

7.6.5 Water Management Plan.

The Water Management Plan for the LPG project is intended to promote efficient water use, protect surface and groundwater resources, and prevent pollution throughout the project lifecycle.

The plan recognizes the importance of water for domestic use, agriculture, and ecosystem sustainability in the host community.

Key elements of the plan include:

- Training all personnel on the importance of conserving and protecting water resources;
- Implementing erosion and sediment control measures to prevent siltation and nutrient loss into

surface water bodies;

- Applying waste management controls to prevent contamination of surface water and groundwater from liquid effluents or leachate;
- Periodic monitoring of significant effluent streams to ensure compliance standards;
- Establishing a site-specific water quality monitoring programme for surface water and groundwater;
- Monitoring downstream water availability to ensure that project water use does not negatively affect other users; and
- Ensuring that any boreholes or water abstraction facilities comply with national standards and do not adversely affect existing groundwater users.

7.6.6 Vegetation Clearing and Biomass Management Plan

The Vegetation Clearing and Biomass Management Plan provides procedures for managing land clearing and biomass generated during site preparation and infrastructure development for the LPG facility.

The plan ensures compliance with FMEENV requirements and aims to minimize ecological disturbance. Uncontrolled vegetation clearing may result in habitat loss, biodiversity reduction, and soil degradation. To prevent this, SHAKKATO will avoid areas of high conservation value and apply environmentally responsible clearing practices.

The plan will include procedures for:

- Clearly defining areas approved for clearing and areas designated for protection;
- Applying clearing methods that allow wildlife to escape from disturbed zones;
- Ensuring optimal utilization of merchantable timber where applicable;
- Allowing local communities reasonable access to non-timber forest products prior to or immediately after clearing;

7.6.7 Air Quality Management Plan

The Air Quality Management Plan aims to control emissions and noise associated with construction

and operation of the LPG facility, thereby safeguarding ambient air quality and community health. Key measures include:

- Ensuring that noise levels during construction and operation comply with Nigerian regulatory limits;
- Using modern, well-designed LPG storage and processing equipment to minimize emissions of nitrogen oxides (NO_x) and other air pollutants;
- Maintaining all project vehicles and machinery in good working condition and fitting them with appropriate emission control devices;
- Avoiding the use of ozone-depleting substances in cooling systems, cleaning agents, or other operational processes.

7.6.8 Emergency Response and Incident Management Plan

The Emergency Response and Incident Management Plan establishes procedures for managing foreseeable emergencies related to LPG operations, including fires, gas leaks, chemical spills, flooding, medical emergencies, and extreme weather events.

The plan defines responsibilities, communication protocols, and resource requirements to ensure rapid and effective response in order to protect workers, the public, property, and the environment. Relevant emergency services and regulatory authorities will be notified promptly in the event of a serious incident. Spill management procedures will address accidental releases that may occur during fuel transfer, equipment maintenance, refuelling, container handling, or as a result of equipment failure.

The plan will:

- Identify responsible personnel and emergency contacts;
- Establish a structured spill response organization;
- Characterize potential spill materials and quantities;
- Define response procedures, equipment, and PPE requirements;
- Provide training for spill containment, recovery, and waste disposal; and

7.6.9 Traffic and Vehicle Management Plan

The Traffic and Vehicle Management Plan is designed to minimize road safety risks, noise, dust, and traffic disruption associated with LPG transportation activities in the project and surrounding communities.

The plan will include:

- Installation of speed limits and appropriate road signage along project access routes;
- Strict enforcement of speed limits within the project site and nearby communities;
- Mandatory road safety training for all project drivers;
- Routine inspection and maintenance of all vehicles to ensure roadworthiness and safety compliance.

7.6.10 Health, Safety, and Security Management Plan

The Health, Safety, and Security Management Plan for the LPG project will comply with national regulations and international best practices. The plan addresses workplace hygiene, occupational safety, security arrangements, and continuous training for employees. Key provisions include:

- Provision and mandatory use of appropriate PPE such as helmets, gloves, safety boots, respirators, eye and hearing protection;
- Job-specific risk assessments to determine PPE requirements;
- Training on proper use of equipment and enforcement of safety rules;
- Installation of physical barriers to restrict unauthorized access to hazardous areas;
- Specialized training on electrical, mechanical, lifting, welding, and vehicle-related hazards;
- Availability of trained first aid personnel, a well-equipped treatment room, and ambulance services for emergency response.

7.6.11 Community Health and Safety Plan

The Community Health and Safety Plan addresses potential impacts of the LPG project on nearby communities. Construction activities may attract job seekers and service providers, which can

increase social risks such as crime or public health challenges.

Mitigation measures include:

- Prioritizing recruitment of local labour to reduce influx of non-local workers;
- Enforcing worker codes of conduct to discourage involvement in drugs, alcohol abuse, or commercial sex;
- Sensitizing communities on potential social risks associated with project activities;
- Implementing community health awareness programmes in collaboration with health authorities;
- Monitoring public health indicators to identify and address emerging risks.

7.6.12 Stakeholder Engagement Plan

Stakeholder engagement has been integrated into the project area from inception. The Stakeholder Engagement Plan provides a structured approach for identifying stakeholders, conducting consultations, and maintaining open communication throughout the project lifecycle. The plan includes:

- Identification and mapping of key stakeholders;
- Documentation of previous consultations;
- Ongoing engagement during construction and operation;
- Allocation of resources for stakeholder engagement;
- Monitoring and reporting on engagement outcomes. A Grievance Redress Mechanism (GRM) will allow individuals or groups to submit complaints in person, by phone, or electronically. All grievances will be documented, investigated, and resolved promptly, transparently, and at no cost to the complainant.

7.6.13 Decommissioning Plan

The Decommissioning Plan outlines the approach for eventual closure of the LPG facility. Although decommissioning is not anticipated in the near term, the plan will be periodically updated as the project matures.

The plan will address:

- Workforce disengagement and retrenchment procedures;
- Possible transfer or conversion of project infrastructure for community or alternative use;
- Capacity building and skills training for affected employees; and
- Restoration of the project site to environmentally acceptable conditions.

The ESMP matrixes presented below (Table 7.1 to 7.3) reflect the project phases, activities associated with each phase, impacts related to these activities, mitigation measures, responsible action personnel/group and implementation time frame, as well as cost of implementation. The project is expected to have positive environmental and social impacts as it will enhance traffic flow in Dutse metropolis towards improvement of economic activities. However, since it is basically a civil works project, the majority of environmental and social impacts and hazards are expected to arise during the construction phase of the project. The EMP also covers potential impacts as perceived during the pre-construction and operation phases.

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7.1 ESMP for Pre-Construction Phase

Table 7.1: ESMP Matrix for Pre-Construction Phase

Component	Sub-Component	Activity	Potential Impact	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Mitigation and Monitoring
ENVIRONMENT	Air	Site clearing, Movement of materials, vehicles, and equipment to site	Release of toxic gases from exhaust which could lead to atmospheric pollution	Ensure that all vehicles are serviced; undergo Vehicle Emission Testing (VET) and Vehicle Exhaust Screening (VES).	Serviced and tested vehicles and equipment	Bimonthly	Mitigation: Contractor Monitoring: Client team Supervision Consultant FRSC	1,000,000
			Increase in fugitive dusts during movement of vehicles bringing in construction materials	Dampening of soil exposed surfaces to reduce dust during movement of vehicles. Enforce appropriate speed limit to reduce dust on	Water wetting chart	Weekly		

Component	Sub-Component	Activity	Potential Impact	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Mitigation and Monitoring
	Soil	Creation of camp sites, staging area for equipment	Pollution of soil from oil leaks from stacked equipment	unpaved surfaces. Install a non-permeable membrane/ drip pans to equipment.	Contractor compliance	One-off	<u>Mitigation</u> Contractor	500,000
	Noise	Mobilization to site and clearing activities	Noise pollution from movement of vehicles and machineries / equipment operations.	Install noise mufflers on heavy duty equipment. Provide & enforce the usage of hearing protection devices (ear plugs/ muffs) for workers	Availability of updated Equipment Servicing Tags. Noise measurement using noise measurement meter to ensure compliance	One-off Daily	<u>Mitigation</u> Contractor <u>Monitoring</u> Client team Supervision Consultant	500,000
	Land degradation	Sourcing of Construction Materials	Sourcing of construction materials such as sand, gravels will lead to impacts related to	Contractor will only source construction materials from approved quarries/ borrow pits.	Contractor's compliance	One –off	<u>Mitigation</u> Contractor <u>Monitoring</u> Client team Supervision Consultant	500,000

Component	Sub-Component	Activity	Potential Impact	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Mitigation and Monitoring
			sand mining and extraction of gravel from borrow-pits or quarries.	Implement Borrow Pit Management Plan (BMP)				
OHS	Safety workers	of Mobilization of workers and equipment. Installation of Site Structures and Facilities	Risk of accidents and injuries to contractor workers. Respiratory diseases to Workers due to inhalation of exhaust fumes and dusts.	Conduct safety and first aid training; Ensure that staging areas for contractor equipment are adequately delineated and cordoned off with reflective tapes and barriers; Provision and use of safety signs and signals;	Safety Training report PPE and First aid box provided	Weekly	<u>Mitigation</u> Contractor <u>Monitoring:</u> Client/ Supervision Consultant Teams	500,000

Component	Sub-Component	Activity	Potential Impact	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Mitigation and Monitoring
				Provision of PPE and first aid boxes. Implement OHS Plan				
SOCIAL	Traffic in constructing site	Movement of materials and equipment to staging area	Obstruction to access route for commuters in the project area Risk of Road Accidents	Contractors to develop and implement a Traffic Management Plan. (a guide provided in Annex 9) Provision of caution signs, speed bumps and flagmen at strategic points to prevent accident and alert drivers/ pedestrians	Controlled traffic.	Daily	<u>Mitigation:</u> Contractor <u>Monitoring:</u> Client/ Supervision Consultant Teams	500,000

Component	Sub-Component	Activity	Potential Impact	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Mitigation and Monitoring
	Grievances	All Preconstruction activities	Grievance from poor recruitment of local labour for semi- & unskilled labour by contractor	Establish effective GRM for receiving and resolution of complaints. Ensure contractors employ local youths; Provide adequate sensitization ; and harness community skills during recruitment process.	GRCs established, complaint boxes on site No of locals recruited	One- off	<u>Mitigation:</u> Contractor, Client <u>Monitoring:</u> Client/ Supervision Consultant Teams GRC	200,000
	Labour Influx	All Preconstruction activities . Presence of foreign (non-locals)	Increase in sexual activities and potential spread of STDs/STIs within the project area.	Limit the number of migrant workers by engaging local workers. Develop an induction program including a	Compliance Signed Codes of Conduct	One –off	<u>Mitigation:</u> Contractor Client <u>Monitoring:</u> Client/ Supervision Consultant Teams	300,000

Component	Sub-Component	Activity	Potential Impact	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Mitigation and Monitoring
		workers and Followers		code of conduct for all workers, with Disciplinary measures and sanctions for defaulters. Increase demand on community health and sanitation infrastructure due to labour influx.	Provision of services in the workers' camp to reduce the need for workers to use local community facilities (water supply, sanitation facilities);			
	Sexual Exploitation and Abuse (SEA)/ Gender	All Preconstruction activities . Presence of	Induced SEA/SH and other GBV Issues due to labour influx	Community sensitization on SEA/SH preventive measures and	Compliance to SEA/SH Action Plan. Sensitization conducted.	One –off	Mitigation: Contractor Client GRC	500,000

Component	Sub-Component	Activity	Potential Impact	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Mitigation and Monitoring
	Based Violence (GBV)	foreign (non-locals) workers and Followers.		response plan. Develop an induction program including a code of conduct for all workers, with Disciplinary measures and sanctions for defaulters.	Signed Code of Conducts		Monitoring: Client team	
		All Preconstruction activities .	Project workers could fall victim of kidnap, thug's activities, social conflicts etc.	Contractors to develop and implement Security Management Plan (SMP) in liaison with security agencies in the state	Contractors compliance Security Management Plan prepared and implemented	Continuous	Mitigation: Contractor Client Monitoring: Contractor Client Security Agents, Police.	-
		TOTAL FOR PRE-CONSTRUCTION PHASE						

7.2 ESMP for Construction Phase

Table 7.2: ESMP for Construction Phase

Component	Sub - Component	Activity	Potential Impact	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Mitigation and monitoring
ENVIRONMENT	Air	Construction activities- Earthworks and Grading, and Drainages	Air pollution due to the release of dust and exhaust gases.	Vehicles and equipment to be installed with emission control devices e.g., catalytic converter, air injection, etc. Routine air quality checks. Routine wetting of the construction sites.	Contractors' compliance Air monitoring log book.	Weekly	Mitigation: Contractor Monitoring: Client/ Supervision Consultant Teams	500,000
	Soil	Construction Earthworks and Grading; , and Drainages	Increased susceptibility of exposed soil to erosion due to excavation of earth materials at construction site and around material sourcing borrow pits.	Fast-track all excavation, backfill and pavement works to prevent erosion of exposed soil surfaces and its uncontrolled encroachment into adjacent areas	Contractors' compliance	One off Weekly	Mitigation: Contractor Monitoring: Client/ Supervision Consultant Teams	500,000

Component	Sub - Component	Activity	Potential Impact	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Mitigation and monitoring
			Soil contamination due to leakages from construction equipment	Regularly inspect construction equipment for signs of leaks.				
	Water	Construction works	Ground water contamination from accidental leakages and spills from diesel, petrol, cleaning agents, lubricants, hydraulic oil.	Develop and implement spill response plan and ensure all fuel storage facilities are bonded and lined with impermeable materials.	Contractors' compliance	Weekly	Mitigation: Contractor Monitoring: Client/ Supervision Consultant teams.	500,000
	Solid Waste	Construction activities	Environmental pollution from waste generated from construction works and debris.	Implement waste Management Plan. Ensure waste is evacuated from site in an environmentally	Contractors' compliance Waste sorting bins provided.	Daily	Mitigation: Contractor Monitoring: Client/ Supervision	200,000

Component	Sub - Component	Activity	Potential Impact	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Mitigation and monitoring
			Campsite waste generation	sound manner to prevent unregulated dumping. Create waste collection areas and clearly marked such as colour coded bins and provide equipment for handling the wastes and evacuation to approved waste disposal site. Ensure up to date records/ register of waste collection and disposal activities in the project site, whereby the records should be important part of the project files. The waste generated shall	An up-to-date record/ register of waste streams and types generated, collection and disposal activities.	One-off	Consultant teams.	

Component	Sub - Component	Activity	Potential Impact	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Mitigation and monitoring
				be tracked and recorded from generation, collection, segregation, transportation and final disposal.				
OHS	Workers' safety	Construction activities	Risks of occupational accidents and injuries to workers. Substance abuse among workers, resulting to accidents and injuries on the work site, jeopardizing their own safety	OHS training and education, implementation of Occupational Health and Safety Management Plan. Sensitize and communicate a clear policy regarding substance abuse, including consequences for violating the policy. Provision of adequate first aid, first aiders, PPEs, safety signage (Hausa and English languages).	Health records from site clinic, records of first aid usage. Evidence of use of PPEs, caution signs onsite, well-stocked first aid kits. Records of absenteeism due to work related illnesses	Weekly	Mitigation: Contractor Monitoring: Client/ Supervision Consultant teams.	500,000 <i>(for OHS training and education)</i>

Component	Sub - Component	Activity	Potential Impact	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Mitigation and monitoring
				Provision of shaded space for breaks / meals.				
			Incidents and injuries associated with poorly managed the construction sit Un-reclaimed borrow pits could become drowning sites, accident prone locations, gully erosion	All borrow pits created for the project purpose must be reclaimed to as near as its original state as possible	Properly reclaimed borrow pits	One-off	Mitigation: Contractor Monitoring: Client/ Supervision Consultant teams.	1,000,000
SOCIAL	Traffic/ Accident	Construction activities	Delay in travel time due to traffic obstruction/ restriction/ diversions around the intervention work site. Members of the public/	Movement of work equipment /machinery should be done at off-peak hours Implement Traffic Management Plan. (Annex 9)	Contractor's compliance	Daily	Mitigation: Contractor Monitoring: Client/ Supervision Consultant teams; FRSC	<i>Covered as part of the cost in pre-construction traffic mitigation</i>

Component	Sub - Component	Activity	Potential Impact	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Mitigation and monitoring
			communities/ road users may be exposed to risks of accidents					
	Noise.	Construction activities	Noise and vibration disturbances to schools, and communities from operation of heavy-duty vehicles and equipment	Select and use vehicles/ equipment with lower sound power levels Noise mufflers should be used on noisy equipment	Contractor's compliance	Monthly	Mitigation: Contractor Monitoring: Client/ Supervision Consultant teams.	<i>Covered as part of the cost in pre-construction noise mitigation</i>
	Public Utilities	Construction activities - Earthworks and Grading	Possible relocation of existing electric poles, water supply pipes, telecom cables. Interruption of affected	Proper public announcements / sensitization on the temporary disruptions in the services ahead of time before the utilities' relocations. Contractor should ensure early consultation	Contractor's compliance	One-off	Mitigation: Contractor Client Utility Firms Monitoring: Client Utility Firms.	1,000,000

Component	Sub - Component	Activity	Potential Impact	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Mitigation and monitoring
			public utility services	and coordination with the relevant utilities' companies/ agencies for swift restoration of the services				
	Labour Influx	All construction Activities	Increase in potential spread of STIs/STDs, HIV/AIDs due to workers on site Potential Abuse of local cultural norms by workers and risk of social unrest / conflict.	Sourcing of local workforce from project communities All contractors' workers to be sensitized and sign Code of Conduct (CoC) and zero tolerance for sexual integration with community members Provide cultural sensitization training to improve awareness of and sensitivity of workers to local cultures, traditions, and lifestyles.	Sensitization conducted	Monthly	Mitigation: Contractor Monitoring: Client/ supervision consultant teams	1,000,000

Component	Sub - Component	Activity	Potential Impact	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Mitigation and monitoring
	Sexual Exploitation and Abuse (SEA)/ Gender Based Violence (GBV)	All construction Activities	Potential risk of Sexual Exploitation and Abuse (SEA), increase in GBV/SEA especially for Girls been exposed to contractors, sexual relations between contractors and minors resulting pregnancies, encouraged presence of sex workers in the project communities.	Implementation of SEA/SH Action Plan All contractors' workers to sign Code of Conduct (CoC) and be sensitized on zero tolerance for sexual misconducts Community sensitization on appropriate conduct with contractors	Compliance to SEA/SH Action Plan Signed codes of conduct Sensitizations conducted	One-off	<u>Mitigation</u> Contractor, Client <u>Monitoring</u> Contractor, Client	200,000
	Child Labour	All construction activities	Sourcing for unskilled labour may lead to risks of child labour and increased schools' dropout/	Contractor to ensure that children and minors are not employed directly or indirectly on the project, this will be closely monitored by	Contractor's compliance	Monthly	<u>Mitigation:</u> Contractor <u>Monitoring:</u> Client and Supervision consultants.	0

Component	Sub - Component	Activity	Potential Impact	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Mitigation and monitoring
			absenteeism during construction activities. This could further predispose children to health & safety risks, Violence Against Children (VAC) etc.	the client, and supervision consultants				
	Security	All construction activities	Robbery and theft of construction equipment. Security risks to workers (kidnapping, thugs / armed attacks) in view of the prevailing insecurity in the country.	Camp/ construction sites and staging areas to be lighted up with flood lights as a way of security for equipment/ materials. Implementation of Security Management Plan.	Contractor's compliance Security/ incident reports	Continuous	Mitigation: Contractor. Monitoring: Contractor Security agencies	1,000,000
TOTAL COST FOR CONSTRUCTION PHASE								6,400,000

7.3 ESMP for Operation Phase

Component	Sub-Component	Activity	Potential Impact	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Mitigation and monitoring
ENVIRONMENT	Air	Road operation	Increase in vehicular movements will lead to increase in air pollution from exhaust fumes and dusts.	Ensure use of serviceable vehicles and ensure routine maintenance of vehicles and machineries Fit pollution reduction devices. Implement appropriate driving techniques.	Routine inspection of motorists' compliance	Quarterly	Mitigation Road users/ the public Monitoring: Vehicle Inspection Officers (VIO)	-
	Drainage system	Road operation	Blockage of drainages and culverts from surface debris and improperly disposed wastes which could lead to deterioration of the LPG road and formation of	Routine maintenance of drainages through waste evacuation/ de-silting. Proper waste management system	Good sanitation practices. Routine maintenance.	Quarterly	Mitigation The general public; State Ministry of Environment and Climate Change (SMoECC); Jigawa State waste Management and Sanitation Board	1,000,000

Component	Sub-Component	Activity	Potential Impact	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Mitigation and monitoring
			gullies from obstruction of water ways.				Monitoring: Ministry of Environment;	
SOCIAL	Traffic in construction site	Road operation	Increased traffic & risk of road traffic accidents and injuries	Ensure installation of appropriate traffic signs & markings to warn drivers. Specifically, adequate numbers of these traffic signs & markings are expected to be installed on and around the new interchange LPG/ underpass structure	Traffic signs, markings installed	Periodic	Mitigation Contractor Monitoring: FRSC JIGAWA State Road Traffic Agency (KAROTA)	500,000
	Routine Road Maintenance	Operation activities	Risks of occupational accidents and injuries to road	Develop and implement specific OHS management plan for the road	OHS Plan developed and implemented	One-off	Mitigation: State Road Minstry of works) Monitoring: Client	5000,000

Component	Sub-Component	Activity	Potential Impact	Mitigation Measures	Monitoring Indicators	Monitoring Frequency	Institutional Responsibility	Mitigation and monitoring
			maintenance workers.	maintenance workers. Provision of adequate first aid, first aiders, PPE, signage (English and Local languages).	Usage of appropriate PPEs Usage of signage and demarcations		Ministry of works	
TOTAL COST FOR OPERATION PHASE								2,000,000

7.7 Institutional Responsibilities for ESMP Implementation

The institutional arrangement presented in this section highlights the implementation organization for the ESMP/ESIA during the proposed project works. **Table 7.4** presents the detailed roles and responsibilities for the ESMP/ESIA implementation among stakeholder organizations.

Table 7.4: Institutional Roles & Responsibilities of ESMP / ESIA Implementation

#	Category	Roles and Responsibilities
1	Jigawa State Ministry of Environment	- Environmental monitoring and compliance overseer at the State level - Review of draft ESMP/ESIA report (in liaison with Federal Ministry of Environment and the client) - Site assessment and monitoring of ESMP/ESIA implementation.
2	Federal Ministry of Environment / EIA Department & NESREA	- Lead roles in the provision of advice on screening, scoping, review of draft ESMP/ESIA (in liaison with State Ministry of Environment and the client), and - Receiving comments from stakeholders, public hearing of the project proposal and social liability investigations, monitoring and evaluation process and criteria. - Disclosure of the ESIA Report - Issuance of ESIA clearance (Environmental Impact Statement – EIS)
3	Contractor	- Compliance to the proposed work methodology and construction. - Mitigate environmental and social Impacts during project works - Implementation of code of conduct for all staff - Preparation of work plans for environmental management in line with the ESMP/ESIA - Ensure any changes during the construction works that may have a significant environmental and social impact are communicated to the Client/Ministry of Environment in time and managed accordingly. - Maintain records of environmental incidents as well as corrective and preventive actions taken - Ensure thorough supervision of implementation of all the measures and preparation of required monitoring report - Contractor should ensure that the safety officer conducts a Job Hazard Analysis (JHA) prior to the commencement of work to identify the hazards associated with the job activities
4	Supervising Engineer	- Preparation of the engineering designs for the proposed project works. - Provides an independent oversight ensuring the contractor adheres strictly to the engineering specifications and provide frequent reports on contractor compliance

#	Category	Roles and Responsibilities
		▪ Enforce strict implementation of the Environmental Monitoring Plan during the civil works. ▪ Thorough supervision of the mitigation of the environmental and social impacts such as labor influx, HIV/AIDS, and GBV ▪ Reporting any incidents or non-compliance with the ESMP/ESIA to the client / Ministry of Environment ▪ Ensuring adequate training and education of all staff involved in project supervision ▪ Making recommendations to the client / Ministry of Environment regarding ESMP/ESIA implementation performance as part of an overall commitment to continuous improvement
5	Relevant State Government MDAs	▪ Relevant MDAs shall come in as and when relevant areas or resources under their jurisdiction or management are likely to be affected by or implicated projects ▪ Participate in the EA processes and in project decision-making that helps prevent or minimize impacts and to mitigate them. ▪ These institutions may also be required to issue a consent or approval for an aspect of the project; allow an area to be included in the project; or allow impact to a certain extent or impose restrictions or conditions, monitoring responsibility or supervisory oversight. ▪ Inspection of project premises in order to ensure strict compliance with sanitation and waste management standards in the state.
6	Affected Communities / CDA	▪ Promote environmental awareness. ▪ Review environmental and social performance report made available by Ministry of Environment. ▪ Provide comments, advice and/or complaints on issues of nonconformity. ▪ Attend public meetings organized by the client / KSMoECC and the Contractor to disseminate information and receive feedback. ▪ Identify issues that could derail the project and support project impacts and mitigation measures, Awareness campaigns. ▪ Address issues of conflicts and grievances

7.8 Training / Capacity Building Program

Training is essential for ensuring that the ESMP provisions are implemented efficiently and effectively. All persons involved in the project implementation should be equipped with appropriate training and/or experience to carry out their roles. Similarly, the contractors shall be required to undertake general HSE awareness for their project workforce and specific training for those whose work may significantly have impact on the environment.

The proposed training program, course content and estimated costs for the proposed project are shown in **Table 7.5** below.

Table 7.5: Proposed Training / Capacity Building Program for ESMP Implementation

S/N	Training Modules	Participants	Duration	When	Responsibility	Cost (N)
1	ESMP mitigation measures and procedures for implementation and monitoring Management GM Implementation Non-discrimination of Persons with Disabilities	Project Manager, Engineers, Supervision consultant, Environmental & Community Liaison Officers	2 days	During project preparatory stage	Client, Technical Consultant	1,000,000
2	Construction HSE Overview of Health and Safety Hazards in Construction Incidents: Causation, Investigation & Reporting Site Specific OHS Construction Site Inspection Personal Protective Equipment	Contractors and their workers	3 days	During project preparatory stage Monthly refresher courses to be organized by contractor	Certified OHS Consultant / Supervision Consultant	1,000,000
3	Training on Code of Conduct, Labor influx, OHS, GM, GBV, stakeholder engagement	Contractors and their workers	10 days	During project preparatory stage Monthly refresher courses to be organized by contractor	Certified OHS Consultant / Supervision Consultant	1,000,000
4	Training of Contractor Drivers, on Road Safety requirements, standards, substance abuse prohibition etc.	Contractor drivers, HSE officers	2 days	1 day during pre-construction. 1 day during construction phase	Contractor, FRSC	500,000

S/N	Training Modules	Participants	Duration	When	Responsibility	Cost (N)
5	Community road safety training / sensitization, including training of children on basic road rules.	Project communities	1 day	Before commencement of civil works	Client, FRSC	500,000
Total						4,000,000

7.9 Monitoring and Evaluation Plan

Environmental monitoring will be an integral part of the Environmental Management Plan for the LPG project, aimed at tracking project impacts and ensuring compliance with environmental standards throughout project implementation.

The objectives of environmental monitoring include:

- verifying that mitigation measures are implemented as prescribed in the EIA report and other relevant project documents;
- providing early warning signals for incidents such as accidents, gas leaks, or equipment failures, thereby enabling timely response to prevent or minimize adverse environmental and safety impacts;
- detecting the occurrence of environmental impacts and assessing their extent and magnitude; and

The monitoring plan for the ESMP is presented in the **Table 7.6** below. Monitoring results shall be documented with preventive / corrective actions to be implemented.

Table 7.6: ESMP / ESIA Monitoring Plan

Monitoring Scope	Parameters	Location	Frequency		Responsibility	Oversight
			Construction	Operation		
Air	TSP, NO ₂ , SO ₂ , CO, CH ₄	Settlement areas, close to LPG sites	Weekly	-	Contractor	FMEnv; Jigawa State Ministry of Env.
Noise	Sound level (dB)	Sensitive spots, e.g., schools, residential	Weekly	-	Contractor	FMEnv; Jigawa State

Monitoring Scope	Parameters	Location	Frequency		Responsibility	Oversight
			Construction	Operation		
Solid waste	Volume	area close to the LPG site Designated waste collection points	Monthly	-	Contractor	Ministry of Env. FMEnv; Jigawa State Ministry of Env.
Public safety	Signs, culverts, incidence / accident records	Proposed LPG site	Monthly	1 st year (Quarterly); Subsequent (Annually)	Contractor	FMEnv; Jigawa State Ministry of Env.FRSC
Land acquisition, structures / utilities relocation	Compensation, income, employment, social adaptation, restored utility services	Proposed LPG site and adjacent communities		-	Contractor	Jigawa State Ministry of land and works

7.10 EMP Budget

The total costs of the EMP, including costs for mitigation; monitoring and capacity building is estimated as: N **17,590,000.00** (Seventeen Million, Five hundred and ninety Thousand Naira only) as summarized in Table below:

Table 7.7: ESMP / ESIA Budgeted

ITEM	RESPONSIBILITY	COST ESTIMATE (N)
Cost of Mitigation and monitoring	Contractor /client/Government	12,900,000.00
Capacity Building	Client / Contractor	4,000,000.00
Sub-total		16,900,000.00
Contingency (10% of sub-total)		1,690,000.00
TOTAL		17,590,000.00

7.11 ENVIRONMENTAL AUDIT

An environmental audit will be undertaken after the first three years project lifecycle and at scheduled intervals during the operational phases of the proposed LPG facility in Dutse. The audit process will serve as a management tool for evaluating environmental performance and ensuring that the project is implemented in line with the principles of sustainable development and applicable regulatory requirements. The environmental audit will focus on verifying that appropriate management systems and control measures are in place and functioning effectively throughout the lifecycle of the LPG project.

Specifically, the audit will aim to:

- assess the level of compliance with relevant environmental laws, guidelines, and permit conditions applicable to LPG operations;
- examine facility management systems, operational procedures, and environmental monitoring practices;
- identify existing and potential environmental issues that may arise during the preconstruction, construction, and operational phases of the project;
- confirm the effective implementation of recommended mitigation measures and management procedures outlined in the EIA and EMP; and
- provide practical recommendations for strengthening and improving the environmental

management system of the LPG project. Findings from the audits will be documented and used to support continuous improvement in environmental performance.

- ensuring that emissions, effluents, and waste generated from LPG-related activities remain within permissible regulatory limits.

Two major types of environmental monitoring will be adopted for the project:

1. **Impact Monitoring:** This will involve monitoring environmental parameters that may be affected by LPG construction and operational activities. Key variables will include:
 - flora and fauna;
 - soil quality and stability;
 - surface water quality and sediment characteristics;
 - ambient air quality and noise levels within and around the project area.
2. **Compliance Monitoring:** Compliance monitoring will be carried out through periodic sampling and, where necessary, continuous measurement of emissions, effluents, noise, and other discharges from the LPG facility. This will ensure that all environmental parameters consistently meet standards prescribed by FMEnv and other relevant regulatory authorities.

CHAPTER EIGHT

CONCLUSION AND RECOMENDATIONS

8.1 CONCLUSION

The Environmental and Social Impact Assessment (ESIA) for the proposed LPG project at Ibrahim Aliyu bypass road opposite Federal University Dutse in Dutse metropolis concludes that the project is environmentally feasible and socially desirable, provided the mitigation measures and management plans outlined in this report are rigorously implemented.

The project assessment covered all phases of the project lifecycle, including site preparation, construction, operation, and decommissioning, with particular emphasis on key environmental components such as air quality, soil characteristics, groundwater protection, ambient noise levels, traffic conditions, occupational health and safety, and community wellbeing within the defined area of influence.

The baseline studies revealed a pre-existing environment already under stress, with some air quality parameters (NO₂, SO₂, PM_{2.5}, PM₁₀) exceeding national and WHO standards, and soil and water quality issues requiring attention. Such impacts are not expected to be significant with mitigation measures to be taken care of by the Environmental and social management plan (ESMP).

The socioeconomic and stakeholder engagement study confirms that the proposed **SHAKKATO Nigeria Limited LPG Plant** is socially acceptable, environmentally feasible, and economically beneficial. The community exhibits strong support, cohesive social structures, and readiness to participate in project activities.

With effective implementation of mitigation and enhancement measures, the project will:

- ▶ Minimise adverse impacts;
- ▶ Maximise local benefits; and
- ▶ Contribute to Jigawa State's sustainable development agenda.

The assessment of alternatives confirmed that the selected option—a cloverleaf LPG—presents the most balanced solution for achieving the project's core objectives of enhanced mobility, safety, and economic efficiency, with manageable environmental and social impacts compared to the "do-nothing" or road-widening options.

Therefore, it is concluded that the project's significant positive impacts can be realized while its negative impacts can be effectively mitigated through a committed implementation of the ESIA's Environmental and Social Management Plan (ESMP). The proposed 30MT LPG storage and refilling plant represents a strategic and sustainable energy infrastructure project that effectively balances economic development with environmental stewardship. Provided that the Environmental Management Plan is fully implemented and regulatory oversight is maintained, the project is considered environmentally acceptable, socially beneficial, and capable of contributing meaningfully to clean energy transition and sustainable development.

8.2 Recommendations

To ensure the project aligns with sustainable development principles and safeguards community well-being, the following key recommendations are made:

A. *Pre-Construction Phase:*

1. **Finalize Compensation and Resettlement:** Expedite the transparent and fair Compensation process for all Project-Affected Persons (PAPs), including property and business owners, as per the commitments made during stakeholder engagements and in line with the Land Use Act.
2. **Detailed Engineering Design Integration:** Integrate all mitigation measures from this ESIA (e.g., drainage design for flood control, heritage preservation plans) into the final engineering designs and tender documents.
3. **Procurement:** Ensure contractors are pre-qualified based on their environmental, health, and safety (EHS) track record and commitment to implementing the ESMP.

B. *Construction Phase:*

1. **Pollution Control:** Strictly enforce dust suppression measures (e.g., regular water spraying, covering trucks) and noise control protocols to minimize air and noise pollution, given the already poor baseline air quality.
2. **Erosion and Sediment Control:** Implement silt fences, sediment traps, and stabilize exposed soils immediately to prevent erosion and contamination of water bodies, a critical measure given the area's sandy and highly permeable soils.

3. **Traffic Management:** Implement a robust Traffic Management Plan (TMP) with clear signage, designated alternative routes, and traffic wardens to minimize disruption and maintain access for residents and emergency services.
4. **Community Grievance Mechanism:** Operationalize the established Grievance Redress Mechanism (GRM) and ensure it is accessible, well-publicized, and responsive to community concerns throughout construction.

C. *Operation Phase:*

1. **Environmental Monitoring:** Conduct post-construction monitoring of air quality, noise levels, and groundwater quality to assess the project's long-term performance against baseline conditions and ensure compliance with standards.
2. **Infrastructure Maintenance:** Establish a scheduled maintenance program for the LPG and associated drainage systems to ensure their structural integrity and operational safety over the long term.

D. *Institutional Capacity:*

1. **Capacity Building:** The Jigawa State Ministry of Works and Housing, in collaboration with Ministry of Environment & Climate Change, should ensure its project supervision team and the contractors receive training on ESMP implementation, monitoring, and community engagement protocols.
2. **Monitoring and Enforcement:** The Ministry, in collaboration with regulatory bodies like NESREA and JIGAWA State Ministry of Environment & Climate Change, must take primary responsibility for monitoring compliance with the ESIA / ESMP and enforcing mitigation measures.

The ESIA therefore recommends proceeding with project implementation, subject to continuous monitoring and adaptive management under the Environmental and Social Management Plan (ESMP).

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ANNEX 1: ESIA TERMS OF REFERENCE

TERMS OF REFERENCE

FOR THE

**PREPARATION OF ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR THE
PROPOSED CONSTRUCTION OF LIQUEFIED PETROLEUM AND GAS PLANT AT DUTSE
LOCAL GOVERNMENT AREA, JIGAWA STATE, NIGERIA.**

SUBMITTED TO:

FEDERAL MINISTRY OF ENVIRONMENT, ABUJA

BY

SHAKKATO NIGERIA LIMITED

Jigawa State – Nigeria

PREPARED BY

ENVIRESOURCE CONSULT LIMITED

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0803874824

JUNE, 2026

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1.0 THE PROPONENT

Shakkato Nigeria Limited plans to construct liquefied petroleum and gas plant at eastern by pass, Dutse Local Government Area, Jigawa state – Nigeria.

Table 1: Proponent details

Name client :	Shakkato Nigeria Limited
Contact person:	Mr. Mukhtar Bello Mukhtarbello67@gmail.com
Office address:	Eastern by pass, Dutse Local Government Area, Jigawa state – Nigeria .
Proposed Location Site:	Eastern by pass, Dutse Local Government Area, Jigawa state – Nigeria.

2.0 INTRODUCTION

The Shakkato Nigeria Limited plans to construct the liquefied petroleum and gas plant in 2626m² (0.263ha) that will produce nearly thirty (30) metric tonnes of LPG per day. This project has the potential for significant environmental and social impacts, necessitating the preparation of an Environmental and Social Impact Assessment (ESIA) to identify, evaluate, and mitigate these impacts. The ESIA will comply with national and international environmental and social safeguards, including the Nigerian Environmental Impact Assessment (EIA) Act Cap E12 LFN 2004, World Bank Environmental and Social Standards (ESS), and other relevant regulations and international best practices.

2.1 PROJECT JUSTIFICATION

The proposed LPG plant is justified by the increasing demand for clean, efficient, and affordable energy for domestic, commercial and industrial use. Population growth, urbanization, and rising energy needs have placed pressure on existing LPG supply and distribution infrastructure, creating need for additional storage and distribution facilities. The project will improve the availability and accessibility of LPG across the state, thereby reducing dependence on traditional fuels such as firewood, charcoal, and kerosene, lower greenhouse gas emissions, and improved air quality. The project is also justified on economic grounds, as it will create employment

opportunities during both construction and operational phases. It will simulate developments in the local business activities, and generate revenue for Jigawa state through taxes and levies. Furthermore, the project aligns with the national energy policies and sustainable development goals that encourage the adoption of cleaner energy sources, energy security, environmental protection, and suitable economic growth. .

2.2 PROJECT OBJECTIVES

The objectives of the proposed project are to establish a safe and efficient Liquefied Petroleum Gas (LPG) storage and distribution facility for the supply of LPG to domestic, commercial and industrial consumers. And also to create employment opportunities during the construction and operational phase of the project.

2.3 NEED FOR THE PROJECT

SHAKKATO Nig. Limited intention to undertake the construction of liquefied petroleum and gas plant in Jigawa city is based on the need of growing demand of LPG for cooking, heating and industrial application, promotion of clean energy, economic development and job creation toward contributing in rising Nigeria's GDP thereby helping the economic growth of the country.

3.0 OBJECTIVES OF THE ESIA

The objectives of the EIA:

This ESIA will be executed to establish the environmental baseline, sensitivities, impacts and mitigation measures with respect to the development (including operation) of the proposed project. The EIA will ensure the effective systematic study process. These include:

- i. Assessment of the present environment status, establishment of environmental issues and factors which are associated with the LPG project development;
- ii. Assessment and prediction of all possible and potential impacts of the project on components of the environment in terms of magnitude and significance;
- iii. Evaluation of alternatives and identification of the best options that is both cost effective and with least potential environmental impact; and

- iv. Incorporation of ESIA recommendations into the project's detailed design as well as other stages of the project development.
- v. Describe project components and activities of relevance to the environmental and social impacts assessments.
- vi. Document the biophysical and socio-economic baseline conditions of the study areas and the affected communities
- vii. Identify all stakeholders and ensure proper consultation and engagement of all stakeholders, including the communities bordering the proposed project, and document and address environmental and social concerns raised by stakeholders and the Public in consultation events and activities
- viii. Assess associated/potential environmental, social, health and safety impacts of the project
- ix. Describe what preventive and mitigative environmental and social measures the project proponent commits to implement to address adverse impacts identified
- x. Develop the corresponding Environmental and Social Management Plan (ESMP) for the project

4.0 SCOPE OF WORK

The TOR for the Impact Assessment of the proposed project shall be designed based on the methodology of scope of work of this project for comprehensive study. The methodology of carrying out this study shall be in many parts. First of all pre-Environmental Impact Assessment Study (ESIA) exercise including:

- 1. Legal framework:** General review of all the environmental regulatory and legal aspects relevant to the construction industry.
Further terms of reference that shall be undertaken in cause of this study shall include.
- 2. Site Inspection/Investigation:** An initial site inspection will be carried out between the consultant, client and the engineer of the Company. The purpose of this is to acquaint the consultants with the proposed project site for the purpose of screening.

- 3. Site Verification Survey:** A reconnaissance survey with representative of Jigawa state ministry of environment and Federal Ministry of Environment and the proponent in and around the proposed site shall be carried out. The aim is to get first hand visual impression of the site so as to determine relevant information/data for the work (Scoping).

4. Description & location of site

Detailed general study of the site in relation to the location shall be studied and taken into recognition the adjoining properties. The immediate land use in the environment and other external adjoining properties of the site shall be investigated and studied. Location and position of the proposed site as defined by GPS shall also be noted and documented for future reference.

- **Interviews:** Questionnaire would be prepared and administered to sample of people to find out their perception of the impacts of the proposed project site on the immediate environment. This is important because public opinion is a prerequisite and a key factor in decision-making during ESIA process and approval. The public concern and participation will help to eliminate or reduce any conflicts between the people and project owners.

All the information and data collected will be analyzed and interpreted. The results of which will be used for impact prediction and recommendations for best practicable mitigation measures.

- **Field Data Generation Survey:** Soil, Water (underground), and ambient air quality would be analysed at various sample locations within the site and at control sample points to evaluate the baseline parameters through laboratory analysis. This strategy will help in drawing appropriate mitigation measures on the identified impacts and will provide bases for environmental monitoring plan.

Table 2: Proposed sampling frame

Environmental Component	Sampling Parameter	Sampling Location	Frequency	Sample Size	Analysis/Methods
Soil (top soil and sub-soil)	- Ph	3 points: North, South, and project site center	Baseline	9 (6 baseline with construction site, 3 control points)	Standard soil testing (e.g., ASTM methods)
	- Heavy metals (e.g., Pb, Cd)	Same as above	Baseline	Same as above	Atomic Absorption Spectroscopy (AAS)
	- Organic content	Same as above	Baseline	Same as above	Loss on ignition (LOI) method
	- Grain size distribution	Same as above	Baseline	3 baseline	Sieve analysis
Water	- Ph	2 points: Upstream and downstream of any nearby water bodies	Baseline	6 (3 baseline within construction site, 3 control points)	pH meter calibration
	- Dissolved oxygen (DO)	Same as above	Same as above	Same as above	Winkler method
	- Total dissolved solids (TDS)	Same as above	Baseline	Same as above	Conductivity meter
	- Heavy metals (e.g., Pb, Cd)	Same as above	Baseline	Same as above	AAS or ICP-MS

Air	- Particulate Matter (PM2.5, PM10)	4 points: North, South, East, and West around project	Baseline	9 (6 baseline with construction site, 3 control points)	Gravimetric method or air monitors
	- Nitrogen Oxides (NOx)	Same as above	Baseline	Same as above	Chemiluminescence
	- Sulfur Dioxide (SO2)	Same as above	Baseline	Same as above	Fluorescence method
	- Carbon Monoxide (CO)	Same as above	Baseline	Same as above	Non-dispersive Infrared (NDIR)

Source: Field work, 2026

Also, in order to provide an accurate spatial dimension to the obtained data, all sampling and observation points shall be geo-referenced using Global Positioning System (GPS) receiver. The sampling protocol will ensure adequate coverage of the spatial and ecological zones of the study area.

Adequate Quality Control and Quality Assurance measures shall be employed during sample collection in the field and laboratory analysis. The analytical methods will be those recommended by the FMENV.

Baseline parameters survey shall be conducted within the site and the control area observing the immediate environment, noting all the socio-economics, residential, and other activities around the study area. This will enable the consultants to predict the potential impacts of the project on the environment.

Photographs of site shall be captured; adjoining properties up to 1km away to left and 1km away to the right of the site shall be studied

➤ **Identification of Associated and Potential Impacts**

- i. Identification of potential impacts shall be carried out in accordance with the following standard methodology:
- ii. Identification of Impact Sources – checklist

- iii. Identification of Impact Indicators – checklist
- iv. Prediction of impact magnitude
- v. Identification of mitigation measures, avoidance/elimination/minimization and enhancement strategy.

The potential environmental impacts associated with various stages of construction and operation of the LPG farm shall be assessed. The potential impacts of the operation on the environment shall be given more emphasis and concern for human life quality.

➤ **Physical / Chemical Category**

This shall cover geology and topography of the area, soil type and land use in terms of agriculture, construction, groundwater storage capacity, and relation between groundwater, rainwater, the flora and fauna

➤ **Human and environmental factor**

The issues to be discussed and studied include:

- i. History and cultural value of the area. This shall extend to architectural, lifestyle, sociocultural values of the area and also religious significance.
- ii. Employment and life pattern of community, human health impacts from noise and vibration and area of endangered species of plant and animal if any.

➤ **Water/soil studies**

Identify and map out soil water distribution of the area, collection of top and bottom soil samples that is homogeneous representative of the ecological zone in the area for laboratory analysis to determine the physicochemical properties (soil texture, electrical conductivity, total hydrocarbon content, colour, porosity material and size etc), soil ecology (soil texture pattern and distribution) and soil microbiology. Other sources of water like underground water shall be surveyed and sampled for laboratory analysis to check for water pollutant. This shall include biochemical oxygen demand (BOD), chemical oxygen demand (COD), dissolved oxygen, pH, temperature, suspended solid, turbidity, oil content and heavy etc.

➤ **Meteorological and climate study**

The study shall involve interpretation of the following climatic elements obtain from secondary data. This shall include

1. Temperature, ambient air and relative humidity
2. Rainfall distribution of selected period from available data
3. Atmospheric nature (humidity)

➤ **Air quality measurement**

An in situ air quality measurement shall be conducted at various mapped-out locations in and around the site. The value obtained on each parameter shall be compared with FMENV and international standards. The parameter shall include ammonia, carbon dioxide, carbon monoxide, sulphur oxide, nitrogen oxide, volatile organic compound, methane, hydrogen oxide and percentage of oxygen and noise.

➤ **Waste management**

This shall include quantification and assessment of adequate waste disposal facilities for both liquid and solid waste that will be generated in the site during clearing construction and operation of the LPG farm, and also to recommend potential site for non-hazardous waste before final evacuation.

➤ **Socio economic studies**

The socioeconomic study shall include description of demographic pattern of the and project site in general, in terms of land use pattern, ethnic group, cultural heritage, occupations and religions.

Community participation of the people to determine their views and worries about the proposed project shall be achieved by administering questionnaire to stake holders and other community members.

➤ **Mitigation measure**

For any identified negative impact of the proposed project development during the ESIA study of the poultry construction, mitigation measures shall be proffered accordingly for the impact to enhance a sustainable operation of the project on the environment.

- **Project De-Commissioning**

Decommissioning of the project shall be contracted to competent registered company to carry out the exercise. Scope of work and monitoring exercise shall be designed for the decommissioning exercise.

5.0 BRIEF PROJECT DESCRIPTION.

The proposed project will involve the construction and operation of liquefied petroleum gas LPG storage, bottling, and distribution plant designed to received, storage, refill, and distribute LPG to domestic, commercial, and industrial consumers.

The plant will typically consists of

- LPG storage tanks
- LPG unloading and loading facilities
- Cylinder filling and bottling units
- Pump and compressor system
- Administrative and control building
- Fire protection system
- Weighing and metering equipment
- Utility services (water supply, electricity and drainage)

The facility will operate in compliance with relevant safety, environmental, and industry regulations. Safety measures will include; fire detection and suppression system, emergency shutdown system, gas leak detection system, personal protection equipment (PPE).

6.0 LEGAL AND ADMINISTRATIVE FRAMEWORKS

The preparation of this ESIA shall be guided by the following laws, regulation, guidelines and policies of government and other relevant international treaties and convention to which Nigeria is a signatory.

1. Constitution of the Federal Republic of Nigeria (1999)

- ✓ Section 20 mandates the state to protect and improve the environment, including safeguarding air, water, land, forest, and wildlife.

2. Environmental Impact Assessment (EIA) Act (Cap E12, LFN 2004)

- ✓ Requires that proposed construction projects undergo an Environmental Impact Assessment before approval, ensuring sustainability and mitigation of environmental risks.

3. Harmful Waste (Special Criminal Provisions) Act (Cap H1, LFN 2004)

- ✓ Prohibits the unlawful depositing of harmful wastes and ensures proper handling of hazardous construction waste.

4. Nigerian Urban and Regional Planning Act (Cap N138, LFN 2004)

- ✓ Governs urban planning, land development, and ensures environmental considerations in construction and development.

5. National Environmental Standards and Regulations Enforcement Agency (NESREA) Act (2007)

- ✓ Establishes NESREA as the primary agency responsible for enforcing environmental laws, guidelines, and regulations in construction projects.

6. Factories Act (Cap F1, LFN 2004)

- ✓ Addresses occupational health and safety in construction and industrial operations, including measures to prevent environmental pollution.

7. National Environmental (Construction Sector) Regulations, 2011

- ✓ Provides specific guidelines to minimize environmental pollution from construction activities.

8. National Environmental (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations, 1991

- ✓ Stipulates standards for pollution control, applicable to construction sites and related industries.

9. National Environmental (Quarrying and Blasting Operations) Regulations, 2013

- ✓ Guides quarrying, excavation, and blasting activities in construction, emphasizing environmental protection.

10. National Environmental (Noise Standards and Control) Regulations, 2009

- ✓ Sets limits on noise pollution for construction activities to protect workers and communities.

11. National Environmental (Soil Erosion and Flood Control) Regulations, 2011

- ✓ Targets erosion and flood prevention measures, especially relevant to large-scale construction projects.

12. National Environmental (Sanitation and Wastes Control) Regulations, 2009

- ✓ Ensures proper sanitation and waste management during and after construction.

13. Land Use Act (Cap L5, LFN 2004)

- ✓ Regulates land acquisition and use for construction, balancing development with environmental conservation.

14. Water Resources Act (Cap W2, LFN 2004)

- ✓ Protects water resources from pollution due to construction activities, including dredging or borrow pit excavation.

15. Endangered Species (Control of International Trade and Traffic) Act (Cap E9, LFN 2004)

- ✓ Restricts construction activities in areas hosting endangered species.

16. Convention on Biological Diversity (1992)

- ✓ Integrated into Nigerian law to protect ecosystems potentially affected by construction.

17. United Nations Framework Convention on Climate Change (UNFCCC)

- ✓ Imposes obligations to reduce greenhouse gas emissions in large-scale construction projects.

Other Relevant Policies

18. National Policy on Environment (Revised 2016)

- ✓ Offers overarching guidelines for integrating environmental concerns into construction and development.

19. Nigeria Building Code (Draft)

- ✓ Provides safety, health, and environmental standards for construction activities.

Jigawa state laws

20. Jigawa State Environmental Planning and Protection Agency (KEPPA) Law (1990)

- ✓ Establishes KEPPA as the primary agency responsible for environmental protection and management in Jigawa State.
- ✓ Ensures compliance with environmental standards in construction activities, including waste disposal, pollution control, and urban planning.
- ✓ Jigawa State Urban Planning and Development Board Law (1988)
- ✓ Regulates urban and rural land use, ensuring that construction projects comply with planning standards and environmental sustainability.

21. Jigawa State Sanitation and Refuse Disposal Law

- ✓ Governs waste management during and after construction, emphasizing proper disposal of construction debris and hazardous materials.

22. Jigawa State Development Permit Regulations: Requires construction projects to obtain a development permit that includes an environmental assessment of the proposed activities.

23. Jigawa State Environmental Pollution Control Law

- ✓ Controls pollution arising from construction activities, such as air, noise, and water pollution, ensuring projects do not harm surrounding communities.

24. Jigawa State Land Use Regulations

- ✓ Governs land allocation and development, ensuring construction projects are compatible with the state's environmental conservation goals.

25. Jigawa State Water Resources and Drainage Law

- ✓ Protects water bodies from contamination due to construction activities, including excavation, dredging, and borrow pit operations.

26. Jigawa State Soil Erosion and Flood Control Policy

- ✓ Addresses soil erosion and flooding risks caused by construction, requiring developers to implement mitigation measures.

27. Jigawa State Occupational Health and Safety Guidelines

- ✓ Enforces health and safety standards on construction sites to protect workers and prevent environmental hazards.

28. Jigawa State Noise Control Guidelines

- ✓ Sets noise limits for construction activities to minimize disruption to residential areas and ecosystems.

29. Jigawa State Waste Management Policy

- ✓ Regulates the handling, transportation, and disposal of construction waste to prevent illegal dumping and environmental degradation.

30. Jigawa State Plastic Waste Control Law (2014)

- ✓ Includes provisions to manage plastic waste generated from construction projects, particularly in packaging and site materials.

31. Jigawa State Forestry and Wildlife Protection Law

- ✓ Restricts construction activities in protected areas, ensuring conservation of biodiversity and natural habitats.

32. Jigawa State Wetlands and Ecosystem Conservation Guidelines

- ✓ Protects wetlands and other ecologically sensitive areas from adverse effects of construction.

33. Jigawa State Environmental Policy (2017)

- ✓ Provides a framework for integrating environmental considerations into construction planning and implementation.

34. Jigawa State Green Building Initiative

- ✓ Encourages the adoption of eco-friendly construction practices to minimize environmental impacts.

7.0 PROJECT LOCATION

The project site is located in Dutse, Jigawa State, which is situated in the **northern part** of Nigeria. The site is a critical point that connects several important road networks that lead to Borno State and it lies within the **outskates of Jigawa** which is the fastest growing city in Nigeria

1. **Coordinates:**

the project site is approximately located at **11.14247°N latitude** and **9.2204°E longitude**, with an elevation of 442.47m

2. **Proximity to Key Locations:**

The proposed project site is located at Eastern bypass opposite to Federal University Dutse relatively close to the heart of the city center, providing easy access to major markets and consumers. The location will facilitate efficient LPG distribution, support commercial and industrial activities

3. **Region:**

the site is part of **Dutse outskirt Area**, which is the largest urban agglomeration in Jigawa State. The area is located within **Dutse Local Government Area**, one of the 27 LGAs in the state.

4. **Terrain:**

The region around project site is relatively flat, characteristic of much of Jigawa State's landscape. The area lies within the **Sudan Savanna zone**, with a semi-arid climate and distinct wet and dry seasons.

5. **Economic Significance:**

Project site is strategically important due to its role in facilitating trade and movement between Jigawa and other northern western states. Jigawa itself is a significant commercial hub, especially known for its agricultural trade, textile industries, and historical markets.

- **Transport:** The project site is a point that connects major highways, including the road leading to **Niger Republic**, making it a key area for both local and international travel.

8.0 ENVIRONMENTAL AND SOCIAL MANGEMENT PLAN

An environmental management plan (ESMP), also referred to as an impact management plan, will be prepared as part of this ESIA reporting. It translates

recommended mitigation and monitoring measures into specific actions that will be carried out by the proponent. The ESMP will form the basis for impact management during project construction and operation.

The EMP will contain the following:

- i. Summary of the potential impacts of the proposal;
- ii. Description of the recommended mitigation measures;
- iii. Statement of their compliance with relevant standards;
- iv. Allocation of resources and responsibilities for plan implementation;
- v. Schedule of the actions to be taken;
- vi. Program for surveillance, monitoring and auditing;
- vii. Contingency plan when impacts are greater than expected.

The ESMP should contain commitments that are binding on the proponent. It will be translated into project documentation and provide the basis for a legal contract that sets out the responsibilities of the proponent. In turn, the proponent can use the EMP to establish environmental performance standards and requirements for those carrying out the works or providing supplies. The EMP can also be used to prepare an environmental management system for the operational phase of the project.

9.0 ENVIRONMENTAL IMPACT ASSESEMENT PROCESS

This ESIA is a systematic process to identify and evaluate the social, cultural, health, economic and environmental effects of the proposed project. Particular attention is given to preventing, mitigating and offsetting the significant adverse effects of the proposed project based on consultations with the affected communities as well as physical data collection.

9.1 Identifying and Defining the Project

The goal of this step is to define the project to accurately determine the zone of possible impacts and to include activities that are closely connected with the proposal so that the entire scope of environmental impacts is evaluated adequately

9.2 Baseline Data collection

This involves collection and evaluation of all relevant environmental and socio-economic data relevant to the project in order to describe adequately the condition and set up of the project area prior to the commencement of the project. The baseline data is key to project monitoring as it will reveal changes from ambient either in the negative or positive after the commencement of the project

9.3 Scoping

Scoping is a stage, involving the public and other interested parties, that identifies the key social, economic and environmental issues that should be addressed. This step provides one of the first opportunities for members of the public and all interested to learn about the project and to voice their opinions. This exercise may also reveal similar or connected activities that may be occurring in the vicinity of the project, or identify problems that need to be mitigated or that may cause the project to be modified.

Examination of alternatives

To establish the preferred or most socially, economically and environmentally sound and benign option for achieving proposal objectives.

Impact analysis

To identify and predict the likely social, economic, environmental and other related effects of the proposal

Mitigation and impact management

To establish the measures that are necessary to avoid, minimize or offset predicted adverse impacts and, where appropriate, to incorporate these into an environmental management plan or system.

Evaluation of significance

To determine the relative importance and acceptability of residual impact.

9.4 Preparing Draft ESIA

A draft ESIA will be prepared in accordance with the Terms of Reference and/ or the range of issues identified during the scoping process. The draft ESIA will also meet the content requirements of the overarching ESIA law or regulations. This step will involve engage a wide range of technical specialists to evaluate baseline conditions, predict the likely impacts of the project, and design mitigation measures.

9.5 Public Participation

Public participation will consist of informational meetings, public hearings, and opportunities to provide comments about the project. Key stakeholders namely, Political office holders at the local level, state and Federal. Also traditional authorities concerned at the village local and state levels. Members of the local communities affected by the projects at all levels will also be involved. Furthermore, experts and NGOs will be engaged to identify key issues that require mitigation. Due to the varying range of concern it is envisaged that public engagement of the different groups will take place at different times.

9.6 Preparing Final ESIA

This produces a final impact assessment report that addresses the viewpoints and comments of the parties that reviewed the draft EIA. These comments may prompt additions to the text of the draft ESIA. The final ESIA will contain an appendix summarizing all of the comments received from the public and other interested parties and provide responses to those comments.

9.7 Submission of final ESIA report

The final ESIA report together with the identification of key impacts, evaluation of alternatives, identification of key stakeholders to be directly impacted by the projects, Mitigation plan and Environmental monitoring plan

10.0 REPORTING FORMAT

In accordance with the ESIA guidelines of the Federal Ministry of Environment, the following reporting shall be adopted:

- a) Title page (including the name of complying facility)
- b) List of preparers
- c) Table of contents
- d) Acknowledgement
- e) Executive summary
- f) Introduction
- g) Overview of the Project/development or Activity
- h) Baseline environmental Assessment
- i) EMP
- j) Bibliography
- k) Appendix

ANNEX 2: SOCIOECONOMIC SURVEY QUESTIONNAIRE

PROPOSED LPG PLANT, DUTSE, JIGAWA STATE (SHAKKATO NIGERIA LIMITED) – HOUSEHOLD QUESTIONNAIRE FOR ESIA

INFORMED CONSENT (READ ALOUD; SIGNATURE REQUIRED)

"Good day. My name is [Enumerator's Name]. I am part of a team charged with the task of conducting a survey to collect data needed for conducting Environmental and Social Impact Assessment (ESIA) with respect to a Proposed LPG Plant to be constructed in Dutse, Jigawa State. Details about the project and the survey are as follows: **Project name and address:** SHAKKATO NIGERIA LIMITED, Ibrahim Aliyu Way Bypass by Madobi Road, Near Main Gate of Federal University Dutse, Adjacent Audu Manager and Sons Ltd Petrol Station, Opposite Eid Prayer Ground. **Purpose of survey:** To collect household socioeconomic baseline data and perceptions to enable conduct of the Environmental and Social Impact Assessment (ESIA). **Voluntary participation:** Your participation is voluntary. You may skip any question or stop at any time without penalty. **Confidentiality of information:** The answers you provide will be kept confidential and used only for the ESIA. No names will be published. **Risks/Benefits:** There is no direct payment for participation in the survey. But the information you provide may help us assess how to reduce potential negative impacts of the project and improve benefits for the community as a whole."

Consent: I have read/heard the information, had the chance to ask questions, and agree to participate.

- **Respondent signature / thumbprint:** _____
- **Enumerator name:** _____ **Date:** ____ / ____ / ____
- **Household ID:** _____ **GPS Lat:** _____ **GPS Long:** _____
- **Interviewer notes:** _____

HOUSEHOLD QUESTIONNAIRE

Interviewer instructions: Ask questions in Hausa where appropriate. Record exact answers for open questions. Use codes where provided. Leave respondent comfortable; keep interview under 60 minutes.

SECTION A — HOUSEHOLD IDENTIFICATION (ADMIN)

- A1. **Household unique ID:** _____
- A2. **Enumerator name:** _____
- A3. **Date of interview (DD/MM/YYYY):** ____ / ____ / ____
- A4. **Village/Community:** _____
- A5. **Ward / Unguwa:** _____
- A6. **Nearest landmark to household:** _____
- A7. **Distance to proposed plant site (approx. metres):** _____
- A8. **Respondent name and relation to household head:** _____
- A9. **Respondent phone (if available):** _____

Interviewer notes: _____

SECTION 1 — DEMOGRAPHY

Purpose: To capture household composition and basic demographic profile.

- 1.1 **Name of household head:** _____
- 1.2 **Sex of household head:** 1=Male; 2=Female; 3=Other _____ (code)
- 1.3 **Age of household head (years):** _____
- 1.4 **How many people normally live in this household? Total =** _____
- **By sex:** Males = _____; Females = _____
 - **By age groups:** 0–4 = ____; 5–14 = ____; 15–24 = ____; 25–59 = ____; 60+ = ____
- 1.5 **Marital status of household head:** 1=Single; 2=Married monogamous; 3=Married polygamous; 4=Widowed; 5=Divorced/Separated; 6=Other _____ (code)
- 1.6 **Ethnicity of household head (tick main):** 1=Hausa; 2=Fulani; 3=Other (specify) _____
- 1.7 **Religion of household head:** 1=Islam; 2=Christianity; 3=Traditional; 4=None; 5=Other _____

1.8 **Primary language spoken at home:** 1=Hausa; 2=Fulfulde; 3=Other (specify) _____

1.9 **Household members who are migrants (seasonal or permanent) in last 12 months?** 1=Yes; 2=No.

- If **Yes**, list number and reason (work, marriage, schooling, other): _____

Interviewer notes: _____

SECTION 2 — SOCIAL STRUCTURE AND ORGANIZATION

Purpose: To understand household position in community, leadership, social networks, and customary practices.

2.1 **Is this household headed by a male or female elder?** 1=Male elder; 2=Female elder; 3=Youth head.

2.2 **Does the household belong to any social groups or associations?** 1=Yes; 2=No.

- If **Yes**, list groups and roles (e.g., farmers' cooperative, women's group, youth association, religious committee): _____

2.3 **Who makes major decisions in the household?** (tick all that apply) 1=Household head; 2=Spouse; 3=Elders; 4=Youth; 5=Other _____

2.4 **Do you recognise any local leaders (e.g., village head, imam, Ardo, traditional ruler)?** 1=Yes; 2=No.

- If **Yes**, name them and describe their role: _____

2.5 **Are there customary rules about land, water, grazing, or resource use in this community?** 1=Yes; 2=No.

- If **Yes**, briefly describe: _____

2.6 **Have there been recent conflicts in the community (last 3 years)?** 1=Yes; 2=No.

- If **Yes**, what were the causes? 1=Land; 2=Water; 3=Grazing; 4=Resources; 5=Other _____

- **Were households displaced?** 1=Yes; 2=No. If yes, how many households? _____

Interviewer notes: _____

SECTION 3 — LIVELIHOODS

Purpose: To capture baseline of income sources, employment, seasonal patterns, and vulnerability to project impacts.

3.1 Main livelihood of household (primary source of income): 1=Crop farming; 2=Livestock rearing; 3=Trading; 4=Formal employment; 5=Artisan; 6=Transport; 7=Other _____ (code)

3.2 Secondary livelihood(s) (if any): _____ (list up to 3)

3.3 Estimate average monthly household income (NGN): _____

- **If unknown, use categories:** 1=<20,000; 2=20,000–50,000; 3=50,001–100,000; 4=>100,000

3.4 Do any household members work at or near the proposed plant site or in similar industries? 1=Yes; 2=No.

- If **Yes**, specify job type and number of members: _____

3.5 Do you own land? 1=Yes; 2=No.

- If **Yes**, total area (hectares): _____
- **Type of tenure:** 1=Customary; 2=Freehold; 3=Lease; 4=Rented; 5=Communal; 6=Other _____
- **Is any of your land within 1 km of the proposed plant site?** 1=Yes; 2=No.

3.6 Do you own livestock? 1=Yes; 2=No.

- If **Yes**, list types and approximate numbers: Cattle ____; Goats ____; Sheep ____; Poultry ____; Camels ____; Other ____

3.7 Do you collect natural resources (fuelwood, wild fruits, medicinal plants, grazing) from areas near the proposed site? 1=Yes; 2=No.

- If **Yes**, list resources and frequency: _____

3.8 Seasonality: Which months are busiest for your main livelihood? From _____ to _____ (months).

3.9 If the plant causes restricted access to land or grazing, how would this affect your household income? 1=No effect; 2=Minor; 3=Moderate; 4=Severe. Explain:

Interviewer notes: _____

SECTION 4 — SOCIAL INFRASTRUCTURE

Purpose: To capture baseline access to services and infer likely project impacts on infrastructure.

4.1 Distance to nearest primary school (walking minutes): _____

4.2 Distance to nearest health facility (walking minutes): _____

4.3 Distance to nearest market (walking minutes): _____

4.4 Main source of water for household: 1=Borehole; 2=Well; 3=River/stream; 4=Tap; 5=Rainwater; 6=Other _____

4.5 Main type of sanitation facility utilized by household: 1=Flush toilet; 2=Pit latrine; 3=Open defecation; 4=Other _____

4.6 Electricity access at home: 1=Grid; 2=Generator; 3=Solar; 4=None. Hours per day: _____

4.7 Road condition to community: 1=Good tarmac; 2=Gravel; 3=Dirt; 4=Seasonal impassable.

4.8 Would construction traffic or plant operations affect access to schools, clinics, or markets? 1=Yes; 2=No; 3=Unsure. Explain: _____

Interviewer notes: _____

SECTION 5 — CULTURAL PROPERTIES

Purpose: To identify cultural, religious, and heritage sites and practices that may be affected.

5.1 Are there any sacred, heritage, or religious sites like mosques, churches, cemeteries, Eid prayer grounds, or burial grounds used by your household near the proposed site? 1=Yes; 2=No.

➤ If **Yes**, name and distance: _____

5.2 List important cultural or religious events celebrated by the household/community (e.g., Eid, naming ceremonies, festivals): _____

5.3 Are there any traditional crafts, songs, or oral histories tied to land or places near the proposed site? 1=Yes; 2=No. Describe: _____

5.4 Would the plant construction or operation disturb any cultural practices or sites? 1=Yes; 2=No; 3=Unsure. Explain: _____

Interviewer notes: _____

SECTION 6 — NATURAL RESOURCES AND LAND USE

Purpose: To capture baseline land use, water resources, grazing, biodiversity, and potential environmental impacts.

6.1 Main land uses around household (tick all that apply): 1=Crop fields; 2=Grazing; 3=Forest/woodland; 4=Wetland; 5=Residential; 6=Commercial; 7=Other _____

6.2 Do you use water from rivers, streams, or wells that are within 2 km of the proposed site? 1=Yes; 2=No. If yes, which and for what use? _____

6.3 Have you noticed changes in water quality or quantity in the last 5 years? 1=Yes; 2=No. If yes, describe: _____

6.4 Are there important grazing routes or seasonal migration paths that cross the proposed site? 1=Yes; 2=No. If yes, describe timing and users: _____

6.5 Do you collect firewood, medicinal plants, or wild foods from areas near the proposed site? 1=Yes; 2=No. If yes, list species and frequency: _____

6.6 Would you expect the plant to change land use (e.g., reduce farmland, block grazing routes)? 1=Yes; 2=No; 3=Unsure. Explain likely changes: _____

6.7 Perceived environmental risks from the plant (tick all that apply): 1=Air pollution; 2=Noise; 3=Water pollution; 4=Loss of grazing; 5=Loss of farmland; 6=Increased traffic; 7=Other _____

➤ **Rate concern level:** 1=None; 2=Low; 3=Medium; 4=High.

Interviewer notes: _____

SECTION 7 — PERCEPTION OF THE PROJECT

Purpose: To capture awareness about the project, expectations, concerns, and willingness to accept mitigation or benefits.

7.1 Have you heard about the proposed LPG plant? 1=Yes; 2=No.

➤ If **No**, skip to 7.6.

7.2 Source of information about the project (tick all): 1=Radio; 2=Community meeting; 3=Friends/relatives; 4=Local leaders; 5=Company; 6=Other _____

7.3 What do you expect the project will bring to the community? (open)

7.4 What are your main concerns about the project? (open) _____

7.5 Would you support the project if the company provides jobs, improved roads, and community development? 1=Yes; 2=No; 3=Depends. If **Depends**, explain:

7.6 Would you accept compensation if land or resources you use are affected? 1=Yes; 2=No; 3=Unsure. If yes, what is your preferred form: 1=Cash; 2=Land-for-land; 3=Community projects; 4=Other _____

7.7 Do you want to be consulted about project decisions affecting your land or livelihood? 1=Yes; 2=No.

Interviewer notes: _____

SECTION 8 — EDUCATIONAL STATUS

Purpose: To capture household education baseline and potential project impacts on schooling.

8.1 Highest education level of household head: 1=None; 2=Quranic only; 3=Primary; 4=Secondary; 5=Post-secondary/tertiary; 6=Vocational.

8.2 Number of household members currently attending school: Boys ____; Girls ____; Total ____

8.3 Barriers to education in this household (tick all): 1=Cost; 2=Distance; 3=Child labour; 4=Early marriage; 5=Quality; 6=Other _____

8.4 Would construction or plant operations likely affect children's school attendance? 1=Yes; 2=No; 3=Unsure. Explain: _____

Interviewer notes: _____

SECTION 9 — SOCIAL VICES AND HEALTH

Purpose: To Capture baseline health status, common illnesses, and social problems that may be affected by the project.

9.1 Main health problems in the household in last 12 months (tick all): 1=Respiratory illness; 2=Diarrhoea; 3=Malaria; 4=Skin disease; 5=Other _____

9.2 Distance to nearest health facility (minutes walking): _____

9.3 Do you have concerns about air quality, dust, or smoke affecting health? 1=Yes; 2=No. If yes, describe: _____

9.4 Have there been cases of accidents or injuries related to industrial activity nearby? 1=Yes; 2=No. If yes, describe: _____

9.5 Social vices observed in community (tick all that apply): 1=Alcohol abuse; 2=Drug use; 3=Theft; 4=Prostitution; 5=Youth idleness; 6=None; 7=Other _____

9.6 Would you expect the project to increase or decrease social vices? 1=Increase; 2=Decrease; 3=No change; 4=Unsure. Explain: _____

9.7 Are there vulnerable persons in the household (elderly, disabled, pregnant women)? 1=Yes; 2=No. If yes, list and describe needs: _____

Interviewer notes: _____

SECTION 10 — IMPACT ASSESSMENT INDICATORS

Purpose: To quantify baseline indicators and potential project impacts for monitoring.

10.1 Household income change indicator: In last 12 months, household income: 1=Decreased; 2=Same; 3=Increased. If decreased, main reason: _____

10.2 Food security: In last 12 months, did household experience food shortage? 1=Never; 2=Sometimes; 3=Often; 4=Always. Months of shortage: _____

10.3 Access to land: Has household lost access to land in last 5 years? 1=Yes; 2=No. If yes, reason: 1=Sale; 2=Conflict; 3=Development; 4=Other _____

10.4 Livelihood vulnerability score (enumerator to compute): Use simple sum of: (a) single income source (1), (b) no land ownership (1), (c) no livestock (1), (d) food shortage often/always (2). Total = _____ (0–5)

10.5 Perceived risk of displacement by project: 1=None; 2=Low; 3=Medium; 4=High.
Explain: _____

10.6 Perceived risk to health from plant operations (air, noise, accidents): 1=None; 2=Low; 3=Medium; 4=High. Explain: _____

10.7 Willingness to accept mitigation measures (tick all acceptable): 1=Employment priority; 2=Compensation; 3=Community development projects; 4=Training; 5=Environmental monitoring; 6=None.

10.8 Suggested mitigation or community benefits (open): _____

Interviewer coding:

- **Household vulnerability category:** 1=Low (0–1); 2=Medium (2–3); 3=High (4–5)
- **Overall project attitude:** 1=Supportive; 2=Neutral; 3=Opposed; 4=Conditional

Interviewer notes and summary of key risks and benefits reported:

ENUMERATOR CHECKLIST AFTER INTERVIEW

- GPS recorded: Yes / No
- Consent signed/thumbprint: Yes / No
- All required fields completed: Yes / No (list missing) _____
- Any safeguarding concerns or complaints raised: _____
- Additional observations (noise, odour, visible pollution, nearby construction):

ANNEX 3: ATTENDANCE AT SITE VERIFICATION/STAKEHOLDERS MEETING



FEDERAL MINISTRY OF ENVIRONMENT ENVIRONMENTAL ASSESSMENT DEPARTMENT ENVIRONMENTAL IMPACT ASSESSMENT

SITE VERIFICATION EXERCISE

TITLE OF PROJECT PROPOSE LIQUEFIED PETROLEUM GAS (LPG)

PROPOSER SHAKKATO NIGERIA LIMITED

LOCATION DUTSE LGA, JIGAWA STATE

DATE 3RD AUGUST, 2026

S/N	NAME OF PARTICIPANT	ORGANIZATION	PHONE NO.	EMAIL ADDRESS	SIGN
1.	Eng. B. Inuwa	Env. Res. Consult. Ltd	08058748266	business@env.com	[Signature]
2.	Sani A. Kende	Env. Res. Consult. Ltd	0806564022	Sakende.george@outlook.com	[Signature]
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14.	Najib Ali	Dutse	08146747624	Dutse	[Signature]
15.	Shehu Usman	Dutse Group	09166592787		[Signature]
16.	Rabiu alhassan	Dutse	09064809020		[Signature]
17.	Jazali Usman	Dutse	09130604678		[Signature]
18.	Kwankwusa	Dutse	09068624441		[Signature]
19.	HARUNA KAILA	Dutse/G. Duma	08061341919		[Signature]

ANNEX 4: GENERAL ENVIRONMENTAL MANAGEMENT CONDITIONS FOR CONSTRUCTION CONTRACTS

General

1. In addition to these general conditions, the Contractor shall comply with any specific Environmental Management Plan (EMP) or Environmental and Social Management Plan (ESMP) for the works he is responsible for. The Contractor shall inform himself about such an EMP, and prepare his work strategy and plan to fully take into account relevant provisions of that EMP. If the Contractor fails to implement the approved EMP after written instruction by the Supervising Engineer (SE) to fulfill his obligation within the requested time, the Owner reserves the right to arrange through the SE for execution of the missing action by a third party on account of the Contractor.
2. Notwithstanding the Contractor's obligation under the above clause, the Contractor shall implement all measures necessary to avoid undesirable adverse environmental and social impacts wherever possible, restore work sites to acceptable standards, and abide by any environmental performance requirements specified in an EMP. In general, these measures shall include but not be limited to:
 - (a) Minimize the effect of dust on the surrounding environment resulting from earth mixing sites, asphalt mixing sites, dispersing coal ashes, vibrating equipment, temporary access roads, etc. to ensure safety, health and the protection of workers and communities living in the vicinity of dust producing activities.
 - (b) Ensure that noise levels emanating from machinery, vehicles and noisy construction activities (e.g., excavation, blasting) are kept at a minimum for the safety, health and protection of workers within the vicinity of high noise levels and nearby communities.
 - (c) Ensure that existing water flow regimes in rivers, streams and other natural or irrigation channels is maintained and/or re-established where they are disrupted due to works being carried out.
 - (d) Prevent bitumen, oils, lubricants and waste water used or produced during the execution of works from entering into rivers, streams, irrigation channels and other natural water

bodies/reservoirs, and also ensure that stagnant water in uncovered borrow pits is treated in the best way to avoid creating possible breeding grounds for mosquitoes.

(e) Prevent and minimize the impacts of quarrying, earth borrowing, piling and building of temporary construction camps and access roads on the biophysical environment including protected areas and arable lands; local communities and their settlements. In as much as possible restore/rehabilitate all sites to acceptable standards.

(f) Upon discovery of ancient heritage, relics or anything that might or believed to be of archaeological or historical importance during the execution of works, immediately report such findings to the SE so that the appropriate authorities may be expeditiously contacted for fulfilment of the measures aimed at protecting such historical or archaeological resources.

(g) Discourage construction workers from engaging in the exploitation of natural resources such as hunting, fishing, and collection of forest products or any other activity that might have a negative impact on the social and economic welfare of the local communities.

(h) Implement soil erosion control measures in order to avoid surface run off and prevents siltation, etc.(i) Ensure that garbage, sanitation and drinking water facilities are provided in construction workers camps.

(j) Ensure that, in as much as possible, local materials are used to avoid importation of foreign material and long-distance transportation.

(k) Ensure public safety, and meet traffic safety requirements for the operation of work to avoid accidents.

3. The Contractor shall indicate the period within which he/she shall maintain status on site after completion of civil works to ensure that significant adverse impacts arising from such works have been appropriately addressed.

4. The Contractor shall adhere to the proposed activity implementation schedule and the monitoring plan / strategy to ensure effective feedback of monitoring information to project management so that impact management can be implemented properly, and if necessary, adapt to changing and unforeseen conditions.

5. Besides the regular inspection of the sites by the SE for adherence to the contract conditions and specifications, the Owner may appoint an Inspector to oversee the compliance with these environmental conditions and any proposed mitigation measures. State environmental authorities may carry out similar inspection duties. In all cases, as directed by the SE, the Contractor shall comply with directives from such inspectors to implement measures required to ensure the adequacy rehabilitation measures carried out on the bio-physical environment and

compensation for socio-economic disruption resulting from implementation of any works.

Worksite/Campsite Waste Management

6. All vessels (drums, containers, bags, etc.) containing oil/fuel/surfacing materials and other hazardous chemicals shall be banded in order to contain spillage. All waste containers, litter and any other waste generated during the construction shall be collected and disposed off at designated disposal sites in line with applicable government waste management regulations.
7. All drainage and effluent from storage areas, workshops and camp sites shall be captured and treated before being discharged into the drainage system in line with applicable government water pollution control regulations.
8. Used oil from maintenance shall be collected and disposed off appropriately at designated sites or be re-used or sold for re-use locally.
9. Entry of runoff to the site shall be restricted by constructing diversion channels or holding structures such as banks, drains, dams, etc. to reduce the potential of soil erosion and water pollution.
10. Construction waste shall not be left in stockpiles along the road, but removed and reused or disposed of on a daily basis.
11. If disposal sites for clean spoil are necessary, they shall be located in areas, approved by the SE, of low land use value and where they will not result in material being easily washed into drainage channels. Whenever possible, spoil materials should be placed in low-lying areas and should be compacted and planted with species indigenous to the locality.

Material Excavation and Deposit

12. The Contractor shall obtain appropriate licenses/permits from relevant authorities to operate quarries or borrow areas.
13. The location of quarries and borrow areas shall be subject to approval by relevant local and national authorities, including traditional authorities if the land on which the quarry or borrow areas fall in traditional land.
14. New extraction sites:
 - a) Shall not be located in the vicinity of settlement areas, cultural sites, wetlands or any other valued ecosystem component, or on high or steep ground or in areas of high scenic value, and shall not be located less than 1km from such areas.

- b) Shall not be located adjacent to stream channels wherever possible to avoid siltation of river channels. Where they are located near water sources, borrow pits and perimeter drains shall surround quarry sites.
 - c) Shall not be located in archaeological areas. Excavations in the vicinity of such areas shall proceed with great care and shall be done in the presence of government authorities having a mandate for their protection.
 - d) Shall not be located in forest reserves. However, where there are no other alternatives, permission shall be obtained from the appropriate authorities and an environmental impact study shall be conducted.
 - e) Shall be easily rehabilitated. Areas with minimal vegetation cover such as flat and bare ground, or areas covered with grass only or covered with shrubs less than 1.5m in height, are preferred.
 - f) Shall have clearly demarcated and marked boundaries to minimize vegetation clearing.
- 15. Vegetation clearing shall be restricted to the area required for safe operation of construction work. Vegetation clearing shall not be done more than two months in advance of operations.
 - 16. Stockpile areas shall be located in areas where trees can act as buffers to prevent dust pollution. Perimeter drains shall be built around stockpile areas. Sediment and other pollutant traps shall be located at drainage exits from workings.
 - 17. The Contractor shall deposit any excess material in accordance with the principles of the general conditions, and any applicable EMP, in areas approved by local authorities and/or the SE.
 - 18. Areas for depositing hazardous materials such as contaminated liquid and solid materials shall be approved by the appropriate local and/or national authorities before the commencement of work. Use of existing, approved sites shall be preferred over the establishment of new sites.

Rehabilitation and Soil Erosion Prevention

- 19. To the extent practicable, the Contractor shall rehabilitate the site progressively so that the rate of rehabilitation is similar to the rate of construction.
- 20. Always remove and retain topsoil for subsequent rehabilitation. Soils shall not be stripped when they are wet as this can lead to soil compaction and loss of structure.
- 21. Topsoil shall not be stored in large heaps. Low mounds of no more than 1 to 2m high are recommended.

22. Re-vegetate stockpiles to protect the soil from erosion, discourage weeds and maintain an active population of beneficial soil microbes.
23. Locate stockpiles where they will not be disturbed by future construction activities.
24. To the extent practicable, reinstate natural drainage patterns where they have been altered or impaired.
25. Remove toxic materials and dispose of them in designated sites. Backfill excavated areas with soils or overburden that is free of foreign material that could pollute groundwater and soil.
26. Identify potentially toxic overburden and screen with suitable material to prevent mobilization of toxins.
27. Ensure reshaped land is formed so as to be inherently stable, adequately drained and suitable for the desired long-term land use, and allow natural regeneration of vegetation.
28. Minimize the long-term visual impact by creating landforms that are compatible with the adjacent landscape.
29. Minimize erosion by wind and water both during and after the process of reinstatement.
30. Compacted surfaces shall be deep ripped to relieve compaction unless subsurface conditions dictate otherwise.
31. Revegetate with plant species that will control erosion, provide vegetative diversity and, through succession, contribute to a resilient ecosystem. The choice of plant species for rehabilitation shall be done in consultation with local research institutions, forest department and the local people.

Water Resources Management

32. The Contractor shall at all costs avoid conflicting with water demands of local communities.
33. Abstraction of both surface and underground water shall only be done with the consultation of the local community and after obtaining a permit from the relevant Water Authority.
34. Abstraction of water from wetlands shall be avoided. Where necessary, authority has to be obtained from relevant authorities.
35. Temporary damming of streams and rivers shall be done in such a way avoids disrupting water supplies to communities downstream, and maintains the ecological balance of the river system.
36. No construction water containing spoils or site effluent, especially cement and oil, shall be allowed to flow into natural water drainage courses.
37. Wash water from washing out of equipment shall not be discharged into water courses or road drains.

38. Site spoils and temporary stockpiles shall be located away from the drainage system, and surface run off shall be directed away from stockpiles to prevent erosion.

Traffic Management

39. Location of access roads/detours shall be done in consultation with the local community especially in important or sensitive environments. Access roads shall not traverse wetland areas.
40. Upon the completion of civil works, all access roads shall be ripped and rehabilitated.
41. Access roads shall be sprinkled with water at least five times a day in settled areas, and three times in unsettled areas, to suppress dust emissions.

Blasting

42. Blasting activities shall not take place less than 2km from settlement areas, cultural sites, or wetlands without the permission of the SE.
43. Blasting activities shall be done during working hours, and local communities shall be consulted on the proposed blasting times.
44. Noise levels reaching the communities from blasting activities shall not exceed 90 decibels.
45. Evacuating work areas during blasting operations.
46. Employees authorized to prepare explosive charges or conduct blasting operations shall use every reasonable precaution including, but not limited to, visual and audible warning signals, flags, or barricades, to ensure employee safety.
47. Blasting operations in the proximity of overhead power lines, communication lines, utility services, or other services and structures shall not be carried on until the operators and/or owners have been notified and measures for safe control have been taken.

Disposal of Unusable Elements

48. Unusable materials and construction elements such as electro-mechanical equipment, pipes, accessories and demolished structures will be disposed of in a manner approved by the SE. The Contractor has to agree with the SE which elements are to be surrendered to the Client's premises, which will be recycled or reused, and which will be disposed of at approved landfill sites.
49. As far as possible, abandoned pipelines shall remain in place. Where for any reason no alternative alignment for the new pipeline is possible, the old pipes shall be safely removed and stored at a safe place to be agreed upon with the SE and the local authorities concerned.

- 50. AC-pipes as well as broken parts thereof have to be treated as hazardous material and disposed of as specified above.
- 51. Unsuitable and demolished elements shall be dismantled to a size fitting on ordinary trucks for transport.

Health and Safety

- 52. In advance of the construction work, the Contractor shall mount an awareness and hygiene campaign. Workers and local residents shall be sensitized on health risks particularly of AIDS.
- 53. Adequate road signs to warn pedestrians and motorists of construction activities, diversions, etc. shall be provided at appropriate points.
- 54. Construction vehicles shall not exceed maximum speed limit of 40km per hour.

Repair of Private Property

- 55. Should the Contractor, deliberately or accidentally, damage private property, he shall repair the property to the owner's satisfaction and at his own cost. For each repair, the Contractor shall obtain from the owner a certificate that the damage has been made good satisfactorily in order to indemnify the Client from subsequent claims.
- 56. In cases where compensation for inconveniences, damage of crops etc. are claimed by the owner, the Client has to be informed by the Contractor through the SE. This compensation is in general settled under the responsibility of the Client before signing the Contract. In unforeseeable cases, the respective administrative entities of the Client will take care of compensation.

Contractor's Environment, Health and Safety Management Plan (EHS-MP)

- 57. Within 6 weeks of signing the Contract, the Contractor shall prepare an EHS-MP to ensure the adequate management of the health, safety, environmental and social aspects of the works, including implementation of the requirements of these general conditions and any specific requirements of an EMP for the works. The Contractor's EHS-MP will serve two main purposes:
 - i. For the Contractor, for internal purposes, to ensure that all measures are in place for adequate EHS management, and as an operational manual for his staff.
 - ii. For the Client, supported where necessary by a SE, to ensure that the Contractor is fully

prepared for the adequate management of the EHS aspects of the project, and as a basis for monitoring of the Contractor's EHS performance.

55. The Contractor's EHS-MP shall provide at least:

- i. a description of procedures and methods for complying with these general environmental management conditions, and any specific conditions specified in an EMP;
- ii. a description of specific mitigation measures that will be implemented in order to minimize adverse impacts;
- iii. a description of all planned monitoring activities (e.g., sediment discharges from borrow areas) and the reporting thereof; and
- iv. the internal organizational, management and reporting mechanisms put in place for such.

56. The Contractor's EHS-MP will be reviewed and approved by the Client before start of the works. This review should demonstrate if the Contractor's EHS-MP covers all of the identified impacts and has defined appropriate measures to counteract any potential impacts.

EHS Reporting

57. The Contractor shall prepare bi-weekly progress reports to the Safety Engineer on compliance with these general conditions, the project EMP if any, and his own EHS-MP. An example format for a contractor EHS report is portrayed below. It is expected that the Contractor's reports will include information on:

- i. EHS management actions/measures taken, including approvals sought from local or national authorities;
- ii. Problems encountered in relation to EHS aspects (incidents, including delays, cost consequences, etc. as a result thereof);
- iii. Lack of compliance with contract requirements on the part of the Contractor;
- iv. Changes of assumptions, conditions, measures, designs and actual works in relation to EHS aspects; and
- v. Observations, concerns raised and/or decisions taken with regard to EHS management during site meetings.

58. It is advisable that reporting of significant EHS incidents be done "as soon as practicable". Such incident reporting shall therefore be done individually. Also, it is advisable that the Contractor keep his own records on health, safety and welfare of persons, and damage to property. It is advisable to include such records, as well as copies of incident reports, as

appendixes to the bi-weekly reports. A sample format for an incident notification is shown below. Details of EHS performance will be reported to the Client through the SE's reports to the Client.

Training of Contractor's Personnel

59. The Contractor shall provide sufficient training to his own personnel to ensure that they are all aware of the relevant aspects of these general conditions, any project EMP, and his own EHS-MP, and are able to fulfil their expected roles and functions. Specific training should be provided to those employees that have particular responsibilities associated with the implementation of the EHS-MP. General topics should be:

- EHS in general (working procedures);
- emergency procedures; and
- social and cultural aspects (awareness raising on social issues).

Cost of Compliance

60. It is expected that compliance with these conditions is already part of standard good workmanship and state of art as generally required under this Contract. The item "Compliance with Environmental Management Conditions" in the Bill of Quantities covers this cost. No other payments will be made to the Contractor for compliance with any request to avoid and/or mitigate an avoidable EHS impact.

ANNEX 5: WASTE MANAGEMENT PLAN

S/N	Potential Source	Waste Type	Waste Streams	Management
A	PRECONSTRUCTION			
1	Movement of vehicles on unpaved surface and engine exhaust	Emission	COx, SOx, NOx, CO, Dust	Use water suppression to prevent dust emission Maintain vehicles and machineries to reduce emission Maintain low speed to reduce dust and gaseous emission Allow aerial dispersal over a large area.
2	Site Clearing and Installation of temporary workers camp and offices and workshops	Non-Hazardous	• Vegetal Waste • Metal scraps, packaging waste	Vegetal waste shall be supplied to farmers for use as compost. Woody vegetal shall be supplied to host communities for domestic uses including as fuel wood for cooking. Segregated and stored on site to be collected at least once a week for reuse or recycle through licensed third-party facilities.
3	Workers' camp	Domestic and Sanitary	• Food remnant, kitchen wastes. Food packaging etc • Domestic Sewage	To be transferred to locals for use as compost and animal feed. Plastic and other packaging to be recycled through licensed recycling third parties. Temporary stored and transferred to licensed carrier for disposal.
B	CONSTRUCTION			
1	Movement of vehicles on unpaved surface and engine exhaust	Emission	COx, SOx, NOx, CO, Dust	See A1
2	Civil works Workers' camp/offices	Non-Hazardous /Industrial	• Spoils • Waste Packaging and Dunnage such as scrap wood, scrap metal, steel, glass, plastic, paper and cardboard, empty metal containers, excess concrete, broken equipment, or components	Reuse spoils as fill materials as much as possible Segregated and kept securely in closed containers on site. To be transferred to approved recycling third parties for reuse/recycling. Non-recyclables to be removed by approved waste contractor for onward disposal at approved sites. To be transferred to locals for use as compost and animal feed.

S/N	Potential Source	Waste Type	Waste Streams	Management
			Domestic-type waste: wastepaper and food scraps, metal cans	Plastic and other packaging to be recycled through licensed recycling third parties.
3	Civil Works	Hazardous Waste	Solid Wastes: used batteries, chemical containers, concrete etc.	Store on site in closed containers with secondary containment and transferred to a registered waste contractor with off-site permitted hazardous waste treatment, storage, or disposal facilities
			Liquid Waste: spent lubricating oils, hydraulic fluids, brake fluids, battery electrolyte, and dielectric fluids, chemical cleaning agents, paints, primers, thinners, and corrosion control coatings; sealants and adhesives etc	
	Civil works	Waste Water	Waste water from equipment washing and concrete production	Discharged to the ground as only very small quantity is envisaged at this stage.
4	Workers' camp	Domestic and Sanitary	- Food remnant, kitchen wastes. Food packaging etc - Domestic Sewage	See A3
C	OPERATION			
1	Movement of vehicles	Emission	COx, SOx, NOx, CO, Dust	See A1
2	Maintenance of bridge and other infrastructures	Non-Hazardous /Industrial	- Packaging waste, scrap metals, plastic, paper and card board, empty metal containers, broken equipment, or components - Domestic-type waste:	Segregated and kept securely in closed containers on site. To be transferred to approved recycling third parties for reuse/recycling. Non-recyclables to be removed by approved waste contractor for onward disposal at approved sites. To be transferred to locals for use as compost and animal feed. Plastic and other packaging to be recycled
	Workers' camp/offices			

S/N	Potential Source	Waste Type	Waste Streams	Management
			wastepaper and food scraps, metal cans	through licensed recycling third parties.
3	Maintenance of bridge and other infrastructures	Hazardous	Same as B3 but smaller quantity may be expected.	See B3

ANNEX 6: OCCUPATIONAL HEALTH AND SAFETY (OHS) PLAN

INTRODUCTION

Every project poses its HSE risks. This plan was necessitated to meet up with OHS standards and to achieve the objectives set for the proposed project. The project team shall undertake to ensure high performance standards and conformity with contract requirements by managing the works in a systematic and thorough manner.

HSE Objectives

The Objectives for this plan are to:

- i. Adopt a positive Health & Safety Culture.
- ii. Adopt the principles of prevention to avoid risk.
- iii. Complete the project without incident (Zero fatalities, Zero Lost Time Injury (LTI) or occupational illness).

Policy Statement

In addition to the existing HSE policy, other policies shall be developed which includes:

Substance Abuse Policy – Prohibiting the consumption or possession of narcotics, drugs, alcohol and other banned substances

Emergency Response Policy – Stating commitment to ensure adequate resources and arrangement are in place in the case an emergency.

Community Affairs Policy – Stating commitment to foster healthy relationships with communities through observance of the highest standard of conduct.

Road Safety Policy–Stating commitment to complying with Road Traffic regulations and continuously improving its road safety performance by implementing a Road Safety Management Plan (RSMP)

KEY RESPONSIBILITIES

HSE Manager/Supervisor Responsibilities

- i. Prepare relevant OHS documentation and procedures.
- ii. Monitor the efficient implementation of OHS requirements.
- iii. Participate and organize the OHS risk assessments.
- iv. Advise management of compliance and of conditions requiring attention.
- v. Conduct regular HSE inspections.

- vi. Make thorough analysis of statistical data and inspections; delineates problem areas; and makes recommendation for solutions.
- vii. Take part in the review of all OHS incidents and assist in investigating incident.
- viii. Monitor the efficient implementation of the Project's OHS requirements.
- ix. Organize the Project's OHS risk assessment exercises.
- x. Check on the use of all types of personal protective equipment specifies the use of appropriate PPE for the various work activities. Evaluates their effectiveness and suggests improvements where indicated.

All employees Responsibilities

Take all reasonable and practical steps to care for their own health and safety and avoid affecting the health and safety of co-workers and the general public.

Follow all instructions and use the equipment properly

Not interfere with any safety arrangements.

Report any circumstances which may not comply with the project's OHS management system.

Competency

All personnel required to operate or work with any equipment or machine must be competent, be tested for each equipment that he/she shall be operating. All personnel who as part of their profession require licensing or certification must obtain the necessary certification before he/she shall be allowed to work on the site.

Induction/Orientation

- i. Every new or rehired employee and Subcontractors employees must undergo mandatory OHS orientation / induction. The purpose of the Induction is to educate workers and make them aware of the major potential hazards he or she shall come into contact with while working on the site; also, it is one more opportunity to stress the importance of HSE being the first priority in the operations.
- ii. The content of the HSE orientation / induction shall cover the following subjects:
- iii. Site safety rules.
- iv. Personnel protective equipment requirements (PPE).
- v. Environmental sensitivity and protection.
- vi. Preparation and planning of the job (Daily Pre-task talk).
- vii. Emergency plan and muster points.

Project Specific HSE Training

- i. In addition to the HSE orientation /induction, there shall be specific site HSE trainings which shall cover the following topics:
- ii. Manual handling.
- iii. Emergency Prevention, Preparedness and Response
- iv. First Aid training (for site First Aiders)
- v. Lifting and Rigging
- vi. Safe Driving techniques (for drivers)
- vii. Hazard identification & HSE risk assessment
- viii. Project HSE Risk Assessment
- ix. The project HSE risk assessment shall be developed and recorded. The Project's HSE risk assessment shall be conducted by a team consisting of HSE Manager/ Supervisor and technical managers/supervisors. It must be approved by the Project manager.

EMERGENCY PREPAREDNESS AND RESPONSE

Emergency procedures and evacuation plan shall be developed by the HSE Department and displayed on the notice board. These procedures shall be communicated to all staff. Also, each section/department shall have at least a trained first aider at all times.

HSE Reporting

All incidents and illnesses must be reported to site supervisor after which investigation shall commence and recorded so that appropriate corrective actions shall be implemented to prevent any re-occurrence and report findings shall be forwarded to management for review. Reporting requirements shall include notification of incident, investigation report, and monthly report. Notification of Incident form shall be developed which shall be filled and submitted to HSE department for investigation.

HSE Inspection and Audits

For continual improvement of HSE management system, HSE inspection and audit shall be conducted. An inspection checklist shall be developed. This is to ensure that the HSE management system is being adhered to. The inspection shall be conducted by the HSE department together with site management.

Project HSE Rules

The project HSE rules shall be developed and supervision shall develop specific rules and procedures when necessary. The following site rules shall be implemented at all times. The Site Manager shall draw these rules to the attention of their own workmen or staff. All sub-contractors must ensure that these rules are drawn to the attention of their workmen and staff.

The Principal Contractor may implement additional site rules during the contract programme. Any such additional rules shall be notified to all personnel engaged on the project prior to their implementation. The HSE rules shall include but not limited to:

- i. Personal Protective Equipment must be worn at all times.
- ii. All instructions issued by the Site Manager regarding the storage, handling or cleaning of materials, plant and equipment must be followed.
- iii. All vehicles must be parked in the designated areas.
- iv. Any workman suffering from a medical condition that might affect his work and/or that could require specific medical treatment must inform the supervisor before commencing work.
- v. All site tools shall either be battery operated or 110 volts.
- vi. No one shall be permitted on site if it is believed that they are under the influence of alcohol or drugs.
- vii. Vehicles must not reverse without a banksman in attendance.
- viii. All visitors to site must undergo a site-specific induction and operative Identity badges must be worn at all times.
- ix. All excavations must be secured.
- x. Smoking and eating shall only be permitted in the designated area. This area shall be identified during induction.
- xi. No hot works operations are permitted without a hot work permit in place.
- xii. There shall be no radios or other music playing devices on site.
- xiii. Good housekeeping practices to be adopted.
- xiv. Compliance with all Ethical Power Permit to Work systems.

SAFE WORK PRACTICES

Implementing safe work practices is one of the keys to achieving our HSE objectives and some of these safe work practices include:

Personal Protective Equipment (PPE)

The basic PPE required for the project shall be Safety Glasses, Safety Boots, Hand Gloves, Hard Hat and Coverall. Any other PPE shall be used as applicable. Management is responsible for the provision of PPE and usage shall be enforced at all time. PPE shall be provided in circumstances where exposure to hazards cannot be avoided by other means or to supplement existing control measures identified by a risk assessment. An assessment shall be made to ensure that the PPE is suitable for purpose and is appropriate to the risk involved. Information, instruction & training shall be given to all employees on safe use, maintenance and storage of PPE. Employees shall, in accordance with instructions given, make full use of all PPE provided and maintain it in a serviceable condition and report its loss or defect immediately to the maintenance department where it shall be replaced. PPE shall be replaced when it is no longer serviceable and returned on a new for old basis. Employees shall sign to state that they have received PPE when issued.

ANNEX 7: BORROW PIT MANAGEMENT PLAN

In general, the contractor will be expected to carry out the construction works in a manner that will minimize the need for the use of borrow materials where technically feasible.

The contractor is also required to prepare a borrow pit management plan which takes account of these activities and follows them through to handing over. These plans need to take account of the potential environmental & social impact and health & safety hazard; including drowning hazards, water-borne disease vectors, impact on local land holdings, land-use and visual impacts. The borrow pit management plan will include restoration measures for the site after decommissioning, such as removal and stockpiling of topsoil layers. Where borrow pits are to be left open, for their use in regular maintenance programs, the responsibility for their management should be assigned to the government entity / local authority in charge of road maintenance and compliance with the borrow pit management plan monitored.

Stage	Activities and features	Measures/mitigation	Responsibility
Site selection	Complete a preliminary site assessment prior to undertaking excavation	• Outreach to the community leadership (e.g., operation, hazards, restoration) • Written approval from community leadership for use of the proposed site • Liaise with the local community on the option of retaining quarry pits as water collection ponds for watering cattle, irrigating crops or similar uses. Highlight issues of disease transmission and the need to prohibit its use for drinking, bathing, and clothes washing	Contractor
		• When siting burrow pit areas, avoid using sensitive areas or sites that drain directly into a sensitive area • Borrow pits will not be located in wetland or densely vegetated areas	Contractor
		• Test pits/excavations to confirm the quantity and	Contractor

Stage	Activities and features	Measures/mitigation	Responsibility
		quality of material in the proposed site Determine presence of any groundwater	
		- Map of the location and a plan of the site, including buffer zone, perimeter berm, stockpiles, operational area - Borrow pit design must comply with standards defined (above), - Photographic record of the site in its undisturbed state	Contractor
Excavation Operation	Excavation will consider the following measures	- Ensure that excavation is accompanied by well-engineered drainage - Topsoil is stripped and stockpiled away from other materials and is to be used only for reinstatement, once pit operations are complete - Overburden soil (layer between topsoil and material of interest) to be used as a perimeter berm to direct drainage or stockpiled separately to backfill the pit - Pit excavations maximum 6 meters in depth, with a vertical slope of 2:1 - Excavation below the water table is not permitted - Heavy machinery access and operation - Carry out necessary preliminary geotechnical investigation to confirm the quality and extent of materials. - Carry out hydrological assessment to determine the presence and depth of aquifer.	Contractor

Stage	Activities and features	Measures/mitigation	Responsibility
		The contractor shall ensure that topsoil (150m-500m) is stripped and stockpiled at a separate location and preserved for future reclamation activities.	
	Site access and safety	- Barrier (e.g., warning tape, perimeter berms, fencing) to control or discourage public access to the pit - Install signposts warning of danger and no trespassing, at no more than 50 meters' distance from the pit - Community awareness and outreach on the dangers of borrow pits and that trespassing is prohibited.	Contractor
	Vegetation	- Avoid or reduce to a minimum vegetation clearance - Existing vegetation within the buffer area should provide some visual and physical screening of the pit operations	Contractor
	Water	- If water is required for borrow pit operation, a water extraction point (e.g., borehole) will be established within the site are and will be planned for use by the community once the site is reinstated - Drainage structures or pumping will remove any standing water in the borrow pit. Alternatively, any pits with 0.75 meters or more of standing water will be fenced - Overburden soil can be used as a perimeter berm to direct water drainage away from the site	Contractor

Stage	Activities and features	Measures/mitigation	Responsibility
		• Use drainage features in flatter areas, such as mitre drains and sumps, to remove water from around the road ditches • Community members are not allowed to use water at an active borrow pit, for any purpose	
	Erosion	• Erosion control measures undertaken in all aspects of the borrow-pit operation, including: reduced slopes, seeding, etc. • Protect topsoil stockpiles from wind and water erosion by reducing slopes, using a cover, and/or spraying with water	Contractor
	Dust and noise	• If a rock crusher is used, dust control measures shall be put in place (water truck or sprinklers on crushing equipment) • Vegetation within the buffer area will screen noise of pit operations	Contractor
Reinstatement of Burrow Pits	Reinstatement of burrow pits will be completed prior to handover of the site	• Fill excavated site with suitable materials • Spread topsoil on top of the overburden	Contractor
		• Develop/construct suitable surface slopes, drainage ditches and conduits to prevent water from collecting at the sites • Scarify the borrow pit operational site to encourage vegetation cover • Establish a vegetation cover corresponding to	Contractor

Stage	Activities and features	Measures/mitigation	Responsibility
		at least 75% of the cover present prior to excavation (supporting photographs) and maintain following the first rains after reinstatement • Minimize erosion by focusing vegetation cover on side slopes of the excavated area • Any required seeding will make use of local plant varieties	
Review	Ensure the Borrow pit management plan implementation	• Review borrow pit management / monitoring reports • Review reinstated borrow pit areas prior to handover of completed road sections • Engage local community authorities to take responsibility for long-term borrow pits in their areas • Ensure that the responsibility for management of borrow pits left open is assigned to the government entity / local authority • Verify conformance with Borrow Pit Management Plan	Client