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MOTA-ENGIL AFRICA

MOTA-ENGIL NIGERIA

Kano-Katsina-Jibiya-Maradi (Niger Republic) Single Track Standard Gauge Railway Project and Branch Line from Kano to Dutse

Final Environmental and Social Impact Assessment Report
(Nigeria Section)

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List of Abbreviations and Acronyms

%	Percent
AC	Alternate current
ADT	Average Daily Traffic
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
AFAN	All Farmers Association of Nigeria
AfCFTA	African Continental Free Trade Area
AIDS	Acquired Immune Deficiency Syndrome
ANC	Antenatal Care
AoI	Area of Influence
BAU	Business as Usual
BMS	Building Management System
BOD	Biological Oxygen Demand
BSC	Base Station Controller
BTEX	Benzene Toluene Ethylene and Xylene
BTS	Base Transceiver Station
Cap	Chapter
CBOs	Community-Based Organisations
CCECC	China Civil Engineering Construction Corporation
CCTV	Closed-circuit Television
CERD	Center for Environment and Rural Development
CHSS	Community, Health, Safety and Security
CO_2	Carbon dioxide
CODE	Connected Development Association
COVID-19	Coronavirus Disease (2019)
CSACEFA	Civil Society Action Coalition on Education for All
CTCS	Chinese Train Control System
DC	Direct current
DHV	Daily Hourly Volume
EAR	Environmental Audit Report
EBRD	European Bank for Reconstruction and Development
EIA	Environmental Impact Assessment
EMS	Environmental Management System

EPA	Environmental Protection Agency
EPC	Engineering, Procurement and Construction
EPs	Equator Principles
EPFIs	Equator Principles Financial Institutions
ERGP	Economic Recovery and Growth Plan
ERTMS	European Rail Traffic Management System
ESF	Environmental and Social Framework
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
ESS	Environmental and Social Standards
ETCS	European Train Control System
FAAN	Federal Airports Authority of Nigeria
FAHYE	Family Health and Youth Empowerment Organization
FAO	Food and Agricultural Organisation
FEPA	Federal Environmental Protection Agency
FGD	Focus Group Discussions
FGN	Federal Government of Nigeria
FMEnv	Federal Ministry of Environment
FMT	Federal Ministry of Transportation
FOMWAN	Federation of Muslim Women's Associations of Nigeria
FULDAN	Fulbe Development Association of Nigeria
GECORN	Gender and Constitutional Reform Network
GHG	Greenhouse Gas
GIIP	Good International Industry Practice
GIS	Geographic Information System
GPS	Global Positioning System
GRC	Grievance Redress Committee
GRM	Grievance Redress Mechanism
GSM-R	Global System for Mobile Communications-Railway
ha	hectares
HDMI	Highway Development Management Initiative
HIA	Health Impact Assessment
HIV	Human Immunodeficiency Virus

HP	Horse Power
HVAC	Heating, ventilation, and air conditioning
IFC	International Finance Corporation
IFIs	International Financial Institutions
ILO	International Labour Organisation
IMM	Impact Mitigation Monitoring
IPCC	Intergovernmental Panel on Climate Change
IPF	Investment Project Financing
ISO	International Organization for Standardization
ITCZ	Inter-Tropical Convergence Zone
IUCN	International Union for Conservation of Nature
JARDA	Jigawa State Agricultural and Rural Development Authority
KII	Key Informant Interview
Km	Kilometre
Km/h	Kilometre per hour
KMRLP	Kano-Maradi Railway Line Project
KNARDA	Kano State Agriculture and Rural Development Authority
KUPDA	Katsina Urban Planning and Development Authority
kVA	Kilo volt-ampere
Kw	Kilowatt
lbs	pounds
LFN	Laws of the Federation of Nigeria
LGA	Local Government Area
LRP	Livelihood Restoration Plan
LV	Low Voltage
MACBAN	Miyetti Allah Cattle Breeders Association of Nigeria
MCC	Manual Classified Count
MDAs	Ministries Departments and Agencies
MEA	Mota-Engil Africa
mm	millimetre
ms^2	Metre per second square
MV	Medium Voltage
N/A	Not Available
NAMA	Nigerian Airspace Management Agency

NARTO	National Association of Road Transport Owners
NAWOJ	Nigeria Association of Women Journalists
NBS	National Bureau of Statistics
NCAA	Nigerian Civil Aviation Authority
NDC	Nationally Determined Contribution
NESREA	National Environmental Standards & Regulations Enforcement Agency
NGO	Non-Governmental Organisations
NIHSA	Nigerian Hydrological Services Agency
NIIMP	Nigeria Integrated Infrastructure Master Plan
NIMASA	Nigerian Maritime Administration and Safety Agency
NIMET`	Nigeria Meteorological Agency
NIWA	National Inland Waterways Authority
NPA	Nigerian Ports Authority
NRC	Nigerian Railway Corporation
NSC	Nigerian Shippers' Council
NST	Nigeria Security Tracker
NTA	Nigerian Television Authority
NTU	Nephelometric Turbidity unit
NUJ	Nigerian Union of Journalist
NURTW	National Union of Road Transport Workers
OCC	Operation Control Centre
OECD	Organisation for Economic Co-operation and Development
OTN	Optical Transport Network
PACs	Project Affected Communities
PAPs	Project Affected Persons (PAPs)
PPE	Personnel Protective Equipment
PBID	Project Background Information Document
PLC	Programmable Logic Controller
QHSE	Quality, Health, Safety and Environment
RAP	Resettlement Action Plan
RICOD	Rural Institution for Community Development
RP	Return Point
RPF	Resettlement Policy Framework
RTU	Remote Terminal Unit

SCADA	Supervisory Control and Data Acquisition
SDGs	Sustainable Development Goals
SDH	Synchronous Digital Hierarchy
SEMP	Social and Environmental Management Plan
SEP	Stakeholder Engagement Plan
SEPA	State Environmental Protection Agency
SGR	Standard Gauge Rail
SIA	Social Impact Assessment
SSCE	Senior Secondary Certificate Examination
STIs	Sexually Transmitted Infections
STP	Standard Penetration Test
SWATCH	Support for Women and Teenage Children
SWILI	Strategic Women In Leadership Initiative
SWMP	Site Waste Management Plan
SWODEN	Society for Women Development and Empowerment of Nigeria
TMax	Maximum Temperature
TMin	Minimum Temperature
ToR	Terms of Reference
TPH	Total Petroleum Hydrocarbon
UK	United Kingdom
UNFCCC	United Nation Framework Convention on Climate Change
UNGPs	United Nations Guiding Principles
UNICEF	United Nations Children's Fund
UPSs	Uninterrupted Power Supply Systems
V	Velocity
VAC	Value Added Concession
VES	Visual encounters survey
WHO	World Health Organization
WRF	Weather Research and Forecasting
YEDA	Youth and Environmental Development Association

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EXECUTIVE SUMMARY

Introduction

The Nigerian government through its Federal Ministry of Transportation proposes to construct a 392 km Standard Gauge Rail (SGR) line from Kano, northwestern part of Nigeria to Maradi Province in the southern part of The Republic of Niger with a Branch Line connecting Kano with Dutse in Jigawa State.

The Proponent

The proponent for the proposed Kano to Maradi Railway project is the Federal Ministry of Transportation (FMT). The Federal Ministry of Transportation of Nigeria (FMT) has appointed Mota-Engil Africa (MEA), to design and construct the railway project. In implementing the above and in conformity with government regulations, Allott Nigeria Ltd, an engineering and environmental consultancy outfit was commissioned to carry out the Environmental and Social Impact Assessment (ESIA) study of the proposed project.

Project Premises

The key premises, which affect the ESIA process, were established from the initial stages of the project. The premises are as follows:

- The project recognizes the Federal Ministry of Transportation and Federal Ministry of Environment policy guidelines issued by the erstwhile Federal Environmental Protection Agency (FEPA) in 1995. Policies by State Ministries of Environment and equivalents of Jigawa, Kano and Katsina, the relevant State Environmental Protection Agencies (State EPAs), Environment Protection Committees at the Local Government level and other laws operating both nationally and internationally.

- The project is being designed and will be operated to comply with these local and national laws, together with all the international protocols, agreements and conventions.
- The agreements and understandings made with Government officials, during the course of the ESIA process will be respected and honoured.
- Extensive consultations have and will continue to be held with Government officials at various levels (Federal, State and Local Governments) together with the host communities that will be affected by the project. Consultation meetings shall be maintained on a mutually agreed basis.
- An Environmental and Social Management Plan (ESMP) will be developed as part of the ESIA process. The implementation of the plan will be the responsibility of the Federal Ministry of Transportation in conjunction with the State governments involved.

Policy, Administrative and Legal Framework

Applicable environmental and social policies, regulations and standards are as follow:

- Environmental Impact Assessment (EIA) Act Cap E12 LFN 2004
- Nigerian Railway Corporation Act No. 20 of 1955 (as amended 1990)
- The Land Use Act Cap L5, LFN 2004
- National Environmental Standards & Regulations Enforcement Agency (NESREA) Act, 2007
- Nigerian Urban and Regional Planning Act CAP N 138, LFN 2004
- Harmful Waste (Special Criminal Provisions) Act Cap H1 LFN 2004
- The Endangered Species Act, CAP E9, LFN 2016
- Factories Act Cap F1 LFN 2004
- Labour Act, Cap L1, Laws of the Federation of Nigeria 2004

- National (Public) Health Act 2014
- State Environmental Regulations and Laws
- *State Land Legislations*
- Local Government Areas Byelaws on Environmental Health
- Penal code Act
- Climate Change Act, 2021 in the key national legislations
- Basel Convention on Transboundary Movement of Hazardous Wastes and their Disposal,
- UN Framework Convention on Climate Change,
- Convention on International Trade in Endangered Species
- Kyoto Protocol,
- Paris Agreement and
- *IFC Performance Standards*
- *World Bank Environmental Health and Safety Guidelines*
- *OECD Recommendations (Common Approaches)*
- *Equator Principles IV*
- *Convention on International Trade in Endangered Species of Wild Fauna and Flora*

Administrative Framework

The Ministries and Agencies, which serve as administrative stakeholders providing the legal frameworks, include:

- Federal Ministry of Environment
- Federal Ministry of Transportation
- Nigerian Railway Corporation (NRC)
- Jigawa State Ministry of Environment
- Jigawa Environmental Protection Agency
- Jigawa State Ministry of Lands and Survey

- Kano State Ministry of Environment
- Kano Environmental Protection Agency
- Kano State Ministry of Lands and Survey
- Katsina State Ministry of Environment
- Katsina Environmental Protection Agency
- Katsina State Ministry of Lands and Survey
- Local Government Authorities affected across the three states.

Project Justification

The Kano – Jibiya – Maradi is an international route connecting Nigeria to The Republic of Niger. The importance of the route with respect to international trade between Nigeria and neighbouring countries in the northern part of Nigeria is that the route is responsible for significant volume of traffic in that axis. The Project is being developed in the context of Nigeria's effort to transform the country's railway system. The transformation of the railway system is also part of a longer-term strategy to eventually involve the private sector in railway system development and operation through Public-Private Partnerships. The investment that the government is making to rehabilitate the railway system will also give confidence to the private sector of the Government's commitment to re-establish rail as an important component of Nigeria's transport system.

Value of the Project

The cost of the proposed project is estimated at $1.96 billion with a substantial amount of the funds to be injected into the local and national economy through various contracts and sub-contracts. In addition, the project will attract foreign direct investment and huge employment opportunities while providing an opportunity for taxes and revenues for the three tiers of government in Nigeria.

Project Alternatives

The project alternatives were analyzed based on technical feasibility, economic viability, and environmental and social (E&S) sustainability, with a focus on minimizing displacement impacts and the project footprint in sensitive environments. The primary options considered were the original alignment and a modified alignment to avoid forest areas. Also, SCADA System was adopted for seamless monitoring and control of railway operations, including centralized control and real-time data monitoring, enhancing operational efficiency and safety. Traditional manual control systems were rejected due to scalability and real-time capability limitations.

In addition, the European Train Control System (ETCS) and GSM-Radio (GSM-R) were chosen for their enhanced safety and communication capabilities, critical for modern railway operations. Older, less automated systems were rejected due to their higher potential for operational errors. Pre-stressed concrete or composite materials were selected for their longevity and low maintenance requirements. Traditional wooden sleepers were rejected due to environmental degradation and higher maintenance needs.

Road Transportation Alternative: This option would favour further development of the road network along the route as opposed to the development of the proposed railway project. Generally, road transportation is a good land transport alternative for the movement of people and goods in the region. The limitation of road transport in comparison with rail transport is enormous and obvious. Additionally, there is always a higher risk of traffic accidents associated with road transportation. The enormous advantage of railway for cargo movement over road haulage was also taken into consideration. Periodic road repairs and maintenance due to traffic pressure along the axis will always hinder smooth movement of people and goods. This option is therefore not favoured.

Alternative Route Alignments: Two routes were considered during the feasibility study phase. In the context of an environmental and social impact assessment, the selection of the alternative RoW was considered. The exploration of these alternatives provided information about the project route so that the heavily built- up areas, particularly in urban Kano and Katsina, were avoided during the project construction.

Technological and Material Alternatives

Locomotive Choice: Diesel or Electric Power

Two alternatives were considered in relation to locomotive choice for the project, diesel and eclectic power. Diesel locomotives are self-powered whilst electric powered locomotives require an overhead line to distribute power. There are positive and negative attributes for both options when comparing performance, cost and associated environmental impacts. The option of diesel-powered locomotive is considered feasible, practicable and favoured.

Material Choice: Concrete or Wooden Sleepers

Two alternative materials were considered for sleepers, concrete and wood, both, which have advantages and disadvantages. In terms of safety, concrete sleepers have the advantage of being heavier (up to 300lbs heavier) and therefore more stable and less susceptible to temperature change which can affect timber. Concrete sleepers are however favoured for this project based on their safety characteristics over wooden sleepers.

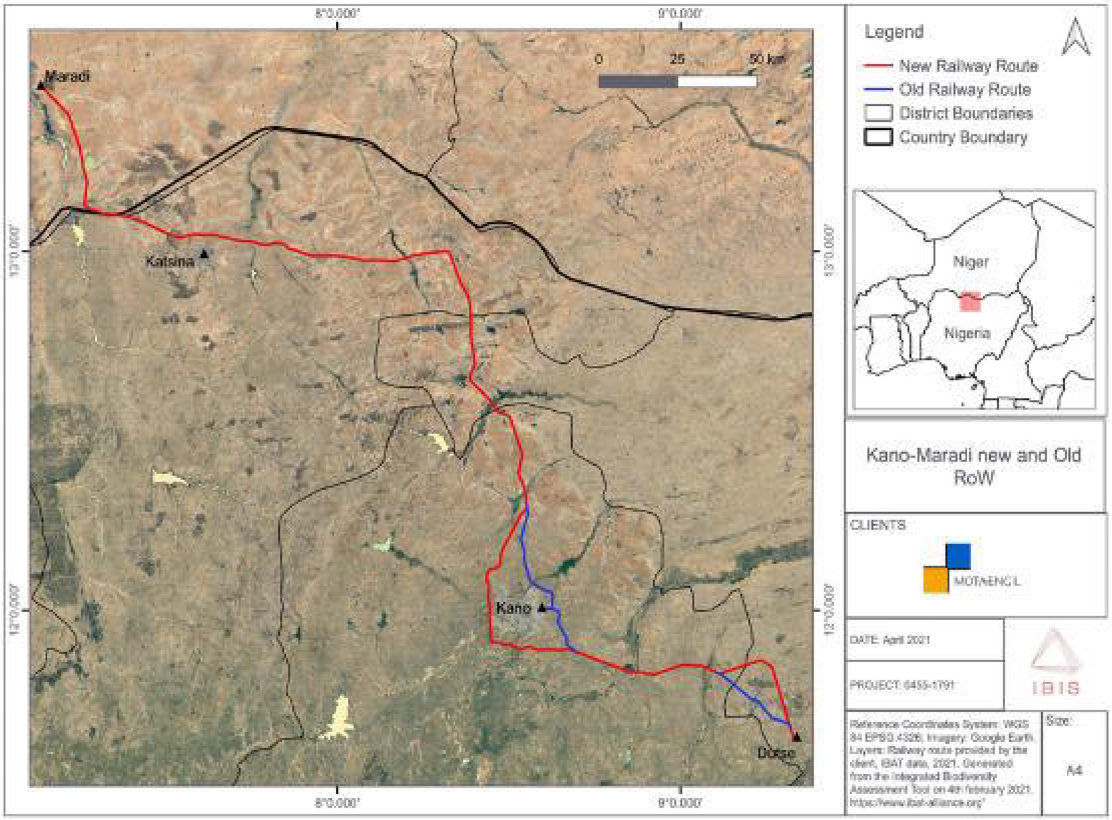

Figure i: Old and New RoW Alignment for the Kano - Maradi Railway Project

<u>Development of Air Transportation Links</u>

Another alternative to the railway project for consideration is the development of air transportation link along the project corridor. This will entail the construction of new airport terminals, runways and other ancillary facilities that are not currently available in some of the states. The option is considered inappropriate for the corridor and therefore rejected.

Project Description

The Project consists of the following elements:

- Construction of standard gauge single rail line
- Construction of 80 overhead bridges, 34 railway bridges, 9 underpasses and 74 culverts (including box culverts)
- Construction of a total of 15 stations - 15 stations along the entire project corridor

- Construction of ancillary buildings to support equipment for the operation of the rail (locomotive depot and maintenance, washing stations and coach servicing, refuelling points for locomotives, freight yard, integrated maintenance centre).
- Construction of any permanent maintenance roads to support the operation of the railway.
- Temporary works (preparation and earthworks) and tracks for construction, including construction camps and temporary access routes.

The rail is designed to accommodate both freight and passengers, with trains with a maximum design speed of 150 km/h for express trains and 120 km/h for local services. Maximum design speed for Freight trains is 100 km/h and 80 km/h for heavy freight. Maximum design speeds for maintenance areas is 30 km/h.

Railway Alignment

The rail alignment has been divided into six sections:

Dutse to Kano (Branch line): Section 1: 0 – 98.5: This section is the branch line running for 108 km from Dutse to Kano in Jigawa State, Nigeria. This route will connect Dutse with the main rail line (Kano to Maradi). This route will also connect the rail to a planned railway line to Lekki Port, Lagos. Five stations will be constructed in this section: Yar Gaya, Wudil, Gaya, Duru and Dutse. A total of 18 road overbridges, 14 railway bridges and 9 road underpasses and culverts will be constructed along this section. A worker's construction camp and laydown areas will be in Wudil. This section traverses the states Kano and Jigawa, running through predominantly agricultural areas. This route also traverses the north of the Shakwadina forest reserve. This section crosses the Lagos-Kano-Nguru narrow gauge rail line, various roads and waterbodies. Most rivers crossed by the railway alignment are used for intensive irrigation purposes. A few buildings including the Capital City University is located within the permanent RoW and will be compensated.

Kano to Dawanau: Section 2 0 – 24.0: This section is located in Nigeria, starting west of the city of Kano running north for 20 km to the south of Dawanau. The stations Kano and Dawanau will be constructed in this section. It should be noted Kano station will be constructed under a separate contract and therefore, is not included as part of the funded Project. The Kano station is an Associated Facility as the use of this station will be required during operation for the Project. The railway alignment predominately crosses the major commercial and industrial centre of Kano comprising a mix of industrial activities, agricultural activities and tourism. The railway alignment also crosses roads and rivers. Two main grains markets are located along this stretch: Zawaciki grains market and Dawanau grains market (one of the largest in Africa). A few buildings, businesses and schools are located within the permanent RoW.

Dawanau to Kazaure: Section 3: 24.0 – 88.5: In Dawanau, the route runs almost in parallel to the west of the A2 road, continuing northwards until it reaches the city of Daura, passing west of the city of Kazaure. Five stations will be constructed in this section: Kano, Dawanau, Kunya, Dambatta and Kazaure. This route, which covers 63 km, passes through the towns Kazaure and runs through predominantly agricultural land and grazing areas. This route crosses west of the Babarangu dam, an area with intensive grazing areas for cattle and irrigation. Further north, this route traverses south of the Gasartani forest reserve (an IUCN Category IV Forest reserve). A few buildings, businesses and schools are located within the permanent RoW. Eight burial grounds are located within the RoW of this section, apart from the Tumfafi graveyard located immediately west of Dawanau station.

Kazaure to Daura: Section 4:88.5 – 130.5: This section continues to run almost in parallel to the west of the A2 road, continuing northwards until it reaches the city of Daura, passing west of the city of Kazaure. The Line then turns westwards, south of Daura. Two stations will be constructed in this section: Durbe and Daura. One camp and laydown area will be constructed in Kazaure. The route passes the towns Kazaure and Daura. This route traverses the eastern tip of the Gwiwa Korel forest reserve and north of Daura Forest reserve – both forest reserves are IUCN Category IV Forest reserves. A school (forming part of the Sabuwura Jawo local community) is located within the RoW. The total distance of this section is 40 km.

Daura to Jibiya: Section 5: 130.5 – 229.5: From the south of Daura and, after crossing the Katsina-Daura Road, this section runs parallel to the road in a westerly direction until it reaches Jibiya, crossing the cities of Mashi and Katsina. One worker's construction camp and laydown area will be constructed in Katsina. The route passes the towns of Mashi, Shargalle, Katsina and Jibiya. Also, Tsamga (near Jibiya) is an international stock route. Four stations will be constructed along this stretch: Shargalle, Mashi, Maradu, Katsina. This section crosses two forest reserves: north of Damangu and the centre of Nasarawa. Daura to Jibiya route is 118 km.

Jibiya to Maradi: Section 6: 222.5 – 284.500: From Jibiya, the route crosses the Nigeria-Niger Republic border and curves northwards, running parallel to the existing road to reach Maradi where it terminates. Two stations are located in this section: Dan Issa/ Anoal Mata (TBC) and Maradi. The route passes an international cattle stock area located in proximity to the Nigeria-Niger Republic border. The railway alignment traverses a predominantly agricultural area. Jibiya to Maradi is 43 km in length.

Rail Infrastructure

The rail infrastructure consists of:

- Bridges and crossings
- Decks and walkways
- Abutments
- Piers, Beams and Piles

- Spans
- Overbridges
- Overpasses
- Road underpasses

Road, Pedestrian and Animal Crossings

- Culverts and Drainage
- Sidings/Loops/Turnouts

Wastes Management

An estimate of waste quantities and types that will be generated during the construction and operation phase is provided below.

Waste Type	**Waste Management/ Disposal**
Sanitary waste solids	Generated sludge will be periodically removed by vacuum suction truck and transported to a wastewater treatment facility or faecal sludge treatment plant
Sanitary liquid waste	After proper treatment, It will be disposed likely in a water line with wastewater disposal license.
Wastewater from concrete plant	Recirculation of water in concrete plants is being considered
Excavated materials	For fill within RoW, for fill Borrow pits after FMEnv approval.
Vegetation waste	Bushes may be packed to a side, and small trees may be harvested by villagers as source of fuel. Timber companies (bigger trees) Waste/ Timber material removal will be carried out by a third-party waste contractor licenced by the State Environmental Protection Agency (EPA) in each of the three states.
Topsoil	For store within RoW, for fill Borrow pits after FMEnv approval.
Concrete and gypsum	All construction debris from stations and building will be placed in appropriate onsite storage containers and periodically evacuated from the site to an approved dumpsite. Waste removal will be carried out by a third-

Waste Type	Waste Management/ Disposal
	party waste contractor licenced by the State Environmental Protection Agency (EPA) in each of the three states.
Asbestos Containing Materials	-
Woods, planks, offcuts of iron and metals	Foreseen the reuse of Woods, planks, offcuts of iron and metals All construction debris will be placed in appropriate onsite storage containers and periodically evacuated from the site to an approved dumpsite. Waste removal will be carried out by a third-party waste contractor licenced by the State Environmental Protection Agency (EPA) in each of the three states.
Glass	Waste removal will be carried out by a third-party waste contractor licenced by the State Environmental Protection Agency (EPA) in each of the three states.
Waste lubricating oil (from machinery)	Hazardous Waste removal will be carried out by a third-party waste contractor licenced by the State Environmental Protection Agency (EPA) in each of the three states.
Packaging wastes (plastics, styro-foam, cardboard, paper)	Foreseen the reuse of Packaging wastes (plastics, styro-foam, cardboard, paper) All Packaging wastes (plastics, styro-foam, cardboard, paper) will be placed in appropriate onsite storage containers and periodically evacuated from the site to an approved dumpsite. Waste removal will be carried out by a third-party waste contractor licenced by the State Environmental Protection Agency (EPA) in each of the three states.
Food	Raw organic waste can be disposed in a Compost unit to create natural fertilizer for the site´s garden/ farm Approved dumpsite.
Fluorescent tubes	Hazardous Waste removal will be carried out by a third-party waste contractor licenced by the State

Waste Type	Waste Management/ Disposal
	Environmental Protection Agency (EPA) in each of the three states.
Contaminated rags	Hazardous Waste removal will be carried out by a third-party waste contractor licenced by the State Environmental Protection Agency (EPA) in each of the three states.
Oil/diesel/herbicide contaminated materials from any spillages	Hazardous Waste removal will be carried out by a third-party waste contractor licenced by the State Environmental Protection Agency (EPA) in each of the three states.
Waste batteries	Hazardous Waste removal will be carried out by a third-party waste contractor licenced by the State Environmental Protection Agency (EPA) in each of the three states.
Electronic waste	Hazardous Waste removal will be carried out by a third-party waste contractor licenced by the State Environmental Protection Agency (EPA) in each of the three states.
Waste paints and solvents	Hazardous Waste removal will be carried out by a third-party waste contractor licenced by the State Environmental Protection Agency (EPA) in each of the three states.
Scrap metal (steel cuttings, metal wires, pipe cuttings)	Foreseen the reuse of Scrap metal (steel cuttings, metal wires, pipe cuttings) All Scrap metal will be placed in appropriate onsite storage containers and periodically evacuated from the site to an approved dumpsite. Waste removal will be carried out by a third-party waste contractor licenced by the State Environmental Protection Agency (EPA) in each of the three states.

Waste Type	Waste Management/ Disposal
Welding waste	Waste removal will be carried out by a third-party waste contractor licenced by the State Environmental Protection Agency (EPA) in each of the three states.
Welding waste (refractory mass)	Waste removal will be carried out by a third-party waste contractor licenced by the State Environmental Protection Agency (EPA) in each of the three states.
Bituminous waste	Foreseen the recycle of the bituminous waste. Waste removal will be carried out by a third-party waste contractor licenced by the State Environmental Protection Agency (EPA) in each of the three states.
Domestic refuse from the workforce	Waste removal will be carried out by a third-party waste contractor licenced by the State Environmental Protection Agency (EPA) in each of the three states

Project Schedule

Early Construction for the Project is due to commence in April 2022 for the main line, with the main construction commencing in July 2022 for approximately two years. Construction for the branch line will commence in April 2023 for a period of approximately one year.

Description of the Environment

The baseline data gathering was conducted from September 20, 2021 to 4th of October, 2021 for the wet season data while the dry season baseline data was acquired between December 10 and 21, 2021. The exercise was witnessed by Representatives of the Federal Ministry of Environment and officials of the Federal Ministry of Transportation, Nigeria. A multi-disciplinary approach was used in baseline data gathering exercise, which entails participation of air quality and climate specialists, ecologists, soil scientist, sociologist, geographic information system specialist, water resources specialists, geologist, civil engineer, environmental toxicologists, and other experts. The study, sampling and analysis of environmental samples were carried out within the framework of Quality, Health, Safety and Environment (QHSE) management system. All samples and *in-situ* data were collected in accordance with the approved scientific and regulatory requirements using suitable equipment, materials and experienced personnel.

The study approach includes review of existing literatures (textbooks, research articles, environmental reports and maps) on the biophysical and human environment and design of field sampling strategies to meet the scope of the EIA and regulatory requirements. In addition, field equipment was pre-tested and calibrated prior to baseline data gathering exercise. During the survey, environmental samples were collected, properly preserved and stored before transfer to laboratory for analysis. The primary objective of baseline studies is to characterise key environmental and socioeconomic resources and conditions identified during scoping as being potentially affected by project activities (e.g., air quality, geology and soil, groundwater, surface water, fauna and flora) and to identify potential sensitive receptors. The baseline of the biophysical and socioeconomic conditions of the project area was documented to provide a basis against which potential effects of the rail project can be assessed and changes can be monitored.

<u>Climate</u>: The climate of the project area is characteristic of an arid and semi-arid region, and it varies considerably from months to months across dry and raining seasons. In general, Nigeria's climate is characterized by the hot and wet conditions associated with the movement of the Inter-Tropical Convergence Zone (ITCZ) north and south of the equator. This ITCZ appears as a band of clouds, usually in form of thunderstorms that circle the globe near the equator, where Nigeria is located. The northeast winds prevail when the ITCZ is to the south of the equator, leading to the dry-season condition; and whenever it moves into the Northern Hemisphere, the south westerly wind prevails to bring rainfall and the rainy season. The Saharan air causes the dry season which is accompanied by low relative

humidity and intense aridity that makes the atmosphere very dusty while the rainy season follows the advancing Atlantic Maritime Air accompanied by high humidity in the rainy season. The harmattan period is usually extremely cold with dry air with mean daily temperature as low as 17 °C from November, when the North-East Trade wind blows from the Sahara Desert.

Air Quality and Noise: The air quality parameters determined were mainly those of public and health concern. The variability of air quality records across the project environment showed the following range: NO_2 (0-0.3 ppm i.e., 0-56 µg/m^3); SO_2 (0-0.3 ppm i.e. 0-56 µg/m^3); CO (0-4 ppm i.e. 0-4582 µg/m^3); VOC (0-0.431 ppm i.e. 1392 µg/m^3), $PM_{2.5}$ (13.6-65.8 µg/m^3) and PM_{10} (52.3-103.5 µg/m^3). The concentrations of the recorded pollutants were almost similar in trends across the project environment and this is resulting from the uniformity of the boundary layer dynamics that dominates the environment. Noise levels for project location ranged between 34.5d B (A) to 65.8 dB (A) with periods of low values ranging between 34 dB (A) to 50 dB (A) and periods of high values ranging between 51 dB(A) to 66 d(BA) for day-time monitoring. These values show a less noise friendly environment good for human habitation. The level of noise at night in the project area ranged from 30.6 dBA in Shagalle to 43.8 dBA recorded in Kano.

Groundwater: Heavy metals measured in groundwater during the wet season ranged as follows Cadmium (Cd), 0.0001 – 0.008 mg/l; chromium (Cr) 0.00 – 0.62 mg/l (mean, 0.14 mg/l), Zinc (Zn) 0.00 – 0.27 mg/l (mean, 0.10 mg/l), Iron (Fe), 0.00 – 2.31 mg/l (mean, 1.14 mg/l), Lead (Pb), 0.01 – 0.119 mg/l and Copper (Cu), 0.01 – 2.78mg/l (mean, 0.55mg/l). For the dry season it ranged as follows: Cadmium (Cd), Not detected (mean, Chromium (Cr) 0.00 – 0.04 mg/l (mean, 0.01 mg/l), Zinc (Zn) , 0.17 – 1.5 mg/l (mean, 0.86 mg/l), Iron (Fe), 0.04 – 1.82 mg/l (mean, 0.48mg/l), Lead (Pb), Not detected and Copper (Cu), 0.00 – 0.21mg/l (mean, 0.04mg/l).

THC values obtained for groundwater during the wet season ranged from 0- 3.2 mg/l; the lowest value being from Mashi, Baba Ruga and Durbi and the highest from Gurji well. For the dry season, THC was mostly undetected, the values ranged from 0 – 1 mg/l (Mean, 0.13 mg/). The presence of some hydrocarbon in water does not necessarily render water unwholesome, if within the threshold limit of 10.0 mg/l for potable water.

Surface Water: During the wet season Cadmium (Cd) values recorded for Surface water ranged from 0.0001 – 0.45mg/l (mean,0.12 mg//), Chromium (Cr) varied from 0.12 – 0.42mg/l (mean, 0.21mg/l), Zinc (Zn) measured 0.18 - 1.62 mg/l (mean, 0.54 mg/l), Iron (Fe) 0.00 – 1.68 mg/l (mean, 0.99 mg/l), Lead (Pb) 0.01 – 0.26mg/l (mean, 0.08 mg/l) and Copper (Cu) 0.15 – 0.75 mg/l (mean, 0.51 mg/l). During the dry season Cadmium (Cd) values recorded for Surface water ranged from 0.00 – 0.03mg/l (mean,0.01 mg/l), Chromium (Cr) varied from 0.00 – 0.38 mg/l (mean, 0.17 mg/l), Zinc (Zn) measured 0.16 – 2.12 mg/l (mean, 0.71 mg/l), Iron (Fe) 0.53– 2.4 mg/l (mean, 1.32 mg/l), Lead (Pb) 0.00 – 0.33mg/l (mean, 0.06 mg/l) and Copper (Cu) 0.03– 0.68 mg/l (mean, 0.26 mg/l). THC values obtained for surface water during the wet season ranged from 3- 108 mg/l (Mean, 51.44 mg/l). The dry season values ranged from 0 – 0.23 mg/l (Mean, 0.06 mg/l).

Sediment Analysis: Total iron (Fe) values recorded for sediment samples during the wet season ranged from 0.34 – 13.5 mg/kg (mean, 3.15mg/kg), Copper (Cu) varied from 0.05 – 12.43 mg/kg (mean, 3.51 mg/kg), Zinc (Zn) measured 0.21 – 5.66 mg/kg (mean, 1.75 mg/kg), Manganese (Mn) 0.00 – 0.31 mg/kg (mean, 0.07 mg/kg), Lead (Pb) 0.04 – 0.4 mg/kg (mean, 0.16 mg/kg) and Nickel (Ni) 0.05 – 0.43mg/kg (mean, 0.22mg/kg). Cadmium (Cd) values ranged from 0.002 – 2 mg/kg (mean, 0.25mg/kg), Chromium (Cr) varied from 0.02 – 0.04mg/kg (mean, 0.03 mg/kg), Mercury (Hg) was not detected in any of the sediment samples. Dry season samples had values that ranged as follows, total iron,1.62 –28.4 mg/kg (mean, 11.64 mg/kg), Copper (Cu) varied from 0.38 – 1.66 mg/kg (mean, 0.98 mg/kg), Zinc (Zn) measured 0.11 – 0.69 mg/kg (mean, 0.27 mg/kg), Manganese (Mn) was undetected), Lead (Pb) 0.00 – 0.62 mg/kg (mean, 0.2mg/kg) and Nickel (Ni) was undetected. Cadmium (Cd) values ranged from 0.03 – 2 mg/kg (mean, 0.32 mg/kg), Chromium (Cr) varied from 0.01 – 0.13 mg/kg (mean, 0.04 mg/kg), and Mercury (Hg) was not detected in any of the sediment samples. The THC of sediment samples measured in the wet season ranged from 0 – 6.1 with an average of 1.43. The lowest measurement was obtained at Dam near Tsamoni while the highest was at Wallawa River and that of the dry season ranged from 1.49 – 7.22 with an average of 3.22. The lowest measurement was obtained at Duduru River upstream, Gaya while the highest was at Muduru river.

Cadmium (Cd) values recorded for top soil ranged from 0.00 - 98.00 mg/kg (mean, 4.21 ± 16.94 mg/kg), Chromium (Cr) varied from 0.00 - 2.20 mg/kg (mean, 0.36 ± 0.57 mg/kg), Zinc (Zn) measured 0.00 - 3.00 mg/kg (mean, 0.92 ± 1.03 mg/kg), Iron (Fe) 0.00 - 540.00 mg/kg (mean, 22.45 ± 94.26 mg/kg), Lead (Pb) 0.00 – 7.50 mg/kg (mean, 1.41 ± 2.39 mg/kg) and Copper (Cu) 0.00 – 98.00 mg/kg (mean, 4.54 ± 17.02 mg/kg). Values obtained in the subsoil for the parameters include Cd values ranged from 0.00 – 54.00 mg/kg (mean, 2.66 ± 10.65 mg/kg), Cr varied from 0.00 - 2.20 mg/kg (mean, 0.32 ± 0.56 mg/kg), Zn measured 0.00 – 2.50 mg/kg (mean, 0.82 ± 0.90 mg/kg), Fe measured 0.00 - 650.00 mg/kg (mean, 19.36 ± 89.18 mg/kg), Pb was 0.00 – 8.20 mg/kg (mean, 1.39 ± 2.63 mg/kg) and Cu, 0.00 – 54.00 mg/kg (mean, 3.16 ± 10.57 mg/kg).

In dry season, cadmium was undetected at some locations and the maximum concentration recorded was 5.33 mg/kg for topsoil at a location near Agangaro while the mean is 0.39 mg/kg. The highest value of chromium recorded was 3.28 mg/kg with a mean value of 0.40 mg/kg. The maximum lead concentration detected in the topsoil was 4.90 mg/kg after Toma Dam area before Danbatta station. Topsoil with the highest copper value (8.18 mg/kg) was collected at Tsamga Dadawa while the mean concentration was 0.70 mg/kg across all the sampling stations. In the subsoil samples collected in dry season, the highest concentration of cadmium detected was 1.11 mg/kg (lower than the topsoil); the maximum concentration of chromium (2.83 mg/kg) was also lower than the topsoil maximum value. The values were detected from subsoil samples collected before the proposed Kazaure station and at Sada respectively. The maximum lead concentration recorded in the subsoil samples for the dry season was 3.19 mg/kg (at Sada) while copper concentration was 62.1 mg/kg.

In wet season, TPH ranged in the topsoil from 0.00 – 0.50 mg/kg (mean, 0.05 ± 0.11 mg/kg), and 0.00 – 0.35 mg/kg (average, 0.04 ± 0.07 mg/kg). The oil and grease content of the topsoil generally measured between 0.00 – 3.30 mg/kg (mean, 0.47 ± 0.70 mg/kg) and subsoil, 0.00 – 5.00 mg/kg (mean, 0.41 ± 0.84 mg/kg). The mean values indicate that subsoil concentrations of oil and grease are slightly lower when compared to those of the top soils during the wet season.

The vegetation of the project area is dominated by grasses and shrubs with an average height of 1.5 metres. These plant species are considered as the cultural vegetation in the project corridor. Common trees across the entire stretch of the study area include *Adansonia digitata* (African baobab tree or locally referred to as *Kuka* in Hausa); *Anogeissus leiocarpus* (African birch; known in Hausa as *Marke* or *Kojoli* in Fulani language); *Diospyros mespiliformis* (Jackal berry / ebony, which is called *Kanya* in Hausa and *Balchi* in Fulani). Other plant species that are widespread in the study area are *Azadirachta indica* (Neem, commonly known as *Dogon yaro* among the locals) and *Khaya senegalensis* (*Madaci* in Hausa and *Dalehi* in Fulani) and *Tamarindus indica* (locally referred to as *Tsamiya*). Edible cash crops such as cashew and mango were encountered at different parts along the route. Also, cowpea, groundnut, maize, millet, onion, rice and sorghum are widely cultivated in the project area.

Almost all the lands are cultivated along the route, and as a result, flora species diversity is low and many of the plant species earlier identified in the Savanna are reducing in population, especially those with value in health care and edible qualities such as *Khaya Senegalensis*. Large trees are few in the dryland ecosystems such as exist in Jigawa State while only shrubs and small trees with a wild variety of grasses predominate. These plants have highly adjusted to the aridity of the zone (drought-resistant) and are useful to the community either as food, livestock feed or medicinal purpose. Generally, during the dry season, the grasses in the project area are usually dry and brown, and bush fires are often a common occurrence. The underground parts of the grass survive the dry season and fires and grow again when the rain comes.

Across the sampling stations, a total of 48 taxa of plants belonging to 25 families were encountered during the study. Most of the encountered taxa serve as herbs and food for livestock or the people in the project area. The physiognomy of most of the sampling stations is characterized by cultivated farmland and open vegetation of scanty trees with similar anthropogenic factors. Sampling station 12 had the highest diversity; having the highest number of plant species (16) while stations 3 and 17 had the least number of plant species. The most frequently encountered plant species along the route were *Azadirachta indica*, which was observed at 24 of the 34 sampling locations. Others were *Balanites aegyptiaca (19), Piliostigma thonningii (17), Guiera senegalensis (16), Diospyros mespiliformis (15), Adansonia digitata (14), and Leptadenia hastate (13).* The least encountered plant species were *Alchornea cordifolia, Anacardium occidentale, Asparagus africanus, Centaurea praecox, Citrus aurantium, Daniellia oliveri, Delonix regia and Ficus sp.* Other flora species encountered at only one sampling location were *Ocimum basilicum, Phoenix dactylifera, Vetiveria sp., Vigna subterranean, Vitellaria paradoxum, Wissadula amplissima and Ziziphus mauritiana.* Although *Saccharum spontaneum* and *Digitaria exilis* were two of the most abundant, each of them was also encountered at only one location.

Fauna Species: The study area is endowed with a wide variety of (wild and domesticated) animal species. They vary from small arthropods like mites and ticks to very large mammals like the camel and donkey. The Phylum Arthropoda dominated the invertebrate community and is represented by insects such as butterflies. Various groups of vertebrates were reported to be present, and they included amphibians, reptiles, birds and mammals. Of the species of vertebrate wildlife identified, the avifauna, reptiles and mammals were the dominant groups. The mammals reported to occur in the area were mainly browsers or grazers including medium-sized mammals such as goats, sheep and rodents (small mammals) like *Thryonomys swinderianus* (Cutting grass), *Xerus erythropus* (ground squirrel).

The low fauna diversity could be attributed to low vegetation cover and extensive farmlands which are a clear indication that primary vegetation and natural habitats have been cleared for cultivation. The fauna species found within the project site at the time of survey include invertebrates such as arthropods (ants, termites, and beetles) and amphibians such as *Bufo bufo*, vertebrates such as reptiles (lizards, and savannah monitor), found in the scrubland microhabitat dominated by Acacia trees. The project area has high avian abundance and diversity and this could be attributed to the richness of seed-bearing grasses, grains, fruits and insects in the open vegetation of the area. The common bird types include the Francolin *Francolinus spp,* African swiff *Apus affinis*, Eagles *Haliaetus vocifer*, Egrets B*ublcus spp,* and many others. Reptilian fauna endemic in the area includes lizard (*Agama agama*), Geko (*Hemidactylus* species), monitor lizard (*Varanus exanthematicus),* chameleon (*Chamaeleo dilepis*), and snakes (*Natrix anoscopis)*. Insects, arachnids and myriapods as well as other species such as earthworms *Eudrilus euginae*, and few snails *Archachatina marginata* were found. Some insect species of this area are of economic importance, serving as food sources, crop pests and disease vectors of man and animals.

During the study, there was no encounter with any animal species that are either threatened, endangered or critically endangered. Most of the animals encountered are insects and birds. In a preliminary study, seven Critically Endangered flora and fauna species were identified and reported to be within the Project's Area of Influence. These are *Saxicolella marginalis*, slender-snouted crocodile (*Crocodylus cataphractus* or *Mecistops cataphractus*), black rhino, hooded vulture (*Necrosyrtes monachus*), white-backed vulture (*Gyps africanus*), Ruppell's vulture (*Gyps rueppelli*) and white-headed vulture (*Trigonoceps occipitalis*). In Jibiya, locals confirmed *Trigonoceps occipitalis* and *Gyps africanus* are occasionally encountered at the traditional medicine stalls; and some are reportedly brought from in from Niger Republic.

Health Impact Assessment and Socioeconomic Survey

Health Impact Assessment (HIA) was conducted in the proposed project area which included 15 Local Government Areas (LGAs) that cut across three states, namely, Katsina (6), Kano (6) and Jigawa (3). Prior to data collection, extensive literature review on the area and the project was conducted. Scoping workshops were carried out to establish baseline data, engage relevant stakeholders and sensitize the affected communities on subsequent field work activities. Thereafter, semi- structured questionnaires and Key Informant Interview (KII) guides were developed targeting main project objectives and research assistants were trained on data collection.

A total of 105 communities were identified within the project area and 53 were selected, representing both urban and rural settlements. A total of 374 respondents were interviewed, the questionnaires were then retrieved and analyzed using statistical package for social sciences (IBM SPSS version 25). The results showed that, 339 (92.4%) respondents were females and 28 (7.6%) were males. (This is because questions on health were asked primarily of female respondents). The mean age was 34.3 years with a standard deviation (SD) of 13.0 years (34.3$\pm$13.0). In terms of residency, 95.0% of the people interviewed were permanent residents in the study area compared to 5.0% that were temporary residents. Majority of the respondents belonged to either Hausa (68.9%) or Fulani (30.0%) ethnic groups, with only about 1.0% belonging to other ethnic groups. About four (4) of ten (10) respondents (39.6%) had Islamic education only, followed by primary (25.9%) and secondary (22.4%) education. Only 12.1% of the respondents had post-secondary education. Similarly, majority (88.8%) of the respondents were married compared to 11.2% that were not. The number of children per respondent ranged from 0 to 22 (median value was 6), whereas the number of dependents per respondent ranged from 0 to 24 (median value was 3). The respondents were mostly into food processing (32.4%), small scale businesses (25.1%), artisanal works (23.5%) and livestock farming (12.6%). The monthly income of the respondents ranged from N1,000 to N300,000 depending on the season, even though the median income per month (N5,000) did not change with the seasons. In terms of expenditures, respondents spent between N100 to N15,000 (median = N2,000) monthly on transportation and between N2,000 to N30,000 (median = N2,000) monthly on health.

Regarding the proposed railway line project, majority of the respondents anticipated positive impact on their health (23.9%), family life (66.7%) and income (90.1%). however, adverse health concerns were also raised by the respondents including fear of accidents and injuries (31.9%), spread of communicable diseases (28.6%) as well as excessive noise and vibrations (15.7%).

Stakeholders Engagement

Stakeholder Identification and Analysis

The engagement process identified three main categories of stakeholders to ensure effective and appropriate interaction: Project-Affected Parties, Other Interested Parties, and Vulnerable Groups. Project-Affected Parties include individuals, groups, and entities directly affected by the rail project along the project corridor. These parties are the most susceptible to changes associated with the project and were extensively engaged to identify likely project impacts, their significance, and potential mitigation measures. Other Interested Parties are those who may not experience direct impacts from the project but perceive their interests as being affected or who could influence the project and its implementation. Vulnerable Groups are individuals who may be significantly impacted by the project or further disadvantaged due to their vulnerable status. These groups require special engagement efforts to ensure their equal representation in the consultation process and decision-making associated with the project.

Methodology and Outcomes

Stakeholders engagement including scoping workshops were organized in the state capitals of the three affected states in Nigeria: Dutse (Jigawa State), Kano (Kano State), and Katsina (Katsina State). In Jigawa, the workshop took place at Dutse Royal Hotel on September 20, 2021. In Kano, it was held at the Grand Central Hotel on September 21, 2021, and in Katsina at the Education Resource Centre on September 23, 2021. The workshops saw the participation of 128 people in Jigawa, 120 in Kano, and 84 in Katsina. These participants included district heads, representatives from national and state government institutions, traditional institutions, NGOs/CBOs, media organizations, and international entities. Invitations, along with the Project Background Information Document, were sent to key stakeholders, including federal, state, and local government ministries and agencies, traditional rulers, and various interest groups.

The workshops, conducted in an open house format, featured presentations in English and Hausa by the Allott Team. Participants actively contributed to discussions, with posters and banners about the project displayed at the venues. Stakeholders overwhelmingly supported the project due to anticipated benefits but raised concerns about economic and physical displacement. Specifically, stakeholders were worried about compensation for potential losses and displacement from farmlands and homes. The Miyetti Allah Cattle Breeders

Association expressed concerns about the possible fragmentation of international cattle routes and the risk of train collisions with cattle. Other key issues included the project's impact on the Great Green Wall and ensuring the inclusion of women and vulnerable individuals in the entire process.

Status of Stakeholder Engagement

Consultations were held with major stakeholders at various levels. Federal agencies consulted included the Federal Ministry of Environment, the Federal Ministry of Water Resources, the Federal Ministry of Works and Housing, among others. State government institutions involved were the Ministries of Environment, Agriculture, Information, Land and Survey, and others across Jigawa, Kano, and Katsina States. Local government authorities and traditional institutions from Bichi, Daura, Dutse, Gaya, Kano, Katsina, and Kazaure Emirates were engaged. Trade unions, NGOs, and CBOs such as the All Farmers Association of Nigeria, Miyetti Allah Cattle Breeders Association, and several women and youth organizations also participated. Media organizations and international bodies like WHO and UNICEF were included in the consultation process.

Key Issues and Concerns from Stakeholders

In Jigawa, key concerns included the employment of local youths to reduce unemployment and associated criminal activities, as emphasized by a representative of the Jigawa State Commissioner of Police. Women’s inclusion in decision-making and employment was stressed by a women leader, while concerns about land take, displacement, and the need for a compensation and grievance resolution mechanism were raised by a security operative.

In Kano, the fragmentation of international grazing routes was highlighted by the Director of Kano State Stock Route, with calls for addressing the impact on cattle and herdsmen during planning and construction. Representatives from the Kano Emirate Council and

Miyetti Allah Cattle Breeders Association emphasized handling the displacement of farmers and livestock owners with caution and setting up a grievance redress mechanism.

In Katsina, stakeholders recommended sensitization campaigns for herders to prevent animal crossings on the rail line. The local content and engagement of local manpower at different project phases were advocated by representatives from Umaru Musa Yar'adua University Centre for Renewable Energy. Women's participation was emphasized by the coordinator of the Katsina Women Economic Empowerment Project. Security concerns were raised by the Deputy Commandant of NSCDC, suggesting collaboration with security operatives and investment in security outposts. The impact on livestock and the importance of a mitigation plan were noted by the representatives of the Katsina Livestock Development Project. Environmental concerns, particularly tree planting to mitigate land clearing impacts, were raised by the representative of the Great Green Wall. Additionally, the Miyetti Allah Cattle Breeders Association highlighted concerns about the fragmentation of local and international grazing routes and its associated impacts, advocating for practical mitigation measures.

Associated and Potential Environmental and Social Impacts

The environmental and social risks associated with the rail project span across pre-construction, construction, and operational phases, each presenting unique challenges and necessitating specific mitigation strategies.

During the pre-construction phase, the acquisition of land will significantly impact both protected and non-protected forest reserves like Damangu, Daura, and Gwiwa Korel, among others. This will lead to the loss of habitats for critical plant species and the displacement of several communities and individuals, who depend on the land for agriculture, residential, and commercial purposes. Economic displacement will also occur due to the loss of livelihoods from shops and farmlands, alongside major human rights concerns related to involuntary displacement and inadequate compensation. The demolition of buildings and structures to clear the way for construction will pose risks to groundwater from spills of hazardous materials, contribute to air and noise pollution, and generate significant waste and dust.

The construction phase introduces further risks including the disruption of surface and groundwater systems, exacerbated by the extensive use of heavy machinery which also contributes to air and noise pollution, and increased greenhouse gas emissions. The movement of construction materials will affect traffic and transport systems, potentially causing congestion and increasing accident risks. Additionally, the extensive earthworks necessary for laying rail tracks and building train stations will alter the topography and potentially lead to increased flooding and erosion, impacting both natural habitats and human settlements nearby.

Operationally, the rail system is expected to generate noise and vibrations, manage high volumes of waste from passengers and operations, and continuously impact groundwater and surface water through the intensive use of resources. Long-term operation also brings the risk of accidents, including potential collisions at rail crossings, which could have severe human safety implications.

Impacts and Mitigation Measures

Mitigating these impacts involves a combination of strategies aimed at minimizing environmental damage and enhancing the social and economic benefits of the project. During the pre-construction and construction phases, measures include avoiding critical habitats, reducing noise through controlled working hours, managing dust and emissions through technology and site management practices, and ensuring proper waste disposal. The mitigation measures address displacement and restoration of homes and livelihood, appropriate compensation, respect for human rights, protection of workers and members of the public from harm and injuries. The project Grievances Redress Mechanism (GRM) will be coordinated through the RAP management committees, which include the Resettlement Steering Committee (RSC), Resettlement Management Committee (RMC) and Community Resettlement Committee (CRC). All grievances would be collected by GOs or CLOs present in the project-affected communities in each state. These grievances would be collated, recorded, and referred to the CRC for resolution at the community level. Unresolved grievances by the CRC shall be escalated to the RMC for resolution. The project will also need to incorporate robust safety measures to protect both workers and local communities from construction-related risks.

For the operational phase, continuous monitoring of environmental impacts such as noise, water use, and pollution will be necessary. Traffic management plans will help mitigate transportation impacts, and emergency response strategies will be crucial for reducing the risks of accidents and ensuring quick containment and resolution. Overall, the mitigation strategies need to be comprehensive, involving strict compliance with environmental management plans, active engagement with affected communities to ensure their rights and livelihoods are protected, and the implementation of advanced technology to reduce and manage environmental impacts effectively. Ensuring the sustainability of the project will require ongoing monitoring and adaptation of strategies to address both anticipated and unforeseen impacts. Detailed mitigation measures applicable to each of the identified impacts are presented in Chapter Six.

Environmental and Social Management Plan

Environmental and Social Management Plan (ESMP) is an environmental management tool generally used to ensure that avoidable adverse impacts of a development project are prevented or minimized while enhancing its (the project) potential benefits. It is a site-specific, strategic programme aimed at ensuring that reasonably avoidable or unanticipated impacts of a proposed project, which were not identified, are controlled and minimized to an acceptable level. The Environmental and Social Management Plan (ESMP) implementation monitoring is projected to cost ₦475,000,000 (approximately $289,307.30). The operation and maintenance phase is estimated at ₦660,000,000, which equates to about $401,984.88. Meanwhile, the construction phase is anticipated to require ₦4,025,566,657, translating to approximately $1,980,635.33. The total cost, combining the ESMP implementation monitoring, operation and maintenance phase, and construction phase, is estimated at ₦5,160,566,657, which equates to approximately $2,671,927.51. The Environmental and Social Management plan for the different project phases is provided in Chapter Seven.

Recommendations

The Federal Government of Nigeria and its counterpart in Niger Republic have shown remarkable commitment to implementing this project in an environmentally and socially friendly manner that will reduce associated negative impacts. In particular, the FMT has been at the forefront of ensuring the project is executed sustainably. There is an appreciable level of commitment to building good relationships with stakeholders, PAPs and PACs, and regulatory agencies, which will no doubt enhance the sustainability and successful implementation of the proposed project.

It is therefore recommended that:

- All project activities from the planning, and construction to operational phases are carried out under the overall monitoring of relevant environmental regulatory agencies.
- The FMT and its contractors shall ensure strict adherence to all specifications and standards for design and construction, mitigation measures and recommended EMP in its implementation of this rail project.

- Continuous consultations with all relevant stakeholders shall be maintained.
- Mitigation measures prescribed in the report shall be strictly followed while complying with regulatory guidelines and standards throughout the implementation of the project.
- When and where unforeseen project impacts occur, mitigation measures shall be modified to effectively manage the impacts.
- All safety measures shall be strictly implemented and enforced as they relate to workers at all phases.
- The Environmental Management Plan (EMP) designed for the project shall be implemented throughout the project life cycle; from construction, through operation to decommissioning.
- In the event of decommissioning, an Abandonment Plan shall be developed. The concept of greenway and railbanking may be adopted to convert the rail infrastructure to further public / commercial use.

Conclusion

Given the detailed description of baseline environmental characteristics of the project area and the impact assessment, mitigations and EMP that has been presented in this report, it is therefore concluded that:

- The technology, equipment, and facilities to be deployed or constructed are among the best available and environmentally friendly technology, which has been used in different parts of Nigeria. An example is the Lagos – Ibadan rail project, which is operational at the time of preparing this report, and which has been widely accepted by different categories of people in the society as a reliable mode of transportation.
- The project has significant benefits and positive impacts such as employment opportunities, reduced traffic on road, shorter travel time for freight and passengers, cheaper mode of transportation, enhanced regional and transnational economy,

among others. The project will be a major source of revenue for government at all levels. The potential benefits outweigh the potential adverse impacts. Despite the potential negative impacts identified, the mitigation measures recommended for this project will eliminate some impacts, minimise some and offset others if properly implemented. In addition, with good management practice, the residual impacts shall be short-term, mostly localized, and reversible on the environment.

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1.0 CHAPTER ONE: INTRODUCTION

1.1 BACKGROUND INFORMATION

The Nigerian government through its Federal Ministry of Transportation proposes to construct a Standard Gauge Rail (SGR) line from Kano, northwestern part of Nigeria to Maradi Province in the southern part of The Republic of Niger with a Branch Line connecting Kano with Dutse in Jigawa State (Figure 1.1). The proposed Kano-Maradi rail line is an international rail line connecting Kano and Katsina with the Republic of Niger (Figure 1.2), consisting of 284-km Kano to Maradi while the planned 108 km branch line will connect Kano to Dutse – the capital of Jigawa State (Figure 1.3). A total of 15 stations are proposed to be built along the Mainline of single track from Kano to Maradi and 5 stations along the Branch line from Kano to Dutse, with an average distance of 20.2 km between consecutive stations.

The Project is expected to enhance the movement of passengers and goods, and as a result, provide support for the trade and commerce in the region. The major cities and towns to be served by the proposed rail line are Dutse, Kano, Dambatta, Kazaure, Daura, Mashi, Shargalle, Katsina, Jibiya and Maradi. The proposed project is part of the objective of the Government of Nigeria to promote the modernization of rail transport infrastructures, as outlined in the "25 Year Strategic Vision for Nigerian Railway System". Aspects of these objectives are already materialized in the construction of the lines, or part of the lines, in Standard gauge, such as Ajaokuta-Warri, Abuja-Kaduna and Lagos-Ibadan.

The current Kano-Maradi and Kano-Dutse line is then one of those lines which when built, will allow the integration of this rail transport with the other existing road transport, to enhance the transport of passengers and goods along of the states served by the new infrastructure. The overall objective of the strategic plan is the development of the Nigerian railway network, promoting logistical integration with other transport networks, seeking to optimize and enhance means, through the construction of a fast, safe, and environmentally friendly railway infrastructure.

Figure 1. 1: Map of Nigeria showing the proposed project route.

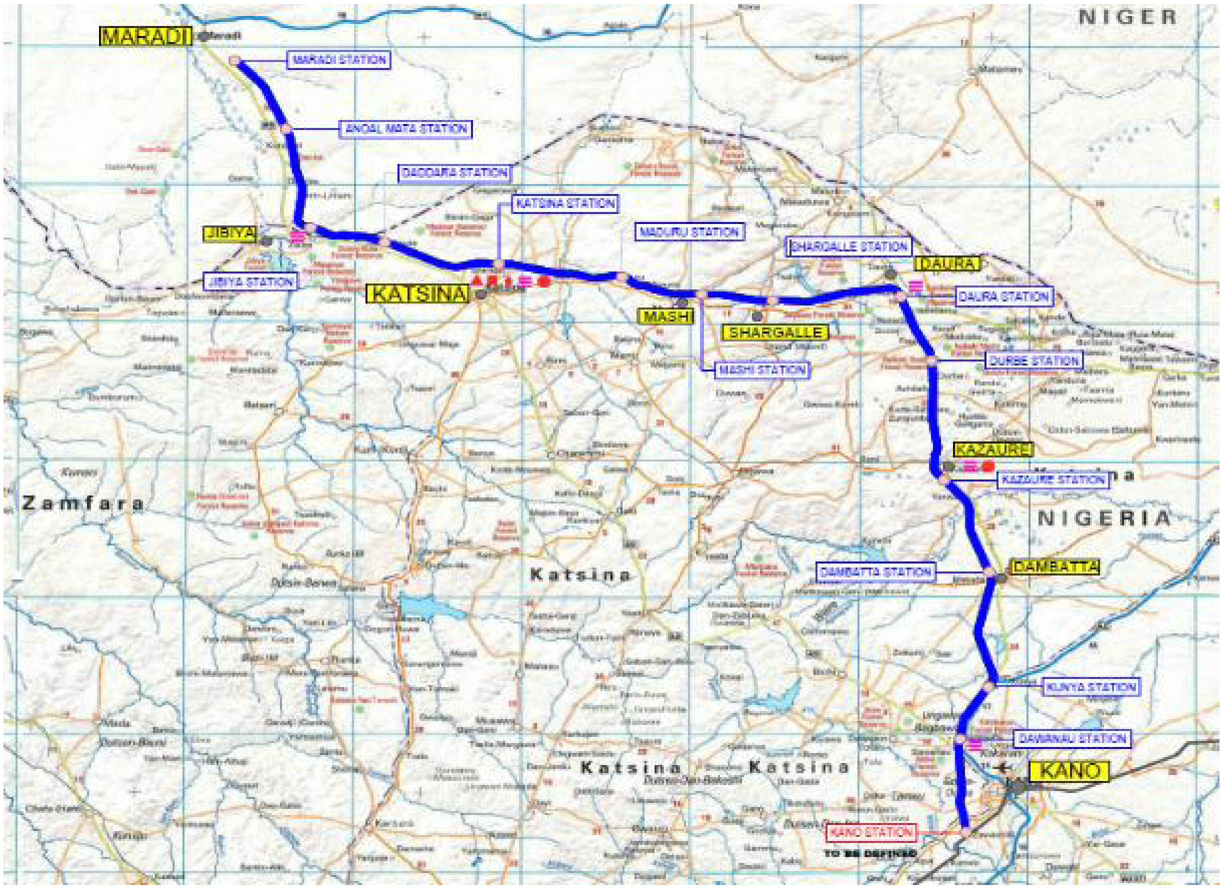

Figure 1. 2: Project Alignment: Kano-Maradi

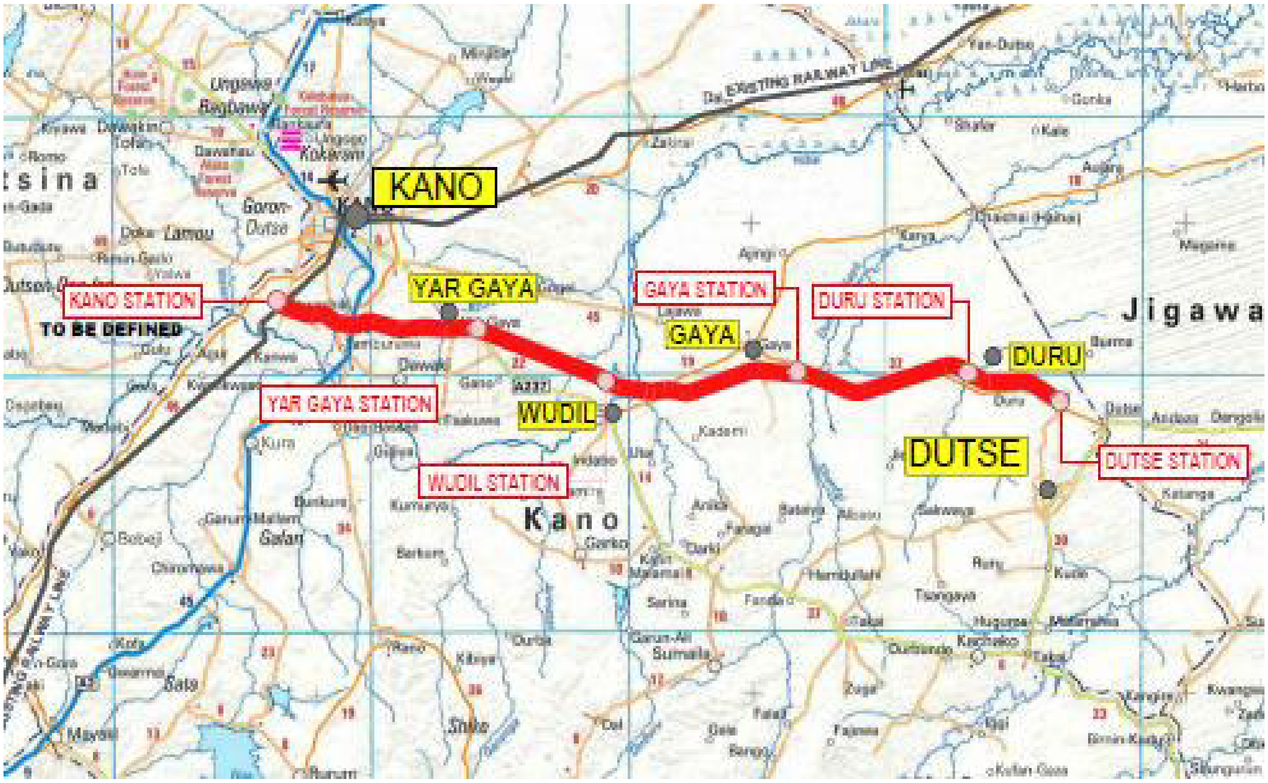

Figure 1. 3: Project Alignment (Branch line) – Kano to Dutse

However, there are ongoing national and global concerns that many developmental projects such as railway development have major environmental and social impacts. Some of these include damage to sensitive ecosystems, loss of productive agricultural lands, resettlement of large number of people, permanent disruption of local economic activities, demographic change due to in-migration, accelerated urbanization and introduction of diseases through changing life pattern.

This development necessitated carrying out an Environmental and Social Impact Assessments (ESIA) along the railway corridor. The primary purpose of the ESIA is to identify the most feasible technical solution for the construction of the project. The ESIA was part of the project based on its preliminary design. The essence of the ESIA is to identify and foresee probable environmental and social conflicts that would arise, to provide solutions and mitigation measures for avoiding permanent negative impacts of this project implementation on the environment and the people.

This report therefore highlights the negative and positive outcomes that could arise from the planned construction and operation of the proposed project, as well as options for minimizing the negative outcomes in both rural and urban areas. The planned construction transcends both rural and urban areas in the three states (Kano, Jigawa and Katsina States). In the rural area setting, the key impacts revolve around removal of productive agricultural lands, pedestrians' safety, water quality, severance and transport cost. Likewise in the urban area where population density is higher, the dominant impacts are the displacement of people and their homes, safety, disruption to means of livelihood, pollution, (atmospheric and noise), accessibility etc.

The report formalizes the information gathered from the field on the existing conditions, an identification of potential impacts arising from the implementation of the different phases of the project on the immediate environment and on the daily economic lives of the people in the rail corridor. Specific emphasis has been made on communities where the impacts are likely to be felt most. The ESIA study assessed the potential environmental impacts from the construction and operation of the rail project on the environment. It also recommends practicable and cost-effective mitigation measures against identified adverse effects.

A team of experts from various disciplines was engaged to undertake different components carried out in the ESIA study. A detailed reconnaissance survey / site verification exercise of the rail corridor was carried out from 2nd to 6th August 2021. The aim of this was to get acquainted with the rail corridor, identify major stakeholders and screen for potential impacts before the actual comprehensive field survey. Prior to commencement of the field surveys, involvement of the public and identified stakeholders was undertaken to determine the scope of the environmental and social Impact Assessment (ESIA). In line with the Ministry of Environment directive, Scoping workshops were organized and this ensured that relevant government agencies at the local, state and federal levels, civil society organizations, nongovernment organizations, other interest groups, and members of the project affected communities contributed to discussions on the scope of environmental components to be assessed, project alternatives, identification of potential impacts associated with the proposed project and mitigation measures to manage the identified impacts. Scoping workshops were organized and held at the state capitals of the three affected states in Nigeria: namely Dutse (Jigawa State), Kano (Kano State) and Katsina (Katsina State). In Jigawa, the scoping workshop was held at Dutse Royal Hotel, Dutse, Jigawa State on Monday, 20th September 2021. The Scoping Workshop for stakeholders in Kano State was held at the Grand Central Hotel, Kano on Tuesday, 21st September 2021 while the workshop was held in Katsina on Thursday, September 23rd, 2021, at Education Resource Centre, Opposite Katsina Museum, Katsina.

For the ESIA field surveys, the wet season field truthing was carried out between the 20th of September– 4th of October 2021; while the dry season field truthing was carried out between 20th – 27th December 2021. During the field surveys, information on environmental attributes of the project area representing the existing characteristics was collected and analyzed.

The following environmental components were investigated to give adequate information on the local environment of the railway right-of-way.

- Climate and meteorology
- Geology and hydrogeology
- Air quality and noise monitoring
- Soil quality assessment
- Surface water quality assessment
- Sediment assessment
- Groundwater quality assessment
- Biodiversity study
- Land use assessment
- Traffic study
- Socio-economic studies
- Health assessment

1.1.1 The Project Proponent

The proponent for the proposed Kano to Maradi Railway project is the Federal Ministry of Transportation (FMT), located at Bukar Dipcharima House, Central Business District 900103, Abuja, Federal Capital Territory, Nigeria. The mandate of the Federal Ministry of Transportation is to ensure fast, safe, efficient, affordable, convenient, integrated, and inter-modal transport system that facilitates Nigeria's socio-economic developmental needs and enhances the quality of life of the public. The Federal Ministry of Transportation of Nigeria (FMT) has appointed Mota-Engil Africa (MEA), to design and construct the railway project. In implementing the above and in conformity with government regulations, Allott Nigeria Ltd, an engineering and environmental consultancy outfit was commissioned to carry out the Environmental and Social Impact Assessment (ESIA) study of the proposed project.

1.2 PROJECT PREMISES

The key premises, which affect the ESIA process, were established from the initial stages of the project. The premises are as follows:

- The project recognizes the Federal Ministry of Transportation and Federal Ministry of Environment policy guidelines issued by the erstwhile Federal Environmental Protection Agency (FEPA) in 1995. Policies by State Ministries of Environment and equivalents of Jigawa, Kano and Katsina, the relevant State Environmental Protection Agencies (State EPAs), Environment Protection Committees at the Local Government level and other laws operating both nationally and internationally.
- The project is being designed and will be operated to comply with these local and national laws, together with all the international protocols, agreements and conventions.
- The agreements and understandings made with Government officials, during the course of the ESIA process will be respected and honoured.
- Extensive consultations have and will continue to be held with Government officials at various levels (Federal, State and Local Governments) together with the host communities that will be affected by the project. Consultation meetings shall be maintained on a mutually agreed basis.
- An Environmental and Social Management Plan (ESMP) will be developed as part of the ESIA process. The implementation of the plan will be the responsibility of the Federal Ministry of Transportation in conjunction with the State governments involved.

1.3 POLICY, ADMINISTRATIVE AND LEGAL FRAMEWORK

1.3.1 National Policy on Environment

The Federal Government of Nigeria formulated the National Environmental Policy in 1989 and launched the document in 1991. It was first revised in 1999 and later in 2016. The goal of the National Policy on the Environment is to 'ensure environmental protection and the conservation of natural resources for sustainable development. The document includes guidelines for achieving sustainable development in fourteen vital sectors of the nation's economy. These include land use and soil conservation, water resources management, wildlife and protected natural areas, waste management, energy production, and air pollution, among others. The policy document is aimed at promoting good environmental practices through environmental awareness and education, most of which are relevant to the project. In addition, there are national policies applicable to the proposed rail development project and the most pertinent is the National Transport Policy.

1.3.1.1 National Transport Policy 2010

The fundamental goal of the National Transport Policy 2010 is to develop an adequate, safe, environmentally sound, efficient and affordable integrated transport system within the framework of a progressive and competitive market economy in Nigeria.

The objectives of the policy are:

- to promote economic development, expand trade and improve Nigeria's competitiveness through an efficient and affordable transport system;
- to encourage and remove all barriers towards the private sector participation in the development, provision, maintenance, operation and upgrading of transport infrastructure and services;
- to promote the use of public transport over private cars;
- to promote a culture of maintenance and continuous upgrading of transport services in Nigeria;
- to improve the safety, security, reliability, quality, and speed of movement of goods and people at local, national and international levels;
- to develop transport infrastructure that ensures environmental sustainability and internationally-acceptable standards;

- to support states and the Federal Capital Territory in the development and promotion of urban transport systems and local governments in developing and promoting rural accessibility.

The primary goal of the Transport Policy for the rail transportation sub-sector is to transform the rail system from its present condition to an efficient, flexible and competitive mode. To achieve its goal, the Federal Government of Nigeria will carry out:

- Rehabilitation of the existing railway infrastructure
- Concession the existing rail lines
- Moderation and expansion of the rail network to link all seaports and international airports, key industrial and economic centres, among others.

In addition, recent investment in the transport sector has been guided by two major policy documents – the Nigeria Integrated Infrastructure Master Plan (NIIMP), which runs from 2014 until 2043; and the Economic Recovery and Growth Plan (ERGP); a mid-term macroeconomic development agenda covering the period from 2017 to 2020. NIIMP is a broad infrastructure roadmap intended to strengthen multi-modal linkages, as well as institutional, legal and policy frameworks, to enhance key project delivery. Its transportation portfolio covers all segments, including rehabilitation of existing rail lines in Nigeria and construction of new tracks.

1.3.2 National Environmental and Social Legislations and Regulations

There are environmental and social regulations pertinent to the proposed Kano-Maradi rail development project. In addition to some international environmental safeguard polices, treaties and conventions, key national regulations which are germane to the project are the Environmental Impact Assessment (EIA) Act Cap E12 LFN 2004; The Land Use Act Cap L5, LFN 2004 and Nigerian Urban and Regional Planning Act CAP N138, LFN 2004.

1.3.2.1 Environmental Impact Assessment (EIA) Act Cap E12 LFN 2004

The EIA Act Cap E12 LFN 2004 (formerly known as EIA Decree No. 86 of 1992) makes Environmental Impact Assessment mandatory for all new major public and private projects in Nigeria. The Act sets out the general principles, procedures and methods of EIA in various sectors, and it gives specific powers to the FMEnv to facilitate environmental assessment of projects. Specifically, Section 1 of the Act states that the objectives of any environmental impact assessment shall be:

- Consider the likely impacts and the extent of these impacts on the environment before embarking on any project or activity.
- To establish, before a decision is taken by any person, authority, corporate body or unincorporated body including the government of the federation, state or local government intending to undertake or authorise the undertaking of any activity that may likely or to a significant extent affect the environment or have environmental effects, the extent of the effects of these activities on the environment.
- To promote the implementation of appropriate policy in all federal lands, states, and local government areas, consistent with all laws and decision-making processes through which the goals and objectives in paragraph (i) of this section may be realised.
- To encourage the development of procedures for information exchange, notification and consultation between organs and persons when proposed activities are likely to have significant environmental effects on boundary or on the environment of border towns or villages.

To achieve these objectives, the Act stipulates that no public or private sector of the economy shall undertake or embark on any project without first carrying out an EIA study. The proposed Kano-Maradi rail line project is a fundamental development project that is expected to, in addition to its key potential benefits, adversely impact on the environment. Therefore, full compliance with the EIA Act is required. The EIA guidelines (procedural and sectoral) issued by the FMEnv apply to all project activities for the development of this project.

1.3.2.2 *Nigerian Railway Corporation Act No. 20 of 1955 (as amended 1990)*

The Nigerian Railway Corporation Act No. 20 of 1955 (amended in 1990 and re-enacted in 2008) established the Nigerian Railway Corporation (NRC) as an independent regulatory agency. The NRC was inaugurated in 1955, and the corporation has the exclusive right to build, operate and maintain rail infrastructure and rail transport in Nigeria.

1.3.2.3 *The Land Use Act Cap L5, LFN 2004*

The Land Use Act of 2004 CAP L5 (formerly Land Use Decree No. 6 of 1978), the Constitution of 1999 and the Public Lands Acquisition Laws of the States of the Federation make up the governing policy for land acquisition in Nigeria and these enable the State to acquire land (that is, to abrogate leases and other authorisations to occupy land). The Act vests all land in each State of the Federation (except land already vested in the Federal Government of Nigeria or its agencies) in the Governor of the State. It makes the State Government the authority for allocating land in all urban areas for residential, agricultural, commercial and other purposes, while it confers similar powers regarding non-urban areas on the local governments in such cases. The Governor of a State can revoke a right of occupancy for overriding public interest. The right for building of residential and other structures, farmlands, and shrines for traditional worship, among others, are rights permitted under Section 51 of the Land use Act.

1.3.2.4 *National Environmental Standards & Regulations Enforcement Agency (NESREA) Act, 2007*

The following National Environmental Standards and Regulations Enforcement Agency (NESREA) regulations are related to the rail line project:

National Environmental (Sanitation and Wastes Control) Regulations, S. I. No. 28 of 2009: The purpose of this regulation is to provide the legal framework for the adoption of sustainable and environment friendly practices in environmental sanitation and waste management to minimize pollution during project implementation.

National Environmental (Noise Standards and Control) Regulations, S. I. No. 35 of 2009: The main objective of the provisions of this regulation is to ensure serenity of the human environment or surrounding and their psychological well-being by regulating noise levels, which could be impacted by anthropogenic or industrial activities.

National Environmental (Soil Erosion and Flood Control) Regulations, S. I. No. 12 of 2011: The objective of this regulation is to control all earth-disturbing activities, practices or developments for non-agricultural, commercial, industrial and residential purposes.
National Environmental (Construction Sector) Regulations, S. I. No. 19 of 2011: The purpose of this regulation is to prevent and minimize pollution of the Nigerian environment from the impacting activities of construction, decommissioning and demolition activities.

National Environmental (Surface and Groundwater Quality Control) Regulations, S. I. No. 22 of 2011: The National Regulations on Surface and Groundwater Quality Control are intended to restore, enhance, and preserve the physical, chemical and biological integrity of the nation's water resources, and to maintain existing water uses.

National Environmental (Electrical/Electronic Sector) Regulations, S. I. No. 23 of 2011: The main objective of this regulation is to ensure that best practices are applied in order to safeguard the Nigerian environment against pollution hazards from Waste Electrical and Electronic Equipment that may be deployed for use especially at the operation phase of the Kano-Maradi rail project.

1.3.2.5 Nigerian Urban and Regional Planning Act CAP N 138, LFN 2004

The Urban and Regional Planning Act is aimed at overseeing realistic, purposeful planning of the country to avoid overcrowding and poor environmental conditions. In this regard, the following sections apply:

- Building and construction plan must be drawn and submitted for approval (Section 30 (3)).
- Planting of trees for environmental conservation (Section 72)

1.3.2.6 *Harmful Waste (Special Criminal Provisions) Act Cap H1 LFN 2004*

The Harmful Waste (Special Criminal Provisions) Act 1988 now Cap H1 LFN of 2004 prohibits activities relating to harmful wastes; and these include the carrying, depositing and dumping of harmful waste on any land and territorial waters of Nigeria, contiguous zone or Exclusive Economic Zone of Nigeria or its inland waterways. The Act, without prejudice to the provisions of the Customs, and Excise Tariff, among others enactments, or law, prohibits all activities relating to the purchase, sale, and importation. The proposed project will generate some hazardous wastes during construction phase. These include oil waste and related materials like oily rags, filters and spent lead acid batteries during repair and or maintenance of construction equipment and vehicles. This waste requires proper handling and disposal in accordance with the applicable requirements of this Act.

1.3.2.7 *The Endangered Species Act, CAP E9, LFN 2016*

This Act (formerly known as Endangered Species Act Cap E9, LFN 2004 now revised) focuses on the protection and management of Nigeria's wildlife and some of their species in danger of extinction because of over exploitation. The following sections are important to the project:

- Section 1 prohibits, except under a valid license, the hunting, capture or trade in animal species, either presently or likely, in danger of extinction.
- Section 5 defines the liability of any offender under this Act.
- Section 7 provides for regulations to be made necessary for environmental prevention and control as regards the purposes of this Act.

Certain sections of the line route of this project will pass through natural areas that serve as wildlife habitats, which will be impacted by the project. Hence, the project activities shall be carried out to comply with major provisions of this Act.

1.3.2.9 Labour Act, Cap L1, Laws of the Federation of Nigeria 2004

This Act is the principal and most direct legislation on employment matters in Nigeria. It is a piece of legislation, which seeks to protect the employment rights of individual workers and it includes matters such as classification of worker types, wages, contracts, employment terms and conditions, and recruitment. Additional legal frameworks for labour administration in Nigeria are:

- Trade Disputes Act, Cap T8, LFN, 2004
- Trade Disputes (Essential Services) Act, Cap T9, LFN, 2004
- Trade Unions (Amended) Act, 2005.
- National Minimum Wage Act, 2019
- Employment Compensation Act, 2010
- ILO Conventions, Recommendations and Protocols

1.3.2.10 National (Public) Health Act 2014

In Nigeria, the Public Health Law such as the Nigeria National Health Act 2014 provides justification for the execution of developmental projects under guidelines that promote health by protecting the environment and safeguarding humans' health. The Public Health Laws empower Medical Officers of Health (operating at the local government council, under the supervision of the State and Federal Ministries) to ensure the promotion of good health.

The Water Resources (Amendment) Act, 2004

This Water Resources Act Cap. W2, Laws of the Federation of Nigeria 2004 (now Water Resources (Amendment) Act, 2016 is an Act of the Parliament of the Federal Republic of Nigeria. This Act vests the right to use and control all surface and groundwater and all water in any watercourse affecting more than one state, together with the banks and beds thereof, in the Federal Government, which shall promote planning, development and use of Nigeria's water resources; coordinate activities likely to influence the quality, quantity, use, distribution and management of water. Also, the federal government under the Act, shall apply appropriate standards and techniques for use, and protection.

Other Applicable Federal Legislations and Policies

- Abandonment Guidelines 1995
- Africa Development Bank Safeguards
- Basel Convention on Trans-Boundary Movement of Hazardous Wastes and their Disposal,
- Climate Change Act 2021
- Employee Compensation Act of 2010
- Environmental Impact Assessment Sectoral Guidelines for Infrastructures 1995.
- Fire Service Act 1981
- Kano State Environmental Pollution Control law of 2022
- Kyoto Protocol,
- National Environmental Health Practice Regulation act 27 of 2016,
- National Environmental Protection (Management of Solid and Hazardous Waste) Regulation, FEPA/FMEnv S.1.15 (1991)
- National Inland Waterways Act
- National Policy on Occupational Safety and Health, 2016
- Natural Resources Conservation Act CAP 286 LFN 1990
- Nigerian Energy Transition plan (2022)
- Paris Agreement,
- Penal Code Act CAP 53 LFN, 2008
- Public Health Law Cap 103 LFN 1990
- United Nations Framework Convention on Climate Change (1992)
- Water Resources Act, CAP W2, LFN 2004

1.3.3 State Environmental Regulations and Laws

In accordance with Section 24 of the defunct FEPA Act, Chapter 131 of the Laws of the Federal Republic of Nigeria, 1990, the State Environmental Protection Edicts were enacted. The Edict empowers the State Environmental Protection Agencies (SEPA) to establish such environmental criteria, guidelines/specifications, or standards for the protection of the state's air, lands and waters as may be necessary to protect the health and welfare of the people. The functions of SEPA among others include:

- Routine liaison and ensuring effective harmonization with the FMEnv in order to achieve the objectives of the National Policy on the Environment.
- Co-operate with the FMEnv and other related regulatory agencies in the promotion of environmental education.
- Be responsible for monitoring compliance with waste management standards; and
- Monitor the implementation of the EIA and Environmental Audit Report (EAR) guidelines and procedures on all developmental policies and projects within the State.

All the state's environmental protection issues, with respect to this project, are under the supervision of Jigawa, Kano and Katsina States Ministries of Environment and their agencies.

1.3.3.1 State Land Legislations

a. Kano State Land Laws, Regulations, and Institutions

The Kano State Bureau for Land Management office is responsible for the management of land in Kano State. Kano State has a Land Use Act, which was developed in 2016 to empower the state Bureau for Land Management for the management of land in the State. The Bureau's mandate is to strengthen land administration (acquire, prepare land documents, allocate and register all land transactions), physical planning of non-urban centers in the State, land acquisition, compensation, and management of land conflict. Kano State Ministry of Physical Planning is also a regulatory body which has a major stake in this project with respect to land acquisition and land use.

b. Katsina State Land Laws, Regulations, and Institutions

Katsina State Ministry of Land, Survey and Environment is the major body responsible for land advisory, land allocation and certification, resettlement, and implementation of land policies in the State. However, Katsina Urban Planning and Development Authority (KUPDA) is a subsidiary of the ministry that deals with land issues and developmental structures in urban cities. The local government has land departments responsible for certifying land ownership prior to confirmation from the State ministry, which shows legal possession of land by individuals in the State.

c. Jigawa State Land Laws, Regulations, and Institutions

Jigawa State in 2021 enacted the Jigawa Land Use Act. The Jigawa State Ministry of Land and Survey and the Ministry of Urban and Regional Planning are responsible for making policies and laws regarding land ownership in Jigawa State. These agencies are responsible for processing certificates of ownership, the statutory certificate for intending landowners, enumeration, and compensation. A land advisory committee is also set at the local government level to advice on land-related matters. The committee comprises representatives from the traditional leaders, ministry of Agriculture, Ministry of Environment (land department), security agencies and religious leaders.

1.3.4 Local Government Areas Byelaws on Environmental Health

The route of the proposed rail line project passes through 18 local governments across the three states. The Byelaws on Environmental Health and Sanitation of the Local Government Authorities, which ensure environmental management, protection and cleanliness for the general well-being of the people in the LGAs, are in place. The LGAs, through its Environmental Health Officers are also responsible, in collaboration with other agencies of government in the states, for the implementation of water and sanitation law.

1.3.5 International Standards

1.3.5.1 IFC Performance Standards

The IFC Policy on Environmental and Social Sustainability defines the IFC's commitments to environmental and social (E&S) sustainability. The requirements for Projects in managing environmental and social risks are defined in the IFC Performance Standards (PS).

Table 1.1: IFC Performance Standards

Performance Standard	Scope	Applicability
1. Assessment and Management of Social and Environmental Risks and Impacts.	Outlines the importance of managing E&S performance throughout the life of a project by using a dynamic environmental and social management system (ESMS). Defines requirements for ensuring appropriate E&S management, policy implementation and accountability, including ESIA requirements, emergency response, and stakeholder engagement.	?
2. Labour and Working Conditions	The requirements set out in PS2 have been in part guided by a number of international conventions negotiated through the UN and ILO. PS2 includes requirements for ensuring definition and implementation of fair recruitment and workforce management policies and safe and healthy working conditions.	?
3. Resource Efficiency and Pollution Prevention	Defines requirements for ensuring an appropriate level of pollution prevention and abatement in line with international available technologies and practices, including consideration of technical and financial feasibility.	?
4. Community, Health, Safety and Security (CHSS)	Defines requirements for ensuring that adverse impacts from the Project on the receiving community are managed and controlled.	?
5. Land Acquisition and Involuntary Resettlement	Defines requirements for land tenure management and community resettlement as part of Project development including the need to improve, or restore, the livelihoods and standards of living of displaced persons.	?
6. Biodiversity Conservation and Sustainable Management of Living Resource	Defines requirements for ensuring that the Project's impacts on nature, ecosystems, habitats and biodiversity are appropriately managed. Outlines requirements to maintain the benefits from ecosystem services.	?
7. Indigenous Peoples	Defines requirements for ensuring that the rights of Indigenous Peoples are respected and that they may benefit from the Project.	?
8. Cultural Heritage	Defines requirements for managing the Project's impacts on	?

	replicable and non-replicable cultural heritage.	

1.3.5.2 World Bank Environmental Health and Safety Guidelines

In addition to the IFC PSs, the IFC and World Bank Group have also developed general and sector-specific environmental health and safety guidelines. The Environment, Health and Safety (EHS) guidelines are designed to be used in conjunction with the IFC PSs, and provide guidance to users on common EHS issues potentially applicable to various industry sectors. The applicability of these guidelines should be tailored to the hazards and risks of a project based on the site-specific variables of host country context, assimilative capacity of the environment, and other project factors as deemed relevant by qualified and experience assessors. The key guideline documents applicable to the Project include:

- General Environmental, Health and Safety Guidelines, 2012;
- Environmental, Health and Safety Guidelines for Railways, 2007;
- Environmental, Health and Safety Guidelines for Telecommunications, 2007
- Environmental, Health and Safety Guidelines for Electrical Power Transmission and Distribution, 2007;
- Environmental, Health and Safety Guidelines for Water and Sanitation, 2007;
- Environmental, Health and Safety Guidelines for Construction Materials Extractions, 2007;
- Environmental, Health and Safety Guidelines for Health Care Facilities, 2007;
- Environmental, Health and Safety Guidelines for Toll Roads, 2007; and
- IFC/EBRD Workers' accommodation: processes and standards, 2009.

The IFC EHS Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice. The industry sector EHS Guidelines incorporate information relevant to the specific facility/development and provide guidance on environmental, occupational health and safety (H&S) and community H&S aspects, as well as performance indicators and monitoring.

1.3.5.3 African Development Bank Integrated Safeguards System and Standards

The African Development Bank (AfDB) has an Integrated Safeguards System (ISS) designed to promote sustainability and mitigate environmental and social risks in its funded projects. The 2023 updated ISS includes a set of 10 Operational Safeguards (OS) which are guidelines and standards to ensure that projects do not harm people or the environment.

These E&S Operational Safeguards (OS) are:

- E&S OS 1: Assessment and Management of Environmental and Social Risks and Impacts
- E&S OS 2: Labour and Working Conditions
- E&S OS 3: Resource efficiency and pollution prevention and management
- E&S OS 4: Community Health, Safety and Security
- E&S OS 5: Land Acquisition, Restrictions on access ato land and landuse, and involuntary resettlement.
- E&S OS 6: Habitat and Biodiversity conservation and sustainable management of living natural resources.
- E&S OS 7: Vulnerable Groups.
- E&S OS8: Cultural Heritage
- E&S OS 9: Financial Intermediaries
- E&S OS 10: Stakeholder Engagement and Information Disclosure

All the operational safeguards are applicable to Kano-Maradi rail project with the exception of E&S OS 9. The updated ISS and its Operational Safeguards provide a robust framework for ensuring that this rail project is implemented in a socially and environmentally responsible manner. By adhering to these safeguards, the project can minimize negative impacts, enhance benefits to communities, and contribute to sustainable development.

1.3.5.4 Project Categorization

Both the OECD Common Approaches (Section 0) and Equator Principles (EP) IV (Section 0) classify projects as Category A, B or C based on the project risk level. EP IV defines Category

A projects as those "*with potential significant adverse environmental and social risks and/or impacts that are diverse, irreversible or unprecedented*" whilst the OECD Common Approaches, expands on this to note that "*These impacts may affect an area broader than the sites or facilities subject to physical works.*" Based on the likely impacts of the Project, it has been assumed for the purposes of this ESIA that the Kano to Maradi Rail Project be classified as a Category A project. This is in line with the illustrative list of Category A Projects provided in Annex 1 of the Common Approaches and which includes "*construction of railway lines that go beyond urban areas and of long-distance railway lines*".

1.3.5.5 OECD Recommendations (Common Approaches)

The OECD Common Approaches are a series of recommendations for addressing environmental and social aspects and are applied by export credit agencies (ECAs) operating in OECD countries. The OECD Common Approaches promote good practices, application of international standards, and are designed to contribute to sustainable development through the consideration of international environmental, climate change, social and human rights policies, and commitments under relevant international agreements and conventions.

1.3.5.6 Equator Principles IV

The Equator Principles (EPs) are a voluntary set of standards for determining, assessing and managing social and environmental risk in projecting financing. They are industry benchmark and risk management framework, adopted by financial institutions, and primarily intended to provide a minimum standard for due diligence to support responsible risk decision-making. Currently 80 Equator Principles Financial Institutions (EPFIs) in 34 countries have officially adopted the Principles. The Equator Principles Association, through its Strategic Review, produced a series of recommendations on key thematic areas, namely: scope, climate change, human rights, reporting and transparency, stakeholder engagement and governance.

The scope of the EP is global and cuts across all industry sectors, and EP Financial institutions (EPFIs) will only provide loans to projects that comply with Principles 1-10 (listed below).

- *Principle 1: Review and Categorization*
- *Principle 2: Environmental and Social Assessment*
- *Principle 3: Applicable Environmental and Social Standards*
- *Principle 4: Environmental and Social Management System and Action Plan*
- *Principle 5: Stakeholder Engagement and Disclosure*
- *Principle 6: Grievance Mechanism*
- *Principle 7: Independent Review*
- *Principle 8: Covenants*
- *Principle 9: Independent Monitoring and Reporting*
- *Principle 10: EPFI Reporting and Transparency*

Equator Principles IV (2020)

EP 1: Review and Categorisation - Requires that a project proposed for financing be categorised based on the magnitude of potential impacts and risks in accordance with the E&S screening criteria of the IFC

EP 2: Environmental and Social Assessment - Requires that for Category A or B projects, the relevant E&S impacts and risks be addressed through an E&S Assessment process, to include assessments of potential adverse Human Rights impacts and climate change risks as part of the ESIA or other assessment

EP 3: Applicable Environmental and Social Standards - Requires projects in non-designated countries, such as Ghana, to be in compliance with the IFC Performance Standards and the World Bank EHS Guidelines

EP 4: Environment and Social Management System and Equator Principles Action Plan - Requires that all Category A and Category B projects to develop and maintain an ESMS as well as prepare an MP to address the findings of the Assessment. This will describe and prioritise actions necessary to manage the impacts and risks identified by the Assessment

EP 5: Stakeholder Engagement - Requires that all Category A and Category B projects to demonstrate effective Stakeholder Engagement as an ongoing process in a structured and culturally appropriate manner with Affected Communities and, where relevant, Other Stakeholders

EP 6: Grievance Mechanism - Requires that all Category A and, as appropriate, Category B projects to establish a grievance mechanism as a component of their management system

EP 7: Independent Review - Requires that for all Category A projects and, as appropriate, Category B projects, an Independent Environmental and Social Consultant, must review the management plans, ESMS and Stakeholder Engagement process and assess compliance with Equator Principles

EP 8: Covenants - Requires that for all Category A and Category B projects the borrower ensures that all financial documentation will be compliant with the set covenant agreement. If compliance is not achieved, the EPFI will work with the borrower on remedial actions to bring the Project back into compliance. If unsuccessful, the EPFI reserves the right to exercise remedies, including calling an event of default, as considered appropriate

EP 9: Independent Monitoring and Reporting - Requires that for all Category A projects and, as appropriate, Category B projects, an independent expert will verify all monitoring and reporting information that is shared with EPFIs

EP 10: Reporting and Transparency - Requires that each EPFI commits to report publicly at least annually about its Equator Principles implementation processes and experience

Figure 1. 4: The Equator Principles

The Equator Principles IV also require a human rights due diligence in accordance with the United Nations Guiding Principles on Business and Human Rights (UNGPs). The EPs serve as a common framework for each adopting institution for its own internal social and environmental policies, procedures, and standards. EPFIs commit to not providing loans to projects where the borrower will not or is unable to comply with their respective social and environmental policies and procedures that implement the EPs.

1.3.5.7 Convention on International Trade in Endangered Species

Officially referred to as Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the objective of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is to control the trade in species of wild animals and plants that are, or may be, threatened with extinction because of international trade. CITES Parties, including Nigeria, regulate international trade in animals and plants, identified in the CITES Appendices to ensure that trade does not threaten their survival and to facilitate appropriate trade. Nigeria has been involved in CITES since its inception and plays a key role in the convention. As a major exporter of plants species such as economic crops, Nigeria helps to ensure the CITES agreement continues to support trade that is sustainable.

1.3.5.8 Other International Agreements, Conventions, and Protocols

- United Nations Framework Convention on Climate Change (1992)
- Kyoto Protocol,
- Basel Convention on Trans-Boundary Movement of Hazardous Wastes and their Disposal,
- Paris Agreement
- African Development Bank Safeguard Standards
- Convention on International Trade in Endangered Species of Wild Fauna and Flora

1.3.5.9 Mota Engil Safety Policy

Mota-Engil uses an integrated management system that covers quality, occupational health and safety and the environment. The organisation is committed to making every effort to provide a safe, healthy work environment where all employees are dedicated to continuing to reduce the risk of injury. Mota-Engil HSE Policy is attached as an Appendix of the report.

1.3.6 Administrative Framework

The administrative framework within which this study is implemented consists of regulatory agencies relevant to the proposed Kano-Maradi rail development project. The Ministries and Agencies, which serve as administrative stakeholders providing the legal frameworks, include:

- Federal Ministry of Environment
- Federal Ministry of Transportation
- Nigerian Railway Corporation (NRC)
- Jigawa State Ministry of Environment
- Jigawa Environmental Protection Agency
- Jigawa State Ministry of Lands and Survey
- Kano State Ministry of Environment
- Kano Environmental Protection Agency
- Kano State Ministry of Lands and Survey
- Katsina State Ministry of Environment
- Katsina Environmental Protection Agency
- Katsina State Ministry of Lands and Survey
- Local Government Authorities affected across the three states (Figures 1.5 – 1.7).

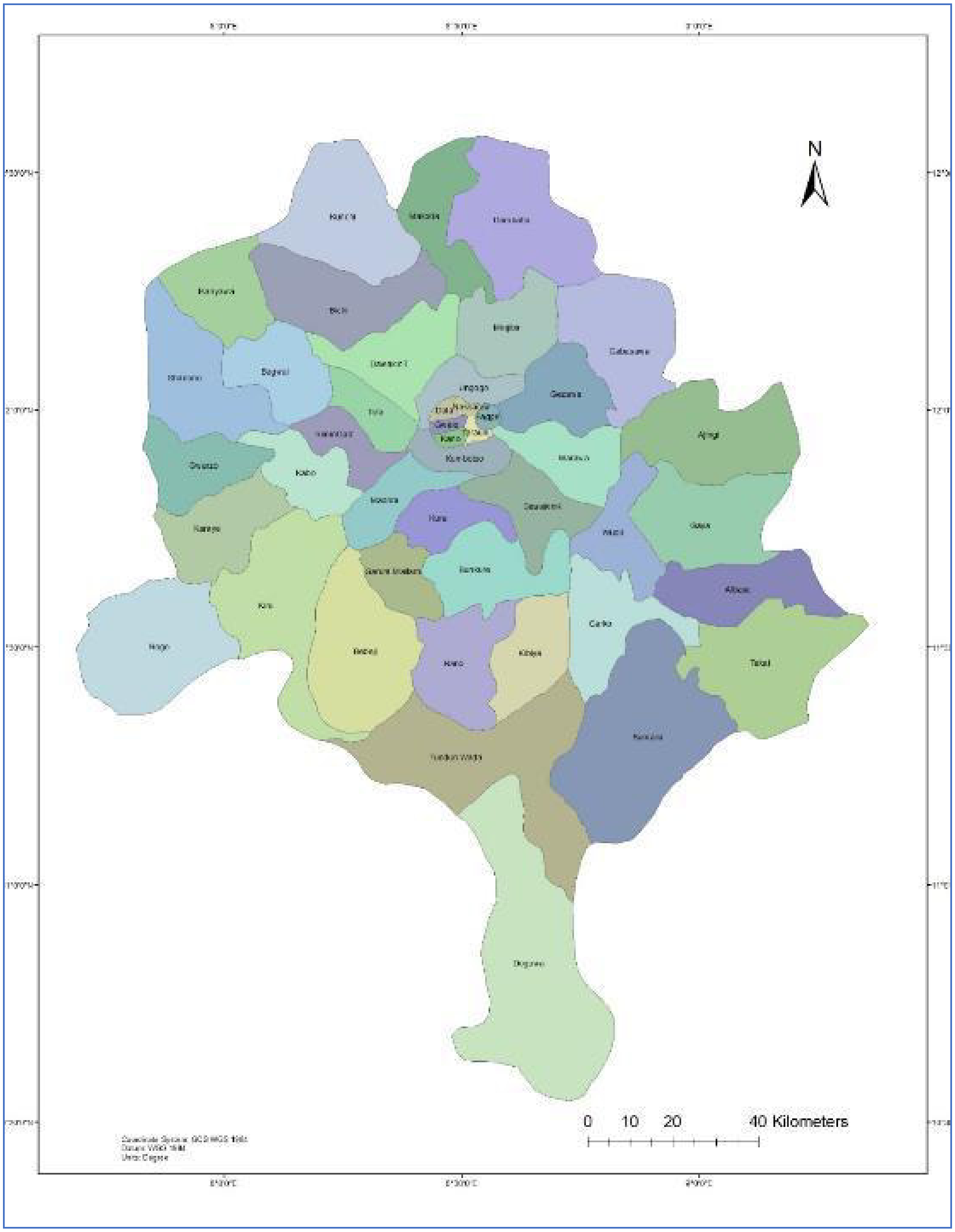

Figure 1. 5: Administrative Map of Kano State, Nigeria

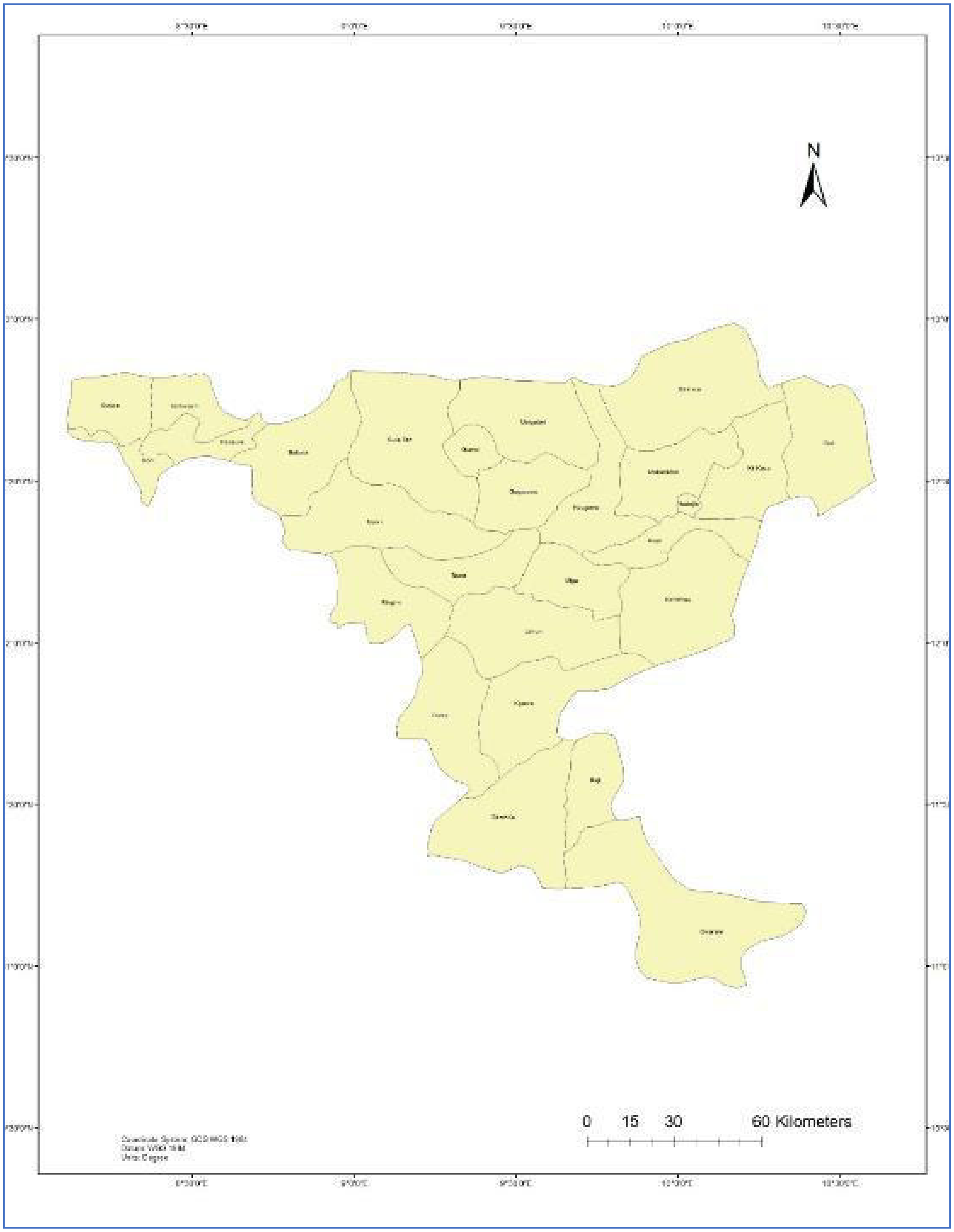

Figure 1. 6: Administrative Map of Jigawa State, Nigeria

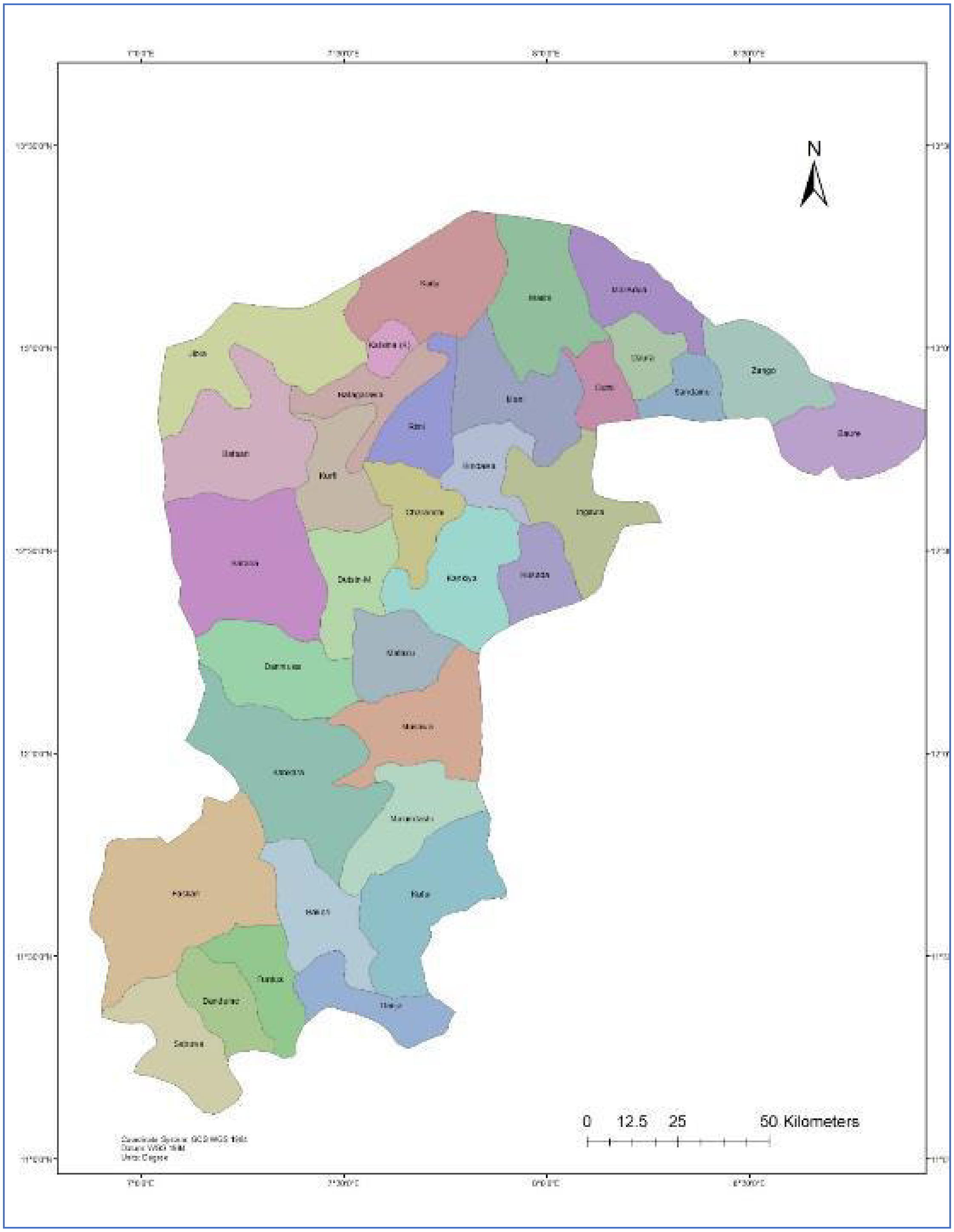

Figure 1. 7: Administrative Map of Katsina State, Nigeria

1.3.6.1 Federal Ministry of Environment

The Federal Ministry of Environment (FMEnv) was established by the Federal Government of Nigeria in June 1999, and subsequently took over the roles of the defunct Federal Environmental Protection Agency, which was established by Decree No 58 of 1988; a decree that was revised by Federal Environmental Protection Agency (FEPA) Decree No. 59 of 1992. The focal role of the defunct FEPA was to provide the appropriate legal and institutional framework for the management of the Nigerian environment in line with the decree establishing the Agency.

The FMEnv was created to ensure effective coordination of all environmental matters, which hitherto were fragmented and under different Ministries. The establishment was intended to ensure that environmental matters are adequately mainstreamed into all developmental activities.

The FMEnv has the mandate to:

- Prepare a comprehensive National Policy for the protection of the environment and conservation of natural resources, including procedures for EIA of all development projects.
- Prepare in accordance with the National Policy on Environment, periodic master plans for redevelopment of environmental science and technology and advise the Federal Government on the financial requirements for the implementation of such plans.
- Advise the Federal Government on National Environmental Policies and priorities, the conservation of natural resources, sustainable development, and scientific as well as technological activities affecting the environment and natural resources.
- Promote cooperation in environmental science and conservation technology with similar bodies in other countries and with international bodies connected with the protection of the environment and the conservation of natural resources.

- Cooperate with Federal and State Ministries, Local Government Authorities, statutory bodies and research agencies on matters and facilities relating to the protection of the environment and the conservation of natural resources.
- Prescribe standards for, and make regulations, on water quality, effluent limitations, air quality, atmospheric protection, ozone protection, noise control as well as the removal and control of hazardous substances, and;
- Monitor and enforce environmental protection measures.

The process for Environmental Impact Assessment in Nigeria is summarized in Figure 1.8.

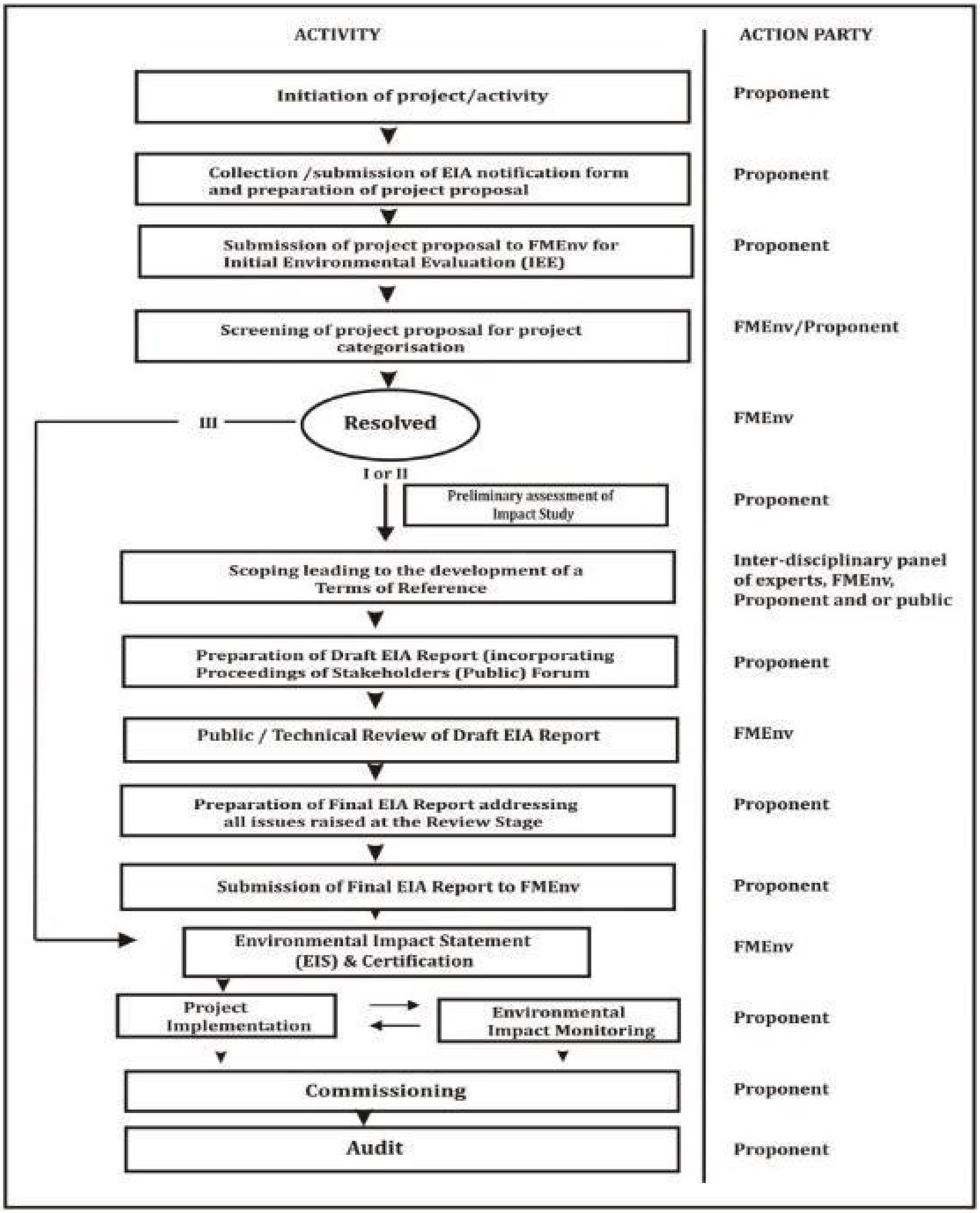

Figure 1. 8: FMEnv EIA Process

Source: FEPA, 1995

1.3.6.2 *Federal Ministry of Transportation*

The Federal Ministry of Transportation (FMT) is the policy making arm of the Federal Government with the responsibility for supervision of all transportation-related policies and projects in Nigeria. The ministry is responsible for overseeing parastatals including the Nigerian Airspace Management Agency (NAMA), Federal Airports Authority of Nigeria (FAAN), Nigerian Civil Aviation Authority (NCAA), Nigerian Maritime Administration and Safety Agency (NIMASA), Nigerian Railway Corporation (NRC), Nigerian Ports Authority (NPA), Nigerian Shippers' Council (NSC), and National Inland Waterways Authority (NIWA), among others. The Rail Transport department of the ministry supervises the activities of the Nigerian Railway Corporation, and formulates policy on railway and infrastructure development.

1.3.6.3 Nigerian Railway Corporation

The Nigerian Railway Corporation (NRC) is an independent regulatory agency that was established in 1955 and Re-enactment Act of 2008. Prior to the establishment of NRC through an Act of the Parliament, the defunct Lagos Government Railway and Baro-Kano Railway were amalgamated on October 3, 1912, which made nationwide rail service under the name Government Department of Railways possible. The Corporation has since its establishment, been the federal government enterprise with the exclusive rights to construct and operate railways for transportation of passengers and goods in Nigeria.

As at August 2021, as part of efforts to enhance service delivery and modernise the rail system in Nigeria, the President of Nigeria, Muhammadu Buhari set up a presidential committee to unbundle the Nigerian Railway Corporation (NRC). The presidential committee is to study and make recommendations for the unbundling of NRC into four separate companies namely operations, infrastructure management, regulations and marketing.

1.3.6.4 National Environmental Standards and Regulations Enforcement Agency

The National Environmental Standards and Regulations Enforcement Agency was established as a largely autonomous Agency under the Federal Ministry of Environment through the NESREA (Establishment) Act, of 2007. The Agency has the responsibility of enforcing all environmental laws, regulations, standards, policies, guidelines and conventions on the environment to which Nigeria is a signatory.

1.3.6.5 States Ministry of Environment

The Jigawa, Kano and Katsina States ministries in charge of environmental protection and management were established to carry out the following functions similar across the three states:

- Ensure sustainable development of the environmental resources at their respective states.
- Use the environmental and the natural resources for the benefit of the people of their states.
- Cooperate and collaborate with the Federal and Local Government Authorities on environmental matters.
- Conserve, protect and enhance the environment, the ecosystem and ecological processes essential for the preservation of biological diversity.
- Control and monitor all forms of environmental pollution or related matters
- Ensure sustainable management of the forest to meet economic, social and ecological needs of the people.

1.3.6.6 Local Government Authorities

The under-listed local government authorities are regulatory authorities that have jurisdiction along the project corridor. Each of these LGAs has Environmental Health Departments, empowered with Byelaws to oversee environmental sanitation and hygiene of communities under their local government authorities.

Jigawa State: Dutse and Kazaure LGAs

Kano State: Kumbotso, Minjibir, Dawakin Tofa, Dambatta, Gaya, Dawakin Kudu, Wudil, Warawa, Ungogo, and Gwale LGAs.

Katsina State: Sandamu, Daura, Rimi, Mashi, Katsina, and Jibiya LGAs

1.3.6.7 Structure of the EIA Report

In line with the requirements of the FMEnv for EIA, this report is presented in the following order:

- Preliminary sections including Executive Summary
- Chapter 1: Provides background information on the proposed project; objectives and scope of work of the EIA; as well as applicable legal and administrative framework.
- Chapter 2: Details the rationale for the proposed project as well as project benefits and analysis of development alternatives.
- Chapter 3: Description of the project components.
- Chapter 4: This chapter provides the environmental and socioeconomic baseline data of the project area.
- Chapter 5: identifies and presents the associated and potential environmental impacts of the proposed rail project.
- Chapter 6: highlights the recommended mitigation measures for ameliorating significant adverse environmental impacts and enhancing beneficial impacts.
- Chapter 7: defines the site-specific environmental management plan that will be adopted by the proponent throughout the project life cycle.
- Chapter 8: sets out the procedures and remediation plans that will be followed in the event of project decommissioning.
- Chapter 9: Conclusion and Recommendations
- References
- Appendices

2.0 CHAPTER TWO: PROJECT JUSTIFICATION

2.1 THE NEED FOR KANO TO MARADI RAILWAY PROJECT

The Kano – Jibiya – Maradi is an international route connecting Nigeria to The Republic of Niger. The importance of the route with respect to international trade between Nigeria and neighbouring countries in the northern part of Nigeria is that the route is responsible for significant volume of traffic in that axis. Therefore, the provision of modern intermodal transportation systems such as the proposed rail project becomes necessary to improve the socioeconomic activities in the region. It is expected that the rail project will facilitate public transportation and stimulate economic development in the region.

The Project is being developed in the context of Nigeria's effort to transform the country's railway system. These efforts include a programme of rehabilitation to repair and upgrade the system as well as expansion of the system to link important economic centers or regions, seaports, and airports. This Project creates an important link between the cities and industrial areas in the north of Nigeria (and southern Niger) to the markets and ports in the south. The railway will provide a cost effective means to transport goods and people and an alternative to less efficient and more expensive truck and vehicle transport, reducing road traffic volumes and congestion. The availability of a reliable rail system will also act to spur economic development and activity in the north.

2.2 PROJECT BENEFITS

There is a fast-growing demand for reliable transport infrastructure and effective means of transportation. The population of Nigeria is growing at an exponential rate with attendant need for more efficient and faster transportation. Additionally, as economies grow and businesses emerge, the need for freight of goods rises. Therefore, movement of larger quantities of goods and passengers across the northern states and the neighbouring Niger Republic will be enhanced at a reduced cost during the operation phase of the project. The operation phase of the project will also provide opportunities for thousands of people in the region to be gainfully employed.

The transformation of the railway system is also part of a longer-term strategy to eventually involve the private sector in railway system development and operation through Public-Private Partnerships. The investment that the government is making to rehabilitate the railway system will also give confidence to the private sector of the Government's commitment to re-establish rail as an important component of Nigeria's transport system.

2.3 VALUE OF THE PROJECT

The cost of the proposed project is estimated at $1.96 billion with a substantial amount of the funds to be injected into the local and national economy through various contracts and sub-contracts. In addition, the project will attract foreign direct investment and huge employment opportunities while providing an opportunity for taxes and revenues for the three tiers of government in Nigeria.

2.4 PROJECT SUSTAINABILITY

2.4.1 Environmental Sustainability Measures

The design, construction and operations of the proposed rail line and facilities shall be carried out with minimal environmental impacts where outright prevention of such impacts is not feasible. In addition, the acquisition of the RoW, proposed sites for the train stations, construction activities and all project activities and components associated with the proposed project shall be in line with local regulatory requirements and international regulations. The robust Health, Safety and Environment (HSE) policy (Appendix IV) and environmental management system (EMS) of the proponent and the EPC Contractor shall also be transferred for implementation, to ensure project executions in an environmentally responsible manner. In addition, this study was initiated to further ensure that the project has minimal environmental impact through implementation of proposed mitigation measures and Environmental Management Plan in Chapters Six and Seven respectively.

It is worthy of mention that the increasing use of fossil fuel-powered engines for road transportation comes with higher energy demand and rising emission of air pollutants including carbon dioxide – an important greenhouse gas. The transport sector has been responsible for about 25% of the global CO_2 emission resulting from fossil fuel. Use of rail for public transportation may significantly reduce air emission as hundreds of passengers depend on one train trip leaving hundreds of cars and buses unused. According to EPA data, freight railroads account for just 0.5% of total U.S. greenhouse gas emissions and just 1.7% of transportation-related greenhouse gas emissions. Moving freight by rail instead of truck lowers greenhouse gas (GHG) emissions by up to 75%, on average (Association of American Railroads, 2023).

2.4.2 Social Sustainability Measures

The Federal Ministry of Transportation has initiated a comprehensive, all-inclusive stakeholder engagement process. The process involved scoping workshops, meetings with landowners and village heads, other affected parties and relevant government agencies at all levels. It also involved documentation of concerns and opinions of all critical stakeholders, which is essential to the sustainability of the project. This process has helped in establishing cordial relationship with all the affected stakeholders, thus providing a friendly, enabling environment for project implementation. As part of measures for social sustainability of the project, the process of stakeholders' consultation shall be sustained throughout the project lifecycle. This will include periodic reporting of the environmental and social performance of the project to regulatory authorities and implementation of corrective actions where potential cause of conflicts are identified. In addition, resettlement action plan, which includes restoration of livelihood and compensation plans, shall be developed to ensure the adverse social issues associated with the projects are properly managed.

2.4.3 Economic Sustainability Measures

The project shall be funded by the federal government through credit facilities from international lending institutions. A detailed feasibility study was carried out to determine the economic viability of the rail project. The design, construction and operation of the proposed project has been deemed economically viable due to the potential critical economic and commercial benefits of rail transportation in the region. The project will provide thousands of employment opportunities; support the local communities and improve the regional and the national economy as a whole.

2.4.4 Technical Sustainability Measures

The FMT has successfully completed similar rail project in the country. These include the Abuja – Kaduna rail project, Lagos – Ibadan rail project and Warri – Itakpe rail project. Therefore, the proponent has sound technical competence and a team of highly experienced professionals in the design, construction and operation of rail project. Suitably qualified and well-trained personnel who are experienced in this area and in accordance with existing standards and procedures shall handle the proposed Kano-Maradi rail project. The technicalities involved in all construction activities for the proposed project concerning soil type and geological characteristics of the area as well as the specific type of technology to be deployed shall be guided by these measures.

2.4.5 Sustainable Development Goals (SDGs)

Sustainable development is defined generally as 'development which meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable development is about creating a balance between meeting the needs of a growing population and the health of our planet by embracing environmental sustainability, safety, inclusion and resilience. The United Nations adopted the Sustainable Development Goals (SDGs), also known as the Global Goals, in 2015 as a universal call to action to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity. The SDGs consist of seventeen global goals (Figure 2.1) designed as a "blueprint to achieve a better and more sustainable future for all".

Sustainable transport is essential to achieving most, if not all, of the SDGs. Although sustainable transport is not represented by a standalone SDG, it is mainstreamed across several SDGs and targets, especially those related to sustainable consumption and production, health, safety, energy, infrastructure and most notably cities and human settlements.

Railway development project, as part of a wider strategy for urban mobility, plays an important role in addressing many of the SDGs – some directly and some indirectly. Understanding this point requires a shift from thinking what rail 'is', to considering what it 'does. Rail underpins economic growth; it has the potential to support responsible consumption and a circular economy in the face of increasing urbanization and population growth. It provides improved access to jobs, creating a more inclusive and equitable society. By connecting communities and providing improved access to education, rail also supports a more diverse, more skilled workforce, as well as cultural exchange, which is key to social cohesion. Rail reduces road congestion and carries more customers and more freight using less energy than most other modes of transport. It also produces fewer emissions. Rail can drive better land planning if the balance with the potential impact on the surrounding environment is successfully considered. Rail is part of the solution to a sustainable future. In this context, a strong commitment of the rail industry's stakeholders to the SDGs will drive the development of safer, more resilient and sustainable railways, for everyone.

The Kano to Maradi Railway Project is proposed to connect several communities in the Northern part of Nigeria and the neighbouring country, The Republic of Niger. It will provide an affordable means of transport, ease the traffic pressure put on the existing road transportation network in the project affected states, connect city airports and connect major agricultural farmland and markets. It will also improve the bilateral relationship between Nigeria and Republic of Niger which will contribute directly or indirectly to Nigeria's commitment of achieve the following SDGs – 1, 2, 8, 9, 10, 11, 13 and 15 in significant terms (Figure 2.1).

Figure 2. 1: Kano – Maradi Railway Project Contribution to Nigeria's Commitment to Achieving Sustainable Development Goals

2.5 PROJECT ALTERNATIVES

2.5.1 Road Transportation Alternative

This option would favour the further development of the road network along the route as opposed to the development of the proposed railway project. Generally, road transportation is a good land transport alternative for the movement of people and goods in the region. The existing link roads between Dutse – Kano – Jibiya – Maradi were designed as dual-carriage roads to enhance transportation in the project corridor. While it is noteworthy to state that construction activities are ongoing at different sections of these roads, the limitation of road transport in comparison with rail transport is enormous and obvious. Additionally, there is always a higher risk of traffic accidents associated with road transportation. Severe, life-threatening injuries and fatalities or disability, which have a wide array of negative consequences on the victims or relations are noteworthy. The enormous advantage of railway for cargo movement over road haulage was also taken into consideration. Another critical challenge of road transportation in the region is security risks associated with road transportation of goods and people, which has been largely mitigated by the commencement of rail operations (Kaduna - Abuja) in the region. Periodic road repairs and maintenance due to traffic pressure along the axis will always hinder smooth movement of people and goods. This option is therefore not favoured.

2.5.2 Alternative Route Alignments

Two routes were considered during the feasibility study phase (Figure 2.2). Alternative A: This route alternative starts on the western side of the city of Kano, in correspondence with the existing Lagos-Kano-Nguru narrow gauge rail line and runs north. After a short stretch, it turns eastwards and arrives at the international airport of Kano. From the airport, the line turns northwards again until it reaches Dambatta, running almost parallel to the western side of the A2 road. Near the city of Dambatta, the line first crosses the A2 road and then continues northwards until it reaches the city of Daura, crossing the city of Kazaure. In correspondence with Daura the line then turns westwards and, after crossing the Katsina-Daura Road, it runs parallel to the road until it reaches Jibiya, crossing the cities of Mashi and Katsina. From Jibiya the line again curves northwards, running parallel to the existing road, to reach Maradi, where the line terminates.

Alternative B: The second alternative route starts on the southwest side of the city of Kano; it is connected to the existing Lagos-Kano rail line, leaves Kano in correspondence with the new station foreseen by the “Lagos-Kano Nigeria Railway Modernization Project” elaborated by China Civil Engineering Construction Corporation (CCECC) and runs northwest. After a short initial stretch, it turns towards the northeast and reaches Dambatta, after first crossing the Kano-Gwarza Road and then the A2 Kano-Katsina Road. In correspondence with the city of Dambatta, the line is superimposed on the alignment of Alternative "A".

Analysis of the project alternatives, particularly the route, was based on the feasibility report for the Kano–Maradi Rail Project, and this includes technical feasibility, economic viability, and environmental and social (E&S) sustainability, including reducing the impact of displacement and the project footprint in sensitive environments.

Alternatives for Kano-Maradi Standard Gauge Railway Project

- Option 1: Original Alignment
- Option 2: Modified Alignment to Avoid Forest Areas

Table 2. 1: Analysis of route alternatives based on technical, economic and environmental considerations

Criteria	**Weight**	**Option 1 (Original Alignment)**	**Option 2 (Modified Alignment)**
Technical Feasibility	30%	8	7
Construction Complexity		Medium	Low
Technology Readiness		High	High
Maintenance Requirements		Medium	Medium
Economic Viability	30%	9	7
Long-term Economic Benefits		High	Medium
Cost of Maintenance		Medium	Medium
E&S Sustainability	40%	6	8
Impact on Forests		High	Low
Impact on Local Communities		High	Medium
Displacement of People		High	Medium
Total Score	100%	7.5	7.5

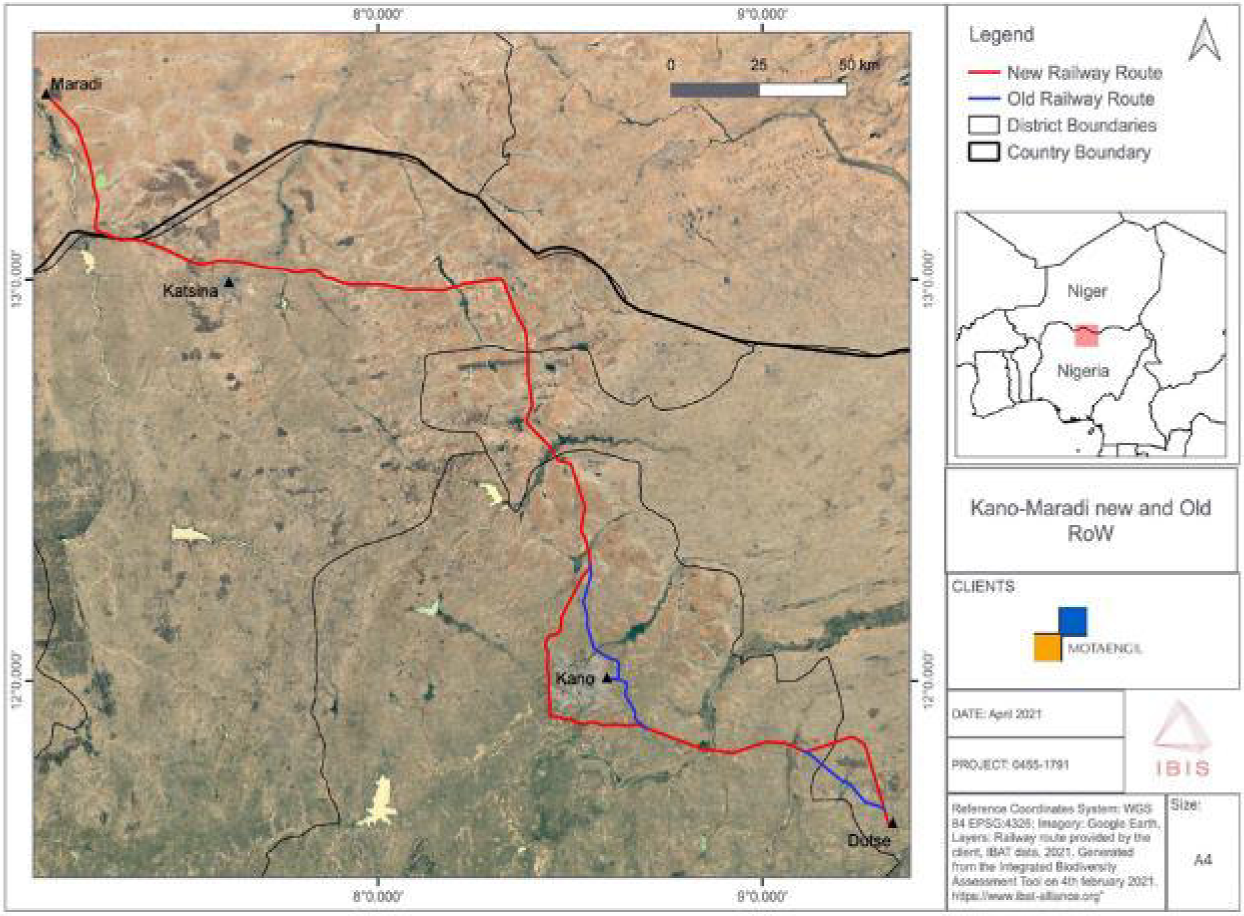

Figure 2. 2: Old and New RoW Alignment for the Kano - Maradi Railway Project

In the context of an environmental and social impact assessment, the selection of the New RoW Alignment was informed by proactive route analysis, project design review, biodiversity risks, avoidances of critical habitats and proactive impact mitigation consideration. The methods used to assess the project alternatives included:

Satellite Imagery Analyses

Site reconnaissance Visit: This has been conducted using a detailed review of the project's routes, exploring comparable and alternative routes, so the project does not cause more harm than good.

Project design review: In conjunction with MEA's technical team and Quadrante, the initial project design has been assessed and reviewed to create an alternative option to avoid, and where avoidance is not possible, minimise displacement. Avoidance of sensitive, religious and cultural monuments including gravesites was also a major consideration during selection of route alignments. Biodiversity Risk Assessment especially with core aim of minimizing impacts to flora, fauna and avoidance of critical habitats.

The old alignment for the Kano-Maradi project would have gone through heavily built-up areas of Ajingi LGA and Kano Municipal. It would also have traversed some forest reserves and across waterbodies with potential to cause significant impacts. This would have resulted in significant physical and economic displacements of households, businesses and other entities. To minimise project impacts, the Kano-Maradi project has increased efforts toward ensuring the project explores all possible alternatives to attain minimal impact on the ecosystem, the people and livelihoods.

The exploration of these alternatives provided information about the project route so that the heavily built- up areas, particularly in urban Kano and Katsina, were avoided during the project construction. Although the new optimized route increased in length by over 25km, it has significantly reduced the anticipated levels of physical and economic impacts in urban Kano and Katsina.

Additionally, the new optimized RoW alignment has the following positive attributes:

- With the Kano-Dawanau-Dambata-Kazaure variant, the length of the route was reduced and consequently the impact on the existing one was reduced (less km, less work, less impact etc). The variant to the route mainly between Dawanau and Kazaure optimized the extension of the Kano-Maradi in 7 km.
- Dambatta Station is closer to the population.
- The variants to the preliminary layout design avoid colliding/impacting with the green walls, which Feasibility Study/Options study sectioned.

- With the Duru-Dutse Bypass and the Dambata-Kazaure Bypass, the route was prevented from crossing the basin / agricultural land downstream of the existing dams in the vicinity, avoiding the impact that this would have had on the watercourse and Agricultural land use. The Kano-Dutse branch line route was optimized in 13 km.
- With the relocation of Dawanau Station, it will be near the airport as well as the Dawanau international market. The same applies to Dutse Station, which is now closer to the Airport.
- The positioning of the Yar-Gaya station has brought it closer to the industrial park site

2.5.2.1 *Reduction in the Right of Way Corridor*

Initial project design preferred that a 100 m corridor must be acquired for every railway project, which implies that the Kano-Maradi project of 293 km will require not less than 4,000 ha of land for the rail track only. To reduce project impact, project right of way corridor was reduced from 100 metres to 60 metres for sensitive areas. Consequently, this review has reduced the project's potential physical and economic displacement and associated vulnerability of project-affected entities. The reduction in the size for the acquisition will also help preserve the natural environment and other sensitive ecosystem areas. This will not only safeguard the economic and social aspects but will also safeguard the footprint around the sensitive biodiversity.

2.5.3 Technological and Material Alternatives

The technological and material alternatives chosen for the Kano-Maradi Standard Gauge Railway Project are aimed at optimizing operational efficiency, safety, and sustainability. These choices were made after careful consideration of their respective advantages and limitations. The Supervisory Control and Data Acquisition (SCADA) system was adopted due to its ability to provide seamless monitoring and control of railway operations. This system includes a central processing unit for station control, SCADA workstations in the Station Master's Office, and redundant server machines in the Operations Control Center (OCC) technical room. SCADA offers significant improvements in operational efficiency and safety through centralized control and real-time data monitoring, allowing for quick responses to any operational issues. The alternative of using a more traditional, manual control system was rejected because it lacked the scalability and real-time capabilities necessary for modern railway operations, which are essential for the project's long-term success and expansion potential.

For signaling and telecommunication, the project adopted the European Train Control System (ETCS) and GSM-Radio (GSM-R) communication systems. These technologies ensure enhanced safety through real-time train control and improved communication between train operators and control centers. Components include radio base stations for communication and balises and signals for train detection and integrity. These systems were preferred over older, less automated signaling systems because they reduce the likelihood of human error and provide higher levels of automation, critical for the safety and efficiency of the railway. Older systems were rejected due to their limited ability to integrate with modern, automated control systems and their higher potential for operational errors.

The project also included rolling stock maintenance facilities to support preventive maintenance and scheduled repairs. These facilities, with dedicated workshops and inspection equipment, ensure the longevity of rolling stock and reduce downtime, thus maintaining operational safety. The alternative of outsourcing maintenance to external facilities was considered but rejected due to the potential for higher long-term costs and less control over maintenance quality and scheduling.

In terms of material alternatives, high-strength steel was selected for the rails due to its durability, resistance to wear and tear, and ability to withstand heavy loads. This choice ensures the longevity and reliability of the railway infrastructure. The alternative of using lower-grade steel or other materials was rejected because they would not provide the same level of durability and would require more frequent maintenance and replacement, leading to higher long-term costs. For sleepers, pre-stressed concrete or composite materials were chosen because of their longevity, stability, and low maintenance requirements. These materials were preferred over traditional wooden sleepers, which were rejected due to their susceptibility to environmental degradation and higher maintenance needs.

In station construction, concrete hollow blocks were used for walls, providing durability, thermal insulation, and soundproofing. Insulated sheeting panels on metal trusses were selected for roofs due to their energy efficiency, weather resistance, and ease of installation. These materials were chosen over traditional brick and mortar or uninsulated metal roofing, which were rejected because they did not offer the same level of thermal efficiency and durability.

Environmental considerations also played a crucial role in material selection. Renewable energy technologies, such as photovoltaic installations and solar heating, were incorporated to reduce the project's carbon footprint and provide sustainable energy sources, resulting in long-term cost savings. The alternative of relying solely on non-renewable energy sources was rejected due to their higher environmental impact and long-term unsustainability.

Some of the alternatives are further discussed in different subsections below.

2.5.3.1 Locomotive Choice: Diesel or Electric Power

Two alternatives were considered about locomotive choice for the project, diesel and eclectic power. Diesel locomotives are self-powered whilst electric powered locomotives require an overhead line to distribute power. There are positive and negative attributes for both options when comparing performance, cost and associated environmental impacts.

Generally, the use of locomotives powered by electricity from overhead lines is considered a better alternative to diesel-powered train engine technology. The electric traction has the advantages of great traction, rapid starting acceleration, cleaner technology, superior brake performance, and high computation speed. They are also generally considered a lower carbon alternative compared with diesel powered locomotives, but only if the power generation mix is not dependent on fuels with high carbon content, such as coal. In Nigeria, higher percentage of the energy mix is from thermal power stations mainly powered by natural gas, with the remainder generated from renewable sources including hydropower. As a result, emissions associated with electricity usage will be lower than those for diesel usage.

In Nigeria, however, the electricity supply from the grid is inefficient and unreliable. This makes the use of electric powered locomotive unattractive and difficult for this project at this moment. Additionally, the Nigeria Railway Authority do not currently have any electric locomotives in their system and none of the Railway corridor is electrified. Therefore, the cost for the project to consider electric powered locomotives without any of the appropriate existing infrastructure would far exceed that of using diesel locomotives. Especially when a major advantage of diesel traction is the one-off project investment, and low cost of diesel engine. This coupled with the glaring inadequate existing electricity infrastructure in the project area meant electric power locomotives would not be viable at this stage. The option of diesel-powered locomotive is considered feasible, practicable and favoured.

2.5.3.2 *Material Choice: Concrete or Wooden Sleepers*

Two alternative materials were considered for sleepers, concrete and wood, both, which have advantages and disadvantages. In terms of safety, concrete sleepers have the advantage of being heavier (up to 300 lbs heavier) and therefore more stable and less susceptible to temperature change which can affect timber. In addition, concrete sleepers are safer in relation to fire hazard. However, during train derailment timber sleepers can absorb the impact from wheels better than concrete sleepers, which can shatter and need frequent replacement.

In relation to cost, concrete sleepers are more expensive to initially produce but generally have a longer life span compared to timber sleepers and require less maintenance because they do not rot like timber. This will result in the end in lower costs and fewer track closures.

However, concrete sleepers do not absorb vibrations from passing trains as well as wooden sleepers and small cracks can form in the concrete, which can cause failure. This can occur when concrete sleepers are located next to a joint. In terms of the environmental impacts, both options have their advantages and disadvantages. Wooden sleepers are usually soaked in creosote and the manufacturing of cement used in concrete sleepers produces high levels of greenhouse gas emissions. Concrete sleepers are however favoured for this project based on their safety characteristics over wooden sleepers.

2.5.4 Development of Air Transportation Links

Another alternative to the railway project for consideration is the development of an air transportation link along the project corridor. This will entail the construction of new airport terminals, runways and other ancillary facilities that are not currently available in some of the states. This mode of transportation is however more expensive and would be out of reach of many Nigerians living within the rail corridor. Furthermore, air transportation is not so practicable to transport most farm produce and other through this means of transport. The option is considered inappropriate for the corridor and therefore rejected.

2.6 PROJECT DEVELOPMENT OPTIONS

2.6.1 The 'No Project' Option

The No-Project represents a decision for the client not to proceed with the construction of the rail line project. Adopting this option would mean avoiding most of the negative effects associated with the railway project and missing all the potential benefits that would accrue because of implementing the project. Some of the anticipated positive impacts of the Kano-Maradi rail line project are as follow:

- The project is significant for the economic development of the project States and the countries and would increase business interactions within and outside the country.
- The project would bring infrastructural development to affected communities, local government areas, and states within the project countries.

- The project would ease the movement of people, goods, and services within the country. This would most importantly help the farmers move their crops and livestock to more markets as the project area is majorly an Agrarian community.
- The project would also increase tourism in the States as travelling within the northern region will be faster using the train rather than the long hours spent on the road moving from one State to another within the northern region.
- The project benefits far outweigh the potential impacts. Therefore, the No Project Option is unattractive and dismissed.

2.6.2 Delayed Project

The option of a delayed project implies that the planned project will not commence until a much later date. The present political, economic or security situation in the country and in particular the project corridor does not necessitate delaying the project further. The most part of the project corridor is peaceful and secured without any form of communal conflict, which could have posed a threat to the sustainability of the project. The stakeholders are favourably disposed to having the project implemented. In addition, the prevalent transport economy in Nigeria favours investment in rail transport sector. Therefore, the delayed option is considered unviable for the project.

2.6.3 Project Implementation Option

The preferred option for the proponent, which is an approval to go ahead and implement the project as planned, does outweigh the other options. The potential benefits of the proposed rail project, if permitted to go ahead, are diverse and huge. Millions of people in the region and the country are potential beneficiaries of the rail project. Project implementation will provide an additional and preferred mode of transportation of goods and passengers, thus improving the commercial and economic activities in Nigeria while enhancing regional economic integration with its attendant economic development and social benefits. The human development index will improve while the huge investment initially committed to this project in terms of preliminary studies and designs would not be lost to the detriment of the Federal Government of Nigeria.

3.0 CHAPTER THREE: PROJECT DESCRIPTION

3.1 PROJECT LOCATION

The proposed standard-guage railway (SGR) line is approximately a 392 km railway line comprising of the Main Line from Kano through Dambatta-Kazaure-Daura-Mashi-Katsina-Jibiya to Maradi with an approximate length of 284 km with 15 stations; and a Branch Line of 108 km from Kano to Dutse, Jigawa State with 5 stations. The new 392 km long standard gauge rail line will connect three federal States in Nigeria, namely Kano, Jigawa, Katsina State and the Niger Republic through Maradi, while the 93 km branch line will connect Dutse to Kano (Nigeria). The Kano to Maradi railway line will start in Nigeria, from Kano, crossing the country's regions of Dawanau, Kunya, Danbatta, Kazaure, Durbe, Daura, Shargalle, Mashi, Maduru, Katsina, Daddara, Jibiya, and Maradi, in the Niger Republic. The Project location is shown in Figure 3.1.

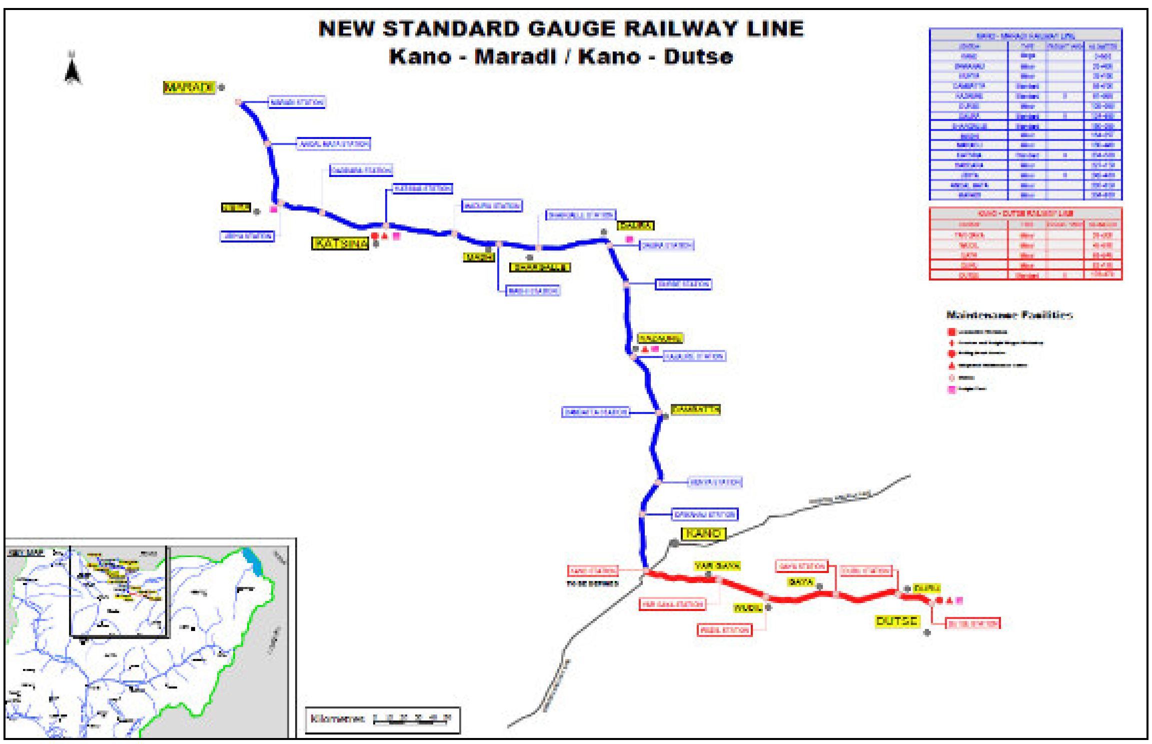

Figure 3. 1: Location of the Kano to Maradi Rail Line
(Source: Mota-Engil Nigeria, 2022)

3.2 PROJECT DESIGN

The Project consists of following elements:

- Construction of standard gauge single rail line
- Construction of 80 overhead bridges, 34 railway bridges, 9 underpasses and 74 culverts (including box culverts)
- Construction of a total of 15 stations – along the entire project corridor.
- Construction of ancillary buildings to support equipment for the operation of the rail (locomotive depot and maintenance, washing stations and coach servicing, refuelling points for locomotives, freight yard, integrated maintenance centre).
- Construction of any permanent maintenance roads to support the operation of the railway.
- Temporary works (preparation and earthworks) and tracks for construction, including construction camps and temporary access routes.

The rail is designed to accommodate both freight and passengers, with trains with a maximum design speed of 150 km/h for express trains and 120 km/h for local services. Maximum design speed for Freight trains is 100 km/h and 80 km/h for heavy freight. Maximum design speeds for maintenance areas is 30 km/h. The railway line has been designed to connect cities, villages, and towns to enhance the agricultural economy, manufacturing industries and to improve public transportation. The primary purpose of the Project is to improve the standard of living of the inhabitants of the region, directly leading to the economic advancement and sustainable growth of the two countries involved. The route and design of the railway corridor has been carefully considered to reduce/avoid adverse impacts on livelihoods, land acquisition and forest reserves categorized as III and IV under the International Union for Conservation of Nature (IUCN). The main livelihood in the area is predominantly agriculture and trading with the movement of people, goods and services across Nigeria and Niger Republic.

3.2.1 Railway Alignment

3.2.1.1 Proposed Route

A branch line from Kano State to Dutse in Jigawa State has been designed with a clear span of 108 km to connect Dutse with the main railway network (i.e., Kano - Maradi) as well as to connect the route to Lekki Port, Lagos. The region is densely populated, with most of the inhabitants engaged in agricultural activities as either a primary source of livelihood or secondary, hence, the volume of agricultural products.

For the purposes of the ESIA the 392 km route has been broken down into six sections based on the country and branch line the route will traverse. These sections are described in Table 3.1.

Table 3. 1: Sections of the Proposed Kano to Maradi Railway

Route	Section	Route Chainage Section (km) (Direction: East to West)	Description
Dutse to Kano (Branch line)	Section 1	0 – 98.5	This section is the branch line running for 108 km from Dutse to Kano in Jigawa State, Nigeria. This route will connect Dutse with the main rail line (Kano to Maradi). This route will also connect the rail to a planned railway line to Lekki Port, Lagos. Five stations will be constructed in this section: Yar Gaya, Wudil, Gaya, Duru and Dutse. A total of 18 road overbridges, 14 railway bridges and 9 road underpasses and culverts will be constructed along this section. A worker's construction camp and laydown areas will be located in Wudil. This section traverses the states Kano and Jigawa, running through predominantly agricultural areas. This route also traverses the north of the Shakwadina forest reserve. This section crosses the Lagos-Kano-Nguru narrow gauge rail line, various roads and waterbodies.

Route	Section	Route Chainage Section (km) (Direction: East to West)	Description
			Most rivers crossed by the railway alignment are used for intensive irrigation purposes. A few buildings including the Capital City University is located within the permanent RoW and will be compensated.
Kano to Dawanau	Section 2	0 – 24.0	This section is in Nigeria, starting west of the city of Kano running north for 20 km to the south of Dawanau. The stations Kano and Dawanau will be constructed in this section. It should be noted Kano station will be constructed under a separate contract and therefore, is not included as part of the funded Project. The Kano station is considered to be an Associated Facility as the use of this station will be required during operation for the Project. The railway alignment predominately crosses the major commercial and industrial centre of Kano comprising a mix of industrial activities, agricultural activities and tourism. The railway alignment also crosses roads and rivers. Two main grains markets are located along this stretch: Zawaciki grains market and Dawanau grains market (one of the largest in Africa). A few buildings, businesses and schools are located within the permanent RoW.
Dawanau to Kazaure	Section 3	24.0 – 88.5	In Dawanau, the route runs almost in parallel to the west of the A2 road, continuing northwards until it reaches the city of Daura, passing west of the city of Kazaure. Five stations will be constructed in this section: Kano, Dawanau, Kunya, Dambatta and Kazaure.

Route	Section	Route Chainage Section (km) (Direction: East to West)	Description
			This route passes through the towns Kazaure and runs through predominantly agricultural land and grazing areas. This route, which covers 63 km, crosses west of the Baba Ruga dam, an area with intensive grazing areas for cattle and irrigation. Further north, this route traverses the south of the Gasartani forest reserve (an IUCN Category IV Forest reserve). A few buildings, businesses and schools are located within the permanent RoW. Eight burial grounds are located within the RoW of this section, except for the Tumfafi graveyard located immediately west of Dawanau station.
Kazaure to Daura	Section 4	88.5 – 130.5	This section continues to run almost in parallel to the west of the A2 road, continuing northwards until it reaches the city of Daura, passing west of the city of Kazaure. The Line then turns westwards, south of Daura. Two stations will be constructed in this section: Durbe and Daura. One camp and laydown area will be constructed in Kazaure. The route passes the towns Kazaure and Daura. This route traverses the eastern tip of the Gwiwa Korel forest reserve and north of Daura Forest reserve – both of these forest reserves are IUCN Category IV Forest reserves. A school (forming part of the Sabuwura Jawo local community) is located within the RoW. The total distance of this section is 40 km.
Daura to Jibiya	Section 5	130.5 – 229.5	From the south of Daura and, after crossing the Katsina-Daura Road, this section runs parallel to the road in a westerly direction until it reaches Jibiya, crossing the cities of Mashi and Katsina. One worker's construction camp and laydown area will be constructed in Katsina.

Route	Section	Route Chainage Section (km) (Direction: East to West)	Description
			The route passes the towns Mashi, Shargalle, Katsina and Jibiya. Tsamga (near Jibiya) is an international stock route. Four stations will be constructed along this stretch: Shargalle, Mashi, Maradi, Katsina. This section crosses two forest reserves: north of Damangu and the centre of Nasarawa.
Jibiya to Maradi	Section 6	222.5 – 284.500	From Jibiya, the route crosses the Nigeria-Niger Republic border and curves northwards, running parallel to the existing road to reach Maradi where it terminates. Two stations are located in this section: Dan Issa/ Anoal Mata (TBC) and Maradi. The route passes an international cattle stock area located in proximity to the Nigeria-Niger Republic border. The railway alignment traverses a predominantly agricultural area. Jibiya to Maradi is 43 km in length.

3.2.2 Rail Width and Permanent Right of Way

The permanent right of way (RoW) for the standard gauge single track rail will be within a 100 m corridor (total width), except for the locations of stations whereby the permanent RoW will be 400 m (total width) or 600 m for Katsina and Dutse stations to accommodate stations and ancillary buildings. This will allow for future expansion of these facilities. In sensitive areas such as densely populated urban areas and areas prone to flooding which will require the RoW to be adjusted and reduced. The permanent RoW may be reduced to 200 m (total width) or to a 130 m (65 m on each side).

Track Design

Track design will follow European Rail Standards (Eurocodes) with the use of specified layers of ballast, precast concrete sleepers, and track. The Kano-Maradi alignment comprises gradients between 0% and 12.5%. This will ensure that the intended open line design speed of the railway for passenger trains (150 km/h) is achieved. The track is designed to have an axle load of 22.5 tonnes. The rails will be continuous over bridge structures and embankments; therefore, the bridge structures and the tracks (rails, sleepers, ballast, and embankments) are jointly designed to resist friction due to traction or braking.

The track laying will use 18 m (minimum) long rails, which will be electrically welded. The rail welding will be conducted in a workshop (located at the worker's construction camps) to prepare rail lengths of up to 144 m long rails which will be transported to site and laid on the sleepers to make up the track. These rails will then be connected in situ using thermit welding to form sections of continuous welded rail.

The total thickness of the track bed is 0.45 m, where a minimum ballast thickness of 0.25 m will be adopted under the sleepers and a thickness of 0.20 m for the sub-ballast layer. Typical cross sections of straight and curved rail alignments are shown in Figure 3.2. Bridges and culverts will be constructed along the rail line and branch line. A summary of track design, including bridges, road crossings, decks and spans is provided in Table 3.2 below. Railway bridges are indicated in the green rows, road underpasses are in blue and road overbridges are in grey.

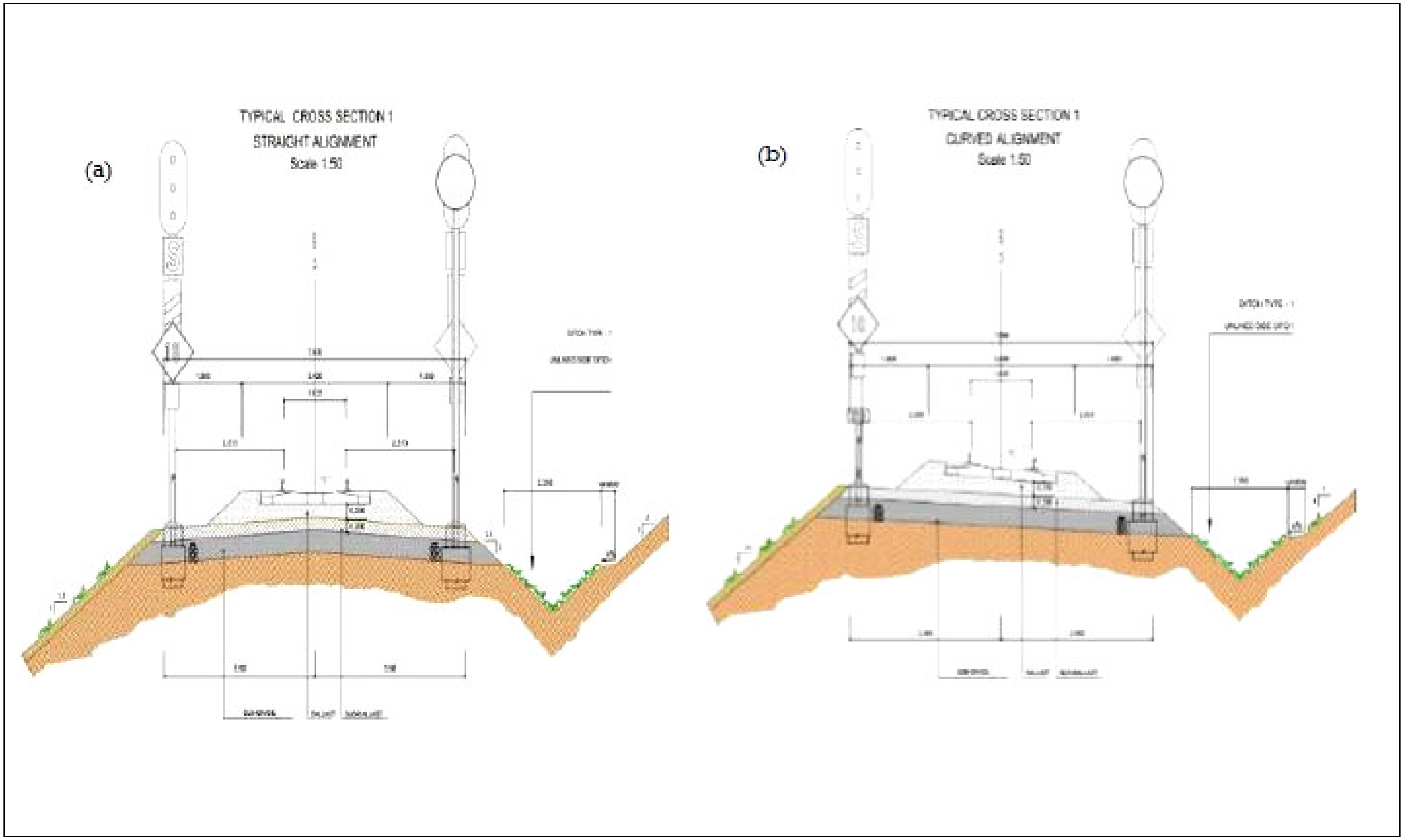

Figure 3. 2: Typical cross-section of a straight alignment (a) and curved alignment (b)

Table 3. 2: Summary of Railway crossings

Route	Section	Chainage	Bridge Type	Deck Width (m)	Span(s)				Road Crossings				
					Spans	No.	Total Length	Crossing	Surface	Width (m)	Total Length (m)	Angle (gradient)	Extension (m)
–Dutse to Kano	Section 1	0+282	Railway Bridge	-	24m middle span	1 x 24	24m	Over river	N/A	–Dutse to Kano	Section 1	0+282	Railway Bridge
Dutse to Kano	Section 1	0+835	Road overbridge	7.5					Unpaved	Dutse to Kano	Section 1	0+835	Road overbridge
Dutse to Kano	Section 1	1+356	Road overbridge	10	18m middle span				Paved	Dutse to Kano	Section 1	1+356	Road overbridge
Dutse to Kano	Section 1	2+291	Road overbridge	15					Paved	Dutse to Kano	Section 1	2+291	Road overbridge
Dutse to Kano	Section 1	7+296	Road overbridge	5					Unpaved	5.0		100	625 m
Dutse to Kano	Section 1	9+586	Railway Bridge	-	18m middle span	3 x 18	54m	Over river	N/A				
Dutse to Kano	Section 1	11+184	Road overbridge	20					Paved	29.0	60	77	930
Dutse to Kano	Section 1	13+015	Road overbridge	7.5					Unpaved	7.5		100	591
Dutse to Kano	Section 1	15+150	Road overbridge	7.5					Unpaved	7.5		100	550
Dutse to Kano	Section 1	17+825	Railway Bridge	-	18m middle span	3 x 18	54 m	Over a road	N/A				
Dutse to Kano	Section 1	18+287	Road underpass	10	N/A	N/A	N/A	N/A	Paved	10.0	45	41	1,203
Dutse to Kano	Section 1	19+300	Railway Bridge	-	24m middle span	1 x 24	24 m	Over river	N/A				
Dutse to	Section 1	23+200	Railway	-	24m	1 x	24m	Over	N/A				

Route	Section	Chainage	Bridge	Deck	Span(s)				Road Crossings				
Kano			Bridge		middle span	24		stream					
Dutse to Kano	Section 1	24+581	Road underpass	10	N/A	N/A	N/A	N/A	Paved	10.0	30	69	227
Dutse to Kano	Section 1	25+494	Railway Bridge	-	18m middle span No.: 4 x 18 Total length 72m Over a road	4 x 18	72 m	Over a road	N/A				
Dutse to Kano	Section 1	27+690	Road overbridge	7.5					Unpaved	7.5		100	593
Dutse to Kano	Section 1	34+065	Road overbridge	7.5					Unpaved	7.5		91	493
Dutse to Kano	Section 1	38+799	Road underpass	7.5	N/A	N/A	N/A	N/A	Unpaved	7.5		100	1,084 m
Dutse to Kano	Section 1	39+270	Railway Bridge	-	18m middle span	3 x 18	54m	Over river	N/A				
Dutse to Kano	Section 1	40+151	Railway Bridge	-	18m middle span	3 x 18	54m	Over river	N/A				
Dutse to Kano	Section 1	42+675	Road overbridge	7.5					Unpaved	7.5		100	682
Dutse to Kano	Section 1	44+563	Road underpass	5	N/A	N/A	N/A	N/A	Unpaved	5.0	25	100	508
Dutse to Kano	Section 1	46+969	Road underpass	5	N/A	N/A	N/A	N/A	Unpaved	5.0	25	100	368
Dutse to Kano	Section 1	48+050	Railway Bridge	-	24m middle span	12 x 24	288m	Over river	N/A				

Route	Section	Chainage	Bridge	Deck	Span(s)				Road Crossings				
Dutse to Kano	Section 1	49+231	Railway Bridge	-	18m middle span	3 x 18	54m	Over river	N/A				
Dutse to Kano	Section 1	49+850	Road underpass	5	N/A	N/A	N/A	N/A	Unpaved	5.0	25	100	344
Dutse to Kano	Section 1	52+226	Road overbridge	10	18m middle span				Paved	10.0		61	702
Dutse to Kano	Section 1	56+866	Road overbridge	5					Unpaved	5.0		100	456
Dutse to Kano	Section 1	62+892	Road overbridge	7.5					Unpaved	7.5		100	609
Dutse to Kano	Section 1	64+285	Road overbridge	10	12m middle span				Paved	10.0		86	630
Dutse to Kano	Section 1	69+462	Road overbridge	5					Unpaved	5.0		100	500
Dutse to Kano	Section 1	70+523	Railway Bridge	-	24m middle span	3 x 24	72 m	Over river	N/A				
Dutse to Kano	Section 1	72+233	Railway Bridge	-	18m middle span	3 x 18	54m	Over river	N/A				
Dutse to Kano	Section 1	75+470	Road underpass	5	N/A	N/A	N/A	N/A	Unpaved	7.5	30	100	326
Dutse to Kano	Section 1	78+809	Road overbridge	5					Unpaved	5.0		100	510
Dutse to Kano	Section 1	82+849	Road overbridge	5					Unpaved	5.0		100	496
Dutse to Kano	Section 1	86+483	Railway Bridge	-	24m middle span	4 x 24	96m	Over river	N/A				
Dutse to Kano	Section 1	91+683	Road underpass	5	N/A	N/A	N/A	N/A	Unpaved	7.5		100	574

Route	Section	Chainage	Bridge	Deck	Span(s)				Road Crossings				
Dutse to Kano	Section 1	92+206	Railway Bridge	-	24m middle span	3 x 24	72m	Over river	N/A				
Dutse to Kano	Section 1	96+932	Road overbridge	5					Unpaved	5.0		100	758
Dutse to Kano	Section 1	98+470	Road underpass	10	N/A	N/A	N/A	N/A	Paved	10.0	40	49	428
Kano - Dawanau	Section 2	2+151	Road overbridge	15					Paved	21.6	55	71	960
Kano - Dawanau	Section 2	2+613	Road overbridge	7.5	18m middle span				Unpaved	7.5		81	510
Kano - Dawanau	Section 2	3+209	Road overbridge	7.5	18m middle span				Unpaved	7.5		61	545
Kano - Dawanau	Section 2	4+266	Road overbridge	15	12 m middle span				Unpaved	7.5		84	446
Kano - Dawanau	Section 2	5+107	Road overbridge	15					Paved	21.6	50	86	880
Kano - Dawanau	Section 2	7+400	Railway Bridge	-	24m middle span	3 x 24	74 m	Over river	N/A				
Kano - Dawanau	Section 2	8+680	Road overbridge	10	12m middle span				Paved	10		100	721
Kano - Dawanau	Section 2	11+205	Railway Bridge	-	18m middle span	3 x 18	54 m	Over road	N/A				
Kano - Dawanau	Section 2	11+515	Road overbridge	7.5	12m middle span				Unpaved	7.5		100	683
Kano - Dawanau	Section 2	13+027	Road overbridge	7.5	12m middle span				Unpaved	7.5		100	558

Route	Section	Chainage	Bridge	Deck	Span(s)				Road Crossings				
Kano - Dawanau	Section 2	14+585	Road overbridge	10	12m middle span				Unpaved	10.0		100	1,000
Kano - Dawanau	Section 2	15+420	Railway Bridge	-	24m middle span	1 x 24	24 m	Over river	N/A				
–Dawanau to Kazaure	Section 3	16+500	Road overbridge	7.5									
–Dawanau to Kazaure	Section 3	18+528	Road overbridge	15					Paved	21.6	55	71	936
–Dawanau to Kazaure	Section 3	19+448	Road overbridge	7.5					Unpaved	7.5		100	526
–Dawanau to Kazaure	Section 3	24+944	Road overbridge	7.5	12m middle span				Unpaved	7.5		100	911
–Dawanau to Kazaure	Section 3	27+649	Road overbridge	7.5	12m middle span				Unpaved	7.5		100	523
–Dawanau to Kazaure	Section 3	29+058	Road overbridge	10	12m middle span				Paved	10.0		84	720
–Dawanau to Kazaure	Section 3	31+840	Road overbridge	10						21.6	55		
–Dawanau to Kazaure	Section 3	34+957	Road overbridge	7.5	12m middle span				Unpaved	7.5		100	640
–Dawanau to Kazaure	Section 3	37+199	Road overbridge	10	12m middle span				Paved	10.0		100	853
–Dawanau to Kazaure	Section 3	39+527	Railway Bridge	-	24m middle span	3 x 24	72 m	Over river	N/A				
–Dawanau to Kazaure	Section 3	42+799	Railway Bridge	-	24m middle span	3 x 24	72 m	Over river	N/A				

Route	Section	Chainage	Bridge	Deck	Span(s)				Road Crossings				
–Dawanau to Kazaure	Section 3	44+623	Road overbridge	7.5	12m middle span				Unpaved	7.5		100	457
–Dawanau to Kazaure	Section 3	47+020	Railway Bridge	-	24m middle span	7 x 24	168 m	Over dam	N/A				
–Dawanau to Kazaure	Section 3	49+694	Road overbridge	7.5	18m middle span				Unpaved	7.5		69	668
–Dawanau to Kazaure	Section 3	51+571	Road overbridge	10	18m middle span				Paved	10.0		68	989
–Dawanau to Kazaure	Section 3	55+500	Road overbridge	10						10	50		
–Dawanau to Kazaure	Section 3	58+421	Road overbridge	10	12m middle span				Paved	10.0		100	840
–Dawanau to Kazaure	Section 3	62+371	Road overbridge	7.5	12m middle span				Unpaved	7.5		100	854
–Dawanau to Kazaure	Section 3	67+785	Road overbridge	7.5	12m middle span				Unpaved	7.5		100	740
–Dawanau to Kazaure	Section 3	71+346	Road overbridge	7.5	12m middle span				Unpaved	7.5		100	655
–Dawanau to Kazaure	Section 3	74+668	Road overbridge	7.5	12m middle span				Unpaved	7.5		100	440
–Dawanau to Kazaure	Section 3	75+353	Railway Bridge	-	24m middle span	11 x 24	264 m	Over dam	N/A				
–Dawanau to Kazaure	Section 3	76+614	Road overbridge	10	12m middle span				Paved	10.0		100	1,300

Route	Section	Chainage	Bridge	Deck	Span(s)				Road Crossings				
Kazaure to Daura	Section 4	83+070	Railway Bridge	-	18m middle span No.: 3 x 18 Total length: 54m	3 x 18	54 m	Over road	N/A				
Kazaure to Daura	Section 4	84+471	Road overbridge	10	12m middle span				Paved	10.0		100	1,305
Kazaure to Daura	Section 4	86+762	Railway Bridge	-	24m middle span	3 x 24	72 m	Over river	N/A				
Kazaure to Daura	Section 4	88+085	Road overbridge	10	12m middle span				Paved	10.0		100	683
Kazaure to Daura	Section 4	97+541	Road overbridge	7.5	12m middle span				Unpaved	7.5		100	594
Kazaure to Daura	Section 4	102+253	Road overbridge	10	12m middle span				Paved	10.0		100	740
Kazaure to Daura	Section 4	105+942	Railway Bridge	-	12m middle span	3 x 12	36 m	Over river	N/A				
Kazaure to Daura	Section 4	107+535	Road overbridge	7.5	12m middle span				Unpaved	7.5		100	427
Kazaure to Daura	Section 4	114+163	Road overbridge	10	12m middle span				Paved	10.0		85	822
Kazaure to Daura	Section 4	120+378	Road overbridge	5					Unpaved	5.0		100	458

Route	Section	Chainage	Bridge	Deck	Span(s)				Road Crossings				
Kazaure to Daura	Section 4	125+050	Road overbridge	7.5	12m middle span				Unpaved	7.5		100	497
Kazaure to Daura	Section 4	128+364	Road overbridge	7.5	12m middle span				Unpaved	7.5		100	719
Kazaure to Daura	Section 4	132+613	Road overbridge	10					Paved	10.0	55	50	812
Kazaure to Daura	Section 4	139+165	Road overbridge	7.5	18m middle span				Unpaved	7.5		75	590
Kazaure to Daura	Section 4	140+000	Railway Bridge	-	24m middle span No.: 11 x 24 Total length: 264m Over river	11 x 24	264 m	Over river	N/A				
Kazaure to Daura	Section 4	143+267	Road overbridge	5					Unpaved	5.0		100	516
Daura to Jibiya	Section 5	150+875	Road overbridge	10	12m middle span				Paved	10.0		100	749
Daura to Jibiya	Section 5	153+954	Road overbridge	5					Unpaved	5.0		100	510
Daura to Jibiya	Section 5	155+100	Railway Bridge	-	18m middle span	3 x 18	54m		N/A				
Daura to	Section 5	160+935	Road	7.5	12m				Unpaved	7.5		100	690

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Route	Section	Chainage	Bridge	Deck	Span(s)				Road Crossings				
Jibiya			overbridge		middle span								
Daura to Jibiya	Section 5	167+416	Railway Bridge	-	24m middle span	5 x 24	120 m	Over a road and stream	N/A				
Daura to Jibiya	Section 5	167+721	Railway Bridge	-	18m middle span	3 x 18	54 m	Over stream	N/A				
Daura to Jibiya	Section 5	171+795	Road overbridge	7.5	12m middle span				Unpaved	7.5		100	575
Daura to Jibiya	Section 5	176+401	Road overbridge	7.5	12m middle span				Unpaved	7.5		100	741
Daura to Jibiya	Section 5	184+659	Road overbridge	10	12m middle span				Unpaved	10.0		100	641
Daura to Jibiya	Section 5	187+429	Road overbridge	7.5	12m middle span				Unpaved	7.5		100	652
Daura to Jibiya	Section 5	191+270	Railway Bridge	-	18m middle span	5 x 18	90 m	Over river	N/A				
Daura to Jibiya	Section 5	192+121	Road overbridge	7.5	12m middle span				Unpaved	7.5		100	620
Daura to Jibiya	Section 5	198+866	Road overbridge	10	18m middle span				Paved	10.0		82	1,097
Daura to Jibiya	Section 5	200+173	Railway Bridge	-	18m middle span	3 x 18	54	Over river	N/A				
Daura to Jibiya	Section 5	200+954	Road overbridge	10	12m middle span				Paved	10.0		85	1,040

Route	Section	Chainage	Bridge	Deck	Span(s)				Road Crossings				
Daura to Jibiya	Section 5	203+567	Road overbridge	5					Unpaved	5.0		100	473
Daura to Jibiya	Section 5	208+560	Road overbridge	7.5	12m middle span				Unpaved	7.5		100	507
Daura to Jibiya	Section 5	213+350	Road overbridge	20					Paved	29.0	60	80	900
Daura to Jibiya	Section 5	215+661	Road overbridge	5					Unpaved	5.0		100	454
Daura to Jibiya	Section 5	221+710	Road overbridge	5					Unpaved	5.0		100	405
Daura to Jibiya	Section 5	229+342	Road overbridge	7.5	18m middle span				Unpaved	7.5		80	617
Jibiya - Maradi	Section 6	239+741	Railway Bridge	-	18m middle span	5 x 18	90 m	Over river	N/A				
Jibiya - Maradi	Section 6	245+700	Road overbridge	5					Unpaved	5.0		100	640
Jibiya - Maradi	Section 6	250+341	Road overbridge	5					Unpaved	5.0		100	713
Jibiya - Maradi	Section 6	253+7821	Road overbridge	5					Unpaved	5.0		100	536
Jibiya - Maradi	Section 6	254+834	Railway Bridge	-	18m middle span	5 x 18	90 m	Over river	N/A				
Jibiya - Maradi	Section 6	267+490	Road overbridge	5					Unpaved	5.0		100	814
Jibiya - Maradi	Section 6	270+174	Road overbridge	5					Unpaved	5.0		100	663
Jibiya -	Section 6	271+203	Railway	-	24m	1 x	24 m		N/A				

Route	Section	Chainage	Bridge	Deck	Span(s)				Road Crossings				
Maradi			Bridge		middle span	24	Over stream						
Jibiya - Maradi	Section 6	275+247	Road overbridge	7.5	12m middle span				Unpaved	7.5		100	582
Jibiya - Maradi	Section 6	277+475	Railway Bridge	-	18m middle span No.: 3 x 18 Total length: 54m Over stream	3 x 18	54m	Over stream	N/A				
Jibiya - Maradi	Section 6	280+427	Road overbridge	7.5					Unpaved	7.5		100	459

Ballast

The track bed layers will be made up of ballast and sub-ballast. Ballast will be formed from 100% crushed granular material. Ballast will typically be made up of 30/60 mm crushed stones using hard, compact and homogeneous rock. Generally, the minimum ballast thickness of 0.25m will be placed under the sleepers. Specifically, the minimum thickness under sleeper is:

- 0.25 m for main, passing and crossing tracks; and
- 0.20 m for stabling and service tracks.

The sub-ballast layer is the support layer of the ballast and is also formed by using 100% crushed granular material and will have a thickness of 0.20m and designed to:

- Improve the bearing capacity by altering stiffness and achieving better distribution of transmitted loads.
- Help to improve dynamic performance.
- Acts a filter between the subgrade and ballast; and
- Allow drainage of surface water.

Within yards and inside tracks, a total thickness of 0.35 m, (0.20 m of ballast under the sleepers and 0.15 m of sub-ballast) will be adopted.

Sleepers

Pre-stressed 2.60 m x 0.30 m concrete sleepers will be laid at intervals of 60 cm on along the main line. Sleeper spacing of 66.6 cm will be adopted on crossing tracks, sidings with heavy traffic and station tracks and 70 cm sleeper spacing will be adopted on other station tracks. The sleepers will be fastened with anti-vandalism sleeper screws.

Fencing

Fencing will be installed along the railway line. The fencing will be limited to areas in the urban crossing areas, mainly near the stations. Installation of fencing that prevents access to the workshop facilities, as well as to the goods yards will be considered. Suitable fencing will be placed around the boundaries of halts and stations.

Pedestrian, cattle and wildlife crossings will be placed as required along the railway line to reduce the barrier effect.

3.2.3 Rail Infrastructure

Bridges and crossings

A total of 83 structures will be constructed between Kano and Maradi and 46 along the Kano to Dutse branch line route. These will be a combination of overbridges (road overpassing the railway line with a multi span structure), overpasses (railway passing through a box culvert under the road) and underpasses (road passing through a box culvert under the railway line). Bridges and culverts will be constructed along the railway route. The typical railway bridge has a total width of 6.5 m comprising the 5 m wide single rail track two-side walkways.

Bridges will be constructed to span the entire bed within the flood zone for the designed return period. Bridges will be constructed using pre-cast concrete and transported to site to minimize disruption of construction activities.

A typical cross section of the bridges is provided in Figure 3.3.

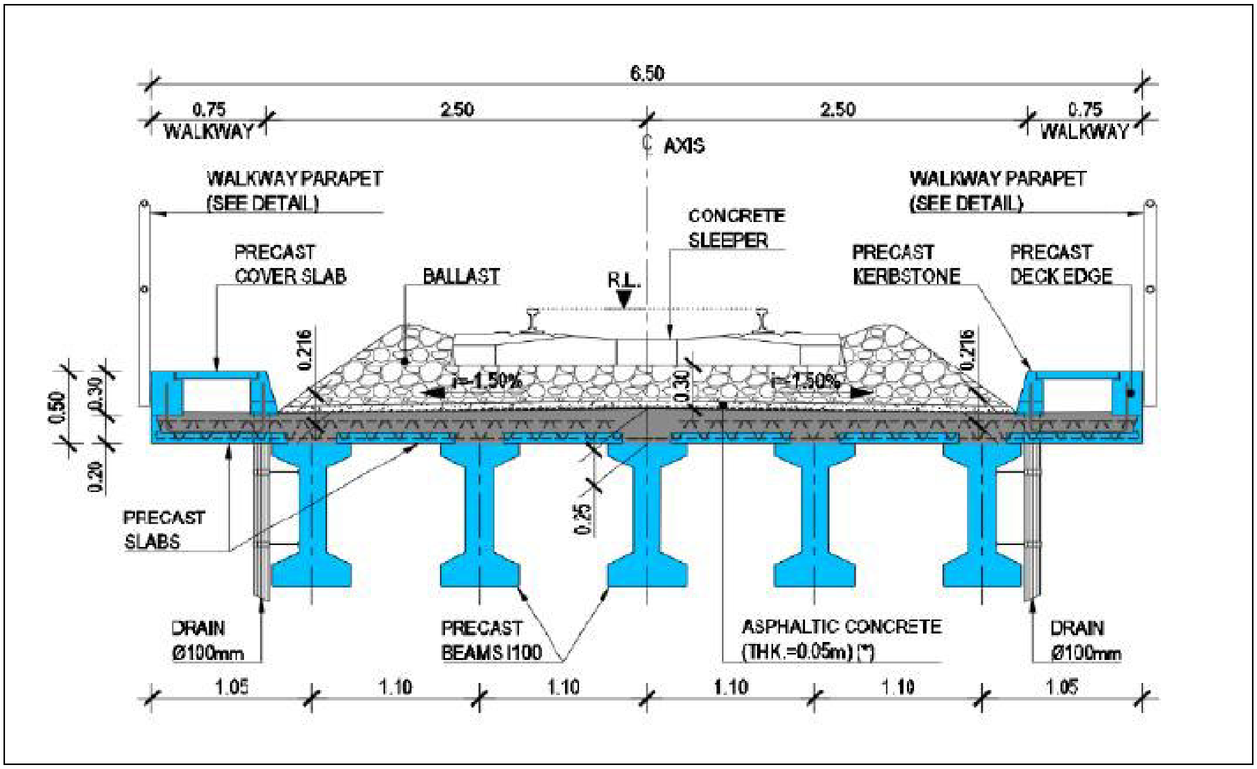


Figure 3. 3: Typical Cross-section of a railway bridge and viaduct

Decks and walkways

Decks will be made up of pre-slabs and a reinforced concrete slab, with variable thickness, to ensure a slope of 1.5% to allow drainage. Overbridges (with a 12 m span length) will have a deck surfacing of 0.6 m with a slope of 2.5%. The pre-slabs will be 0.07 m thick and will be placed over beams and joined by spatial trusses to allow the concreting of the cantilever zone (Figure 3.4).

The pre-cast slabs will serve to form the concreting in situ with a 0.22 m total thickness upper reinforced slab. On major roads that are already asphalted, a 5 cm bituminous carpet will be adopted on road crossing bridges. The remaining overbridges over local roads will have a surface coating. Deck surface protection will consist of the following layers:

- Bituminous emulsion.
- Bituminous membrane, based on polymer bitumen, integrating in their respective bituminous mixtures static polypropylene or styrene-butadiene-styrene resins; and
- Covering in 0.03 m thick mechanical protection.

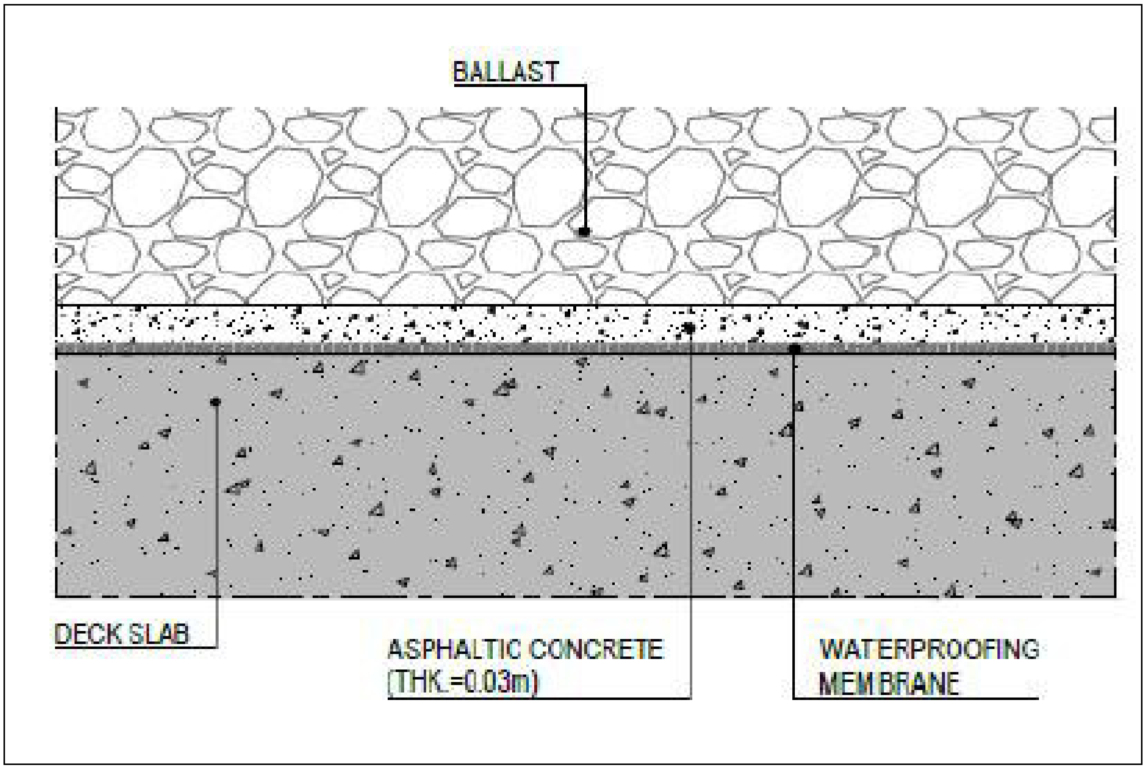


Figure 3. 4: Deck Surface Protection

The walkways will be elevated, allowing the installation of cable troughs, which will enable electrification in the future as required. Walkways will typically be between 0.75 m or 1 m wide. Each walkway will be formed using two pre-cast concrete kerbstones, fixed to the slab, which will be cast in situ. For overbridges, the decks will have a total width of 5.0 m, 6.0 m, 7.5 m or 10.0 m. This will be defined according to road crossing category – the road category definition is to be defined by competent local authorities. Each deck includes 0.75 m or 1.0 m wide side walkways.

Abutments

Two types of abutments will be used - Type 1 (lighter abutment) or Type 2 (heavy abutment) will be used (Figure 3.5).

- Type 1 will be the standard abutment and comprised of 1.0 m diameter piles driven into the ground. A transversal cap beam will also be used to support the deck loads (Figure 3.5), completed using front and side retaining walls.
- Type 2 abutments will be adopted where foundation soils are rocky and installation of piles is not preferred or if there is a need for the abutments to resist important horizontal loads.

These abutments have a front transversal wall supporting the bridge beams and a single central longitudinal wall with a top head supporting the railway line. The piers and abutments foundations will be direct with prismatic slab, supported on 1.2 m bored piles. Where the soil foundation is found to be rocky, the piers and abutments foundations will be designed using prismatic foundation slabs. In general, the maximum embankment height is limited to 10 m. A transition zone is defined to make this stiffness variation gradual.

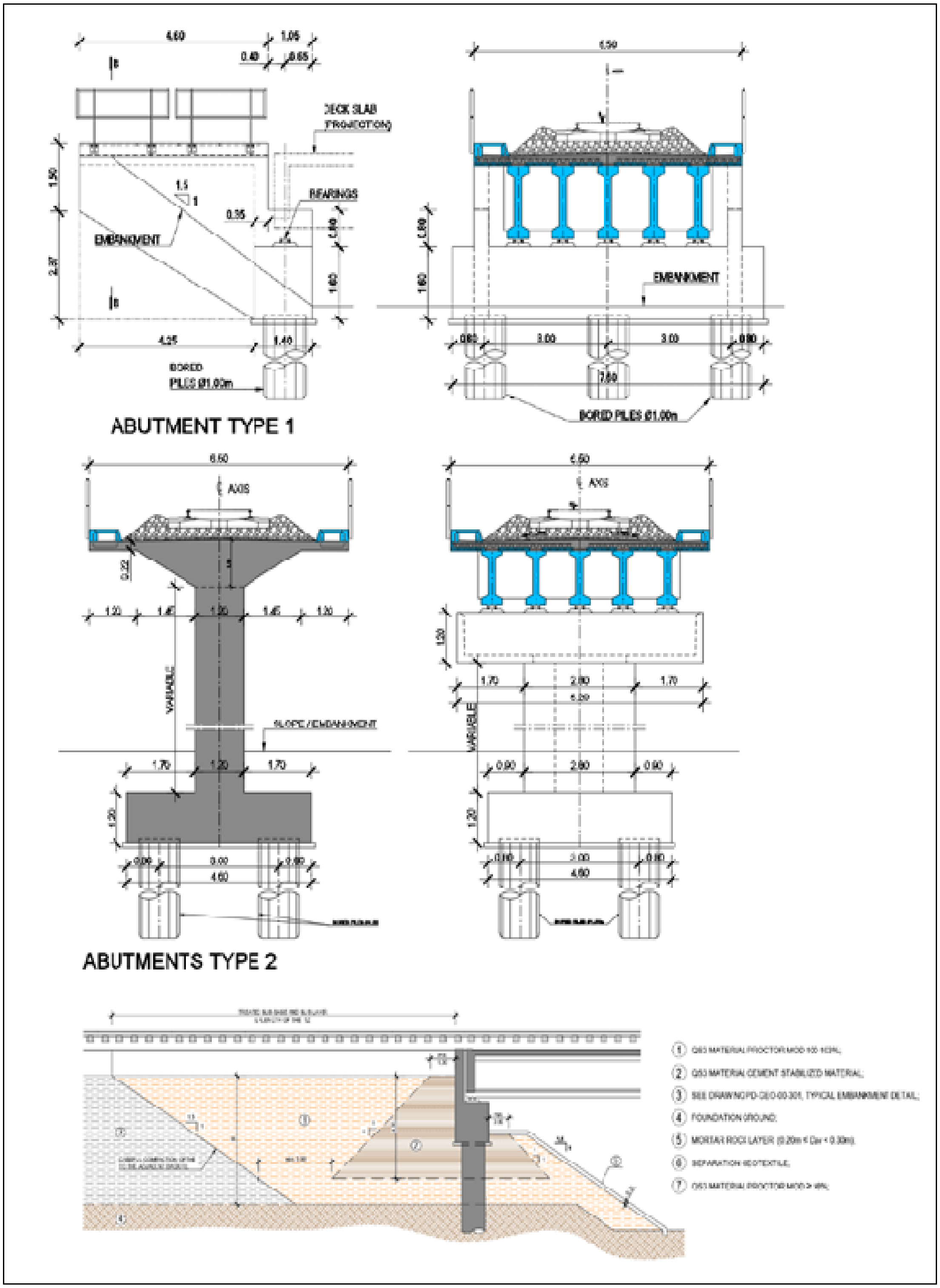


Figure 3. 5: Abutment type 1 (a) and type 2 (b) and Abutments Transition Zone (c)

Piers, Beams and Piles

Geotechnical surveys will be undertaken during detailed design to determine the type of support required for the bridges. The design includes indirect for support with piles or support with direct foundations. Piers will be formed using sets of piles/columns and by two transversal beams, one at the connection between the pile and the column and an upper transversal cap beam at the top of the column, which will serve as support for deck pre-cast beams (Figure 3.6).

The pile/column sets will be two (2) for a 5 m or 6 m wide deck and three (3) or four (4) for a 7 m or 10 m wide deck, respectively. The foundation dimensions will be adjusted for each span length and for each type of foundation. For the indirect foundations (use of piles), 4 or 6 bored piles with 0.8 m or 1.0 m diameter, with pile caps of 1.2 m or 1.5 m height will be installed.

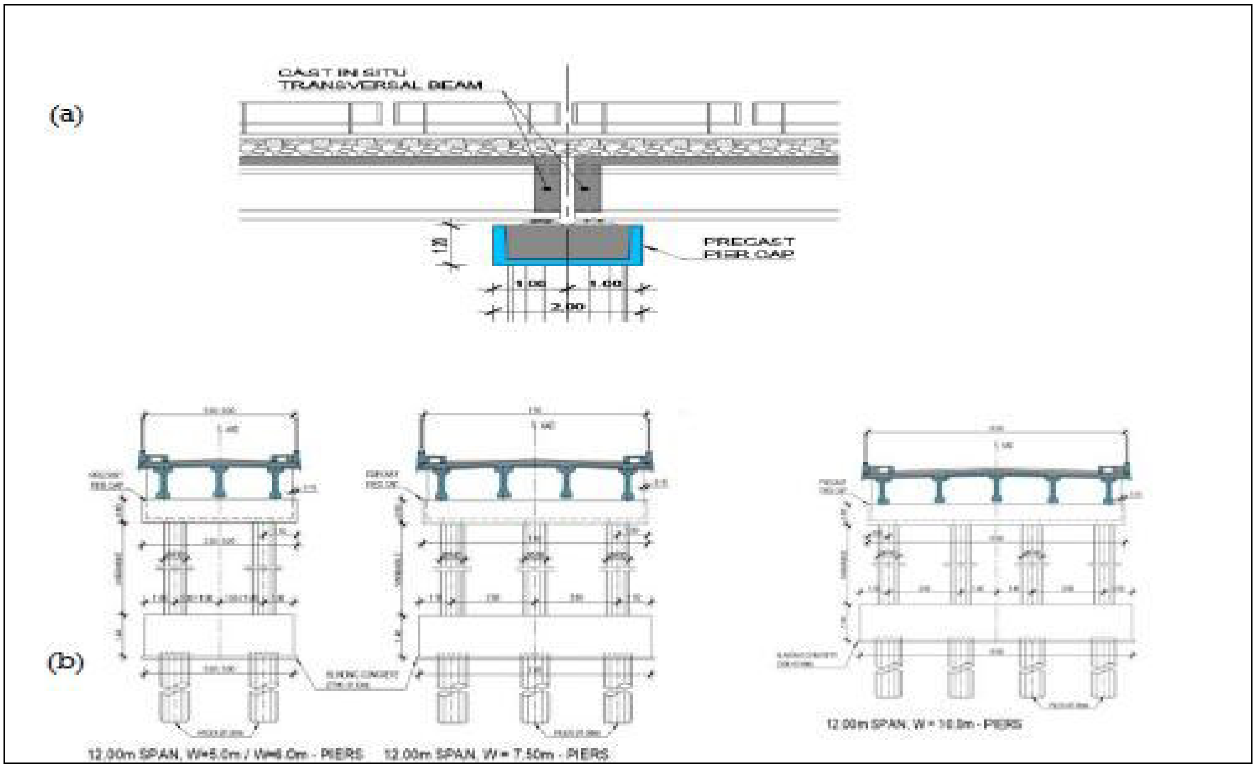


Figure 3. 6: Pier Cap/Deck (a) Typical layout of an Overbridge – Piers Elevation (5 m, 6 m, 7.5 m and 10 m width) (b)

Various span lengths will be adopted for the Project. Figure 3.7 below show typical longitudinal profiles for a 12 m, 18 m and 24 m multi-span bridges.

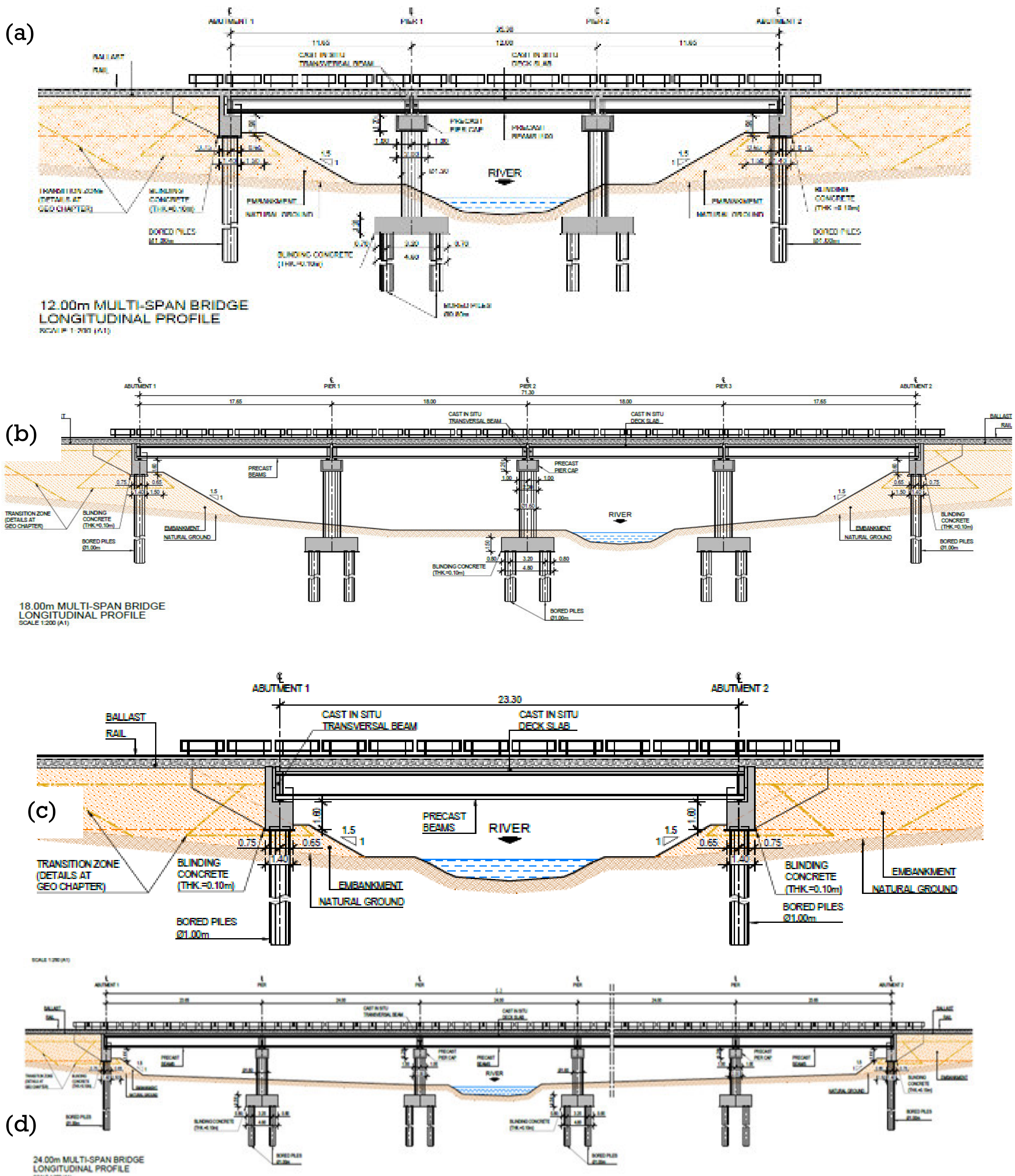
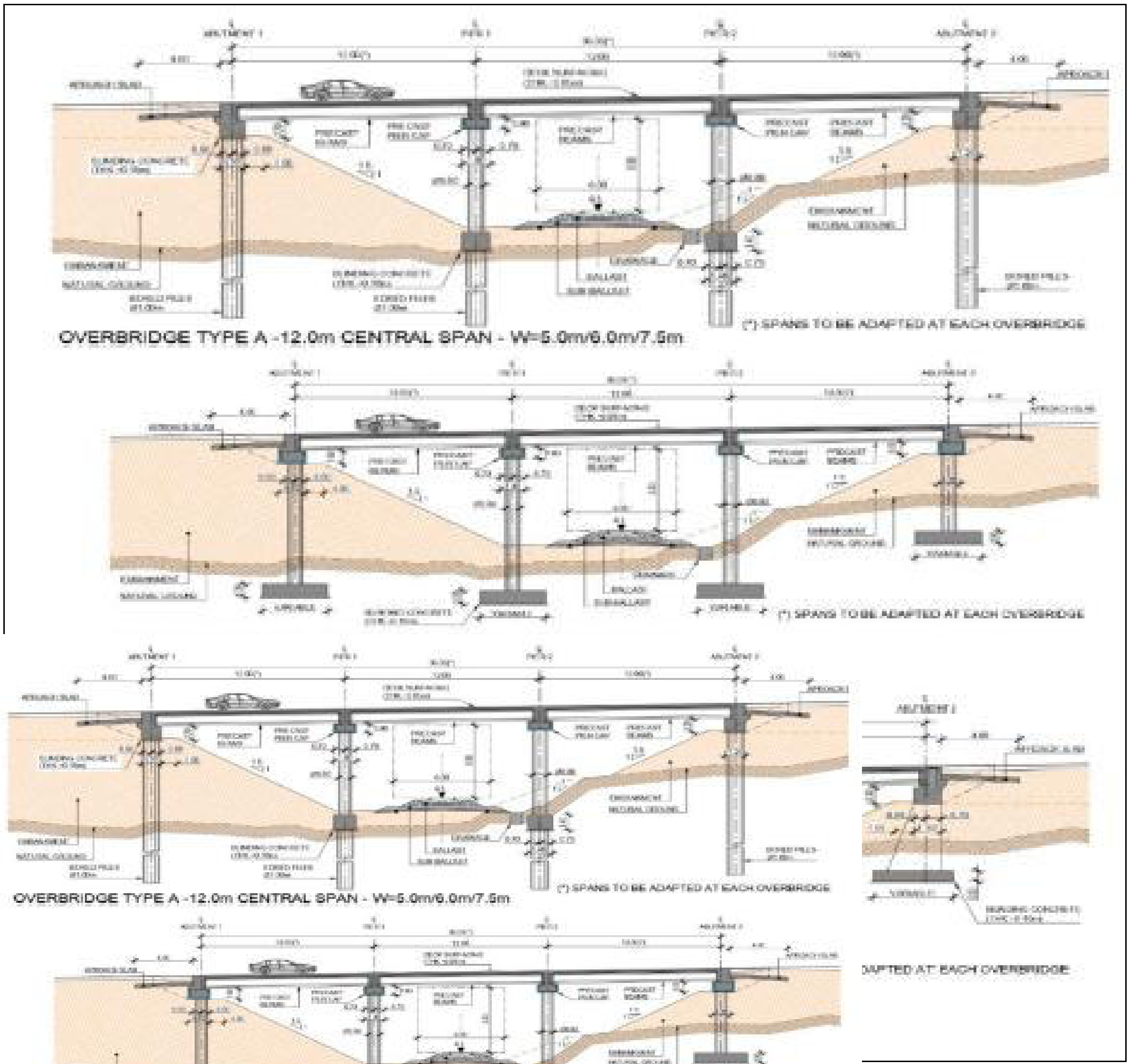


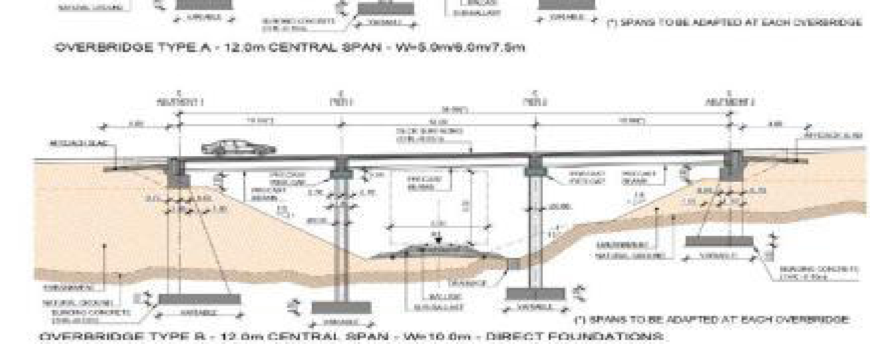
Figure 3. 7: Typical longitudinal profiles for bridges. 12 m multi-span bridge, (b) 18 m multi-span bridge, (c) 24 m multi-span bridge, (d) Single span bridge (24 m).

Overbridges

Overbridges will be the main bridges constructed for integrated road and rail. Overbridges will include 12 m span lengths for single-track situations and 18 m span lengths for a double-track situation. When the skew angle between the railway and the road alignment is less than 70^0, the minimum spans will be proportionally increased and the railway line will pass through a culvert box, underneath the road. Two types of overbridge design have been adopted. Type A overbridge design will be adopted for Minor roads and Type B overbridge (conventional design) will be adopted for roads defined as "Major Important" (Figure 3.8). The road classification will be defined by local authorities and the type of bridges will be constructed accordingly.



(12m span length) - Direct



Overpasses

Overpasses will be adopted only when the skew angle between railway line and roads alignments is less than 45° and it is not possible to amend the road to have a more perpendicular crossing. Only in these cases will the railway line pass through a culvert box, under the road. The overpass will comprise a single box culvert concrete cast in situ, with 7.8 m wide with a total 8.4 m height. The vertical clearance of the overpassing road will be 6.50 m and can be reduced to 6.2 m where necessary. A typical cross-section of an overpass is shown in Figure 3.9. The foundation slab will be 0.8 m thick and other in other cases be 0.70 m thick. At each box culvert ends, the cross-section changes to a "U" shape, where sidewalls will have variable height, decreasing in ends direction, following the embankment height decrease. Land made available in the RoW will not restrict the areas where bridges and their access will be constructed and retaining walls will be avoided or other structural solutions.

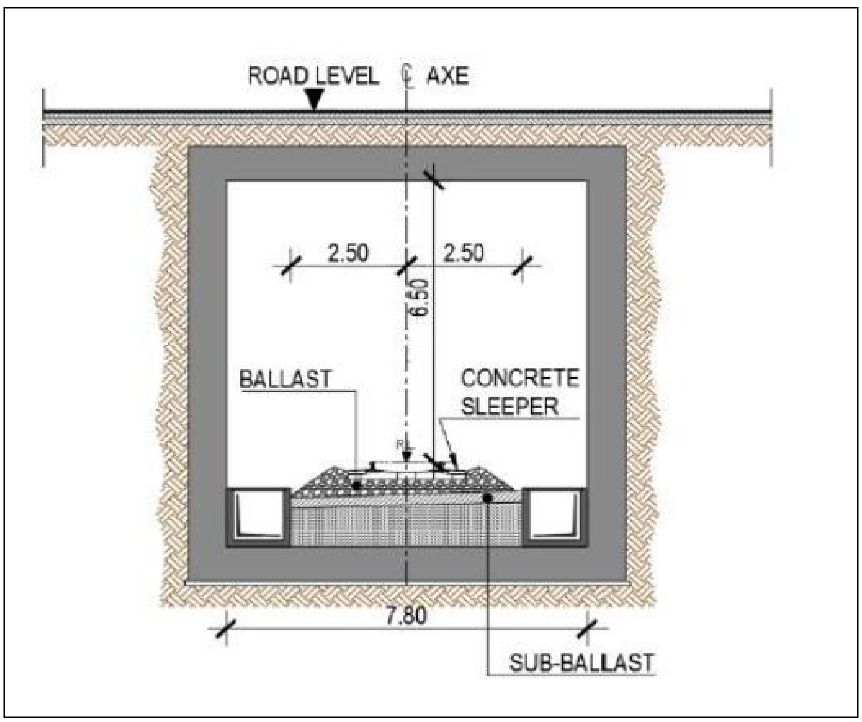


Figure 3. 9: Overpass typical layout

Road Underpasses

Nine (9) underpasses will be constructed along the Kano-Dutse branch line. Road underpasses will be made of reinforced concrete and will consist of box culverts under the railway and retaining walls at both ends. In general, due to the weight of pre-cast, box culverts and retaining walls will be cast in situ. On less important roads, with 5 m interior width, prefabricated design will be included with overlaps of 2 U-shaped elements. On the 10 m wide carriageway, the bottom slab will not be filled to reduce material use. Road underpasses will include double or single drainage channels. Typical transversal profiles of an underpass bridge with widths of 5 m, 6 m, 7.5 m and 10 m are shown in Figure 3.10.

The typical cross section of a road underpass has a total width of 6.50 m, allowing the installation of a single rail track in 5.0 m wide, and completed with two 0.75 m wide side walkways. The walkways will be elevated, allowing the installation of cable troughs, and composed of two precast concrete kerbstones, a precast cover and steel parapets (Figure 3.11).

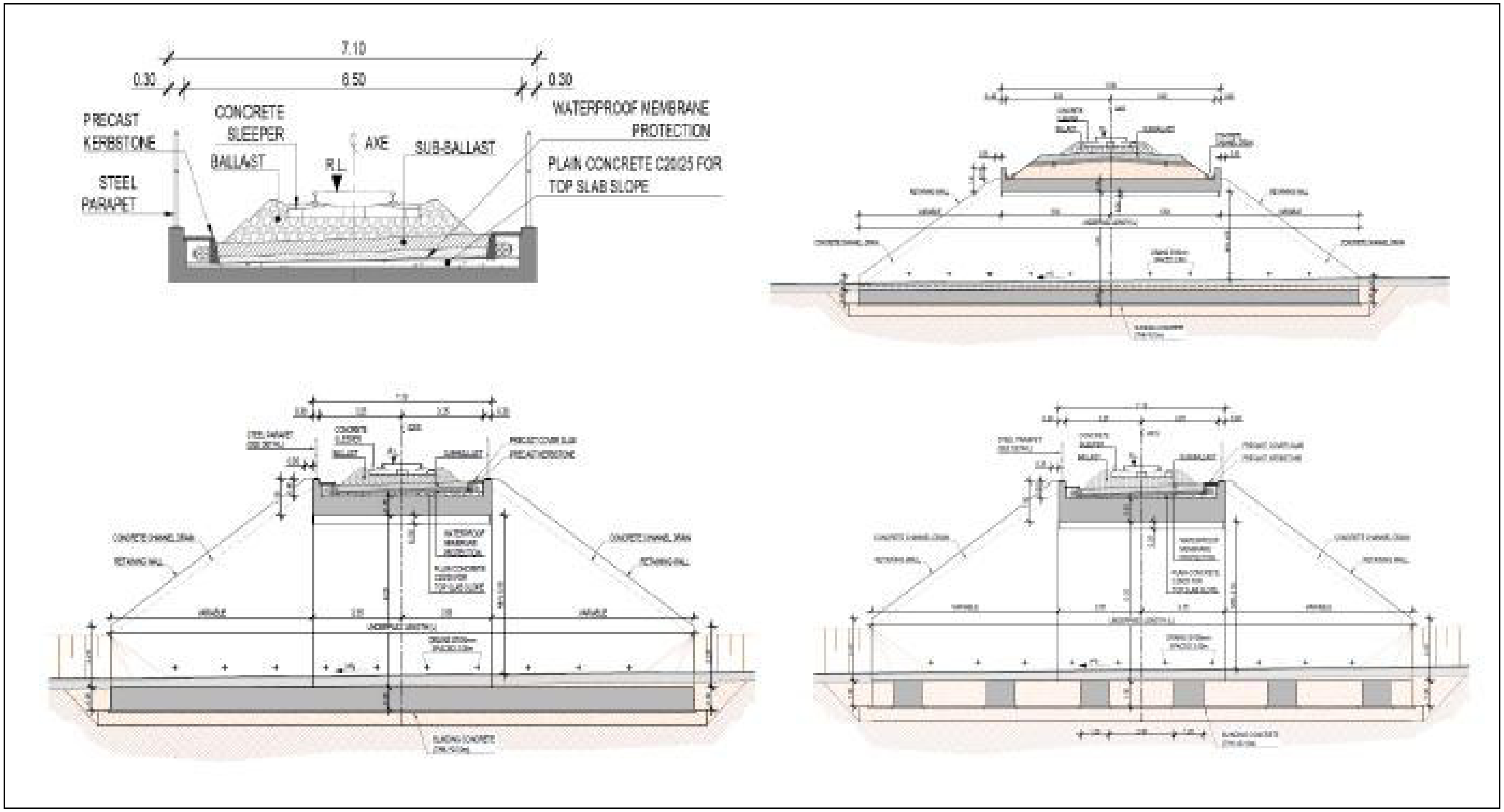


Figure 3. 10: Typical cross section of a road underpass (a), Typical Transversal Profile of an underpass bridge with a width of 5 m or 6 m (b), Typical Transversal Profile of an underpass bridge with a width of 7.5 m (c), Typical Longitudinal Profile of an underpass

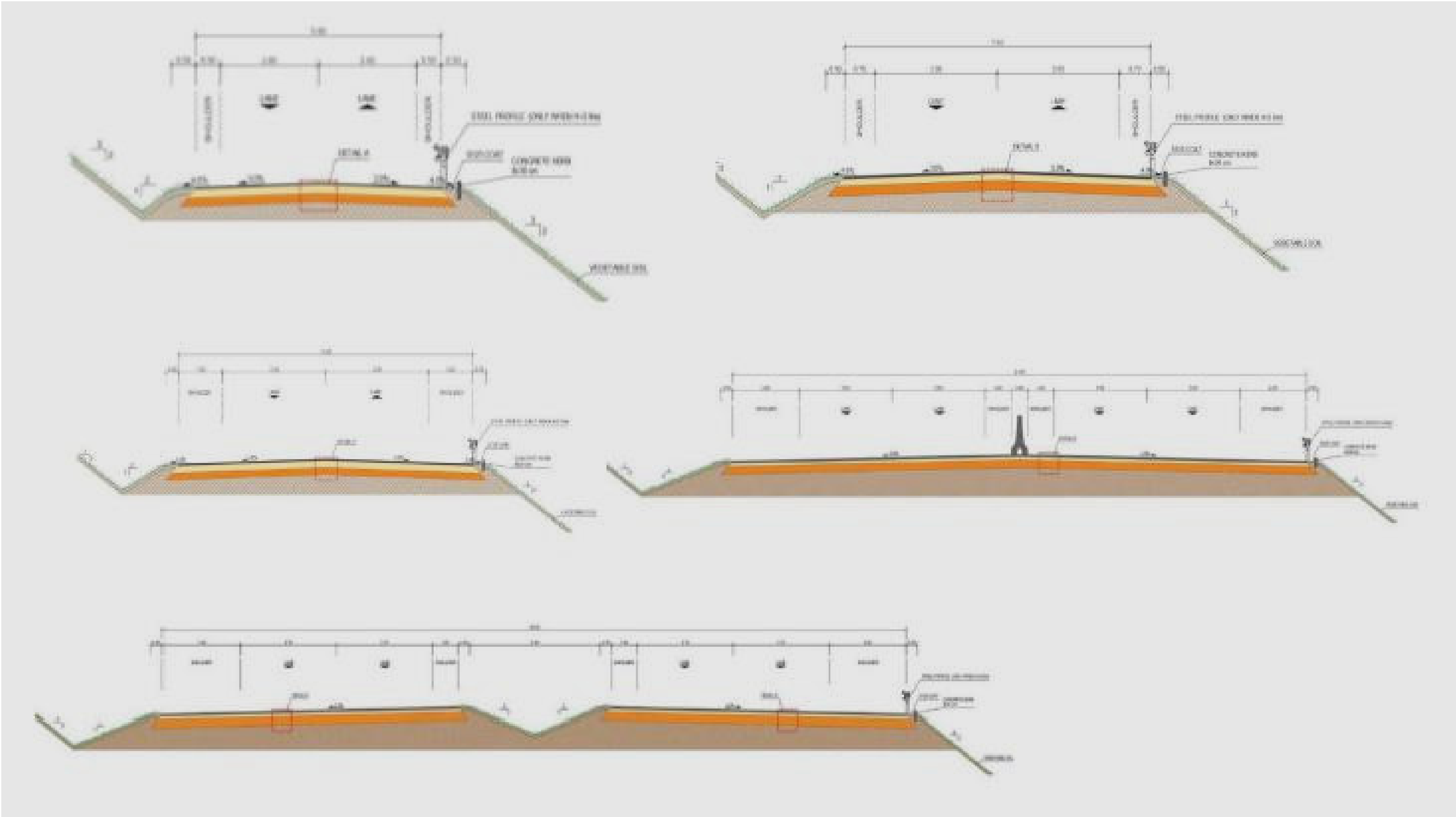


Figure 3. 11: Type I Cross section (5 m total width) (a), Type II Cross section (7.5 m total width) (b), Type III Cross section (10 m total width) (c), Type IV Cross section (21 m total width) (d), Type V Cross section (29 m total width) (e)

Road, Pedestrian and Animal Crossings

Road Crossings

The Project roads have been classified based on the Nigerian Highway Code as follows:

- Private Drive Pathways: These roads have occasional road traffic.
- Two-Lane Highways: These are single lanes. Traffic on two-lane highways typically flow in the opposite direction on one lane. Two-lane highways can be rural, urban, intra or intercity, depending on traffic.
- Dual Carriageway: This is a road which has multiple lanes with traffic going in the opposite direction. These roads may be physically separated by non-passable dividers such as concrete barriers.
- Expressways: This is a specially designed and restricted highway divided with barriers, which make traffic in opposite directions completely separated from each other.

The existing road network affected by the new railway network will be restored to minimize the socio-economic impacts resulting from the barrier effect of the infrastructure and the change in the road network. Crossings to the railway track by overpasses will be constructed in cities while underpasses will be constructed in rural areas. For a very limited number of pedestrian pathways, level crossings will be provided.

Five different types of road crossing will be constructed depending on the type of road width lane and shoulder (Table 3.3).

Table 3. 3: Types of Road Crossings

Type	Total lane width (m)	Shoulder (m)	Total crossing width (m)
Type I	4	0.5	5
Type II	6	0.75	7.5
Type III	7	1.5	10
Type IV	14	2.5	21
Type V	15	3	29

Road speeds for the road crossings will be as follows:

- Rural ways and Municipal ways with occasional car traffic: 50 km/h
- Municipal roads and municipal ways with significant car traffic: 60-70 km/h
- National Highways: 80-100 km/h

In general, the geometric definition of the road was aimed at saving the volume of land and reusing the material from the excavation for the execution of the dumpsite.

<u>Pedestrian and Animal Crossings</u>

Pedestrian, cattle and wildlife crossings will be placed as required along the railway line to reduce the barrier effect.

Culverts and Drainage

Drainage structures will be provided in all-natural watercourses and elsewhere such that ponding water is avoided and to avoid excessive flows inside culverts (Figure 3.12).

The following criteria has been considered when selecting the drainage structure is required at the different crossing points of a waterway with the railway alignment:

- Bridge Structures - for watercourses with a calculated water flow greater than 100 m^3/s.
- Culvert Structures - for water flows less than 100 m^3/s and greater than 70 m^3/s.
- Box Culverts – for water flows less than 70 m^3/s and greater than 5 m^3/s.
- Pipe Culverts - for small water courses with flows less than 5 m^3/s.

A total of 15 culverts and 49 box culverts will be constructed along the railway route. A total of four (4) culverts will be constructed along the Kano – Daura route, ten (10) for the Daura – Maradi route and two (2) along the Kano – Dutse route.

For hydraulic culverts, pipe culverts will be made up of pre-cast reinforced concrete with an internal diameter of 1.2 0 m or 1.50 m (single or multiple). Box culverts will be pre-cast with internal sections of 2.00 x 2.00 m, 2.50 x 2.50 m and 3.00 x 3.00 m (single or multiple).

The return periods to be adopted for the Project is as follows:

- 20 years for the railway longitudinal drainage system.
- 25 years for the small streams with flows till 5m³/s (circular pipes).
- 50 years for moderated to critical situations with flows between 5 to 100 m³/s (box culverts);
- 100 years for very critical and risky specific situations with flows higher than 100 m³/s (bridges).

Cross drainage structures will be designed to the allowed minimum distance to top of Rail of 1.5 m. The hydraulic culverts will be designed to function with an inlet control where applicable. Cross drainage structures will include a headwater depth of 1.20 times the culvert depth, with a clearance of 0.60 m below the railway's base height. When pipes are placed in a multiple installation, the spacing between pipes will be half the diameter of the pipes and the spacing will be measured between exterior surfaces of the pipes.
To prevent erosion associated with cross drainage, riprap outlet protection with stones of a diameter suitable to the outlet velocity will be installed. Interference of the water lines will be limited to the land acquisition boundaries. The RoW limit will be increased to 150 m downstream and 150 m upstream, where applicable.

For erosion protection, protection works will be provided at outlet sections of the culverts to correctly drive the flow and protect the natural soil to avoid/limit erosion. In cases where the inclination of the culvert leads to maximum flow, velocities up to 4.5 m/s, a riprap apron will be installed for protection from scour. In cases where the inclination of the culvert leads to flow velocities between 4 m/s and 6 m/s, a Reno mattress will be used to protect from scour. In cases where the inclination of the culvert leads to flow velocities at the outlet between 6 m/s to 7.5 m/s, a gabion mattress shall be used to protect from scour.

For drains and subsoil drainage, triangular concrete lined crest ditches will be provided. Crest drains will discharge into natural watercourses. In other cases, crest drains will discharge into groundwater where a change in slope allows drainage away from the railway. No gutters will be provided for the top of embankment or any kind of downspouts and flumes. Wherever possible, side drains will end at cross drainage structures or natural watercourses, with the purpose to remove water from the railway area. If longitudinal sub-soil drainage requires sub-soil drains below the side ditches, they will be constructed with or without a pipe, depending on the assessment of each situation. If a pipe is required, then a 200 mm perforated pipe surrounded by gravel filter material wrapped in geotextile fabric will be installed. Underdrain grades will not be less than 0.5%.

For underpasses and underpasses, on embankment slopes above 3m height, ditches will be placed according to the shoulder flooding. The drainage for the overpasses and the underpasses will not be connected to the railway platform drainage. In the underpasses, the drainage will be designed to carry the water by gravity to the lowest point outside. For roads, uncoated platform ditches and curbs for dumpsite slopes over 2 m high will be installed.

At the carriageway side limits, next to the walkways, 100 mm diameter metal tubes will be placed to drain the deck. Decks will be sloped at 1.5% to allow drainage. The walkways side kerbstone, which limit the ballast, will have openings allowing drainage of the cable troughs zone (located alongside railway tracks). In residential areas viaducts, the water from the fall pipes will be directed to the abutments by the longitudinal piping. The vertical gauge between the base of the deck and the maximum full level for a return period of 100 years, must be greater than 1 m. The spans, piers geometry and its location will ensure a good hydraulic flow in the event of flooding. The pier will stay out of the permanent riverbed. Road underpasses will include double or single drainage channels. Road drainage system will be calculated and adapted to each underpass and therefore, appropriate drainage ditches adopted.

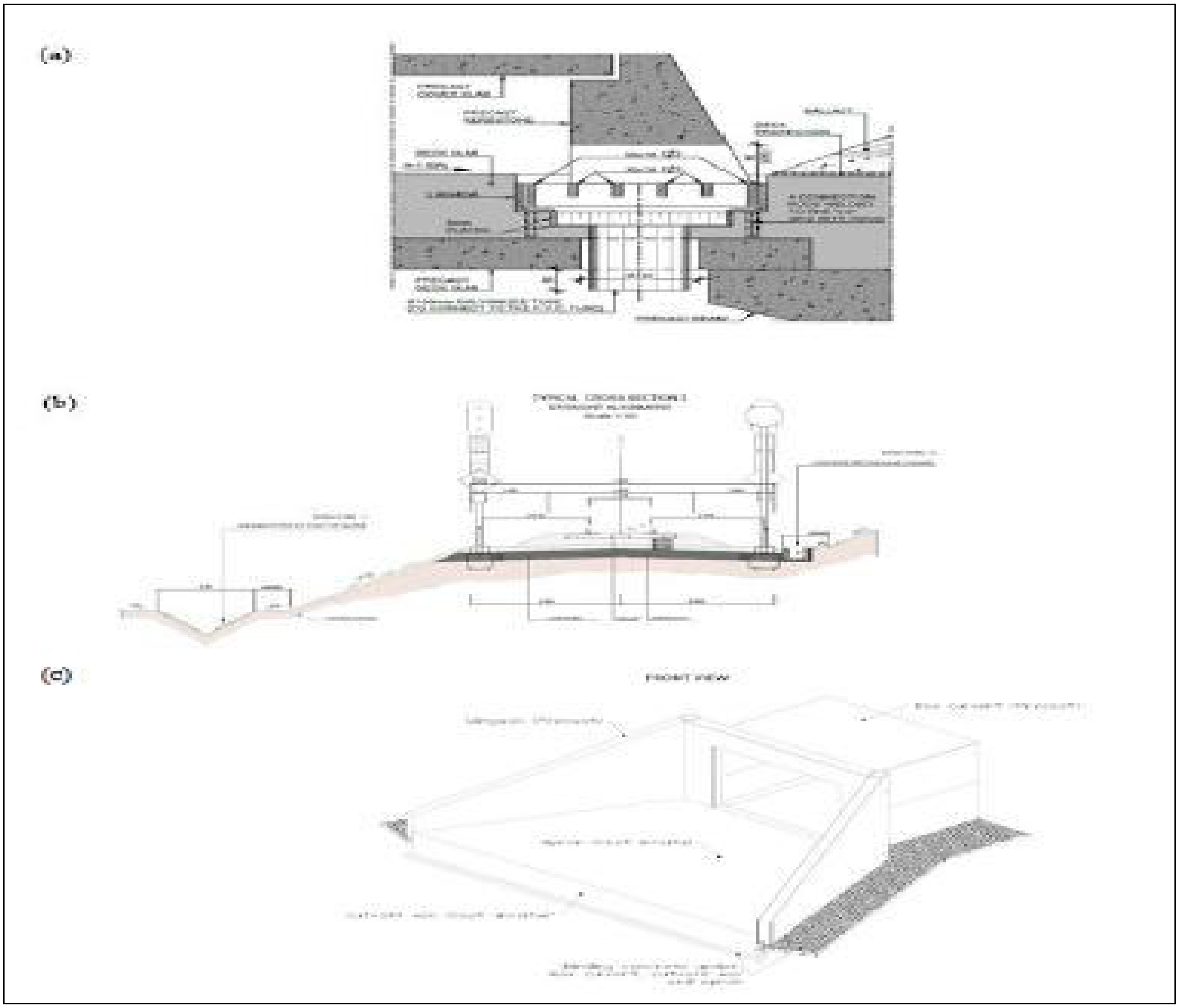


Figure 3. 12: Bridge Drainage Design (a), Typical cross section of drainage (b), Box Culvert (c)

Sidings/Loops/Turnouts

The turnouts will be connected to the track by thermit welding. The buffer stop that will be used will be fixed to ensure safe track closures even with short track ends, preventing slow rolling vehicles from leaving the track (they will also work also as an optical marking of the end of the track).

3.2.4 Rail Operational Facilities

The rail is designed to accommodate both freight and passengers, with trains with a maximum design speed of 150 km/h for express trains and 120 km/h for local services. Maximum design speed for Freight trains is 100 km/h and 80 km/h for heavy freight.

Trains

The train operations will be designed as follows:

- 20 h/day operating time to allow for night maintenance period of about 4 hours each day;
- Freight train sets of 30 wagons, with a useful capacity of 50 ton/each; that is maximum capacity of a train is 1,500 tonnes, with effective capacity of approx. 1,200 tonnes, taking into consideration a usage coefficient of 80%.
- Passenger trainsets of 12 carriages with a useful capacity of 100 passengers/each. i.e. maximum capacity of a train is 1200 passengers with effective capacity of approx. 1020 passengers, taking into consideration usage coefficient of 85%:
- The axle load considered in the design have the design value of 22.5 t.

It is anticipated that the traffic volumes for passengers and freight will be approximately 4,684 passengers/day in each direction, and 1,536 tons/day from Kano to Maradi, and 1,167 tons/per day from Maradi to Kano.

Signalling and Telecommunications

The Signalling and Telecommunication Systems to be installed for the Project is the European Train Control System (ETCS), the modern European ERTMS/ETCS Level 2, associated with the GSM-R Radio Communication System, and supported by an optical fibre backbone network. This is the same as the Signalling and Telecommunications Systems already deployed for the Ajaokuta- Warri standard gauge line, and it is consistent with the policy of construction of a new Nigerian standard gauge railway network. The system will be integrated with the necessary Train Detection and Train Integrity verification devices, achieved with the installation of an electronic Axle Counting System.

All trains, at regular intervals will automatically report their exact position and direction of travel to the Radio Block Centre, through the balises (also known as a transponder) installed along the track. Train movements are monitored continually by the Radio Block Centre. The Movement Authority, together with the data of speed and section information, will be transmitted continually to the vehicle by GSM-R. Radii communications will use the standard system GSM-R of the last generation. A Base Station Controller (BSC) will be set up in Katsina station to place a radio link connection with the node controller of the overall Nigerian Railway network.

Stations

A total of 15 stations will be constructed along the route: fifteen stations along the Kano to Maradi route and five (5) stations along tor Kano – Dutse branch-line. Stations will be constructed at an average distance of 20.2 km between consecutive stations.

Stations will be constructed according to their types as follows:

- Standard Type A - For 1,500 passengers at peak time - in State Capital cities or for large centres with over 300,000 inhabitants.

- Standard Type B - For 300 passengers at peak time - for cities with the Headquarters of Local Government Areas or for centres with over 100,000 inhabitants.
- Minor - For 100 passengers at peak time - apply to the remaining centres.

The station's building will include two main areas:

- Passenger area: waiting area, toilets, ticket hall and service areas; and
- Technical area: signalling and controlling room, staff office, stationmaster office, toilets, and shower rooms.

These will include a series of technical support areas, such as a cable room, computer room, electrical room, electrical and water substation. The layout of a typical station is shown in Figure 3.13 below.

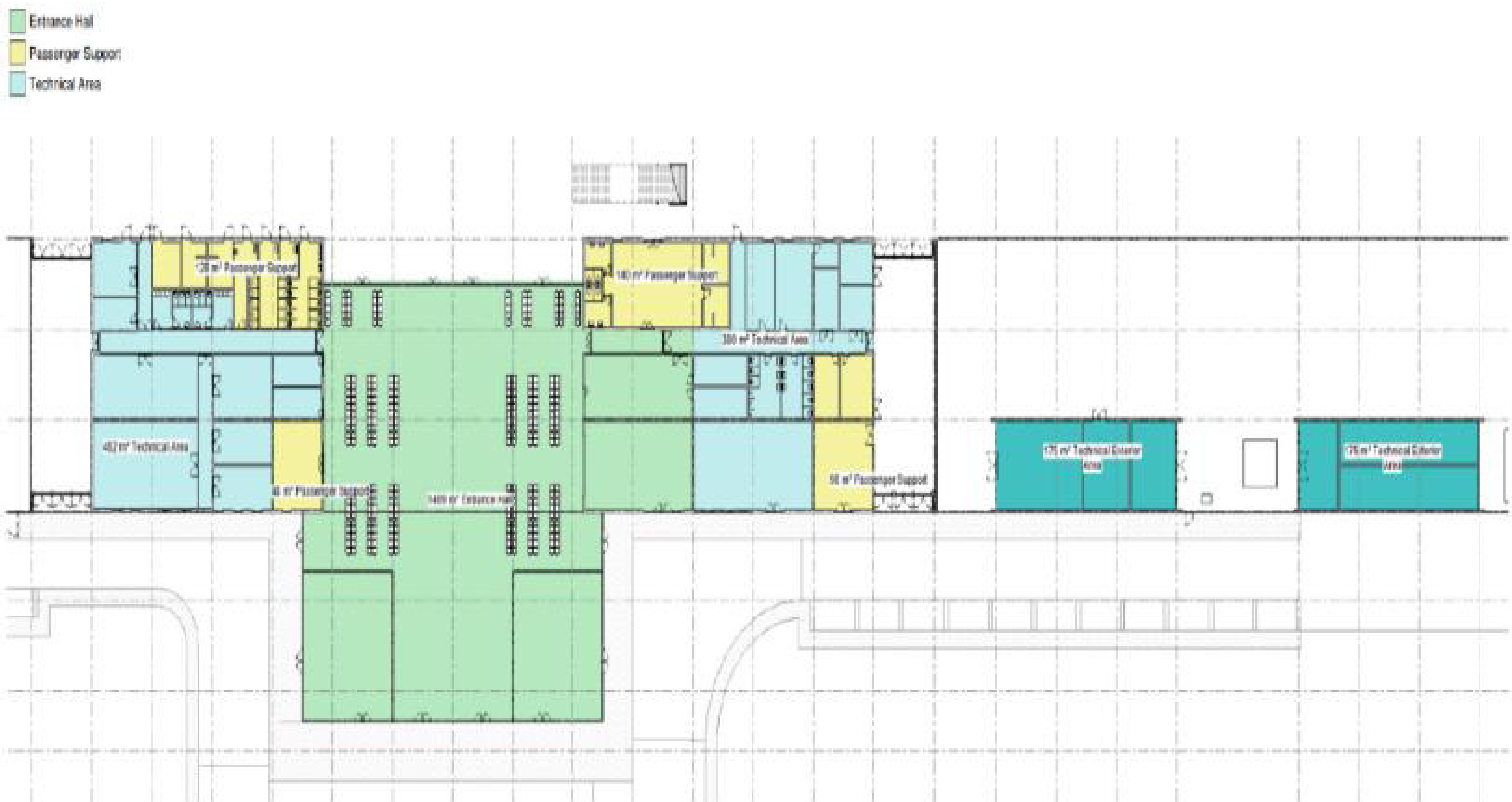


Figure 3. 13: Typical layout of Stations (example showing a Type A station)

Types of stations

The stations and station types from Kano- Maradi and the Kano-Dutse branch line is provided in Table 3.4 and Table 3.5 below, respectively. The permanent RoW for stations will be 400 m (total width) and 600 m (for Katsina and Dutse).

Table 3. 4: Stations and Types – Kano to Maradi

Station No.	Station	Chainage	Description	RoW Station Limits
Standard Type A				
11	Katsina	203+800	• Freight Yard • Integrated Maintenance Centre • Locomotive depot and light maintenance • Washing station and coach servicing • Refuelling point for locomotives	600m
Standard Type B				
4	Dambatta	60+595	• No ancillary buildings	400m
5	Kazaure	90+610	• Freight Yard • Integrated Maintenance centre	400m
7	Daura	132+380	• Freight Yard	400m
8	Shargalle	157+930	• No ancillary buildings	400m
Minor				
2	Dawanau	20+400	• Freight Yard	400m
3	Kunya	37+530	• No ancillary buildings	400m
6	Durbe	116+705	• No ancillary buildings	400m
9	Mashi	171+690	• No ancillary buildings	400m
10	Maradu	187+895	• No ancillary buildings	400m
12	Daddara	235+100	• No ancillary buildings	400m
13	Jibiya	250+000	• Will also function as a border checkpoint between Nigeria and Nigeria. • Freight Yard	400m
14	Anoal Mata	272+400	• No ancillary buildings	400m
15	Maradi	291+855	• No ancillary buildings	400

Table 3. 5: Stations and Types – Kano to Dutse

No.	Station	Chainage	Description	
Standard Type A				
5	Dutse	112+375	• Freight Yard • Integrated Maintenance Centre • Locomotive depot and light maintenance • Washing station and coach servicing • Refuelling point for locomotives	600m
Minor				
1	Yar Gaya	26+300 (old) 19+000 (new)	No ancillary buildings. It should be noted that this station will be repositioned so that it is closer to the town of Dawakin-Kudu, an industrial area of the region.	400m
2	Wudil	45+970	No ancillary buildings	400m
3	Gaya	68+940	No ancillary buildings	400m
4	Duru	92+170	No ancillary buildings	400m

Buildings

For purposes of the Project, all buildings are classified as non-residential, with the stations classified as Transport Stations, while the ancillary buildings are classified as Industrial. Ancillary buildings include facilities for rolling stock services. The station's buildings will consist of a ground floor and two roofs. Buildings will comprise an entrance hall, passenger and technical support. Buildings will be constructed with a transparent façade and the glass will be protected from the sun with a detached roof that will absorb the sunlight and will provide natural ventilation. In certain cases, where the glass façade is facing West, sun protection fixed on the exterior metallic structure will be installed.

For the technical and passenger buildings, a lower roof, supported by steel frames with spans between 15 m and 22 m will be used. Brick opaque walls and opened brick will be installed to create natural ventilation for interior spaces. The roofs of will be thermos-insulated.

On the side of the station building three buildings will be constructed: one dormitory and two technical buildings (water and energy). A dormitory building will be located in the station complex, on the left side of each station type. The building comprises six individual bedrooms with private bathrooms and a shared kitchen. Waiting halls will have suspended baffles to absorb the sound that is reflected by the glass façades. Passenger support areas will include a VIP area, toilets, praying rooms, ticket hall and commercial areas.

Platforms

Station platforms will comprise:

- Paving with anti-slip characteristics;
- Tactile routes and tactile maps for the blind;
- A tactile yellow line to indicate the safety strip along the edge of the platform.

Shelters

Shelters will be installed in stations and will be long enough to cover the waiting areas on the platforms. However, the installation of shelters will depend on the type of station.

Platform Overpasses

Platform overpass structures will connect the platforms over a span of 14 m. The structure will be made up of two parallel trusses, with approximately 3.2 m in height (corresponding to the full height of the overpass), and 5.4 m between. The floor will be made of steel plate, with the roof consisting of sandwich panels. Elevators connecting platforms and underpasses will be installed.

Overpasses for the use of passengers have been foreseen for the specific use of the station. The width of the underpasses, in proportion with the passenger flows, must be multiples of

M (M = 60 cm) and, in any case, no less than 3 m. The net height from floor to ceiling will be 2.5 m. The overpasses conform to regulations for overcoming architectural and sensorial barriers and for escape routes for fire prevention safety. The overpass will be supported by a metallic structure and the tray and roof have a metallic finishing. The overpass will be enclosed with a metallic mesh as a safety and sun protection measurement. The modularity of the structure and metallic mesh aim to create a similar layout as the entrance hall façade.

Fencing, Station Accesses and Circulation

To ensure the security of the entrance hall, platforms and trains, a security metal check system will be installed at the entrance hall and building exits. One main entrance through the passenger hall and two exits on the edge of the station will be provided, maintaining the train platform security. The halts and stations will be protected from intruders by a suitable fence around the boundaries, with a height above the level of the external paving that is no less than 1.80 m. The exterior fence will be a metallic vertical tubular painted in grey with 3 m height, with doors and gates where necessary.

Access for both the public and personnel will allow a safe exit for all users, in conformity with the regulations for overcoming architectural and sensorial barriers. Escape routes for fire prevention safety will be equipped with gates for the closure of the station when not in operation and to allow the entry of emergency vehicles.

Foundations

In the Entrance Hall and Support Areas, considering the loads on the structures, low tensions are expected on the supports, allowing a solution with direct foundations.

Safety and Security

Each station and its buildings (freight yard, integrated maintenance facilities, locomotive depot and light maintenance, washing station and coach servicing and refuelling point for locomotives) will have its own fire detection control panel located in technical area. The stations buildings will be equipped with manual portable fire extinguishers.

Every station building will have CCTV system, covering the following areas:

- Hall;
- Main platform;
- Overpass;
- Technical areas entrance; and
- Emergency exits.

An access control system will be considered on sensible points for each station buildings, where there is the need to control personnel access to certain restricted areas. The system will be entirely controlled by a main computer connected to LAN/IP network and running access control platform, which stores and processes all access requests, user information, configurations, and permissions.

Safety and security signage to be installed using a universal language, which will include symbolism, warning of existing or likely hazards, identify the location of means and alarm equipment and firefighting prohibit dangerous behaviour and force the use of equipment or processes contributing to security in general. Safety signage will ensure the safety of life, the correct identification of escape routes, exits and emergency exits.

They will be properly signed by the photo luminescent pictograms for:

- All escape routes;
- Identification of outputs;

- Identification of emergency exits;
- Location of firefighting equipment;
- Identification of signalling equipment;
- Identification and hazard awareness;
- Prohibition of dangerous behaviour; and
- Indication of personal protective equipment.

A Photo luminescent material that incorporates floor plans on a small-scale, indicating the position of the observer, the normal output paths and alternatives, and the location of resources and combat gear fire will be made available at the stations. These signs will have the following characteristics:

- Be made of shock-resistant material, weathering and environmental stress;
- Be made of non-combustible material or self-extinguishing and when the passive type should not have a thickness of less than 2 mm. If the application type for the diffusers of light fixtures should be of vinyl and transparent colours;
- The surface of the signs must resist to the deposition of dust;
- Passive signals must use phosphorescent colours and reflective materials;
- The colorimetric and photometric characteristics of signs must guarantee good visibility and understanding;
- The signs must conform to the National and Community regulations applicable in force; and
- The plates will have areas (A) not lower than those determined depending on the distance (d) to which they will be seen, with a minimum of 6m and a maximum of 50m, in accordance with the expression $A \geq d^2/2000$.

The distribution of the signs will allow visibility from any point. To ensure their visibility, the plates shall be fixed at a height of 2.1 m or more and not more than 3 m. In addition, fire and smoke seals will be installed and used in accordance with Good International Industry Practice (GIIP).

3.2.5 Maintenance Facilities

The rolling stock services facility includes cleaning, refuelling and the light maintenance of the trains and will comprise three ancillary buildings: locomotive depot and light maintenance workshop, refuelling point for locomotives, washing station and coach servicing, freight yard, an integrated maintenance centre and a Type 2 electrical substation.

The locomotive depot and light maintenance workshop will be equipped with three lines, each with an open pit and one with inspection walkways matching the roof. The building also provides offices, storage, workshops and service facilities for personnel. Figure 3.14 shows the typical layout for the maintenance facilities.

Locomotive Depot and Light Maintenance Workshop

Locomotive depots and light maintenance workshop will be constructed for the Katsina and Dutse stations. The locomotive depot and light maintenance workshop building will be made of two blocks with different roof levels. A drainage channel will be installed beneath the ground floor of the locomotive depot and light maintenance workshop building and will be a pre-cast concrete box.

Refuelling point for Locomotives

Refuelling points for locomotives will be constructed for the Katsina and Dutse stations. The refuelling point for the locomotives provides for two diesel pumps (supplied by underground tanks), oil and sand.

Integrated Maintenance Facilities

To ensure the maintenance of the track, civil works and electromechanical installations, three main integrated maintenance centres have been located along the line at Kazaure, Katsina and Dutse stations. The integrated maintenance facilities will be made of two structurally independent buildings. The first, is the service vehicle garage, for both road and rail vehicles. It will be equipped with two inspection pits; and the second, provides offices, warehouses, workshops, and service facilities for staff.

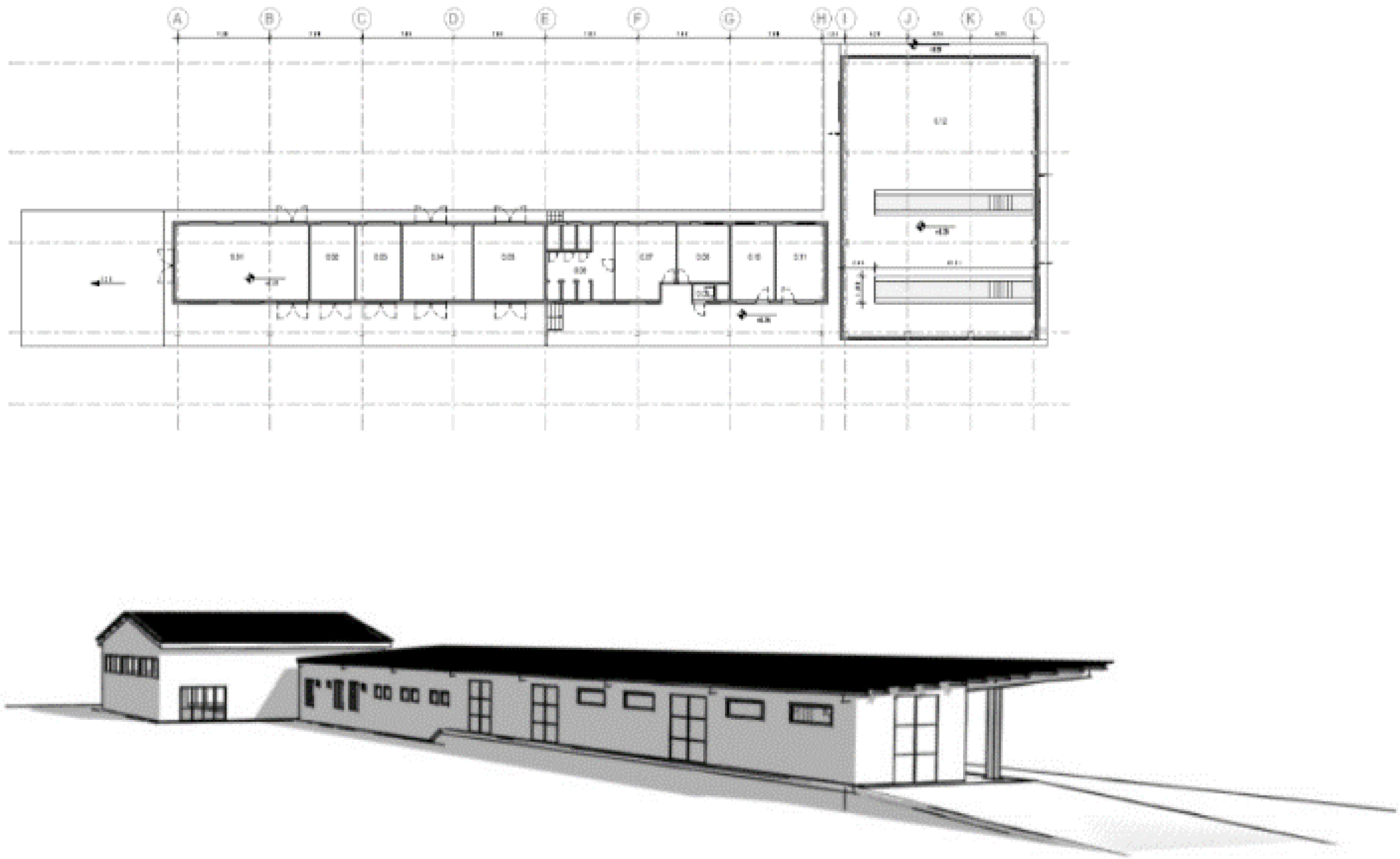


Figure 3. 14: Typical layout of an integrated facility

Washing Station

The washing station and rolling stock service building will contain storage for equipment and materials and will be equipped with a cleaning platform for coaches and freight cars that is connected to the arrival and departure tracks. The platforms for cleaning trains will be equipped with a drainage system with an oil separator.

Freight Yard

To guarantee the goods traffic services, six (6) Freight Yard Facilities will be located along the line (Kano – Maradi and Kano – Dutse), that will allow loading and unloading operations of freight trains and for which a typical layout has been elaborated. A freight yard is composed of the following elements:

- Loading platforms;
- Freight sheds;
- Direct/indirect loading and unloading tracks; and
- Container yard.

Specifically, freight yards will be constructed for Dawanau, Kazaure, Daura, Katsina, Jibiya and Dutse stations. Freight yards will comprise a freight shed and electrical substation. This will comprise:

- Access and eventual routes to other means of transport;
- Parking places for private cars;
- Parking places for handicapped people (1 every 50 places and at least 2);
- "Kiss-and-ride" and taxi spaces or lanes near the station entrance;
- Entry and space for emergency vehicles; and
- Lighting systems.

.

A freight shed will be located in the middle of the platform for the storage of goods waiting to be loaded onto the train wagons. A series of service premises (offices, small workshops for recharging electric bogies, toilets, etc.) will be included; this will be excluded for the warehouse. Gantry cranes will be installed on two rails in the section of the freight yard that corresponds to the loading area.

3.2.6 Associated Facilities

3.2.6.1 Kano Station

The Kano Station (chainage KP 0+600) layout and maintenance and freight yard will be defined with the local railway authority. This station will be a major station. The use of this station will be required during operation for the Project, and therefore is considered to be an Associated Facility.

3.2.6.2 Quarry Sites

Ballast is a supply chain from local existing quarries. The quarries are a key off-site component of the Project serving as source of granite for the rail ballast and other construction activities. There are nine (9) existing quarries (and operational) identified in the Project area, which are in proximity to the railway line alignment (Table 3.6). The nearest quarry is located 1.3 km in Dan Issa/ Maradi. The existing quarries will be the supply chain for the ballasts required for the Project; and the potential impact of Project activities with respect to quarry operations for the Project will be minimal.

Table 3. 6: Identified quarries along the project corridor

SN	Quarry Name	Location / Coordinates	Distance to the route (Km)
1	MEN/GAN/101 (1)	Gano, Kano State Co-ordinates: E:467186; N: 1307770	28.85
2	MEN/GAN/101 (2)	Gano, Kano State Co-ordinates: E:467186; N:1307770	28.85
3	MEN7KAZ/102 (3)	Kazaure, Jigawa State Co-ordinates: E:424019; N: 1399221	9.6
4	MEN/KAZ/102(4)	Kazaure/Jigawa State Co-ordinates: E:424019; N: 1399221	9.6
5	MEN/BUR/103 (5)	Buroni, Katsina State Co-ordinates: E:362958; N:1438441	2.15
6	MEN/BUR/103 (6)	Riana Gado/Kano State Co-ordinates: E:362958; N: 1438441	19.7
7	MEN /MRD/01 (7)	Dutsen Beguwa/ Maradi Co-ordinates: E:310486; N: 1457209	2.02
8	MEN/MRD/02 (8)	Dan Issa/ Maradi Co-ordinates: E:310680; N: 1461747	1.32

SN	Quarry Name	Location / Coordinates	Distance to the route (Km)
9	MEN/FAN/102	Fanisau/Ungoggo/LGA/Kano Coordinates 8°32'56"E; 12°06'21"N	8.52

3.2.7 Equipment

Table 3.7 provides details of the equipment required for the construction of the rail line project and related works.

Table 3. 7: List of Equipment for railway construction

Equipment Type	Qty	Use	Fuel Source	Sound Level (dBA)	Work Hours
Construction Equipment					
Backhoe	24	Excavation	-	100	100
Water Bowser Trucks	25	Water supply	-	-	180
Truck with Crane	9	Construction	-	-	120
Track type Dozer (23 – 40 T)	15	Construction	-	111	110 – 180
Crawl Excavator (30, 50 and 90 T)	30	Excavation	-	106 – 111	160 -190
Wheel Excavator	9	Excavation	-	103	120
Hydraulic Hammer Excavator (25 to 40 T)	4	Excavation	-	-	140 – 300
Wheel Loader (20, 25 and 30 T)	14	Movement of materials	-	113	-
Generator SET (6.5, 50, 100, 150, 400, 700 , 800, 1,000 Kva)	77	Energy supply	Diesel	Max. 80	40 – 286
Articulated Dump Truck (40 T)	6	Movement of materials	-	-	180
Vibrator Soil Compactors (17 T)	14	Soil compaction	-	105	
Motor Graders (15 and 20 T)	14	Construction	-	100	160 – 175
Asphalt Roller (10 T)	2	Construction	-	-	
Asphalt paver (18 T)	3	Paving	-	-	40
Asphalt Chip Spreader	2	Construction	-	-	

Equipment Type	Qty	Use	Fuel Source	Sound Level (dBA)	Work Hours
Four drum / Pathfoot / Sheep foot roller	3	Construction	-	-	
Drum Vibratory Roller (0.8T)	12	Construction	-	-	-
Pneumatic Rollers (28 T)	4	Construction	-	-	
Tipper Truck (26 and 52 T)	84	Movement of materials	-	-	160 – 180
Tipper Semi-Trailer	6	Movement of materials	-	-	-
Low Bed Semi-Trailers (60 and 80 T)	6	Construction	-	-	-
Flat Body Semi-Trailers	19	Construction	-	-	-
Agricultural Tractors and Trailler	3	Movement of materials	-	-	80
Tractor and Joper	12	Movement of materials	-	-	80
Lowboy	3	Construction	-	-	-
Dolly	3	Construction	-	-	-
Crushing and screening plant (300 T)	3	Crushing plant	-	125	220
Hydraulic drilling cars (125 KW)	4	Drilling	-	-	-
Concrete Plant	25	Concrete mixing	-	-	-
Self Loading Mobile Concrete Mixer	6	Construction	-	-	100
Truck Mounted Concrete Pumps	3	Construction	-	-	70
Light pre-cast factory (concrete bricks)	2	Construction	-	-	-
Horse Truck	27	Construction	-	-	120
Pilling Rigs Machine	2	Construction	-	-	-
Diesel Compressor	6	Construction	Diesel	-	125
Diesel Vibratory Motor	12	Construction	-	-	-
Electrical Vibratory Unity	61	Construction	-	-	-
Pre-cast Plant	1	Construction	-	-	-
Small Pickup Truck	100	Construction	-	-	-
Commercial Cab and Chassis - 3 Seats	7	Transportation	-	-	-
Large Off-Road - 7 Seats	18	Transportation	-	-	-

Equipment Type	Qty	Use	Fuel Source	Sound Level (dBA)	Work Hours
Small cars - Hatchback 5D - Diesel	12	Transportation	-	-	-
Box Trucks (3 T)	12		-	-	-
Ambulance	4	Emergency Response	-	-	-
Minibus from 20 to 29 Seats	30	Transportation	-	-	-
Light Tower (Equipment)	24		-	-	-
Cement Spreader	2	Construction	-	-	40
Road Reclaimers	2	Construction	-	-	210
Mass Scales	80		-	-	-
Service Truck 5.000L Diesel Tank	5	Construction	Diesel	-	-
Diesel Auto-Tanks 15.000 L to 20.000 L	6	Construction	Diesel	-	-
Mechanical brooms	2	Construction	-	-	-
Truck Mounted Bitumen Sprayer 8.000 L	2	Construction	-	-	-
Tamping Machine	4	Construction	Diesel	112	-
Ballast regulating machine	4	Construction	Diesel	100	-
Locomotive	7	Construction	Diesel	118	-
Draisine	6	Construction	Diesel	-	-

3.3 THE PROJECT ACTIVITIES

The Kano-Maradi project involves the design, construction, and operation of a new rail line from Kano through Jigawa, Katsina and Maradi. The rail line construction activities will involve:

- Site surveys and design
- Site Preparations
- Earthworks
- Installation of ballast and railway tracks
- Construction of structures including bridges, viaducts, and culverts

- Construction of 15 stations along the Main Line and 5 stations on the Branch Line
- Installation of mechanical and electrical equipment
- Installation of signaling and telecommunication systems
- Operational Phase

After the completion of the construction of the new railway it is anticipated that the traffic volumes for passengers and freight will be approximately 4 684 passengers/day in each direction, and 1536 tons/day from Kano to Maradi, and 1 167 tons/per day from Maradi to Kano.

3.3.1 Project Phases

The project will be developed in phases which include Site preparation, Construction phase and the Project Commissioning phase.

3.3.1.1 Site Preparation

Site Preparation require the clearance and stripping of topsoil ready for the next phases of construction. Topsoil, in an average thickness of 0.2 m, will be removed from excavation and embankment slopes. This operation must be carried out cautiously to avoid further contamination of materials to be used in the embankment.

3.3.1.2 Construction Phase

Earthworks

Excavations

Excavation slopes with a height greater than 10 m will include benches at 8 m gradient, acting as a breaker of large, exposed surfaces and at the same time as a stabilizing element. The benches will have a minimum width of about 3 m and 10% slope towards the interior of the massif and include lined drainage ditch. Whenever the excavated slopes are extended by a natural slope, a drainage system will be included (ridge ditch) that provides for the detour of water from the adjacent terrain, to avoid surface overflows on the cut faces.

The excavation slopes will be in accordance with the natural terrain, rounding off the last 2 m of the slope in the crest area. The development of the respective concordance curve will be checked on site according to the alteration rock layer or the thickness of the overburden soils. An appropriate vegetation will be used to cover the slopes. Geological and geotechnical surveys will be undertaken on the slopes to avoid collapse. To avoid the landslide caused by surface water circulation, excavation slopes will be covered with a 0.20 m thick layer of vegetal earth with native plant species.

Embankments

The foundation ground of the embankment is mainly composed of residual soils of a silty-clayey, clayey-sandy or silty nature. Where the existing ground has good geotechnical properties, the embankment will be placed directly on top. However, it may be necessary to remove the upper part of the existing ground (to a depth of 1-2 m) if that part could cause problems concerning either bearing capacity or deformability. This is the case for organic soils, for example, which should be removed. The inclination of the foundation ground should not be greater than a depth (V) and heigh (H) 1V:5H to avoid collapse/sliding. If the inclination of the foundation ground is greater than 1V:5H, some berms will be excavated in the natural ground.

In-Fill Section

The formation width at sub-ballast top level is 7.50 m for single track. The top surface consists of two asymmetric planes inclined at 3% to the horizontal, in opposite directions, to allow drainage of rainwater. The sub-ballast consists of a layer of selected material, average thickness 24 cm (with a minimum thickness of 21 cm) and a protective layer of asphalt concrete (6 cm thick), which completes the base structure. The normal slope of the embankment is 5/3, without berms up to 10 m high. For higher embankments, the slope of the exceeding part is 2/1. The slope thus realized is equivalent to a gradient of 3/2 with berms, but it is easier to construct and avoids the necessity to create costly ditches on the berms. The slopes are protected against erosion by a vegetative soil layer 15 cm thick, suitable grass seeding and anchored by wickerwork.

In-Cut Section

The width of the track formation is the same as embankment, with two side drains to collect rainwater located at the edge of the formation; the gradients of the slopes vary from 7/10 to 1/7, depending on the construction material of the embankment. Only the average thickness of the sub-ballast material in rock is reduced to 10 cm. Lined side drains and berms are foreseen on both sides of the formation, that are not less than 1.50 m wide up to the slope toe. Topsoil cut and fill volumes are provided in Table 3.8 below. Typical cross-sections of cut and fill are shown in Figure 3.15.

Table 3. 8: Topsoil, cut and fill volumes

Section	Topsoil (m^3)	Cut Fill (m^3)	Fill (m^3)
Kano – Maradi Route (Sections 2,3,4,5 and 6)	898,271.42	2,310,327.79	6,285,802.13
Kano – Dutse Route (Section 1)	371,867.56	454,165.37	4,125,381.70
Dawanau Yard	27,484	10,575	640,660
Kazaure Yard	37,774	31,526	1,115,178
Daura Yard	26,140	0	511,747
Katsina Yard	60,092	66,695	1,594,255,00
Jibiya Yard	26,541	357,077	8,974
Dutse Yard	54,406	2,729	2,729

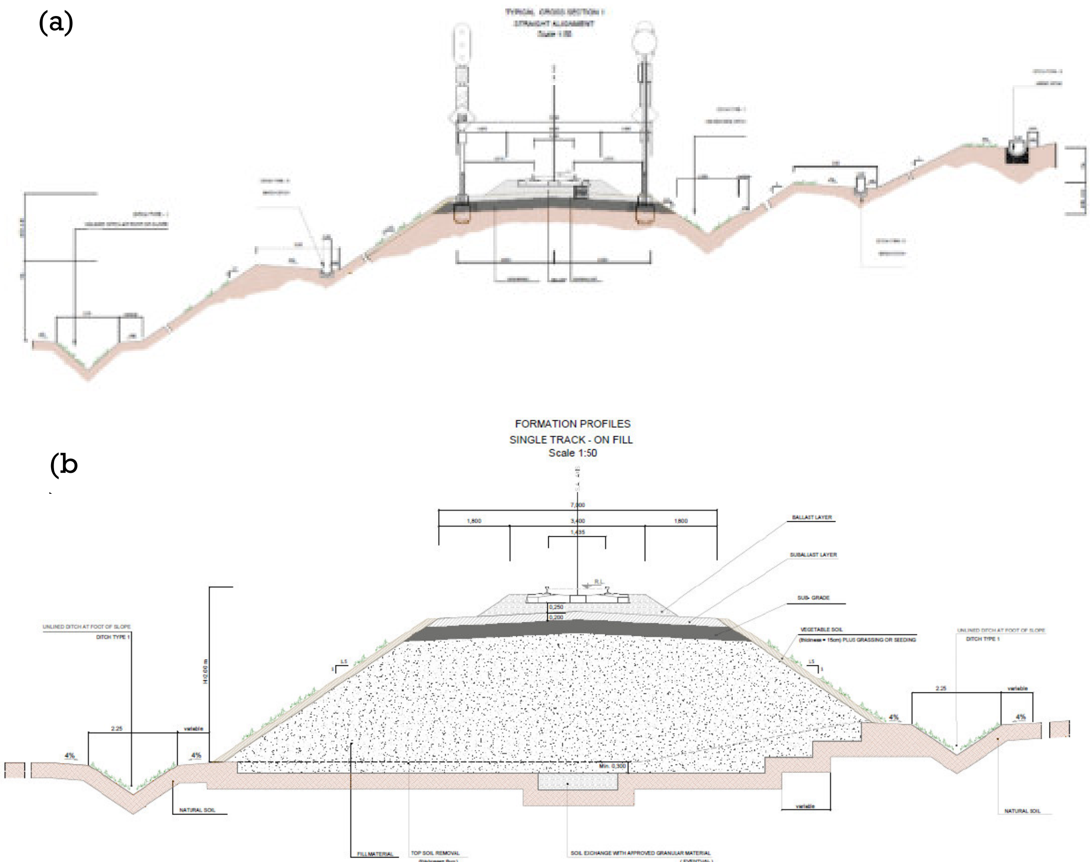


Figure 3. 15: Typical cross section – Cut and Fil (a) and Fill (b)

Structures

- Culverts

Pipe and box culverts will be made up of precast reinforced concrete pipes.

- Drainage

Manholes will be used to provide access to drainage lines. Manholes will be installed at the end of each pipe, at all pipeline intersections, changes in grade, size, alignment, at distances not greater than 50 m or the limit of existing pipe cleaning equipment.

The wastewater drainage network will have the following general design parameters:

- minimum design flow velocity of 0.75 m/s to assure self-cleansing pipelines
- maximum flow speed of 3.00 m/s;
- the branch discharge pipes should be designed with a filling degree of 0.50 (50%, system I); and
- minimum diameter for buried sewage drainage collectors of 100 mm.

The final discharge of the treated effluents will take place on local drainage or nearby water line, through a gravitational emissary. This discharge will be periodically monitored and should be protected by a grid and a tidal valve.

For rooftop rainwater drainage, the rainwater system will be composed by roof drains, gutters, downpipes, collectors and manholes (or inspection chambers). The rainwater drainage of the rooftop building will be directed to the exterior storm water drainage system. The rainwater network will be discharged by gravity. In the case of rainwater oil contamination, before arriving at the collection point, this water will pass through an oil removal system, to eliminate any waste contained in the rainwater and avoid any cause of pollution to the surrounding environment. Where applicable, washing water-pumping station will be provided, to recollect the water from washing operations and firefighting equipment and direct this flow to the storm water network.

Asphalt works

Asphalt works will be required for the Project. An asphaltic batch plant office will be located in each of the campsites.

Track Laying

The track bed layers will be made up of ballast and sub-ballast. The total thickness of the track bed will be 0.45 m thick, with minimum ballast thickness of 0.25 m under sleepers and a thickness of 0.20 m for the sub-ballast layer. Concrete sleepers will be placed using a front-end loader with a sleeper grab attachment, which picks up the sleeper and lays them in the correct configuration.

Temporary Facilities

Worker Accommodation Construction Camp Sites and Laydown areas

During project construction, three (3) camps will be provided for the workers on-site, which will have facilities to meet the essential needs of the workers. The camps will also have laydown areas that will be used for the collection, temporary storage, and the assembly of construction equipment and supplies. Campsites have been designed for construction in three areas, namely: Kazaure, Katsina and Wudil. The campsites will comprise security points, sanitary facilities, clinic, canteen halls, offices, control rooms, laboratories, equipment area and houses. The worker accommodation construction campsite layout is shown in Figure 3.16.

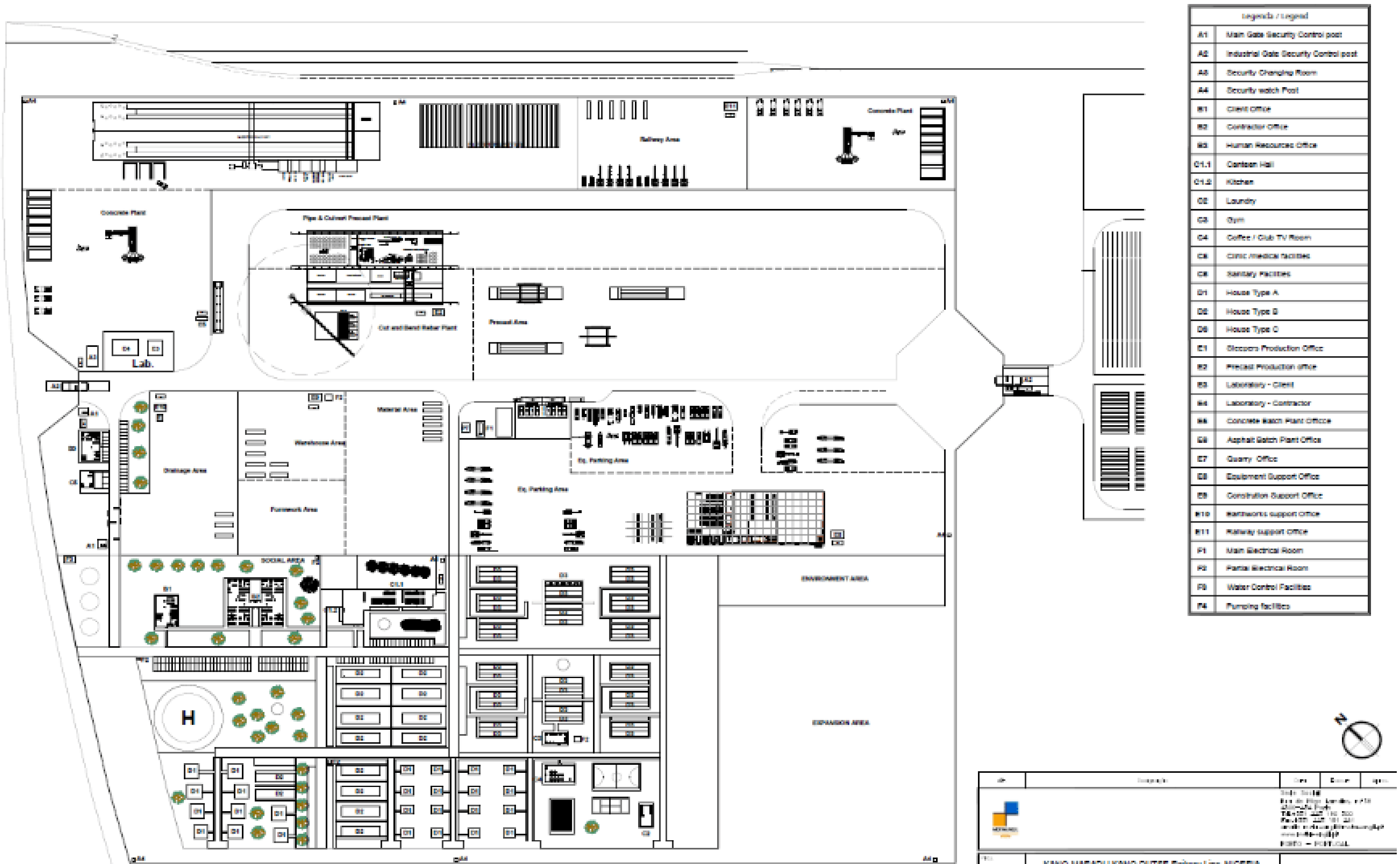


Figure 3. 16: General Worker's Construction Camp Layout

Borrow Pits

Whilst many of the materials required for the construction of the Project can be sourced via supply chain, some borrow pits may be required to supply construction materials such as crushed rock or laterite. There are numerous existing borrow pits along the route, which have either been abandoned or are used for other purposes, still in use or where excavation has recently finished. 59 Borrow pits which could potentially be used for the project have been identified in total. The land take for the borrow pits ranges from 1 to 50 hectares (ha). The proximity of the borrow pit is shown in Table 3.9.

Table 3. 9: Borrow pits along the planned route for rail project

SN	Borrow Pit Tag	Route Section	Distance to route (Km)
1	Existing Borrow Pit 2 Km 30+000	Kano - Maradi	5.01
2	Existing Borrow Pit 3, 38+000		0.47
3	Existing Borrow Pit 4, 52+000		1.94
4	Existing Borrow Pit 5, Km 57+000		0.55
5	Existing Borrow Pit 6, Km 59+000		0.83
6	Existing Borrow Pit 7. 62+000		2.11
7	Existing Borrow Pit 8, 91+000		0.26
8	Existing Borrow Pit 9, 92+000 (Activo)		0.27
9	Existing Borrow Pit 10, 97+000		0.97
10	Existing Borrow Pit 11, 99+000		0.74
11	Existing Borrow Pit 12, 101+000		0.52
12	Existing Borrow Pit 13, 102+000		0.89
13	Existing Borrow Pit 14, 104+000		1.15
14	Existing Borrow Pit 15, km 108+000		1.3
15	Existing Borrow Pit 16, Km 110+000		0.79
16	Existing Borrow Pit 17, Km 103+000		1.02
17	Existing Borrow Pit 18, Km 114+000		1.13
18	Existing Borrow Pit 19, Km 115+000		1.19
19	Existing Borrow Pit 20, Km 117+000		1.27
20	Existing Borrow Pit 21, Km 118+000		1.19
21	Existing Borrow Pit 22, Km 120+000		0.54
22	Existing Borrow Pit 23, Km 122+000		0.54
23	Existing Borrow Pit 24, Km 124+000		0.73
24	Existing Borrow Pit 25, Km 126+000		0.74
25	Existing Borrow Pit 26, Km 131+000		0.64
26	Existing Borrow Pit 27, Km 137+000		1.27
27	Existing Borrow Pit 28, Km 141+000		1.19

SN	Borrow Pit Tag	Route Section	Distance to route (Km)
28	Existing Borrow Pit 29, Km 143+000		1.06
29	Existing Borrow Pit 30, Km 145+000		2.21
30	Existing Borrow Pit 31, Km 148+000		1.65
31	Existing Borrow Pit 32, Km 150+000		1.41
32	Existing Borrow Pit 33, Km 155+00		2.83
33	Existing Borrow Pit 34, Km 158+000		0.01
34	Existing Borrow Pit 35, Km 163+000		1.39
35	Existing Borrow Pit 36, Km 165+000		1.56
36	Existing Borrow Pit 37, km 168+000		0.55
37	Existing Borrow Pit 38, km 172+000		0.15
38	Existing Borrow Pit 39, Km 184+000		0.32
39	Existing Borrow Pit 40, Km 187+000		0.44
40	Existing Borrow Pit 41, Km 197+000		2.84
41	Existing Borrow Pit 42, Km 199+000		0.13
42	Existing Borrow Pit 43, Km 205+000		1.57
43	Existing Borrow Pit 44, Km 212+000		0.79
44	Existing Borrow Pit 45. Km 215+000		0.19
45	Existing Borrow Pit 46, Km 216+000		1.31
46	Existing Borrow Pit 47, Km 231+000		0.75
47	Existing Borrow Pit 48, Km 233+000		0.5
48	Existing Borrow Pit 49, Km 244+000		1.41
49	Existing Borrow Pit 50, km 251+000		0.45
50	Existing Borrow Pit 51, Km 280+000		1.11
51	Existing Borrow Pit 4, Km 17+000	Kano - Dutse	25.13
52	Existing Borrow Pit 5, Km 21+000		29.2
53	Existing Borrow Pit 6, kM 24-000		32.09
54	Existing Borrow Pit 7, Km 26+000		33.76
55	Existing Borrow Pit 8, Km 28+000		36.92
56	Existing Borrow Pit 9, Km 36+000		43.65
57	Existing Borrow Pit 10, Km 37+000		44.9
58	Existing Borrow Pit 11, Km 38+000		46.18
59	Existing Borrow Pit 12, km 41+000		49.26
60	Existing Borrow Pit 13, Km 43+000		51.21
61	Existing Borrow Pit 14, Km 46+000		52.73
62	Existing Borrow Pit 15, Km 50+000		56.6
63	Existing Borrow Pit 16, km 59+000		65.14
64	Existing Borrow Pit 17, Km 64+000		70.86
65	Existing Borrow Pit 18, Km 66+000		73.08
66	Existing Borrow Pit 19, Km 72+000		79.69
67	Existing Borrow Pit 20, Km 73+000		81.17
68	Existing Borrow Pit 21, Km 74+000		82.69
69	Existing Borrow Pit 22, Km 90+000		95

3.4 RESOURCE REQUIREMENTS

3.4.1 Energy Use

The stations and ancillary buildings will require electricity supply and will rely on the existing power grid. Power supply distribution will comprise the following:

- Low voltage: 230 V phase to neutral / 400 V phase to phase
- High voltage: 33 kV phase to phase
- Frequency: 50 Hz

Installation of power supply will be in accordance with GIIP. Electricity supply for the stations and buildings will be sourced from the public electrical supply distribution network operator, which will supply the Main Substation Transformer, located in technical buildings of the stations. Backup power will be supplied by diesel generators (n+1) whenever public power network fails or performs unstable. The generators will be installed inside a fireproof in the technical area. Except for the built-in fuel tank, all diesel generators will be equipped with an external buried fuel tank and pumping system, with a 3-day autonomy capacity.

Table 3. 10: Proposed power generators for the project

Description	Qtd.
1.000 Kva Generator SET	4
1.250 Kva Generator SET	1
100 Kva Generator SET	6
150 Kva Generator SET	3
200 Kva Generator SET	1
400 Kva Generator SET	3
50 Kva Generator SET	12
6.5 Kva Generator SET	30
800 Kva Generator SET	2
Total	**62**

The normal power supply to the Stations and Ancillary Buildings (Yards) will be supported by Oil type transformers and also secured by the diesel generators. Oil distribution transformers (33000/400V) will be used. Transformers will be fed at 400V-230V phase, the main Low Voltage Switchboards located in the Technical Buildings of the Stations and Yards, from which will be made the electrical distribution. Each of the ancillary buildings will have its own substation. The power demand of the Stations without Ancillary Buildings (Yards) will be the same as the station types with yards.

Lighting

Lighting will be used for normal, emergency and exterior lighting. For emergency lighting, panic type emergency lighting will be provided for the stations and buildings, in all locations where large concentrations of people are predicted. Signalling type emergency lighting with associated pictogram for escape routes will also be provided. Environment type emergency lighting will be held by light fixtures equipped with emergency kits consisting of nickel-cadmium batteries and fitting charger, ensuring light for at least 1 hour after a power cut.

Signalling type emergency lighting will be provided by a structure fitted with LED lamp, equipped with emergency kits consisting of nickel-cadmium batteries and fitting charger, ensuring light for at least 1 hour after a power cut.

3.4.2 Water Consumption

The Project requires water supply during the construction and operation phase. Specifically, water would be required for laundry, at the clinic and sanitary facilities, for sleepers and pre-cast production. Therefore, the likelihood of groundwater abstraction for the water demand is high, especially along the Project corridor where there is no public water supply system. During the operation phase, the need for water at the conveniences inside the train and at the train stations is high. Groundwater abstraction remains the possible major source of water for this purpose. There are thirty-one (31) water collection points located in the Project area and these are depicted in Table 3.11.`

Table 3. 11: Water sources for construction in the project area

SN	Description	Distance to the rail route (Km)
1	Water Pits	70.58
2	Water Pits	2.33
3	Water Pits	13.7
4	Kano River	2.41
5	Jidawa water dam	86.49
6	Water River	88.36
7	Water pits	82.62
8	Water dam	72.97
9	Wudil River	47.09
10	Kunya Water Dam	17.82
11	Site Camp water bore hole	0.19
12	Jibiya water dam	7.5
13	Madarounfa water dam	9.36
14	Ajiwa water dam	7.87
15	Katsina Water dam	4.47
16	Malangata water dam	8.99
17	Hudda Gangarra water dam	5.45
18	Kazaure water dam	2.3
19	Kazaure water dam	1.67
20	Katsina water dam	5.43
21	Yanzaki River	0.44
22	Baba Ruga water dam	2.94
23	Water pits	0.98
24	Water River	3.55
25	Water Dam	17.17
26	Water dam	7.71

SN	Description	Distance to the rail route (Km)
27	Water dam	0.7
28	Water dam	0.54
29	Water Pit	0.77
30	Water dam	3.63
31	Maradi water dam	9.17

Each station will have a centralized system for both water supply (civil and fire prevention uses) and power distribution. Water will be extracted from groundwater with submerged pumps that channel the water into two separate tanks of suitable capacity near the station. Water requirements for the Project entails:

- One underground well that supplies the firefighting system, as well as all the potable water system;
- One water compact treatment system including a pumping station;
- An elevated tank;
- A water network. In some cases, on stations with yards, to guarantee the minimum pressure of 2.5 bar it will be necessary to predict a small buster on the network.

Specifically, the following will installed:

- A 110m^3 underground tank for the supply of water to the fire prevention system;
- A 40m^3 super-elevated tower tank for the supply of water for civil uses, with a height of 20- to supply an adequate head for the water distribution.
- Hot water for sanitary uses will be generated by solar panels installed on the building roofs Furthermore, the drinking water provided in the restrooms and/ or kitchens will be treated in a purifying unit located in a special room at each station. The water requirements for each station is shown in Table 3.12. A typical water supply process is shown in Figure 3.17 below.

Table 3. 12: Water supply design Flows (m³ per day)

Name of Station	Passengers	Stations Staff	Yard Staff	Residence	Total (m³ per day)
Dawanau	5.10	0.54	0.27	0.96	6.87
Kunya	5.10	0.54	0.00	0.96	6.60
Dambatta	15.30	0.99	0.00	0.96	17.25
Kazaure	15.30	0.99	1.17	0.96	18.42
Durbe	5.10	0.54	0.00	0.96	6.60
Daura	15.30	0.99	0.27	0.96	17.52
Shargalle	15.30	0.99	0.00	0.96	17.25
Mashi	5.10	0.54	0.00	0.96	6.60
Maradu	5.10	0.54	0.00	0.96	6.60
Katsina	15.30	0.99	3.15	0.96	20.40
Daddara	5.10	0.54	0.00	0.96	6.60
Jibiya	5.10	0.54	0.27	0.96	6.87
Anoal Mata	5.10	0.54	0.00	0.96	6.60
Maradi	5.10	0.54	0.00	0.96	6.60
Yar Gaya	5.10	0.54	0.00	0.96	6.60
Wudil	5.10	0.54	0.00	0.96	6.60
Gaya	5.10	0.54	0.00	0.96	6.60
Duru	5.10	0.54	0.00	0.96	6.60
Dutse	15.30	0.99	3.15	0.96	20.40

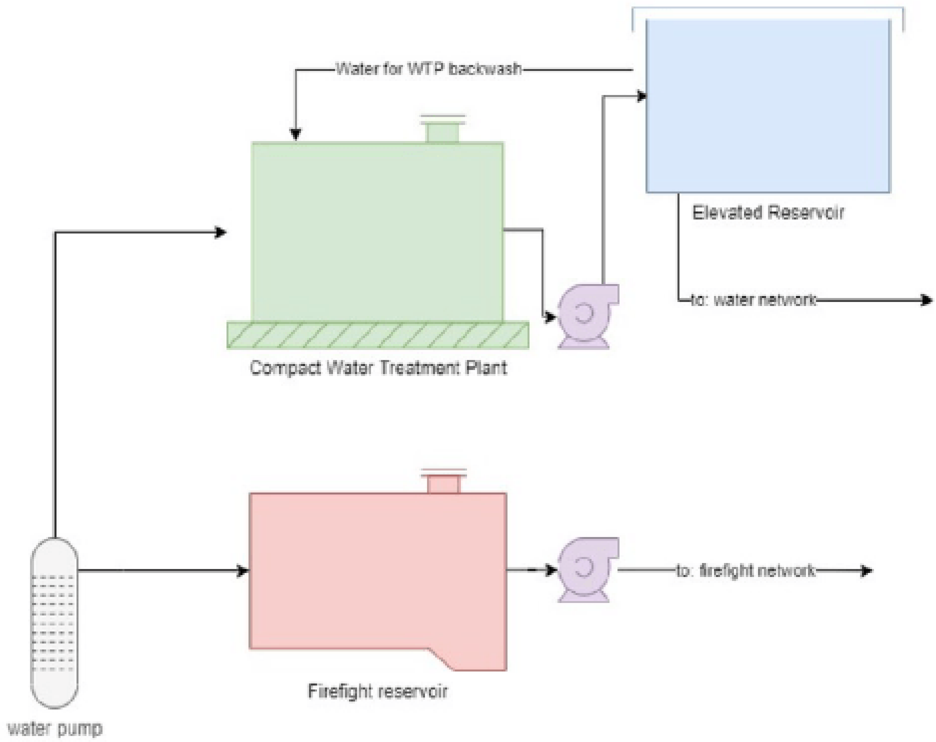


Figure 3. 17: Typical Water System Processes

3.4.2.1 *Water Wells*

A well with two submersible pumps will be placed (one in stand-by) in each station. The pumps will develop the required pressure to overcome friction losses and provide satisfactory working pressures in compact water treatment plant.

3.4.2.2 *Compact Water Treatment Plant*

To supply the Project's water needs at the stations, and considering 8 h/day operation of the water treatment system. Standard type stations will have water treatment equipment with capacity to process up to 5 m^3/h and minor type stations will have also have water treatment equipment with capacity to process up to 2 m^3/h.

The water treatment system will be a compact water treatment plant composed by the following treatment stages:

- Preliminary filtration (100 µm);
- Process additives injection (coagulation-flocculation) ;
- Sand and pyrolusite filter;
- Disinfection
- Elevation pump to boost the system and elevate the treated water to the reservoir.

This equipment will be installed in the adjacent room to the firefight reservoir, alongside with the firefight pumping station. A booster pump will be installed downstream of the equipment to guarantee the transportation of treated water to the elevated reservoirs. In parallel to this water treatment system, boreholes will also be available to supply water to the firefight reservoir directly from the borehole, without treatment. The compact water treatment for minor and standards stations will be designed to meet the IFC Environmental, Health and Safety Guidelines for Water and Sanitation (2007).

3.4.2.3 *Elevated Tanks*

Prefabricated elevated tanks for all stations to ensure the pressure to feed the water networks by gravity. These tanks will be installed between 45 m and 35 m above ground level. Minor stations will have a reservoir capacity of 15 m^3 and standard stations will have a reservoir capacity of 40 m^3.

To supply all fire protection systems a water tank will be provided. For maintenance purpose, the fire water tank will have at least two independent cells. The fire protection tank will be separated from the water supply volume. Associated to this fire water tank, to ensure the necessary flow and pressure in all fire protection equipment, a fire pumping station is needed, composed by a main electrical pump, a main diesel pump and an auxiliary (or pilot) pump. The Firefighting (or fire protection) system is essentially made up of fire hydrant systems. Interior and exterior fire hydrants will be installed for the buildings. All buildings will have its own means of fire protection.

3.4.3 Utilities

Heating, ventilation, and air conditioning

The following systems will be used for the Project:

- Rooms ambient cooling through split type air conditioning.
- Natural ventilation of the main areas systems; and
- Mechanical extraction of internal compartments and sanitary facilities.

Air intakes will be designed to prevent entry of rain, airborne debris, or any other item into the system. The installed louvres maximum velocity through the free area will not exceed 2.5 m/s. All air intakes will be located within non-hazardous areas, a minimum of 2 m outside the boundary of any hazardous area. Air intake will be provided with weather louvres & insect mesh. All Heating, ventilation, and air conditioning (HVAC) equipment will be easily accessible for maintenance. The duct networks will include inspection doors for cleaning and in accordance with GIIP. Natural ventilation will be used for stations, bathrooms with external walls and windows and ancillary building.

For the extraction of pollutants in garage facilities, a natural smoke exhaust scenario will be considered with grills integrated into the architecture, being more economical and simpler compared to mechanical ventilation.

3.5 WASTE MANAGEMENT

3.5.1 Waste Type and Quantification

An estimate of waste quantities and types that will be generated during the construction and operation phase is provided in Table 3.13 and Table 3.14, respectively.

Table 3. 13: Waste Types, Quantities – Construction Phase

Waste Type	Quantity / Volume	Destination	Waste Management / Disposal Method
Concrete, gypsum (from stations and building) and general structures, glass (sourced from demolition of structures)	22,278 m^3	Approved dumpsite	All construction debris will be placed in appropriate onsite storage containers and periodically evacuated from the site to an approved dumpsite. Waste removal will be carried out by a third-party waste contractor licenced by the State Environmental Protection Agency (EPA) in each of the three states of Nigeria. In the Republic of Niger, the Company will consult with the Authorities and ensure the most appropriate disposal is achieved in line with National requirements and GIIP.
Wood, planks, offcuts of iron and metals	500 tonnes	Approved dumpsite	It is anticipated that wood, planks, offcuts of iron and metals will be reused. All construction debris will be placed in appropriate onsite storage containers and periodically evacuated from the site to an approved dumpsite. Waste removal will be carried out by a third-party waste contractor licenced by the State Environmental Protection Agency (EPA) in each of the three states of Nigeria, and in the Republic of Niger wherever possible
Scrap metal (steel cuttings, metal wires, pipe cuttings) (sourced from onsite equipment maintenance and reinforcement work)	1000 tonnes	Approved dumpsite. Approved scrap metal recycle company.	It is anticipated that scrap metal (steel cuttings, metal wires, pipe cuttings) will be reused. All Scrap metal will be placed in appropriate onsite storage containers and periodically evacuated from the site to an approved dumpsite. Waste removal will be carried out by a third-party waste contractor licenced by the EPA in each of the three states of Nigeria and in the Republic of Niger.
Welding waste (sourced from rail welding)	25 tonnes	Approved dumpsite	Waste removal will be carried out by a third-party waste contractor licenced by the State EPA in each of the three states of Nigeria and in the Republic of Niger.
Welding waste (refractory mass)	300 tonnes	Approved dumpsite	Waste removal will be carried out by a third-party waste contractor licenced by the State EPA in each of the three states of Nigeria and in the Republic of Niger.
Bituminous waste	10 tonnes	Approved dumpsite	It is anticipated that bituminous waste will be recycled. Waste removal will be carried out by a third-party waste contractor licenced by the State EPA in each of the three states of Nigeria.

Excavated materials	3,233,095.16 m^3	Approved Borrow pits. Approved dumpsite	Excavated material will be disposed of in borrow pits and to fill the RoW after FMEnv approval. In the Republic of Niger, the Company will consult with relevant Authorities.
Vegetation waste (from RoW clearance)	2,452 ha + 85,000 cut down trees (from 0.8 to 3,0 m Girth)	Approved dumpsite (bushes, scrap and small trees) Timber companies (bigger trees)	Vegetation waste is anticipated to be disposed of in approved dumpsite (bushes, scrap and small trees). Timber companies will be used to dispose large trees. Waste/ Timber material removal will be carried out by a third-party waste contractor licenced by the State EPA in each of the three states of Nigeria and in the Republic of Niger.
Topsoil (from Row clearance)	1,502,575.98 m^3	Stored within RoW	Topsoil will be stored within RoW and to fill borrow pits after FMEnv approval. In the Republic of Niger, the Company will consult with relevant Authorities.
Asbestos containing materials (ACM) (from demolition of structures)	Undefined	Unknown	If found, any ACM material removal will be carried out by a third-party waste contractor licenced by the State EPA in each of the three states of Nigeria and in the Republic of Niger.
Refuse and Other Non-Hazardous Solid Waste Quantities and Type			
Waste Type	***Quantity / Volume***	***Destination***	***Waste Management / Disposal Method***
Packaging wastes (plastics, styro-foam, cardboard, paper) (from packaging)	10 tonnes	Onsite Incinerator. Approved dumpsite.	It is anticipated packaging wastes (plastics, styro-foam, cardboard, paper) will be reused. All Packaging wastes (plastics, styro-foam, cardboard, paper) will be placed in appropriate onsite storage containers and periodically evacuated from the site to an approved dumpsite. Waste removal will be carried out by a third-party waste contractor licenced by the State EPA in each of the three states of Nigeria and in the Republic of Niger.

			Onsite incinerator is being assessed.
Food waste (from construction worker accommodation sites and the workforce)	0,8 tonnes / day (3 construction worker accommodation sites)	Compost unit on near the camp site / approved dumpsite	It is anticipated raw organic waste will be disposed of in a compost unit to create natural fertilizer for the site's garden / farm. Food waste may be disposed of in an approved dumpsite in Nigeria and in the Republic of Niger.
Domestic refuse from the workforce	0,5 tonnes / day (3 construction worker accommodation sites)	Onsite Incinerator. Approved dumpsite.	Onsite incinerator is being assessed. Waste removal will be carried out by a third-party waste contractor licenced by the State EPA in each of the three states of Nigeria and in the Republic of Niger.
Hazardous Waste Quantities and Type			
Waste Type	***Quantity / Volume***	***Destination***	***Waste Management / Disposal Method***
Waste lubricating oil (from machinery used for construction and maintenance of demolition equipment)	1,000 tonnes	Onsite Incinerator. Hazardous Waste Management Company.	Onsite incinerator is being assessed. Hazardous waste removal will be carried out by a third-party waste contractor licenced by the State EPA in each of the three states of Nigeria and in the Republic of Niger.
Fluorescent tubes (workers accommodation sites)	1 ton	Hazardous Waste Management Company	Hazardous Waste removal will be carried out by a third-party waste contractor licenced by the State EPA in each of the three states of Nigeria and in the Republic of Niger.
Contaminated rags	5 tonnes	Onsite Incinerator Hazardous Waste Management Company.	Onsite incinerator is being assessed. Hazardous Waste removal will be carried out by a third-party waste contractor licenced by the State EPA in each of the three states of Nigeria and in the Republic of Niger.
Oil/diesel contaminated materials from any spillages, machinery breakdown	10 tonnes	Onsite Incinerator Hazardous Waste Management Company.	Onsite incinerator is being assessed. Hazardous Waste removal will be carried out by a third-party waste contractor licenced by the State EPA in each of the three states of Nigeria of Nigeria and in the Republic of Niger.
Waste batteries from maintenance	5 tonnes	Hazardous Waste	Hazardous Waste removal will be carried out by a third-party waste

of machinery		Management Company	contractor licenced by the State EPA in each of the three states of Nigeria.
Electronic waste	1 ton	Hazardous Waste Management Company	Hazardous Waste removal will be carried out by a third-party waste contractor licenced by the State EPA in each of the three states of Nigeria of Nigeria and in the Republic of Niger.
Waste paints and solvents (for construction of site offices)	5 tonnes	Onsite Incinerator Hazardous Waste Management Company.	Onsite incinerator is being assessed. Hazardous Waste removal will be carried out by a third-party waste contractor licenced by the State EPA in each of the three states of Nigeria of Nigeria and in the Republic of Niger.
Asbestos Containing Materials (Demolition of stations)	Unknown	Unknown	If found, any ACM material removal will be carried out by a third-party waste contractor licenced by the State EPA in each of the three states of Nigeria of Nigeria and in the Republic of Niger.
Medical Waste	Unknown	Unknown	Medical Waste will be managed by the Clinic of each camp site.
Wastewater and Sewage Quantities and Type			
Waste Type	***Quantity / Volume***	***Destination***	***Waste Management / Disposal Method***
Wastewater from concrete plant	60,000 m^3	Compact wastewater treatment or septic tanks.	Recirculation of water in concrete plants is being considered.
Sanitary waste solids from wastewater treatment plant	Kazaure: 30 m^3/ day Katsina: 18 m^3/day Wudil: 18 m^3/ day	Compact wastewater treatment or septic tanks at each station and yard	Generated sludge will be periodically removed by vacuum suction truck and transported to a wastewater treatment facility or faecal sludge treatment plant.
Sanitary liquid waste from wastewater treatment plant			After proper treatment, sanitary waste will be disposed likely in a water line with wastewater disposal license.

Table 3. 14: Waste Quantities and Types – Operational Phase

Waste Type	Source	Quantity/ Volume	Destination	Waste Management/ Disposal
General domestic/office waste – paper, food, packaging (plastic, scrap wood, etc.)	Office, construction worker accommodation sites, Stations, Admin offices, Maintenance facility office	TBC	Onsite Incinerator. Approved dumpsite.	Waste removal will be carried out by a third-party waste contractor licenced by the State Environmental Protection Agency (EPA) in each of the three states
Vegetation waste	RoW clearance	TBC	TBC	TBC
Vegetation waste	Drain maintenance	TBC	TBC	TBC
Maintenance wastes – paints, solvents, rags, old fluorescent tubes	Maintenance activities - Stations, Maintenance facility	TBC	TBC	TBC
Oil/diesel/herbicide contaminated materials from any spillages	Rolling stock maintenance, Spillages	TBC	TBC	TBC
Waste lubricating oil (from machinery)	Maintenance activities & operation - Maintenance facility	TBC	TBC	TBC
Contaminated rags	Maintenance activities & operation - Maintenance facility	TBC	TBC	TBC
Waste batteries	Maintenance activities & operation	TBC	TBC	TBC
Electronic waste	Maintenance activities & operation	TBC	TBC	TBC
Domestic wastewater from stations	W/C in stations	TBC	TBC	TBC

3.5.2 Construction and Operational Waste Management Facilities

Solid and Liquid Wastes

Solid and liquid waste will be generated during the construction and operation phase. Waste management will entail the collection, sorting, transport, treatment, and disposal of waste. The Project will aim to prevent waste generation through in-process modification, reuse, and recycling. In general, waste management practices are related to the types and amount of equipment and machinery used for the Project and the waste types generated during phases. Solid waste and wastewater from the site will be managed in such a way to prevent the spread of vector-borne diseases and contamination of soil and groundwater resources in the area.

Site Waste Management Plan (SWMP)

Mota-Engil Africa (MEA) has developed a waste handling and management programme, which defines the general guidelines to ensure proper handling and management of waste generated from the project. Waste generated during the construction and operation phase will fall into the following waste categories: domestic, paper and cardboard, electrical and electronic, demolition or building rubble, plastic, and rubber waste. A waste management plan will be assigned to an officer.

The types and quantities of waste to be generated at every phase of the Project, especially during construction activities, will be determined. In addition, waste management options will be identified with reference to the waste hierarchy and consideration will be given to waste management hierarchy. This is necessary as studies show that about 15% of materials delivered to construction sites are wasted (FAS, 2002). That is, reusable and recyclable construction wastes are usually disposed of. The waste hierarchy will be applied to minimize the resources needed to carry out the tasks on site. Where further reduction is not practicable, products and materials can sometimes be re-used, either for the same or for a different purpose. Only if none of these solutions is appropriate should waste be disposed of.

Construction Waste

One of the main sources of non-hazardous waste during construction is domestic-type solid waste from construction workers. These wastes will likely be produced daily, comprising of residual packaging and food wastes, metal cans, wooden pallets and cartons, scrap metal and concrete waste. Construction waste will consist of demolition waste and concrete, which can be reused for filling. Other construction wastes are wood, planks, offcuts of iron and metals. All waste that cannot be reused or recycled will be appropriately disposed of. All construction debris will be placed in appropriate onsite storage containers and periodically evacuated from the site to an approved dumpsite. Waste removal will be carried out by a third-party waste contractor licensed by the State Environmental Protection Agency (EPA) in each of the three states.

A waste transfer note will be prepared and handed over to the persons concerned and all practical steps shall be taken to check unauthorized handling or disposal of waste by others. Authorized persons include local council waste collectors or registered waste carriers. The refuse bins/containers to be used for temporary storage of waste before they are transported to the dump site shall follow local standards and regulations and will comply with ISO 14001.

Hazardous Materials

Hazardous materials generated during the construction and operation phase include a number of hazardous materials such as hydrocarbon materials (lube oil, spent lube, lead-acid batteries, oily rags and filters). The risk of environmental contamination and human exposure to these hazardous materials is likely, and appropriate mitigation measures are required to minimize or eliminate the risks. All the identified hazardous materials will be properly handled on site to avoid on-site spillage and soil contamination. Hazardous wastes shall be managed by specialists while solid wastes containing hazardous substances shall be properly disposed of. Managing or handling hazardous waste such as chemicals, oils or contaminated soils will involve correspondence with environmental regulators at the state and federal levels. Hazardous waste recipients must be clearly marked/labelled, stored in a contained area (or have a drip tray) and covered (either stored under a roof or the top of the container must be covered with a lid); and a detailed waste transfer note shall be provided.

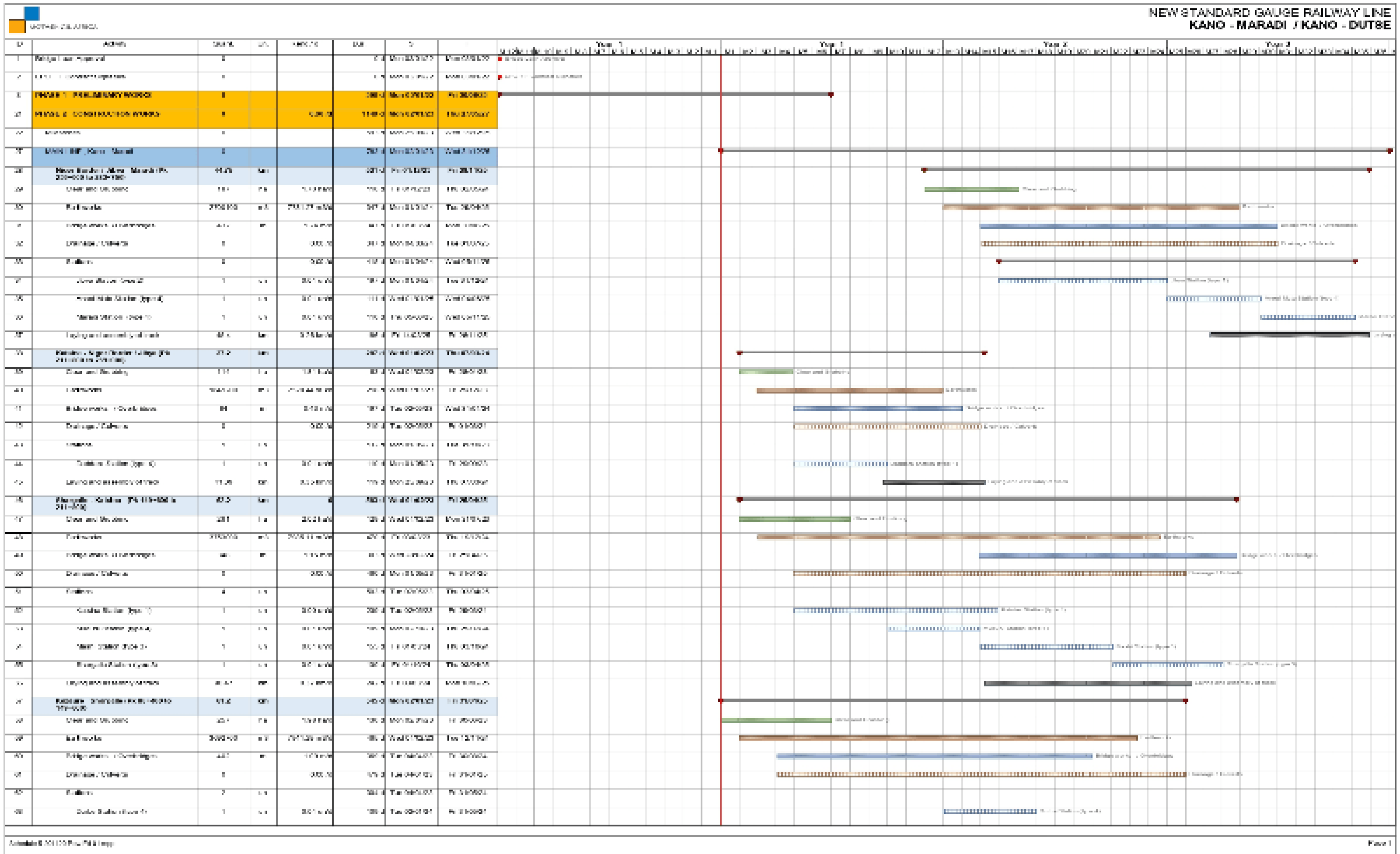
3.6 WORKFORCE

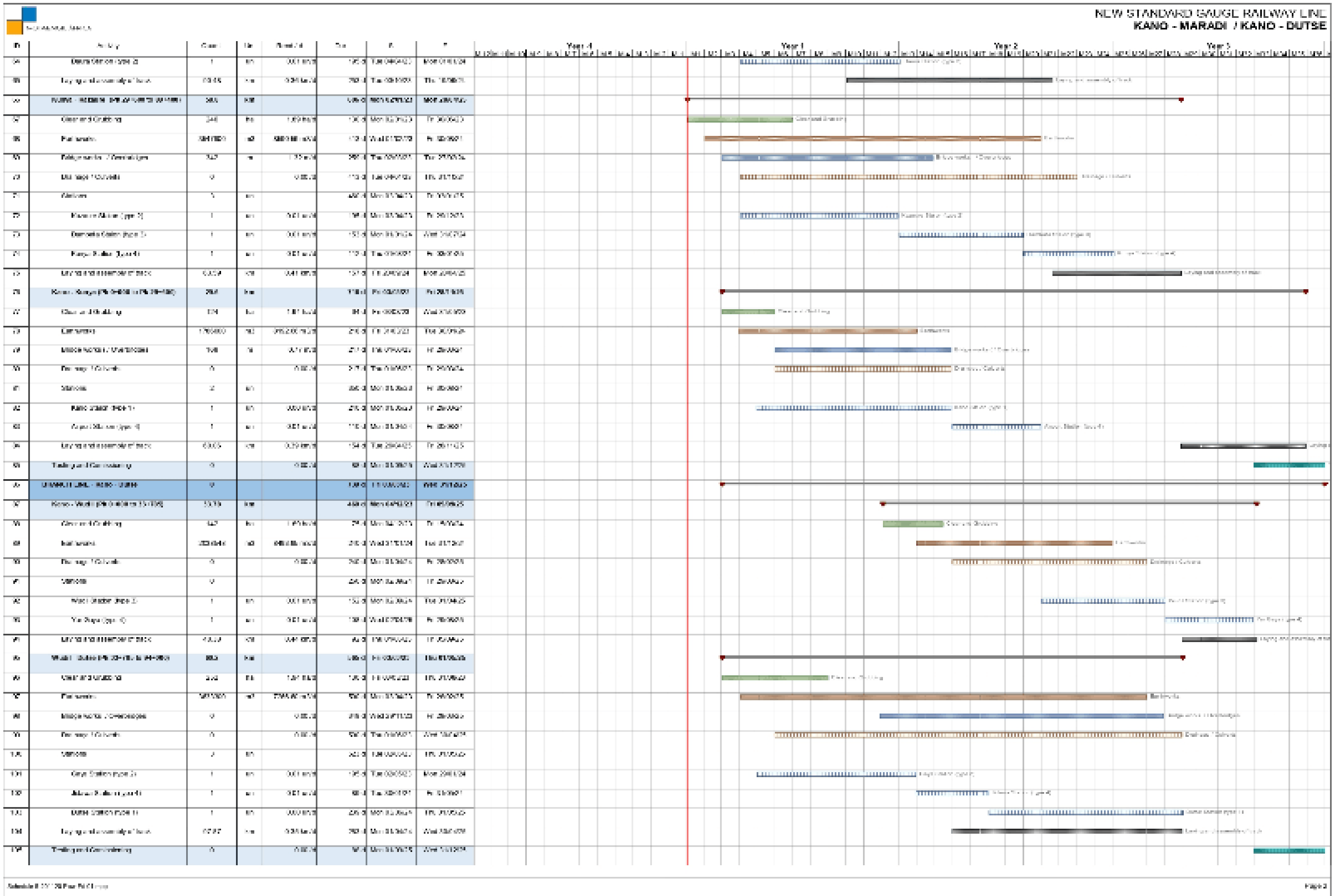
The construction workforce will comprise a total of 6,501 employees at the start of construction rising to higher numbers along all work fronts at later stages. The workforce will comprise of approximately 96% local workers from the surrounding areas with only 4 % expatriates expected to make up the construction workforce.

3.7 PROJECT SCHEDULE

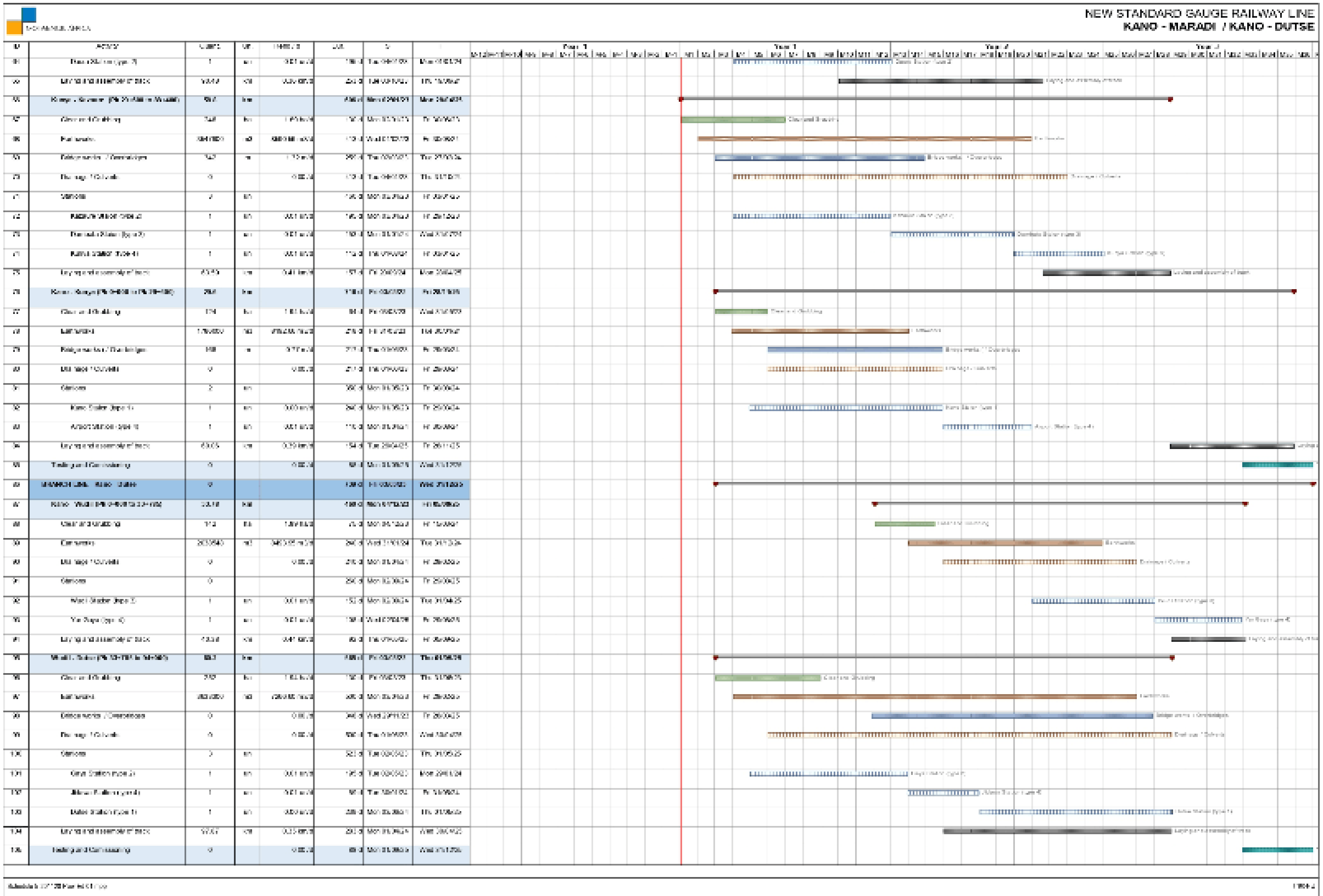
Early Construction for the Project is due to commence in April 2022 for the main line, with the main construction commencing in July 2022 for approximately two years. Construction for the branch line will commence in April 2023 for a period of approximately one year. A summary schedule is provided in Table 3.15 below.

Table 3. 15: Construction Project Schedule





NEW STANDARD GAUGE RAILWAY LINE
KANO - MARADI / KANO - DUTSE
Year 1
Year 2
Year 3


NEW STANDARD GAUGE RAILWAY LINE
KANO - MARADI / KANO - DUTSE

CHAPTER FOUR: DESCRIPTION OF THE EXISTING ENVIRONMENT

4.1 BASELINE INFORMATION OF THE PROJECT AREA OF INFLUENCE

This chapter provides a description of the existing environmental, socio-economic, cultural and health conditions of the study area against which the potential and associated impacts of the proposed rail project may be assessed and possible deviations from the current baseline conditions monitored. It covers information on the aspects of the environment relating to the project's Area of Influence (AoI), which includes the route, the communities the route and within the corridor, and which may be directly or indirectly affected by the project.

The Area of Influence (AoI) - set at 2.5 km from the centre of rail line on both sides - was determined by considering the potential impacts related to project activities such as transportation of materials, equipment and personnel, construction works, labour hire during construction and operation phase of the Project. Others include noise and air pollutants generated during construction and operation of the Project. The IFC requires that environment and social impact study be carried out to cover the Project's AoI and associated facilities. According to the IFC, associated facilities are facilities not financed as part of the project, and that would not have been constructed or expanded if the project did not exist and without which the project would not be viable.

The project corridor cuts across Jigawa, Kano and Katsina States and 20 local government areas earlier mentioned. These are areas affected either directly or indirectly by the project and its activities. The areas with direct interaction with the project activities are areas directly impacted in the project area. Beyond the communities adjacent to the route, other areas and places was indirectly impacted by the project.

4.2 BASELINE DATA GATHERING

The baseline data gathering was conducted from September 20, 2021 to October 4, 2021 for the wet season data while the dry season baseline data was acquired between December 10 and 21, 2021. The exercise was witnessed by Representatives of the Federal Ministry of Environment and officials of the Federal Ministry of Transportation, Nigeria. A multi-disciplinary approach was used in baseline data gathering exercise, which entails participation of air quality and climate specialists, ecologists, soil scientist, sociologist, geographic information system specialist, water resources specialists, geologist, civil engineer, environmental toxicologists, and other experts. The study, sampling and analysis of environmental samples were carried out within the framework of Quality, Health, Safety and Environment (QHSE) management system. All samples and *in-situ* data were collected in accordance with the approved scientific and regulatory requirements using suitable equipment, materials and experienced personnel. The coordinates of the sampling locations and sampling map are presented in Table 4.1 and Figure 4. 1.

Table 4. 1: Sampling locations and geographical coordinates

SN	Name	Samples / Matrix		Latitude	Longitude
Soil Sampling / Air Quality and Noise Monitoring Locations					
1	Daura	Air, soil		13.02765636	8.311722099
2	Guidan Issa	Air, soil		13.41632942	7.183446718
3	Dan Issa	Air, soil		13.20709988	7.260340819
4	May Daboro	Air		13.1086415	7.302808802
5	Tsamga	Air, soil		13.09066592	7.390840262
6	Katsina	Air		13.00399213	7.591178358
7	Makurda	Air, soil		13.01702578	7.74399793
8	Maduru	Air, soil		13.01819338	7.828689516
9	Moshi	Air		12.98264953	7.949603794
10	Shargalle	Air, soil		12.96923573	8.102151832
11	Kayawa	Air		12.95674514	8.151245256
12	Settlement near Tambo	Air, soil		12.97633635	8.222292237
13	Gurjiya	Air, soil		12.99159658	8.336173773
14	Sandamu	Air		12.96026151	8.358222368
15	Fago	Air, soil		12.89688538	8.37953782
16	Juba	Air, soil		12.85824603	8.394417907
17	Korare	Air, soil		12.81254679	8.395829886
18	Achilafia	Air, soil		12.8008165	8.39610142
19	Agangaro	Air		12.79446259	8.393820531
20	Zungunba	Air, soil		12.75017533	8.399468447
21	Sada	Air, soil		12.72543466	8.392882432
22	Bayan Dutsi	Air, soil		12.68983789	8.396777455
23	Kazaure	Air		12.65149996	8.391718813
24	Ungwa Kusa	Air, soil		12.55816151	8.454402626
25	Yammawar Wanzamai	Air, soil		12.48781877	8.474819249
26	Danya Gari	Air, soil		12.4637744	8.488816848
27	Karanbanin Lalai - Dambatta	Air, soil		12.42763317	8.495713823
28	Kano Township	Air		11.96900768	8.439549671

SN	Name	Samples / Matrix		Latitude	Longitude
29	Fulani	Air, soil		12.01618546	8.440744406
30	Jajira Cikin Gari	Air, soil		12.0353504	8.43931924
31	Zogarawa	Air		12.09333631	8.434906986
32	Daruman	Air		12.11616282	8.43552143
33	Dan Meyangun	Air, soil		12.15223503	8.45016042
34	Built-up near Tangaji Gari	Air		12.33065912	8.479615932
35	Unguwar Chiroma	Air, soil		12.3559956	8.491661171
36	Shinkafi - Katsina	Air, soil		13.02804329	7.647121237
37	Yan Daki	Air		13.04791282	7.685163209
38	Unknown	Air, soil		13.05868015	7.49698812
39	Unknown	Air, soil		13.04999248	7.593691586
40	Unknown	Air, soil		12.98465142	8.033494766
41	Unknown	Air, soil		12.60381673	8.42064649
42	Unknown	Air, soil		12.52004463	8.456035262
43	Unknown	Air, soil		12.25499324	8.485846988
44	Unknown	Air, soil		12.21735036	8.494379319
45	Unknown	Air, soil		12.18537877	8.470628237
46	Unknown	Air, soil		12.06287121	8.437272237
47	Unknown	Air, soil		11.98950372	8.438411551
48	Unknown	Air		11.94669814	8.446086484
49	Unknown	Air, soil		11.92724902	8.448883719
50	Unknown	Air, soil		12.39732072	8.496771331
51	Unknown	Air		12.57890499	8.44272388
52	Unknown	Air, soil		12.62522592	8.40042671
53	Unknown	Air, soil		12.9224076	8.36213828
54	Unknown	Air, soil		12.95555818	8.34260799
55	Unknown	Air, soil		13.00317332	8.31689659
56	Unknown	Air, soil		13.00585241	8.285664936
57	Unknown	Air, soil		12.99685078	8.249825827
58	Unknown	Air		12.97052167	8.180090918
59	Unknown	Air, soil		12.97052167	8.141212059
60	Unknown	Air		12.9784203	8.062101294
61	Unknown	Air, soil		12.98767148	7.994328445
62	Unknown	Air, soil		12.99289483	7.907022965
63	Unknown	Air		13.00860436	7.869012628
64	Unknown	Air, soil		13.02186569	7.777750249
65	Unknown	Air, soil		13.05004903	7.638142834
66	Unknown	Air, soil		13.30481524	7.248325307
67	Unknown	Air, soil		13.25777898	7.257039871
68	Unknown	Air		13.17511633	7.277064001

SN	Name	Samples / Matrix		Latitude	Longitude
69	Unknown	Air, soil		13.44781514	7.16108141
70	Unknown	Air, soil		13.36096017	7.21978119
71	Unknown	Air, soil		13.38506872	7.20842419
72	Unknown	Air		13.10807128	7.34442145
73	Unknown	Air, soil		13.07959875	7.45171279
74	Unknown	Air, soil		13.04464083	7.54687752
75	Unknown	Air, soil		13.0330829	7.71064627
76	Unknown	Air		13.12863606	7.26773673
77	Unknown	Air, soil		13.33555496	7.23174590
78	Unknown	Air, soil		12.28609028	8.47593698
79	Kano	Air, soil		11.91236267	8.45881991
80	Kano	Air, soil		11.90701831	8.47499855
81	Kano	Air		11.9042848	8.49027998
82	Kano	Air, soil		11.90317748	8.50653718
83	near kano	Air, soil		11.89517528	8.52179782
84	near Kano	Air, soil		11.89286175	8.54082937
85	near kano	Air		11.89663743	8.55929680
86	near Kano	Air, soil		11.8898873	8.58461586
87	Unknown	Air		11.89013201	8.61148807
88	near Yar Gaya	Air, soil		11.88961091	8.63492603
89	Yar gaya	Air, soil		11.8898439	8.66408649
90	near Yar Gaya	Air, soil		11.88504356	8.69205521
91	Unknown	Air, soil		11.87740103	8.71338303
92	Unknown	Air, soil		11.86948865	8.73545789
93	Unknown	Air		11.86225277	8.75563999
94	Unknown	Air, soil		11.85384026	8.77909747
95	Unknown	Air, soil		11.84490548	8.80400371
96	Unknown	Air, soil		11.83594427	8.82604051
97	near Wudil	Air		11.82744743	8.84393153
98	Wudil	Air, soil		11.80856504	8.84556359
99	Near Wudil	Air, soil		11.82299517	8.87463734
100	Kasauni	Air		11.82477432	8.903328226
101	near Kausani	Air		11.82116201	8.925997366
102	Unknown	Air, soil		11.82850836	8.94870683
103	Unknown	Air, soil		11.83766601	8.976549667
104	near Gaya	Air, soil		11.84476171	8.999634984
105	Gaya	Air		11.86578961	8.998066075
106	Unknown	Air, soil		11.84302417	9.025438456
107	Unknown	Air, soil		11.84015976	9.055295666
108	Unknown	Air		11.83285684	9.085243675
109	Unknown	Air, soil		11.82196525	9.113910196

SN	Name	Samples / Matrix		Latitude	Longitude
110	Unknown	Air		11.82960811	9.146473681
111	near Dundubus	Air		11.83983786	9.180980914
112	Dundubus	Air, soil		11.84656783	9.20063265
113	near Dundubus	Air, soil		11.85031681	9.227106648
114	Unknown	Air, soil		11.83853457	9.25594937
115	Unknown	Air		11.83241579	9.29385403
116	near Shuwari	Air		11.82613079	9.325273964
117	Near Shuwari	Air, soil		11.81272976	9.359806659
118	Shuwari	Air, soil		11.78855887	9.406602458
Surface water and sediment					
1.	Duduru River Upstream (Gaya)	Water and sediment		11.83282	9.08977
2.	Duduru River downstream	Water and sediment			
3.	Marmara River Downstream (Wudil)	Water and sediment		11.82395	8.86576
4.	Marmara River upstream	Water and sediment			
5.	Challawa River 1	Water and sediment		12.32575List of P	8.47688
6.	Kwatari Mai Kaho	Water and sediment		13.48675	7.09351
7.	Dam Near Tsamoni	Water and sediment		12.07237	8.56725
8.	Dam at River Zakara	Water and sediment		12.12838	8.67286
9.	Thomas Dam	Water and sediment		12.96823	7.96682
10.	River before Kazaure (Dam)	Water and sediment		12.6436	8.41987
11.	Muduru River	Water and sediment		13.043819	7.853056
12.	Baba Ruga Dam	Water and sediment		12.316618	8.522725

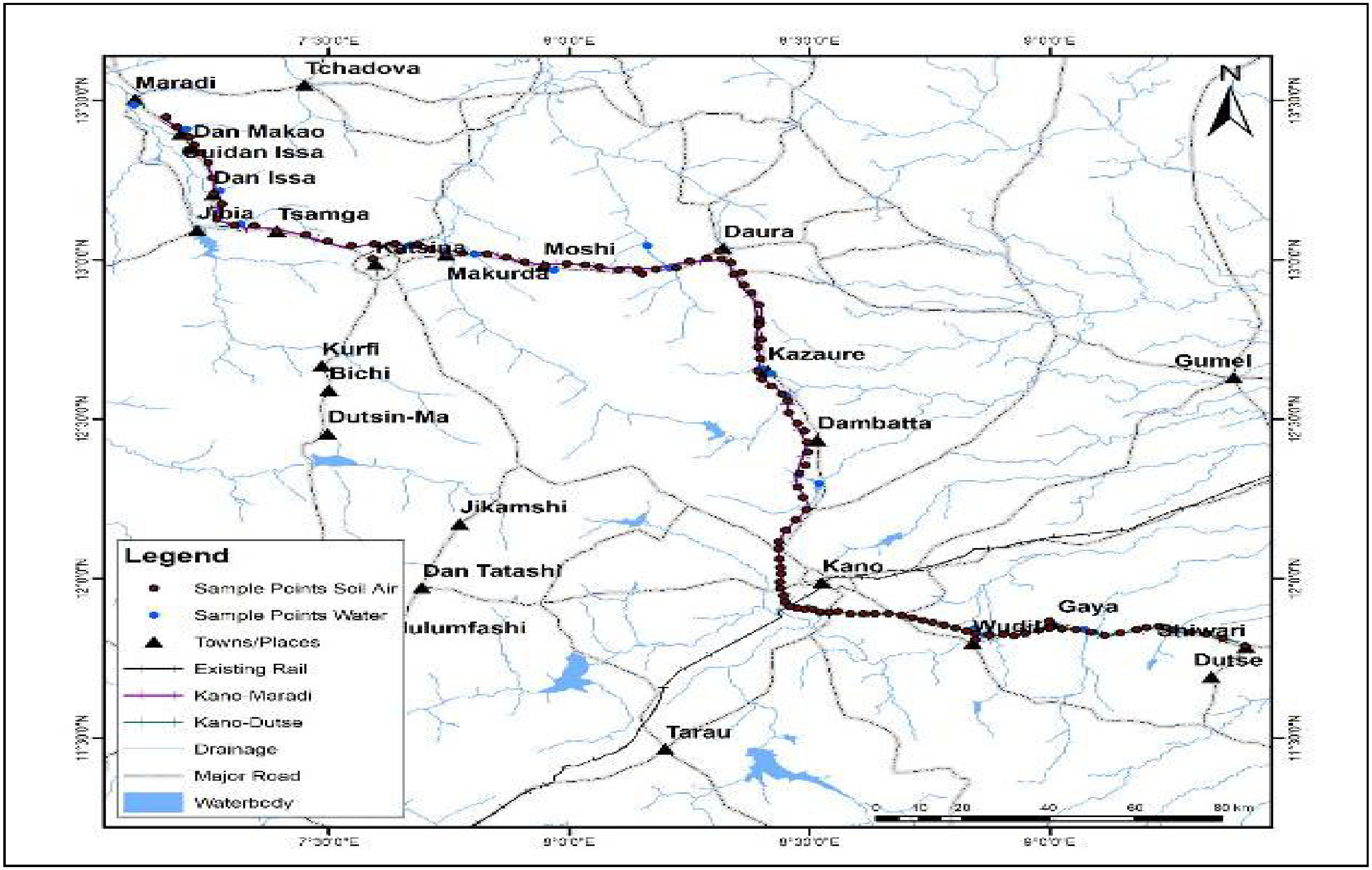


Figure 4. 1: Map showing sampling locations along the project corridor

The study approach includes review of existing literatures (textbooks, research articles, environmental reports and maps) on the biophysical and human environment and design of field sampling strategies to meet the scope of the EIA and regulatory requirements. In addition, field equipment was pre-tested and calibrated prior to baseline data gathering exercise. During the survey, environmental samples were collected, properly preserved and stored before transfer to laboratory for analysis. The primary objective of baseline studies is to characterise key environmental and socioeconomic resources and conditions identified during scoping as being potentially affected by project activities (e.g., air quality, geology and soil, groundwater, surface water, fauna and flora) and to identify potential sensitive receptors. The baseline of the biophysical and socioeconomic conditions of the project area was documented to provide a basis against which potential effects of the rail project can be assessed and changes can be monitored. The study is divided into three (3) different sub-groups, namely biophysical study, socio-economic survey and health assessment.

Biophysical Study

- Climate and meteorology
- Geology and hydrogeology
- Air quality and noise monitoring
- Soil quality assessment
- Surface water quality assessment
- Sediment Assessment
- Hydrobiology
- Groundwater quality Assessment
- Ecology (Flora and Fauna) / Biodiversity study
- Land use/cover study
- Traffic study

Socio-economics Survey

- Demography
- Social-cultural features and communities' profile

- Socio-economic condition of the communities,
- Socio-political structure/organisation, political/dispute resolution institutions and mechanisms,
- Historical data
- Social structure/trends and social groups,
- Social facilities,
- Social needs of the communities, and
- Community perceptions/view/opinions/benefits of the projects

Health Assessment

- Vital health statistics
- Individual/family/community health determinant
- Health outcomes
- Institutional health determinants
- Knowledge, attitudes and practices

4.2.1 Air Quality and Noise Monitoring

Air quality and noise level monitoring were carried out at 100 pre-determined sampling stations along the proposed route and adjacent communities during the daytime. Over a period of 5 minutes at each of the sampling locations, *in-situ* air quality monitoring was carried using pre-calibrated portable ambient air quality meters mounted on a tripod stand to measure the following parameters: Sulphur (IV) Oxide (SO_2), Nitrogen (IV) Oxide (NO_2), Carbon Monoxide (CO), Volatile Organic Compounds (VOC), and Particulate Matters ($PM_{2.5}$ and PM_{10}). Ambient noise levels at different points were measured using sound level meter with a detection range of 30 dBA to 130 dBA. Noise Level measurements were taken during the day and at night (between 6 pm and 7 pm) at about 30 safe locations at a height of approximately 2 m above ground level, and the response time set to slow and read on the 'A' frequency weighting scale in unit decibels. As much as practicable, readings were taken when there was no or very low vehicular or human activities at the noise monitoring locations.

Emission Dispersion Modeling

The potential emission dispersion levels were determined for ground level concentrations of nitrogen oxide (NO_2), carbon monoxide (CO) and particulate matter (of size 2.5 microns). A recent version of the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) Version 21112 was used to determine the air pollutants concentrations at averaging time periods of 1-hour and 24-hour. Meteorological data processor (AERMET) that accepts surface meteorological data and upper air soundings was used to determine the atmospheric conditions of the study environment and fitted into AERMOD. The AERMOD model was chosen for this analysis because it is regularly updated and the most popular modelling tool for regulatory purposes. The estimation of the potential ground level pollutants concentrations from the proposed rail construction activities was based on the aggregate emissions data for railway construction equipment from former studies.

The procedure used for this dispersion modelling was to convert emission from "potential" sources mainly from construction equipment and potential emission from the transportation of materials on unpaved road directly linked with the proposed project. The estimation of the potential ground level pollutants concentrations from the proposed rail construction activities was based on an aggregate emissions data for railway construction equipment from former studies. Table 4. 2 shows the emission rate inputs in grams per second (g/s) used in the dispersion model from the construction equipment with diesel engines. Data from weather Research and Forecasting (WRF) model was used as a driving surface and upper air as well as terrain data in AERMOD model to calculate the ground level concentrations of emitted pollutants. The Weather Research and Forecasting Model (WRF) which serves as a wide range for meteorological applications across scales of meters and thousands of kilometres was the platform for the simulation of the AERMET component of AERMOD. Output includes surface meteorological observations and parameters and vertical profiles of several atmospheric parameters. The following surface meteorological variable were considered and these include wind speed, wind direction and temperature at a height of approximately 10 m. Receptor locations were chosen to be within about 2 km radius from the centre of each station, also with extension across UTM coordinates bordering within areas of the proposed project environment. The receptors were placed along all directions (covering north, northeast, east, southeast, south, southwest, west, and northwest directions).

Table 4. 2: Emissions rate input into AERMOD Model

Pollutants	Emission Rate (g/s)
CO	0.0001-0.00004
$PM_{2.5}$	0.007-0.1
NO_x	0.000011-0.0003
SO2	0

Source: Phillips (2006)

Air emissions from railway construction can come from a number of sources being used during the project construction made up of a number of elements including stations, tunnels, bridges, signalling and telecommunication etc. (Dimoula, 2016). In addition, pollutants are typically emitted into the environment through fugitive releases, accidental releases, or plant upsets. In Nigeria, infrastructural developments such as the Kano – Maradi Rail Project are expected to be on the increase in the coming years with the potential for environmental pollution to increase with corresponding effects on the health of the communities within, and those residing near the proposed projects activities.

4.2.2 Groundwater Sampling

In order to assess the quality of existing groundwater in the study area, groundwater samples were collected from thirteen (13) existing sources (hand-dug wells and deep boreholes) at 10 locations very close to the rail route. Specifically, samples were collected from Gandu Dutse, downstream and upstream wells, Zango Well, Pangalle Wudil borehole, Jajira Borehole, Zakara well, Ungwan Kutsa well, Zungunba borehole, Doka Borehole, Agangaro borehole, Zuba well, Gurjiya well and Shargelle Katoge – all along the project corridor. The samples were collected into amber bottles and preserved in ice packs after *in-situ* analysis to determine the temperature, TDS, conductivity and dissolved oxygen of the water. Most of the water sources sampled for this study were being used for domestic purposes such as drinking, washing, and cooking, according to residents.

4.2.3 Surface Water Sampling and Hydrobiology

Water samples were collected from surface waters at the basins of the Jakara, Thomas, Gari, Tuwari, Sabke, Jaruka, Havsani and Gada Rivers, which the rail line will run through. Preliminary sampling sites selection was done during the reconnaissance survey and scoping activities. A multi-disciplinary approach was adopted to determine the hydrobiology of the project location and immediate environment. Fish types were assessed from direct observations in markets and fisher folk interviews from group discussions during stakeholder consultations.

4.2.4 Sediment Sampling

Seven (7) sediment samples were collected at each pre-selected geo-referenced station using a 0.1 m^2 Van-veen Grab. Each sample was analysed for the following parameters: pH, particle size, moisture content, anions, cations, total hydrocarbons, microbiology, and benthos. A successful grab haul will form the composite sample at each station. A portion of the top layer (1 cm-2 cm) was preserved for physical, chemical, and microbial analyses in labelled plastic containers and stored in adequate preservation containers.

4.2.5 Soil Sampling

Representative top (0-15 cm) and sub (15-30 cm) soil samples were collected and analysed at pre-selected points at each town where the station/stops are located along the proposed routes of the Main and Branch lines for analysis. In-situ soil sampling was conducted, according to BS ISO 18400-104:201, using stainless steel screw-type soil auger and Field Observations with description of each collected sample inserted into applicable soil logging sheets. The soil samples collected were homogenized in plastic bucket lined with aluminium foil sheet, and from the homogenized soil samples, sub samples were taken for microbial and physico-chemical analysis. Sub samples for microbial analysis were also wrapped up using aluminium foil sheets. Pollutants such as hydrocarbon and heavy metals which may be present in the soil prior to commencement of project was investigated through laboratory analysis. One hundred and twenty-four (124) samples were collected and analysed for chemical and microbial parameters with sixty-seven (67) samples each for the top and subsoils. The discussion is presented in two sections namely, chemical properties of the soils and microbial properties of the soils.

4.2.6 Laboratory Analysis of Environmental Samples

Laboratory analysis of environmental samples (soil and groundwater) collected during the wet season field sampling exercise was carried out at Kano State Ministry of Environment Laboratory, an FMEnv accredited laboratory. Samples collected for the dry season were analysed at the LACH Laboratory, Matori, Lagos. Table 4. 3 highlights the data requirements and methodos of analysis and parameters of interest.

Table 4. 3: Data Requirements and Environmental Indicators

S/N	Environmental Component	Data Acquisition	Parameters to be Measured
1	Air Quality	In-situ	Particulate, CO, NO_2, SO_2, VOC
2	Noise	In-situ	Ambient Noise Level dB(A)
4	Surface Water	In-situ/Lab Analysis	Colour, pH, Conductivity, TDS, Turbidity, Redox Potential, DO, BOD, Oil & Grease, TPH, $NO_{3,}$ SO_4, Na, K, Ca, Mn, Fe, Cd, Cr, Pb, Zn, BTEX. Microbiology: Total Hydrocarbon Utilising Bacteria, *E.coli*, Total and Faecal Coliform
5	Groundwater	In-situ / Lab Analysis	Colour, pH, Conductivity, TDS, Turbidity, Redox Potential, DO, BOD, Oil & Grease, TPH, $NO_{3,}$ SO_4, Na, K, Ca, Mn, Fe, Cd, Cr, Pb, Zn, BTEX. Microbiology: Total Hydrocarbon Utilising Bacteria, *E.coli*, Total and Faecal Coliform
7	Soil / Sediment	In-situ/Lab Analysis	Colour, pH, Conductivity, Potential, Oil & Grease, TPH, $NO_{3,}$ SO_4, Na, K, Ca, Mn, Fe, Cd, Cr, Pb, Zn, BTEX. Microbiology: Total Hydrocarbon Utilising Bacteria, *E. coli*, Total and Faecal Coliform

4.2.7 Terrestrial Biodiversity Assessment

Biodiversity assessment of the project area was carried out during the wet season. Dry season was observed to be generally characterised by intense harvesting, clearing of vegetation and heavily grazed land with scanty plant species in the project area. For the study, thirty-four (34) geo-referenced sampling locations, which represent the habitats crossed by the project, were randomly established along the rail route. Afterwards vegetation survey was carried out using belt transect of 50 x 100 m followed by identification and classification of species and the relative abundance. In addition to the *in-situ* assessments of the 34 points, the biodiversity status (especially the plant species) of the directly impacted forest reserves, which have been classified by the IUCN, was assessed.

Terrestrial fauna survey was carried out at the 34 sampling stations where the flora assessment was conducted by walking through the transects. Sampling techniques used were identification of nest type on trees and shrubs, feeding sites, sound, and faecal samples. Brief interviews were conducted with local farmers and residemts of rural communities adjacent Daura, Gaya, Jibiya, Kazaure and Shuwarin to ascertain the diversity of fauna assemblage endemic to the project area and adjacent communities (Table 4. 4).

Table 4. 4: Sampling Techniques for Terrestrial Fauna Survey

Taxon	Sampling Methodology
Herpetofauna (Amphibians and Reptiles)	Visual encounters survey (VES): On farmlands, along footpaths within the project area both during the day and evening periods.
Entomo-fauna(Insects)	Direct observations in various microhabitats such as hives, holes/crevices, tree boles, leaves etc. Butterflies, bees and other insects to be observed in flight as well as during spasmodic brief immobile moments.
Avifauna (Birds)	Opportunistic sighting/observations and point count methods was employed along ecotones (e.g footpaths and habitats).
Domestic Animals / Mammals	Direct and indirect observations using faecal remains. In addition, information about wild mammals in the area was sourced through interview from farmers and residents in the project communities.

4.2.8 Fisheries and Piscifauna Assessment

According to the Food and Agricultural Organisation (FAO), fishery is typically defined in terms of the "people involved, species or type of fish, area of water or seabed, method of fishing, class of boats, and purpose of the activities or a combination of the foregoing features". The definition often includes a combination of fish and fishers in a region, the latter fishing for similar species with similar gear types. The diverse species of fish was based on secondary data from research articles and through direct observation of locally sourced fishes sold in markets and river banks at Jibiya (Katsina State) and Wudil (Kano State).

4.2.9 Land Use Assessment

The land use of the project area within this special zone was carried out using direct observation, interactive spatial data structure within Geographic Information System (GIS) and other ancillary data sources. The satellite imagery from Google Earth Pro and files ArcGIS and related tools are to be subjected to analysis for spatial management processes such as image interpretation. Hand-held Global Positioning System (GPS) was used on the field to enhance basic ground trothing, interpretation of the images and geo-referencing of identified special features. In addition, an extensive field survey was carried out to ensure on-spot assessments.

4.2.10 Traffic Assessment

The collection of traffic data as regards the flow and volume of traffic is a basic requirement for traffic management. It helps in the identification of various traffic problems and to effectively provide solutions to the identified problems. This traffic study provides information about the flows of passengers and goods along the Project Route. This is in line with the requirement of the FMEnv for a proposed project of this magnitude. The study approach and methodology for the traffic survey and impact assessment includes.

Selection of roads for study: The two major roads selected for the study are Wudil – Dutse Road and Kano to Katsina-Jibiya Road. These two roads serve as the route for movement of passengers and goods between Dutse (from the east) and Niger Republic (to the west).

Establishment of traffic base line data: The base line traffic data was obtained by carrying out traffic count at the selected sites to obtain average daily traffic (ADT) and the total vehicle volume within the period of the survey.

The objectives of the traffic impact assessment of the proposed project are:

a. To determine the volume of traffic at the project corridor and obtain the average daily traffic (ADT) at the locations, peak volume and daily hourly volume (DHV).
b. To provide a detailed description of the existing roads which interacts with the rail line

c. To identify the impact of the proposed rail line project on the existing traffic, commercial motorists, and other road users.
d. To suggest effective and appropriate mitigation measures to prevent potential negative impacts associated with the project on traffic and transportation.

4.2.11 Socio-economic Survey

The socioeconomic survey entailed use of structured questionnaire for household survey in Project Affected Communities. Interviews shall be conducted mostly in Hausa and Fulfude; being the predominant languages in the project area. In addition to questionnaire administration, Key Informant Interview (KII) and Focus Group Discussions (FGD) were carried out to gather socioeconomic data and document key social issues of concern.

4.2.12 Displacement Evaluation and Resettlement Framework Development

The scope of the RPF covered the review of safeguard documents developed and applied by International Financial Institutions (IFIs) inclusion experiences and lessons learnt while executing social safeguards on similar projects. It will also include the review of country frameworks and systems on land acquisition and involuntary resettlement, conduction of extensive consultations with stakeholders to identify gaps in the legal framework and how to address these gaps can be addressed.

4.3 RESULTS AND DESCRIPTION OF THE BIOPHYSICAL ENVIRONMENT

The biophysical environment of the project area has been extensively described with data and information from baseline data-gathering exercise, *in-situ* analysis, results of laboratory analysis. This is in addition to secondary data and information sourced from published literatures such as journals, books, and environmental reports relevant to the project area. It covers the meteorological and climatic conditions, air quality, noise level, biodiversity, groundwater, surface water bodies, soil quality, among biophysical components of the project area.

4.3.1 Climate and Meteorology

The climate of the project area is characteristic of an arid and semi-arid region, and it varies considerably from months to months across dry and rainy seasons. In general, Nigeria's climate is characterized by the hot and wet conditions associated with the movement of the Inter-Tropical Convergence Zone (ITCZ) north and south of the equator. This ITCZ appears as a band of clouds, usually in form of thunderstorms that circle the globe near the equator, where Nigeria is located. The northeast winds prevail when the ITCZ is to the south of the equator, leading to the dry-season condition; and whenever it moves into the Northern Hemisphere, the south westerly wind prevails to bring rainfall and the rainy season. The Saharan air causes the dry season which is accompanied by low relative humidity and intense aridity that makes the atmosphere very dusty while the rainy season follows the advancing Atlantic Maritime Air accompanied by high humidity in the rainy season. The harmattan period is usually extremely cold with dry air with mean daily temperature as low as 17 °C from November, when the North-East Trade wind blows from the Sahara Desert. For a comprehensive information about the climatic conditions of the project area, the mean annual and monthly meteorological data of the project area obtained from (NIMET) for a thirty (30) year period (1990–2020) is presented below for rainfall, temperature, relative humidity, wind speed and direction as well as sunshine hours.

4.3.1.1 Rainfall

The seasonal pattern in the project area is representative of Kano and Katsina States in general, which are characterized by both wet and dry seasons. The wet season starts in April lasting to October, with a peak period in August. During the peak period of rainfall, rainfall is steady and common as notable in the southwestern part of the country. The Dry season sets in around late October and extends to early April. In the States, peak dry periods are experienced between late December and early March. The mean annual rainfall in Kano across the recorded years ranged from 46.0 mm – 162.7 mm. The year 2000 recorded the highest value while the lowest value was recorded in 2013. The mean annual rainfall over the 30-year period was however, 98.3 mm. For the mean monthly rainfall, the lowest was recorded in November, December, and January at 0.0 mm respectively, while the highest mean was recorded in August at 362.4 mm.

The mean annual rainfall in Katsina across the recorded years ranged from 23.6 mm – 115.8 mm. The year 2015 recorded the highest value while the lowest value was recorded in the year 2000. The mean annual rainfall over the 30-year period was however, 49.4 mm. For the mean monthly rainfall, the lowest was recorded in November, December, January, and February at 0.0 mm respectively, while the highest mean was recorded in August at 193.8 mm. Figure 4. 2 and Figure 4. 3 show the mean annual and mean monthly rainfall pattern from 1990 to 2020 for the project area respectively.

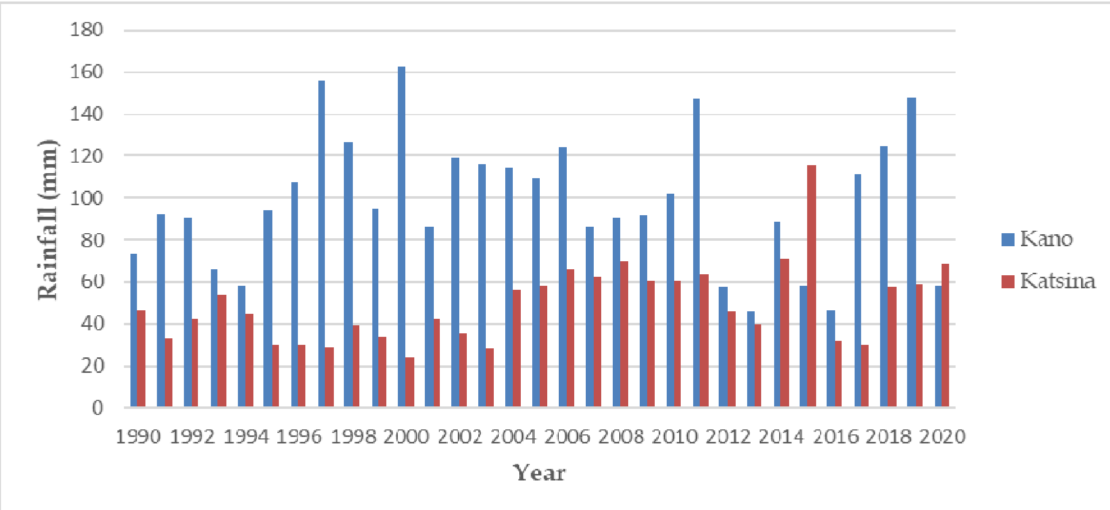


Figure 4. 2: Mean Annual Rainfall Distribution for the Project Area (1990-2020)
Source: *NIMET 2021*

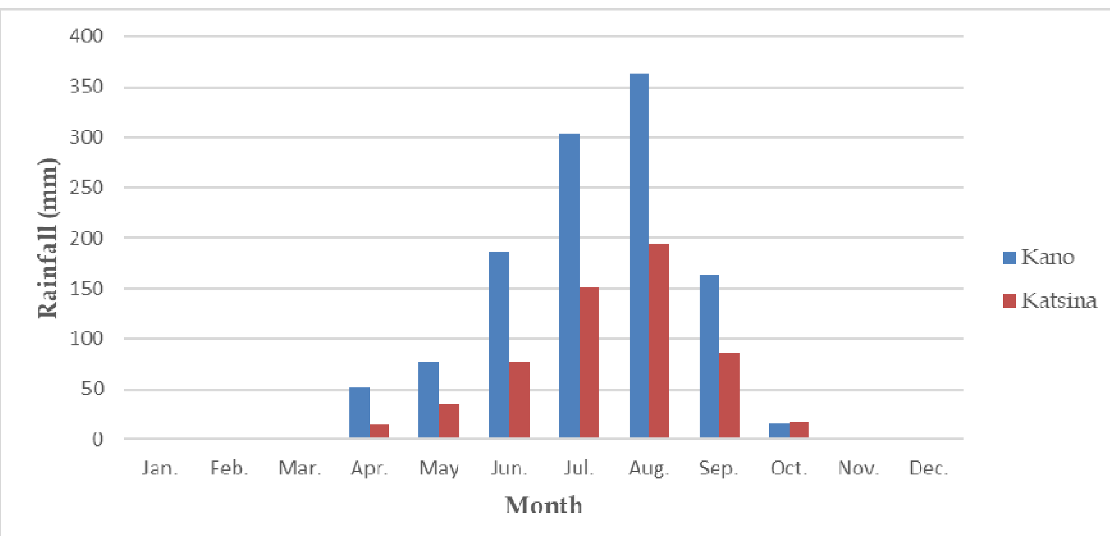


Figure 4. 3: Mean Monthly Rainfall Distribution for the Project Area (1990-2020)
Source: *NIMET 2021*

4.3.1.2 Temperature

In Kano State, the mean annual maximum temperature (TMax) over the 30-year period ranged between 31.9˚C and 34.5˚C with the highest in 2013 and the lowest in 2006. The mean annual minimum temperature (TMin) of the same period ranged between 18.7˚C and 23.9˚C. As relating to the monthly readings, the highest mean monthly maximum temperature was recorded in April at 39.3˚C. The lowest mean monthly maximum temperature was recorded in December and January at 29.4˚C respectively. The lowest mean monthly minimum temperature was recorded in December at 14.1˚C.

In Katsina State, the mean annual maximum temperature (TMax.) over the 30-year period ranged between 32.5˚C and 35.0˚C with the highest in 1996 and 2016 respectively and the lowest in 2012. The mean annual minimum temperature (TMin.) of the same period ranged between 17.4˚C and 20.6˚C. As relating to the monthly readings, the highest mean monthly maximum temperature was recorded in April at 39.1˚C. The lowest mean monthly maximum temperature was recorded in December at 30.4˚C respectively. The lowest mean monthly minimum temperature was also recorded in December at 12.3˚C. Figure 4. 4 and Figure 4. 5 depict the mean annual and monthly maximum and minimum temperature patterns in the project area between 1990 and 2020.

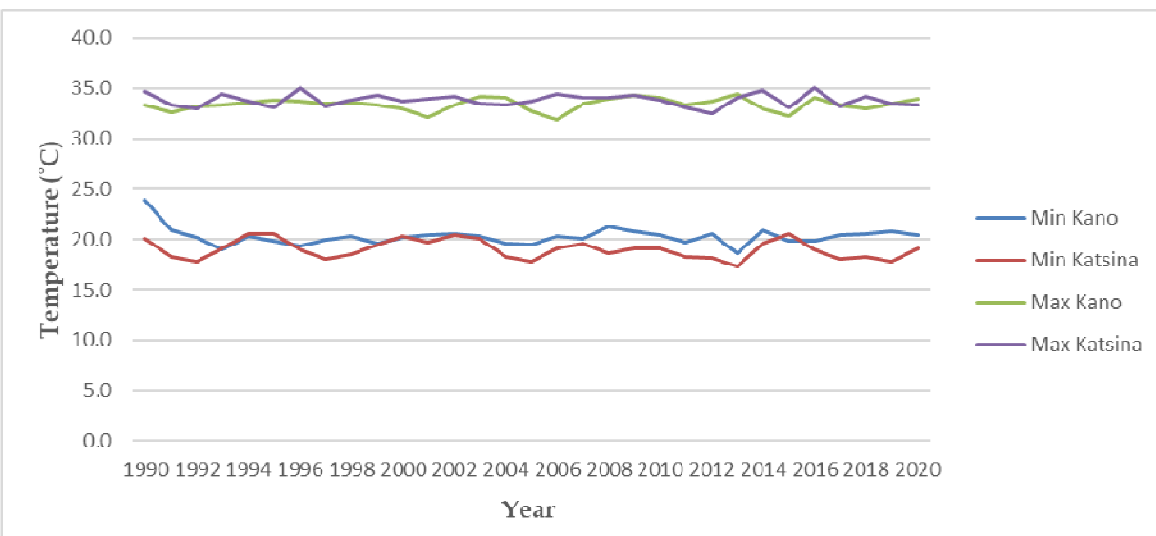


Figure 4. 4: Mean Annual Temperatures for the Project Area (1990-2020)
Source: *NIMET 2021*

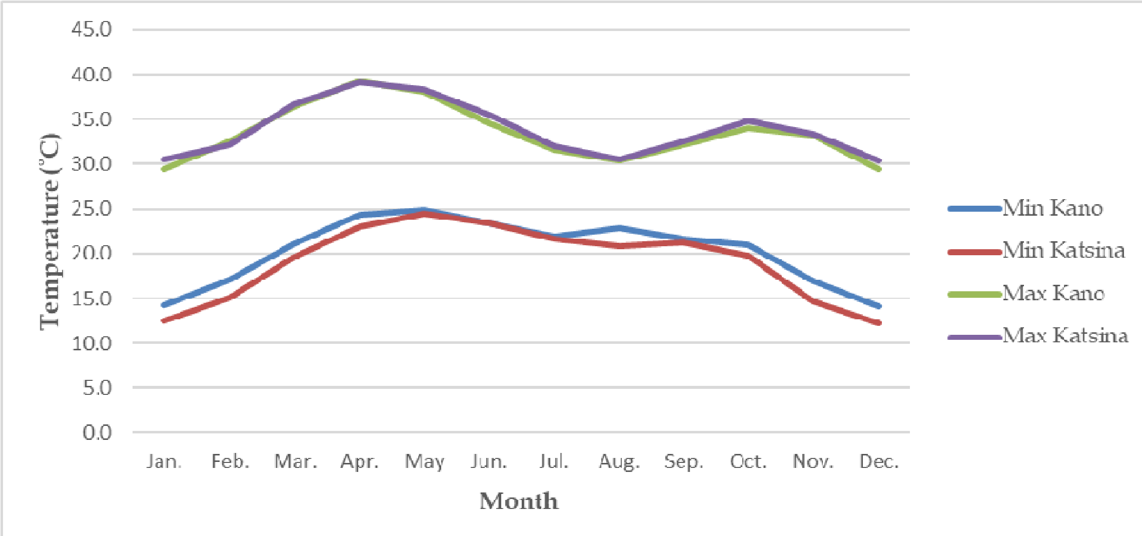


Figure 4. 5: Mean Monthly Temperatures for the Project Area (1990-2020)
Source: *NIMET 2021*

4.3.1.3 Relative Humidity

Within the years of meteorological data for the study area obtained from NIMET, the mean annual relative humidity of Kano recorded at 09.00hrs ranged between 41.1% - 48.8% with the highest value reported in 1997 and the lowest reported in 2014. While the values recorded at 15.00 hrs ranged between 27.5% and 41.0%. The mean monthly relative humidity for the area recorded at 09.00 hrs tends to be lowest in February but starts to ascend as from April. After peaking in August, a continuous descent is observed until January.

The mean annual relative humidity of Katsina recorded at 09.00 hrs ranged between 34.5% - 42.9% with the highest value reported in 1992 and the lowest reported in 2008. While the values recorded at 15.00 hrs ranged between 20.7% and 31.1%. The mean monthly relative humidity for the area recorded at 09.00 hrs tends to be lowest in March but starts to ascend as from April. After peaking in August, a continuous descent is observed until March. Figure 4. 6 and Figure 4. 7 show mean annual and monthly relative humidity for the project area from 1990 and 2020.

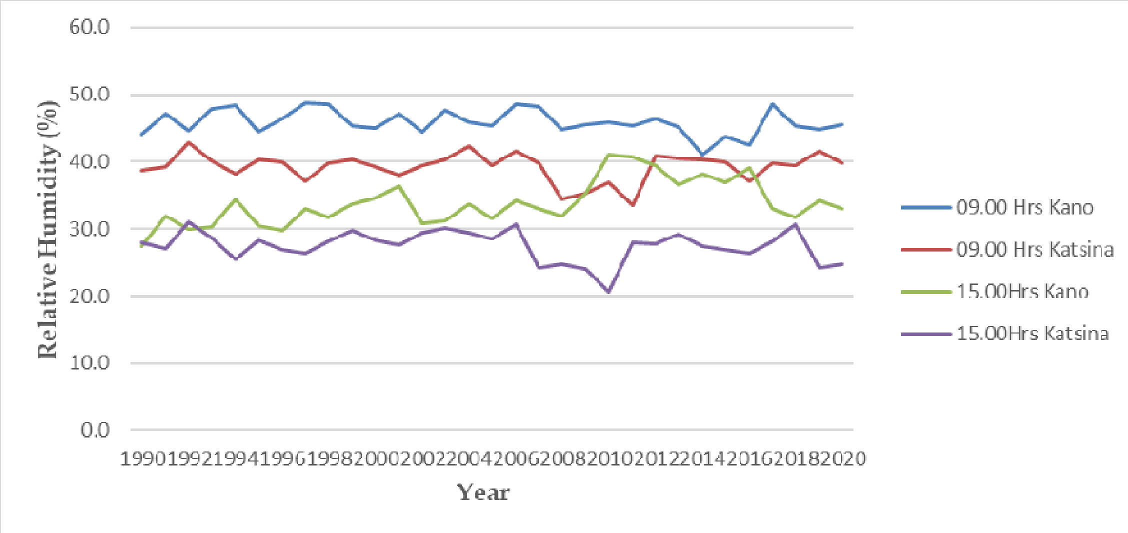


Figure 4. 6: Mean Annual Relative Humidity for the study Area (1990-2020)
Source: *NIMET 2021*

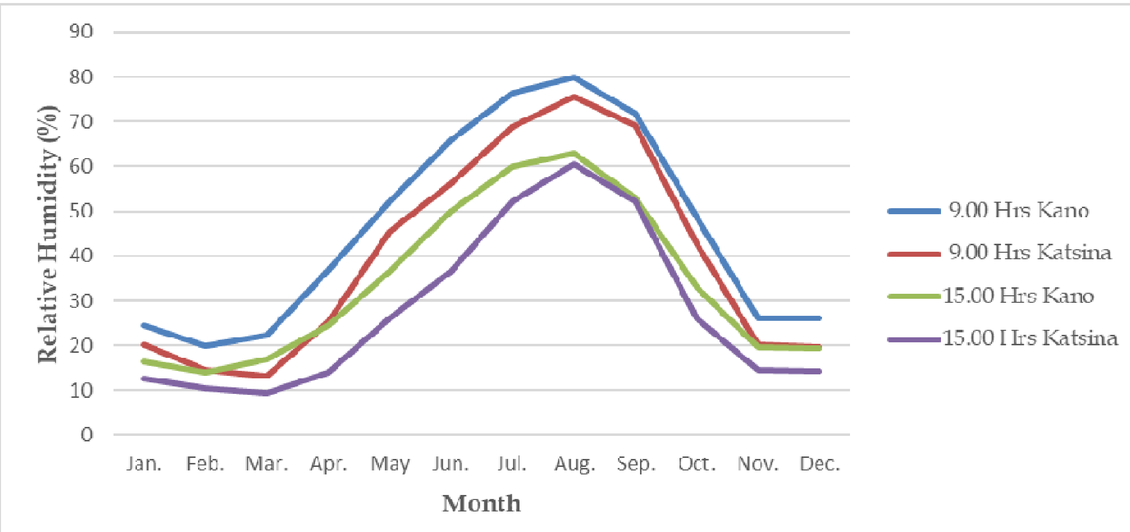


Figure 4. 7: Mean Monthly Relative Humidity for the Study Area (1990-2020)
Source: *NIMET 2021*

4.3.1.4 Sunshine Hours

The available records from NIMET over the 30-year period, showed mean annual sunshine hours ranging from 6.8 hours/day in 1994, to 8.4 hours/day in 2002, 2007 and 2018 respectively in Kano. The mean monthly sunshine hours in the same area within the period ranged between 7.0 hours/day in July to 8.7 hours/day in November. In Katsina, the mean annual sunshine hours ranged from 7.3 hours/day in 1997 and 2016 respectively, to 8.9 hours/day in 2000. The mean monthly sunshine hours in the same area within the period ranged between 7.6 hours/day in March to 8.8 hours/day in October. Figure 4. 8 and Figure 4. 9 show the mean annual and mean monthly sunshine hours from 1990-2020.

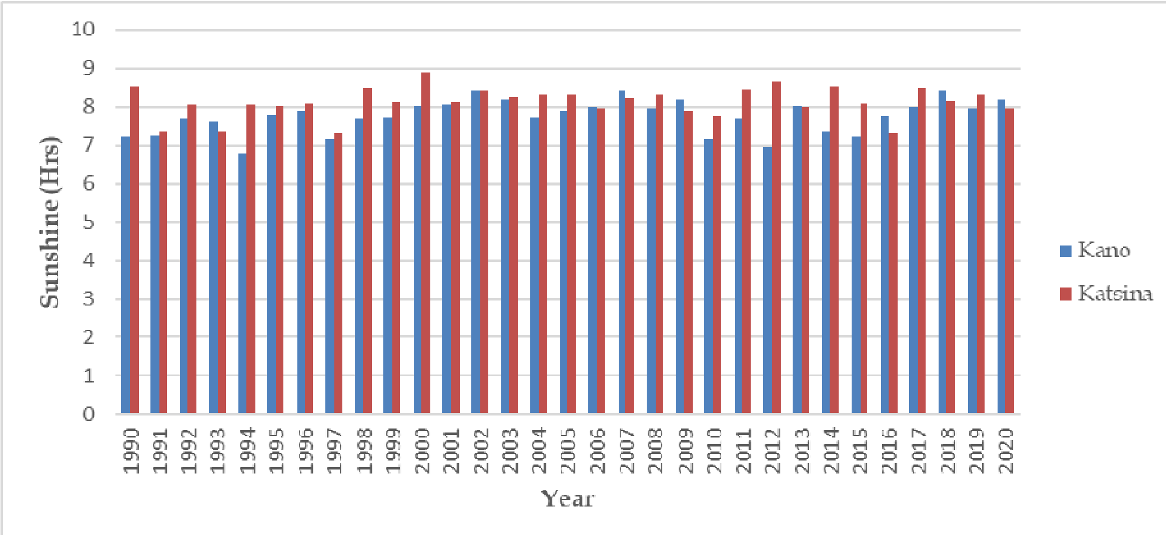


Figure 4. 8: Mean Annual Sunshine Hours for the Project Area (1990 – 2020)
Source: *NIMET 2021*

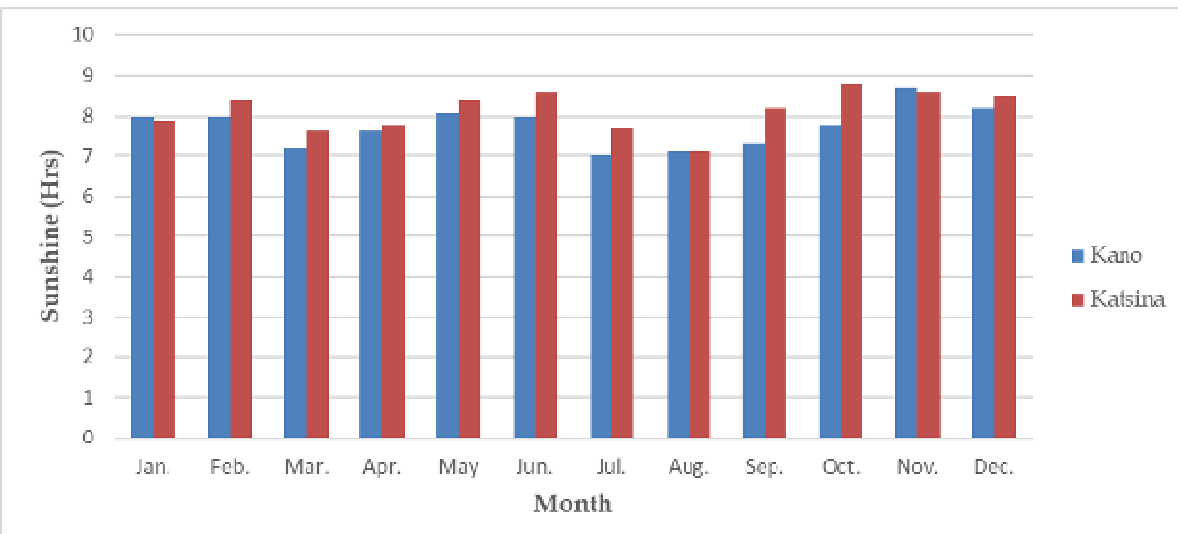


Figure 4. 9: Mean Monthly Sunshine Hours for the Project Area (1990-2020)
Source: *NIMET 2021*

4.3.1.5 *Wind Speed and Direction*

In the area (Kano-Katsina), there are two prevalent directions wherein wind blows, they are, the south-west (S-W Trade Wind) and north-east directions (N-E Trade Wind). The N-E trade wind also known as the tropical continental airmass, predominate wind directions during the dry season. The wind brings along large amount of dust and it is usually cold. The second wind direction, S-W trade wind, also known as the tropical maritime airmass, is predominant during the wet season bringing along thick clouds filled with rain. The mean annual wind speed in Kano over the 30-year period recorded its peak in 1992 at 10.6 m/s and lowest in 1997 and 2008 at 7.9 m/s respectively. The mean monthly wind speed in the Kano ranged from 10.6 m/s in June to 7.0 m/s in October and November. The mean annual wind speed in Katsina over the 30-year period recorded its peak in 1991 at 9.3 m/s and lowest in 2009 at 5.2 m/s. The mean monthly wind speed in the Katsina ranged from 9.0 m/s in June to 4.9 m/s in October. Figure 4. 10 and Figure 4. 11 show the mean annual and monthly wind speed values from 1990-2020. The wind climatology patterns in the project area are shown from Figures 4.12 to 4.19 while the spatial wind patterns of the area are shown in Figure 4.20 to 4.27.

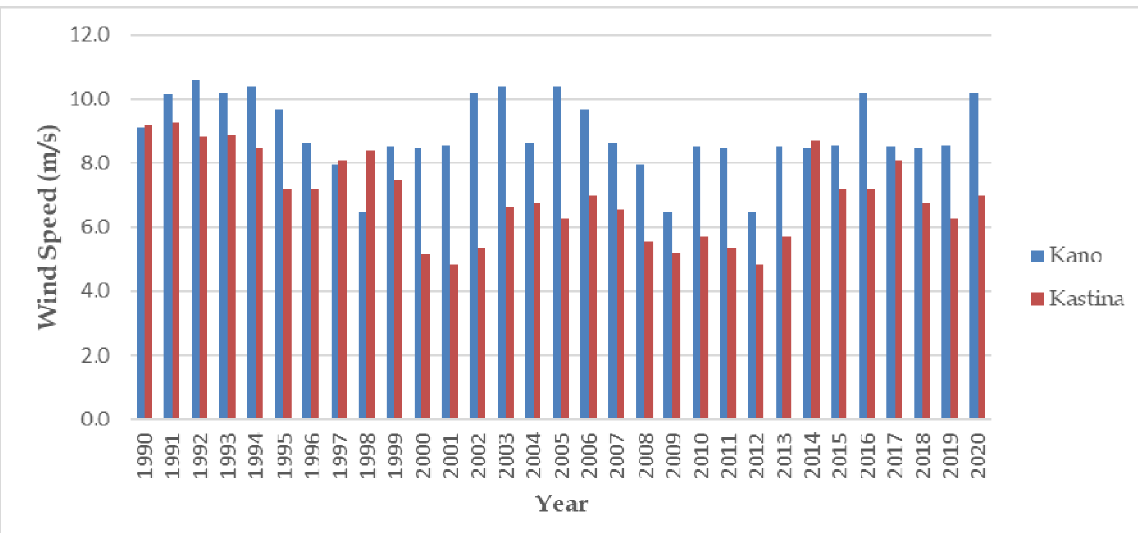


Figure 4. 10: Mean Annual Wind Speed for the Project Area (1990-2020)
Source: *NIMET 2021*

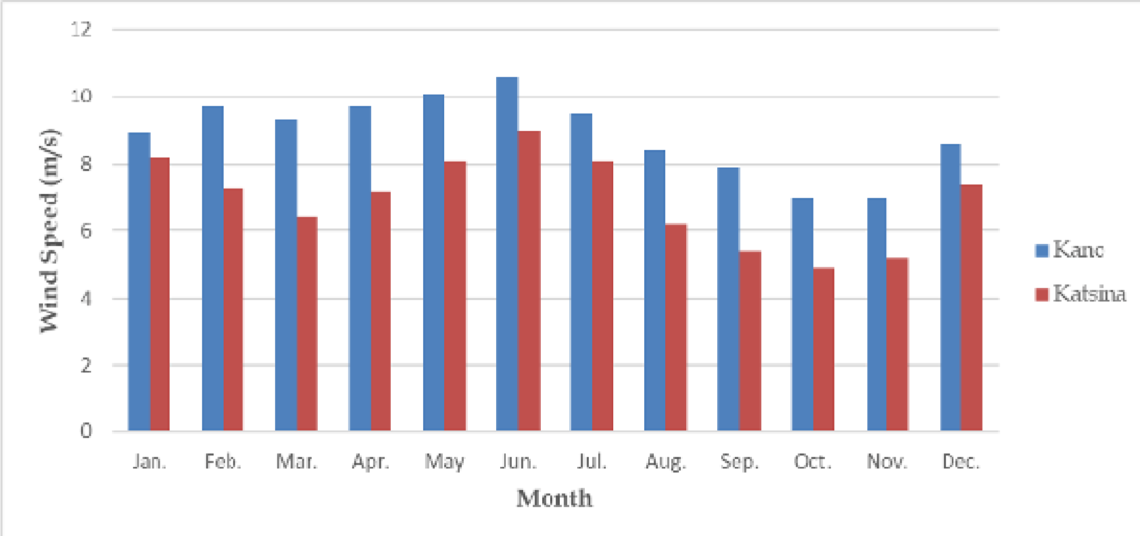


Figure 4. 11: Mean Monthly Wind Speed for the Project Area (1990-2020)

Source: *NIMET 2021*

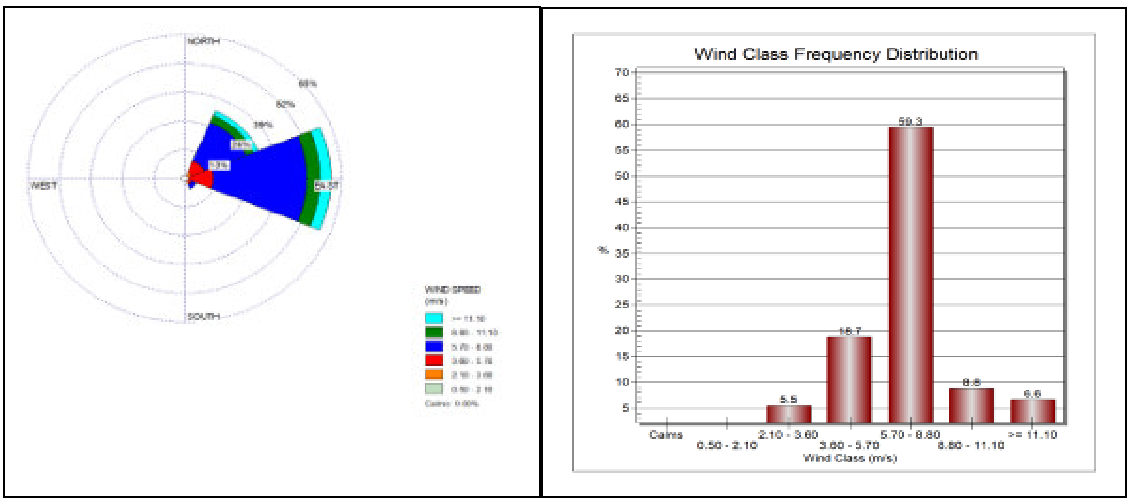


Figure 4. 12: Wind climatology pattern from November to January in Katsina

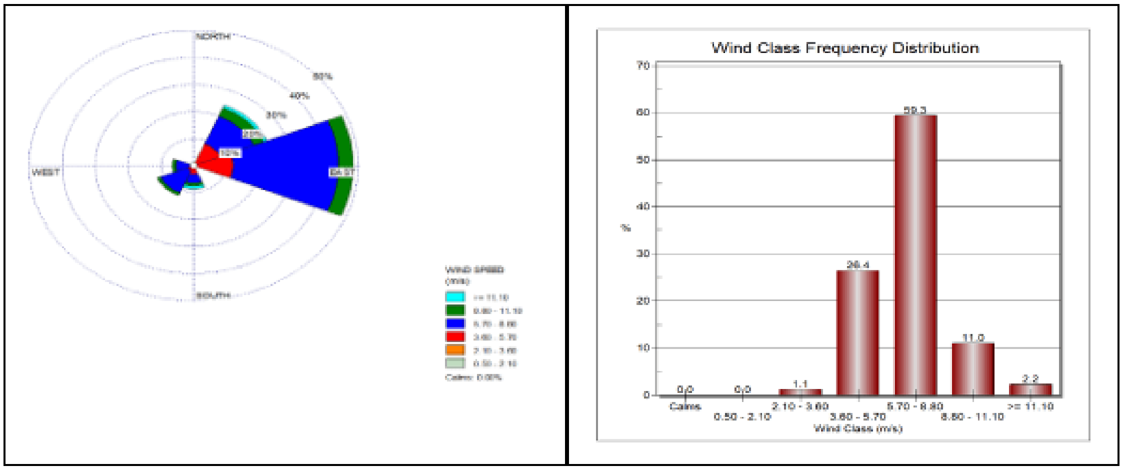


Figure 4. 13: Wind climatology pattern from February to April in Katsina

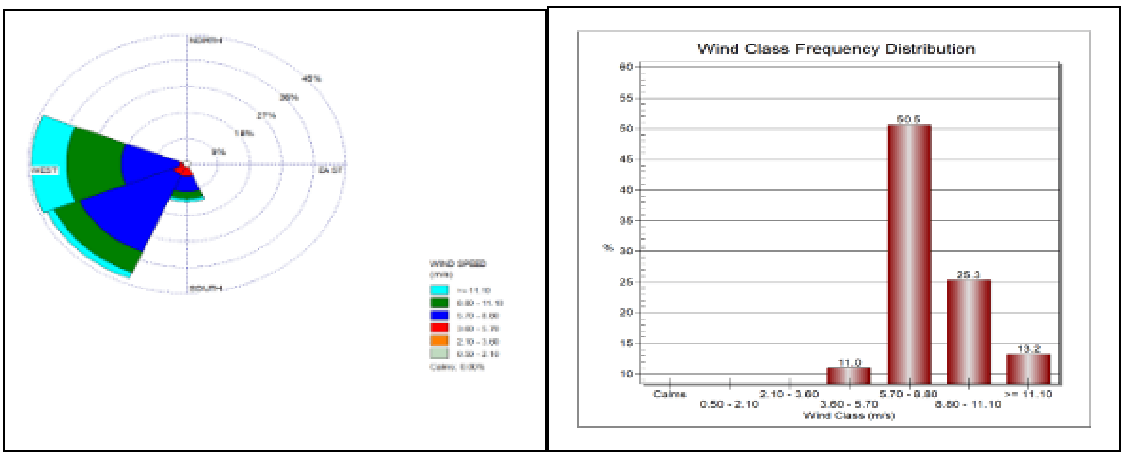


Figure 4. 14: Wind climatology pattern from May to July in Katsina

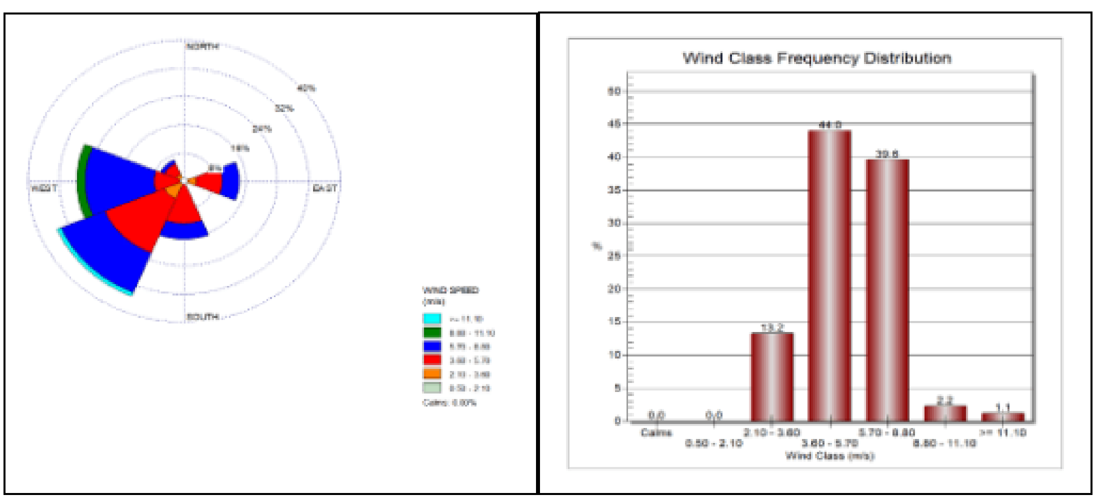


Figure 4. 15: Wind climatology pattern from August to October in Katsina

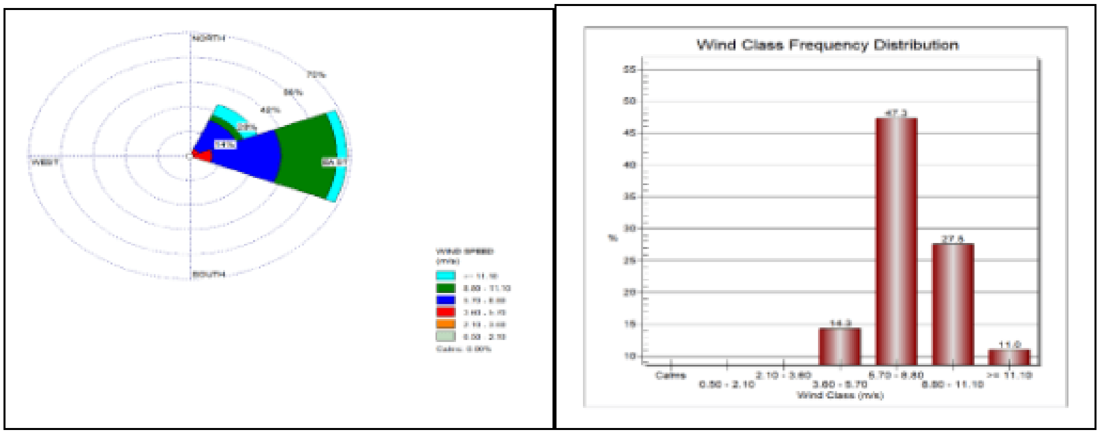


Figure 4. 16: Wind climatology pattern from November to January in Kano

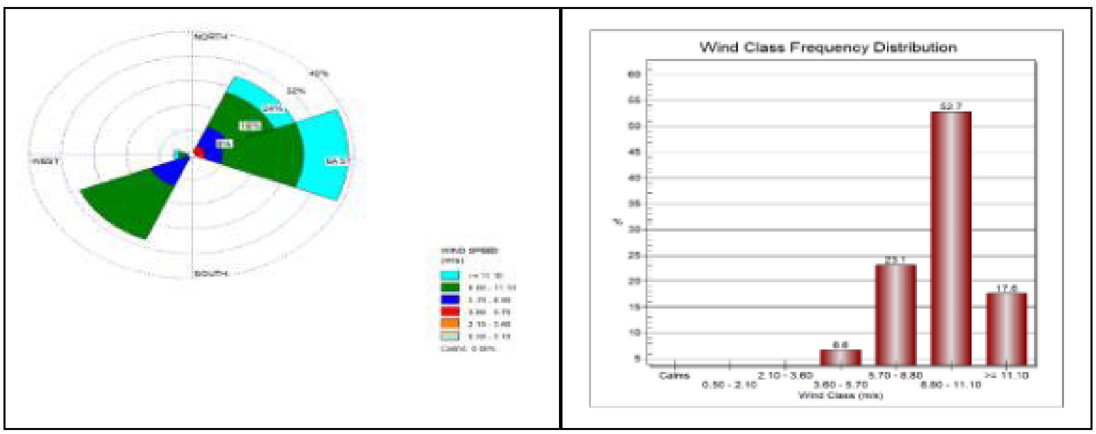


Figure 4. 17: Wind climatology pattern from February to April in Kano

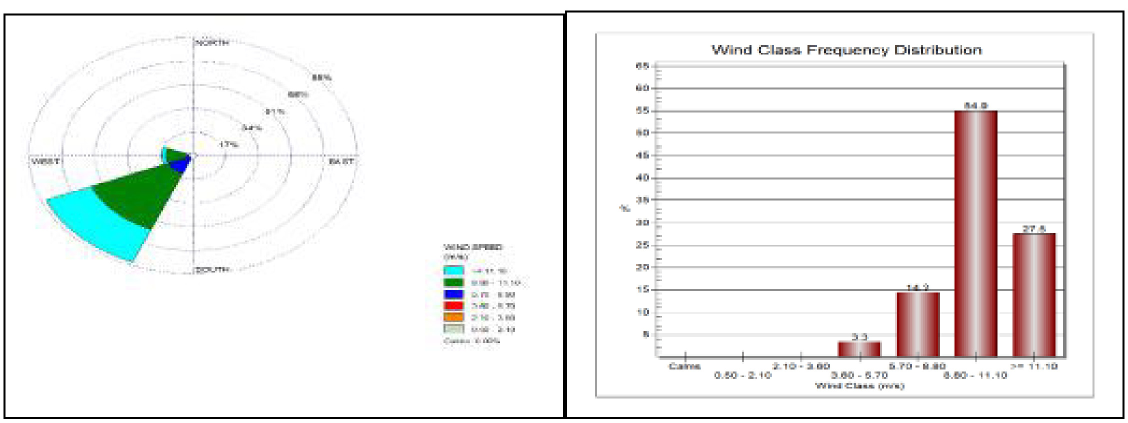


Figure 4. 18: Wind climatology pattern from May to July in Kano

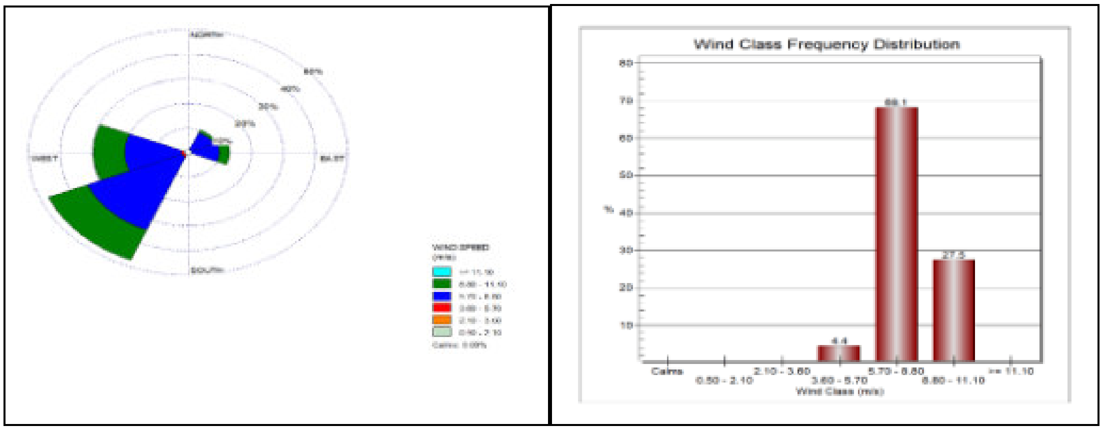


Figure 4. 19: Wind climatology pattern from August to October in Kano

Figure 4. 20: Spatial wind pattern from November to January in Katsina

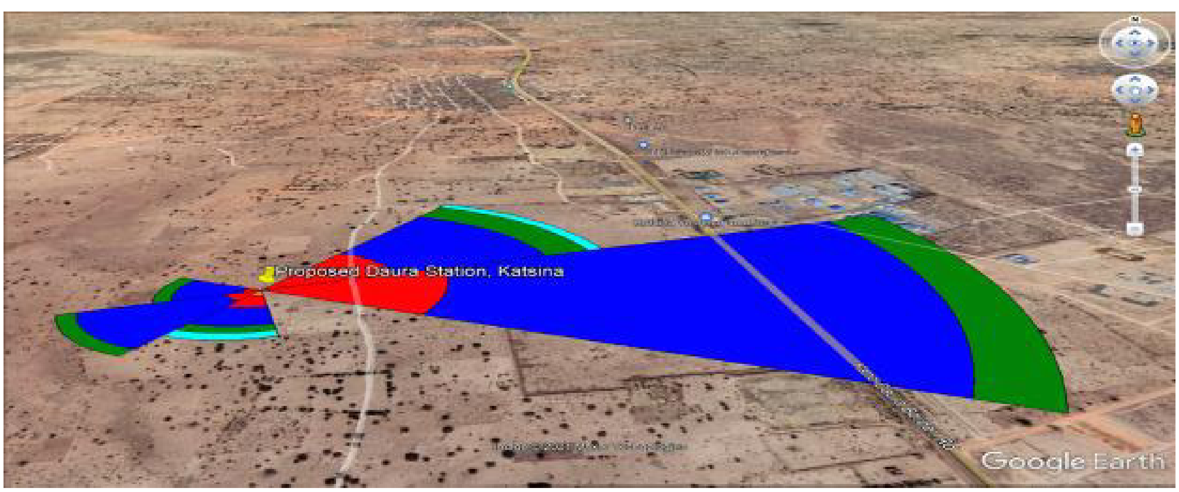


Figure 4. 21: Spatial wind pattern from February to April in Katsina

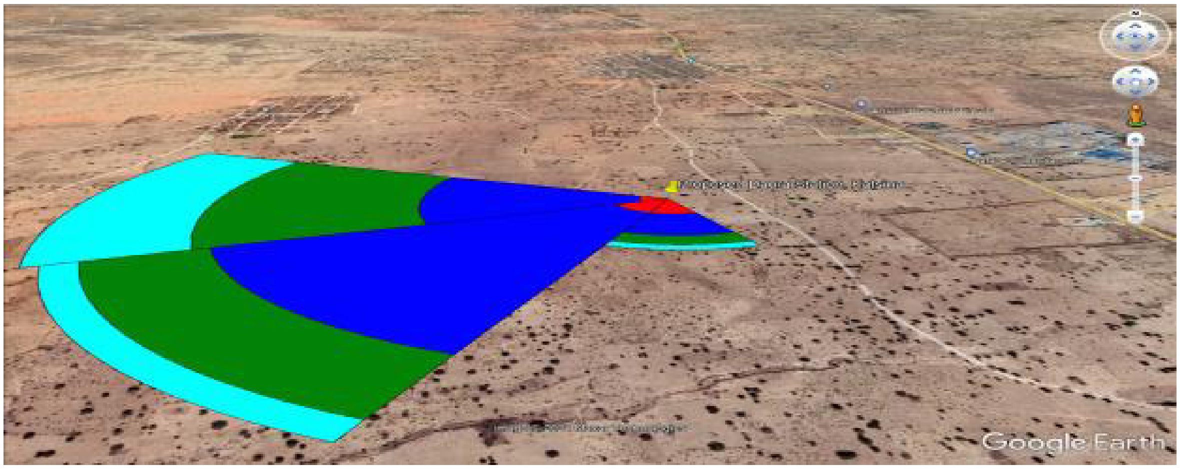


Figure 4. 22: Spatial wind pattern from May to July in Katsina

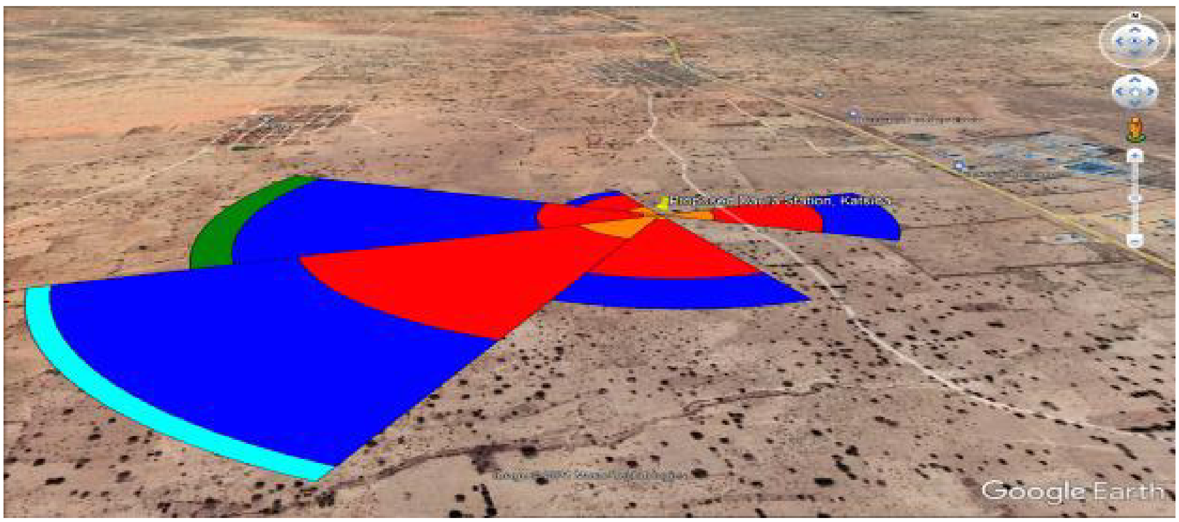


Figure 4. 23: Spatial wind pattern from August to October in Katsina

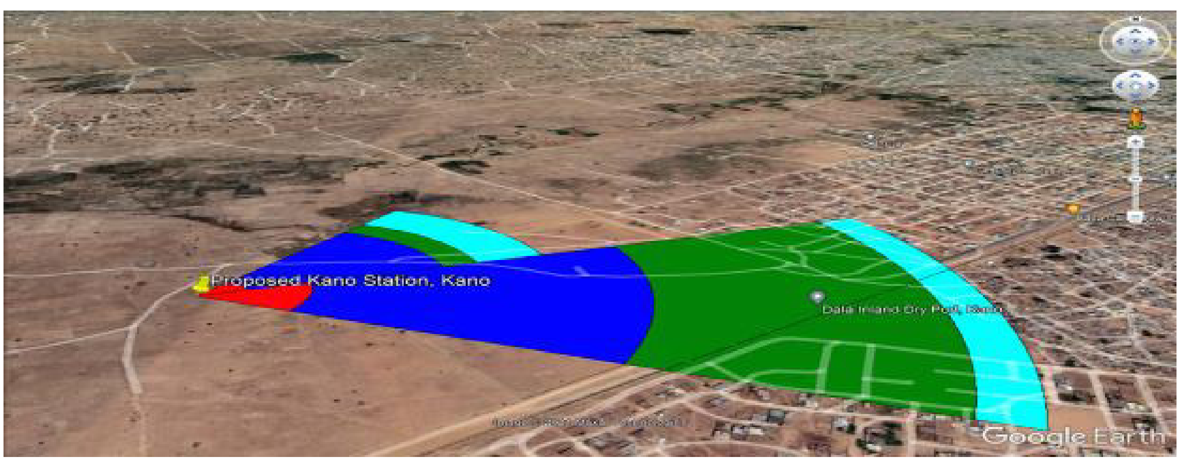


Figure 4. 24: Spatial wind pattern from November to January in Kano

Figure 4. 25: Spatial wind pattern from February to April in Kano

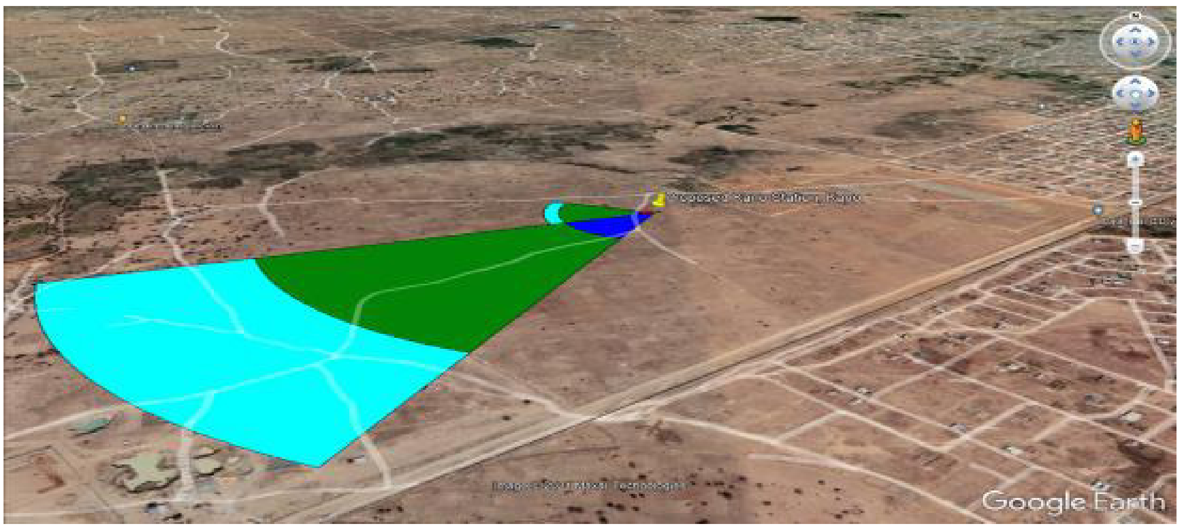


Figure 4. 26: Spatial wind pattern from May to July in Kano

Figure 4. 27: Spatial wind pattern from August to October in Kano

4.3.2 Air Quality and Noise Level Monitoring of the Project Area

Air quality is the extent of deviance of the ambient air from its natural state due to contamination by air pollutants in quantities large enough to produce harmful effects. The undesirable constituents may damage human health, vegetation, human property, or the global environment as well as create aesthetic insults in the form of brown or hazy air or unpleasant smells. The assessment of the air quality of the study area was necessary in order to determine the baseline status of the area and investigate the possible contribution of the proposed project activities when it commences. The air quality parameters determined were mainly those of public and health concern. The variability of air quality records across the project environment showed the following range: NO_2 (0-0.3 ppm i.e., 0-56 µg/m^3); SO_2 (0-0.3 ppm i.e. 0-56 µg/m^3); CO (0-4 ppm i.e. 0-4582 µg/m^3); VOC (0-0.431 ppm i.e. 1392 µg/m^3), $PM_{2.5}$ (13.6-65.8 µg/m^3) and PM_{10} (52.3-103.5 µg/m^3). The concentrations of the recorded pollutants were almost similar in trends across the project environment and this is resulting from the uniformity of the boundary layer dynamics that dominates the environment. Table 4. 5 shows the ambient limits of air quality for sensitive receptors.

Table 4. 5: Tolerance Limits and Standards for Ambient Air Quality

Pollutants	Nigeria (FMEV)		National Air Quality Standard for Nigeria	WHO Guidelines and World Bank Standards	EU Standards
	Long-term Tolerance Limits 24-hours (mg/m³)	Short-term Tolerance Limits 30 min (mg/m³)			
SPM	0.015	0.5	250 μg/m³ (24-h) 600 μg/m³ (1-h) (0.6mg/m³)	60-90μg/m³ (annual mean) 150-230μg/m³ i.e. 0.15-0.23mg/m³ (24h)	
CO	1.0	0.5	10 μg/m³ (1-h) 20 μg/m³ (8-h)	60μg/m³ (24-h), 10 μg/m³ (8-h), 30mg/m³ (1h)	10mg/m³ (daily max for 8-h)
NO_2	0.085	0.085	75 -113 μg/m³ (24-h)	40-50 μg/m³ (annual), 150 (8-h), 200 μg/m³ (24-h) 190-320μg/m³ i.e. 0.19-0.32mg/m³ (1-h)	200μg/m³ i.e. 0.2mg/m³ (1-h)
SO_2	0.05	0.5	0.26mg/m³ (1-h)	50 μg/m³ annual, 350 μg/m³ i.e. 0.350mg/m³ (1-h), 125 μg/m³ (24-h)	350μg/m³ i.e. 0.35mg/m³ (1-h) 125 μg/m³ (24-h)

(Sources: FMEV (1991); WHO (2006); World Bank (1995); EU (2015)

Noise Level Assessment

During the wet season survey, daytime noise level monitored ranged from 34.5-65.8 dB(A)), while in dry season, daytime noise ranged from 32.0 to 76.8 dB(A)) and nighttime ambient noise level ranged from 30.6 - 43.2 dB(A)). The level of noise at night in the project area ranged from 30.6 dBA in Shagalle to 43.8 dBA recorded in Kano (Table 4. 6).

Table 4. 6: Noise level at selected locations along the rail line project corridor

S/N	Locations	Longitude	Latitude	Sound Level (dBA)	
				Day Time	Night Time
1. `	Maradi	7.105946347	13.50288232	54.1	N/A
2.	Daura	8.311722099	13.02765636	57.8	41.5
3.	Gidan Issa	7.191696917	13.39668521	59.2	40.9
4.	Sabon Gari	7.253823993	13.3484607	54.7	N/A
5.	Dan Issa	7.260340819	13.20709988	59.1	41.2
6.	May Daboro	7.302808802	13.1086415	54.7	36.8
7.	Tsamga	7.390840262	13.09066592	64.0	N/A
8.	Katsina	7.591178358	13.00399213	54.8	42.7
9.	Makurda	7.74399793	13.01702578	53.7	40.1
10.	Maduru	7.828689516	13.01819338	53.6	39.7
11.	Moshi	7.949603794	12.98264953	61.3	41.2
12.	Shargalle	8.102151832	12.96923573	56.1	30.6
13.	Kayawa	8.151245256	12.95674514	34.5	N/A
14.	Near Tambo	8.222292237	12.97633635	61.2	N/A
15.	Gurjiya	8.336173773	12.99159658	65.8	38.7
16.	Sandamu	8.358222368	12.96026151	45.9	N/A
17.	Fago	8.37953782	12.89688538	56.8	39.4
18.	Juba	8.394417907	12.85824603	65.1	37.3
19.	Korare	8.395829886	12.81254679	63.8	N/A
20.	Achilafia	8.39610142	12.8008165	64.3	N/A
21.	Agangoro	8.393820531	12.79446259	56.3	38.5
22.	Zungunba	8.399468447	12.75017533	47.9	N/A
23.	Sada	8.403134162	12.71302942	55.1	34.9
24.	Bayan Dutsi	8.405876659	12.68280764	53.3	40.0
25.	Kazaure	8.407831707	12.64552596	54.1	42.1
26.	Ungwa Kusa	8.468139502	12.56868172	52.1	N/A
27.	Yammawar Wanzamai	8.474819249	12.48781877	51.6	33.4
28.	Danya Gari	8.488816848	12.4637744	52.1	N/A
29.	Karanbanin Lalai - Dambatta	8.495713823	12.42763317	53.9	N/A
30.	Tukui	8.518115412	12.37085532	54.0	N/A
31.	Jigawa Satame	8.561913915	12.31717297	51.9	N/A
32.	Gagarawa	8.559931713	12.28935426	54.2	34.9
33.	Burasawa	8.561384422	12.25841292	43.2	38.7
34.	Kuka Bakwai	8.554093723	12.23014618	54.3	N/A
35.	Jirgabawa	8.544970167	12.20025024	51.4	40.6
36.	Kuru	8.5499664	12.17082949	54.7	N/A
37.	Tsakiya - Samunaka	8.551975755	12.16018534	51.6	N/A
38.	Kwamna	8.550943924	12.13808244	54.6	N/A
39.	Kano Township	8.582794912	12.05496575	51.3	42.9

S/N	Locations	Longitude	Latitude	Sound Level (dBA)	
				Day Time	Night Time
40.	Kano Township	8.429323657	11.96052608	51.4	43.8
41.	Fulani	8.424680418	12.02523273	52.1	N/A
42.	Jajira Cikin Gari	8.421469523	12.0333584	53.6	N/A
43.	Zogarawa	8.428570149	12.09388342	59.1	32.5
44.	Daruman	8.43552143	12.11616282	53.1	N/A
45.	Built-up near Tangaji Gari	8.479615932	12.33065912	54.6	39.1
46.	Unguwar Chiroma	8.491661171	12.3559956	53.2	41.8
47.	Shinkafi - Katsina	7.647121237	13.02804329	51.4	N/A
48.	Yan Daki	7.685163209	13.04791282	51.1	40.7
49.	Unknown location	7.49698812	13.05868015	51.6	N/A
50.	Unknown location	7.593691586	13.04999248	53.4	N/A
51.	Unknown location	8.033494766	12.98465142	51.9	30.9
52.	Unknown location	8.42064649	12.60381673	51.6	N/A
53.	Unknown location	8.474009968	12.525903	45.9	N/A
54.	Unknown location	8.448124493	12.25303695	45.0	N/A
55.	Unknown location	8.432624713	12.22330867	43.1	N/A
56.	Unknown location	8.426754397	12.17833742	45.1	N/A
57.	Unknown location	8.422898863	12.06377632	51.3	N/A
58.	Unknown location	8.426190274	11.99505562	41.5	N/A
59.	Unknown location	8.425373998	11.92290615	43.1	N/A
60.	Unknown location	8.4444618701	11.90028617	55.3	N/A
61.	Unknown location	8.5569163876	12.10950796	54.1	N/A
62.	Unknown location	8.5652404211	12.08623294	45.3	N/A
63.	Unknown location	8.571749913	12.06445148	51.3	N/A
64.	Unknown location	8.608555336	12.04424819	54.5	N/A
65.	Unknown location	8.630540945	12.03160658	51.4	N/A
66.	Unknown location	8.630926248	12.00187225	51.7	N/A
67.	Unknown location	8.549152131	12.34283855	51.6	N/A
68.	Unknown location	8.5338759944	12.359871581	52.4	N/A
69.	Unknown location	8.496771331	12.398732072	45.7	N/A
70.	Unknown location	8.44272388	12.57890499	43.4	N/A
71.	Unknown location	8.4004267	12.62522592	45.8	N/A
72.	Unknown location	8.36213828	12.92940876	55.9	N/A
73.	Unknown location	8.342608997	12.95555818	47.1	N/A
74.	Unknown location	8.316896599	13.00317332	55.8	N/A
75.	Unknown location	8.285664936	13.00585241	55.4	N/A
76.	Unknown location	8.249825827	12.99685078	45.1	N/A
77.	Unknown location	8.180090918	12.97052167	55.8	N/A
78.	Unknown location	8.141212059	12.97052167	54.4	N/A
79.	Unknown location	8.062101294	12.9784203	55.1	N/A
80.	Unknown location	7.994328445	12.98767148	54.6	N/A
81.	Unknown location	7.9087022965	12.99289483	53.6	31.8
82.	Unknown location	7.869012268	13.00860436	54.6	N/A
83.	Unknown location	7.777750249	13.02186569	55.6	N/A
84.	Unknown location	7.638142834	13.05004903	54.1	N/A
85.	Unknown location	7.256661527	13.30444497	54.5	N/A
86.	Unknown location	7.263303895	13.26007211	54.3	N/A
87.	Unknown location	7.277064001	13.17511633	54.8	N/A
88.	Unknown location	7.135974926	13.473200873	54.9	N/A

S/N	Locations	Longitude	Latitude	Sound Level (dBA)	
				Day Time	Night Time
89.	Unknown location	7.161081411	13.44781514	53.3	N/A
90.	Unknown location	7.1954287094	13.41783695	46.9	N/A
91.	Unknown location	7.23132871	13.37108659	43.6	N/A
92.	Unknown location	7.220482223	13.39419338	46.6	N/A
93.	Unknown location	1.344421452	13.10807128	55.4	N/A
94.	Unknown location	7.451712789	13.07959875	54.7	N/A
95.	Unknown location	7.546877917	13.044640873	56.8	N/A
96.	Unknown location	7.710646272	13.0330829	54.8	N/A
97.	Unknown location	7.278384281	13.13240076	56.7	N/A
98.	Unknown location	7.24634606	13.33659464	45.9	N/A
99.	Dumbus	9.20063265	11.84656783	54.9	43.1
100.	Shuwari	9.406602458	11.78855887	56.8	33.8

The noise values show a less noise friendly environment good for human habitation. The following are causes of high noise levels: industrialization, poor urban planning that leads to congested houses and activities, social events, transportation, construction activities etc. The upper levels of noise recorded were as a result of vehicular flow, human activities as well as whistling from birds within the study environment. The level of noise at night in the project area ranged from 30.6 dBA in Shagalle to 43.8 dBA recorded in Kano. According to Berglund *et al.* (1999), exposure to high level of noise results in hearing impairment and this causes vibration inside the ear that could lead to permanent damage. In addition, insomnia and tiredness can also result from high noise exposure. Noise affects wildlife in a variety of ways. High levels can cause the temporary and permanent displacement of animals and birds from particular environment. It can also have physiological effects that are detrimental to wildlife health. All values recorded were below the Nigeria and World Bank Noise Exposure Limits set within the various durations (Table 4. 7 and Table 4. 8).

Table 4. 7: Noise Exposure Limits for Nigeria

Duration per Day, Hour	Permissible Exposure Limit dB (A)
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.5	110

Duration per Day, Hour	Permissible Exposure Limit dB (A)
0.25 or less	115

(Source: FEPA, 1991)

Table 4. 8: Maximum Allowable Log Equivalent (Hourly Measurement) in dB (A)

Receptor	Day-time (7:00 – 22:00)	Night-time (22:00 – 7:00)
Residential, institutional, educational	55	45
Industrial, commercial	70	70

Source: World Bank (2007)

4.3.2.1 *Results of Air Dispersion Modelling*

Table 4. 9 shows the result summary of modelling outputs from the construction activities that will take place for the proposed project throughout the listed stations. Results outputs show that all scenarios were below set regulatory limits for the criteria pollutants considered.

Table 4. 9: Summary of Air Pollutants Ground Level Concentrations Output

S/No	Station	Level	Pollutants Ground Level Concentration (µg/m³)					
			CO 1h	CO 24h	NO_x 1h	NO_x 24h	$PM_{2.5}$ 1h	$PM_{2.5}$ 24h
1	Kano	High	0.078	0.006	0.026	0.002	5.481	0.439
		Low	0	0	0	0	0.0003	0.00001
		Mean	**0.009**	**0.0009**	**0.003**	**0.0003**	**0.645**	**0.063**
2	Dawanau	High	0.073	0.005	0.004	0.0003	25.871	1.963
		Low	0	0	0	0	0.0016	0.00007
		Mean	**0.008**	**0.0007**	**0.004**	**0.00004**	**2.683**	**0.263**
3	Kunya	High	0.029	0.002	0.010	0.0007	23.863	1.794
		Low	0	0	0	0	0.004	0.0002
		Mean	**0.003**	**0.0003**	**0.001**	**0.00001**	**2.419**	**0.237**
4	Dambatta	High	0.060	0.005	0.007	0.0005	20.992	1.595
		Low	0	0	0	0	0.0013	0.00006
		Mean	**0.0062**	**0.0007**	**0.00069**	**0.00007**	**2.186**	**0.214**
5	Kazaure	High	0.032	0.0024	0.0019	0.0001	2.215	0.168
		Low	0	0	0	0	0.0001	0.00001
		Mean	**0.0033**	**0.0003**	**0.0002**	**0.000019**	**0.229**	**0.023**
6	Durbe	High	0.006	0.0005	0.004	0.0003	2.234	0.169
		Low	0	0	0	0	0.0012	0.00005
		Mean	**0.0007**	**0.00005**	**0.0004**	**0.00004**	**0.230**	**0.023**
7	Daura	High	0.0081	0.0006	0.0051	0.0004	30.362	2.217
		Low	0	0	0	0	0.014	0.00058
		Mean	**0.0008**	**0.00007**	**0.0005**	**0.00005**	**2.871**	**0.280**
8	Shargalle	High	0.0153	0.0012	0.0039	0.0003	25.441	1.947
		Low	0	0	0	0	0.0035	0.00014
		Mean	**0.002**	**0.0002**	**0.0004**	**0.00004**	**2.693**	**0.263**
9	Maduru	High	0.0255	0.0016	0.0041	0.00025	13.259	0.817
		Low	0	0	0	0	0.0012	0.00005

S/No	Station	Level	Pollutants Ground Level Concentration (µg/m³)					
			CO 1h	CO 24h	NO_x 1h	NO_x 24h	$PM_{2.5}$ 1h	$PM_{2.5}$ 24h
		Mean	**0.004**	**0.0004**	**0.0006**	**0.00006**	**1.985**	**0.199**
10	Katsima	High	0.0289	0.0022	0.0039	0.0003	29.492	2.228
		Low	0	0	0	0	0.0048	0.0002
		Mean	**0.003**	**0.0003**	**0.0004**	**0.000038**	**3.027**	**0.297**
11	Daddara	High	0.0304	0.0019	0.0027	0.0002	12.620	0.795
		Low	0	0	0	0	0.001	0.00004
		Mean	**0.005**	**0.00046**	**0.0004**	**0.00004**	**1.905**	**0.192**
12	Jibiya	High	0.080	0.0047	0.0028	0.0002	19.897	1.175
		Low	0.00001	0	0	0	0.0017	0.00007
		Mean	**0.011**	**0.001**	**0.0004**	**0.000037**	**2.695**	**0.269**
13	Anoal Mata	High	0.024	0.0018	0.0057	0.0004	28.136	2.165
		Low	0	0	0	0	0.0043	0.0002
		Mean	**0.003**	**0.0003**	**0.0006**	**0.000059**	**3.018**	**0.296**
14	Maradi	High	0.060	0.0045	0.0035	0.003	27.251	2.072
		Low	0	0	0	0	0.0017	0.00007
		Mean	**0.0062**	**0.0006**	**0.0004**	**0.00004**	**2.839**	**0.287**
GRAND MEAN (All Stations)			**0.0045**	**0.0005**	**0.0007**	**0.000065**	**2.102**	**0.207**
Ambient Standard for Pollutants (µg/m³)								
FMEnv			**10,000-11,800**		**75-113**		**600**	**250**
WHO (2006)			**30,000**		**190-320**	**200**		**150-230**
EU (2016				**10,000**		**200**		

Modelling results revealed that ground level concentrations for nitrogen oxides (NO_x), carbon monoxide (CO) and particulate matter of size ($PM_{2.5}$) for the averaging time periods considered i.e., 1-hour and 24-hour were within the following range: 0-0.026 µg/m³ and 0-0.002 µg/m³; 0-0.08 µg/m³ and 0-0.006 µg/m³; and 0.0001-30.362 µg/m³ and 0.00001-2.217 µg/m³ for the pollutants and hours considered respectively. Modelling results showed that the potential concentrations of airborne particulates would be higher than other considered pollutants during the construction activities of the proposed project. The potential airborne particulates coupled with fugitive dust emissions will be dependent on the atmospheric stability conditions of the project environment as well as the wind climatology in dispersing and diluting the particulates across sensitive receptors.

The atmospheric stability pattern of the proposed project environment such as Kano is moderately unstable (Pasquill-Gifford stability class B) with moderate to high mechanical turbulence during the day. This atmospheric condition will ensure rapid mixing condition due to the extension of the atmospheric boundary layer; however, enhancing air pollutants concentrations at receptors close to emission sources but reducing concentrations at receptors farther away from emission sources (Edokpa, 2017). During periods of dawn, stable atmospheric stability condition exist (Pasquill-Gifford class E) within the project environment and this atmospheric condition enables pollutants concentrations to be minimal and maximum at closer and distant receptors of emission sources respectively due to the contraction of the atmospheric boundary layer to less than 200 metres (Edokpa, 2017).

From Figure 4. 28 to Figure 4. 48 the geospatial distribution of the pollutant's concentrations at ground level within 2 km radius of stations and entire proposed project environment are shown respectively. The modelling outputs has shown that close receptors to the emission source of radius 100-500 m are considered vulnerable to the very low concentrations values. However, receptors greater than 1 km both north-east and south-west of emission sources were the least impacted. The average dominant wind climatology as shown in Figures 4.49 to 4.54 for the proposed project environment show a dominant north-easterly/south-westerly wind directions from wind data of 1990-2020. This indicates that the average pollutant concentrations will be more of the south-westerly/north-easterly directions. The results which were evaluated with reference to regulatory limits shows that all ground level pollutants concentrations within the radius of point source up to 200 km were far below acceptable ambient limits at a reduction range of between 88-99.99 % for all scenarios.

Air quality records from ground-trotting assessments during the wet season showed range values for the following parameters: NO_2 (0-0.3 ppm i.e. 0-56 μg/m^3); SO_2 (0-0.3 ppm i.e. 0-56 μg/m^3); CO (0-4 ppm i.e. 0-4582 μg/m^3); VOC (0-0.431 ppm i.e. 1392 μg/m^3), $PM_{2.5}$ (13.6-65.8 μg/m^3), PM_{10} (52.3-103.5 μg/m^3). In dry season, the ground-trotting assessments showed range values for NO_2 (0-0.4 ppm); SO_2 (0-0.4 ppm); CO (0-4 ppm); VOC (0-0.431 ppm), $PM_{2.5}$ (3-130 μg/m^3), PM_{10} (10-379 μg/m^3).

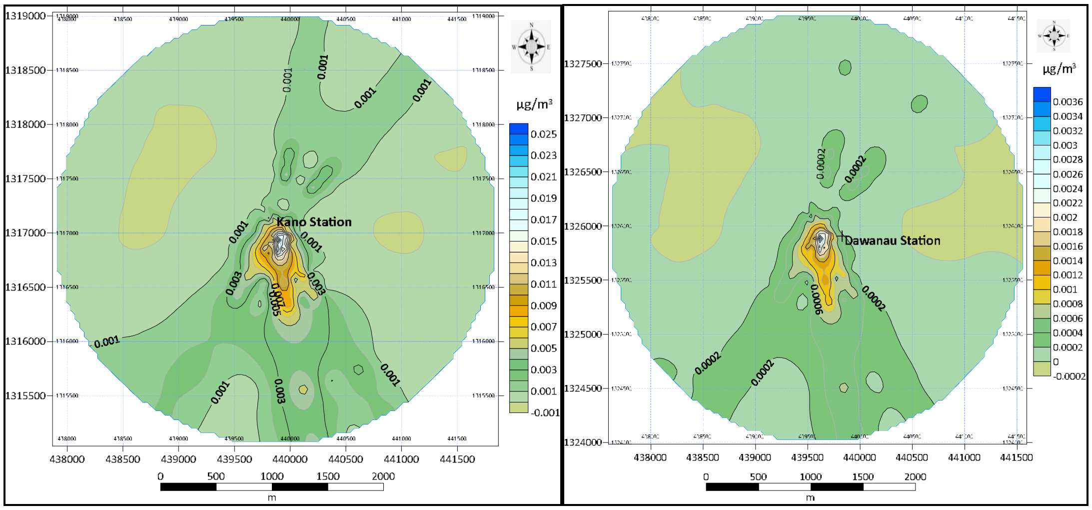


Figure 4. 28: Potential NOx concentrations around Kano and Dawanau Stations

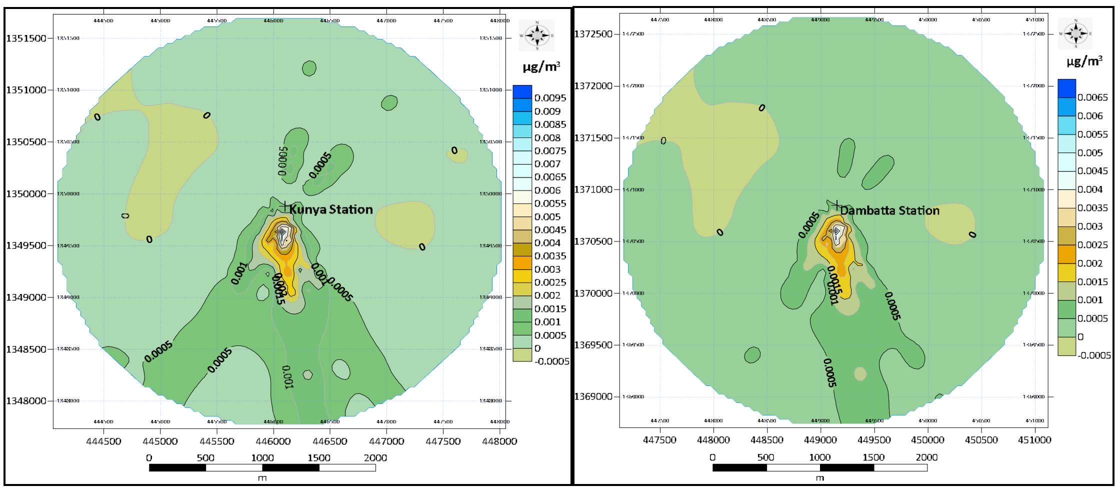


Figure 4. 29: Potential NOx concentrations around Kunya and Dambatta Stations

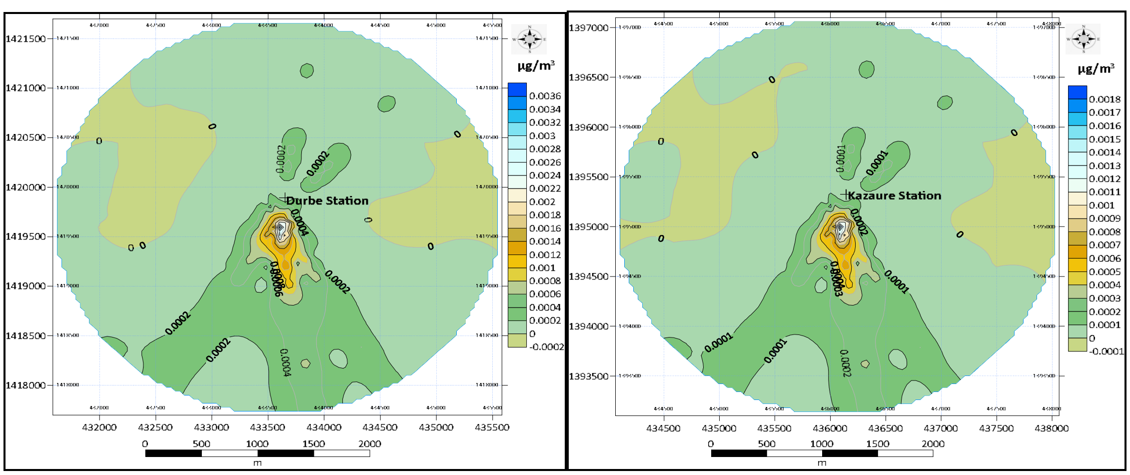


Figure 4. 30: Potential NOx concentrations around Durbe and Kazaure Stations

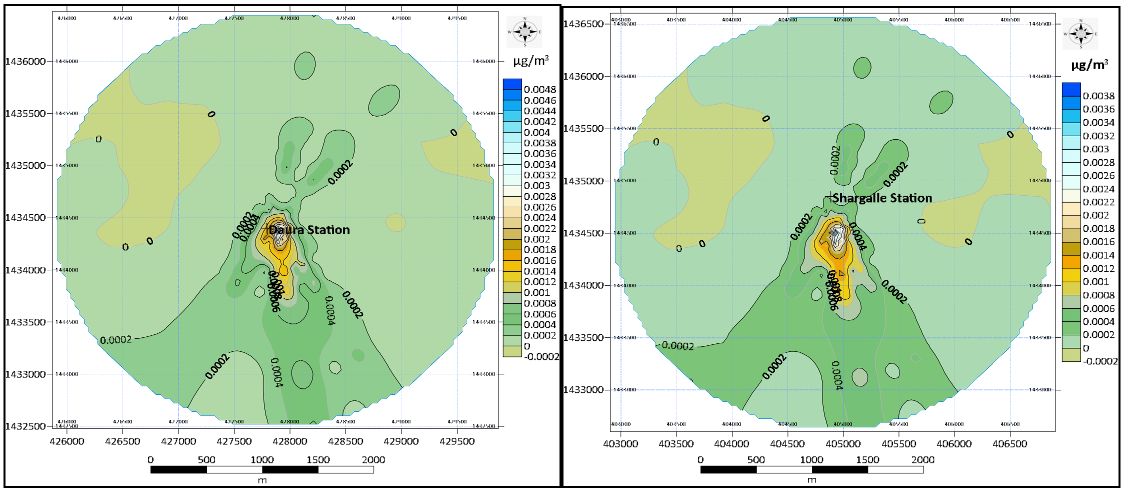


Figure 4. 31: Potential NOx concentrations around Daura and Shargalle Stations

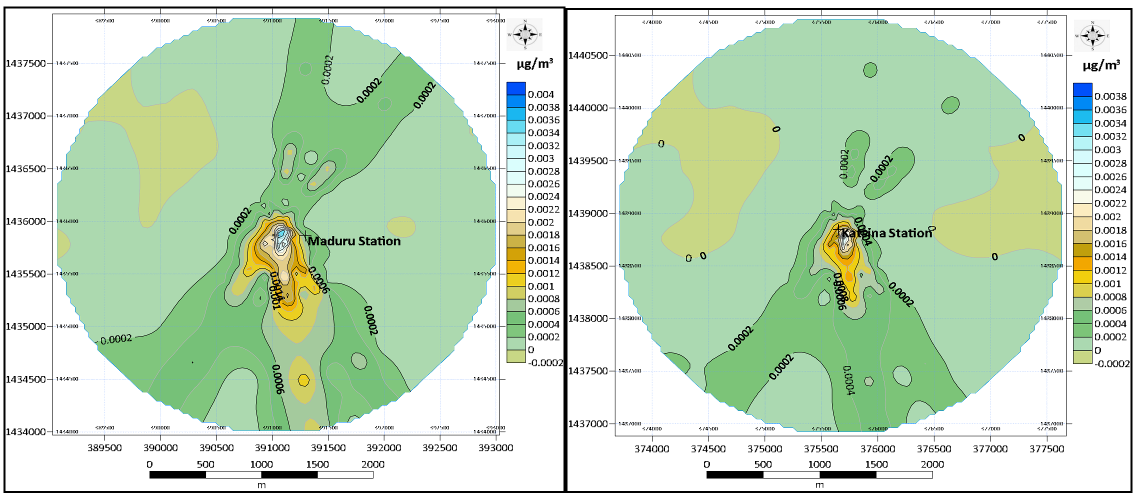


Figure 4. 32: Potential NOx concentrations around Maduru and Katsina Stations.

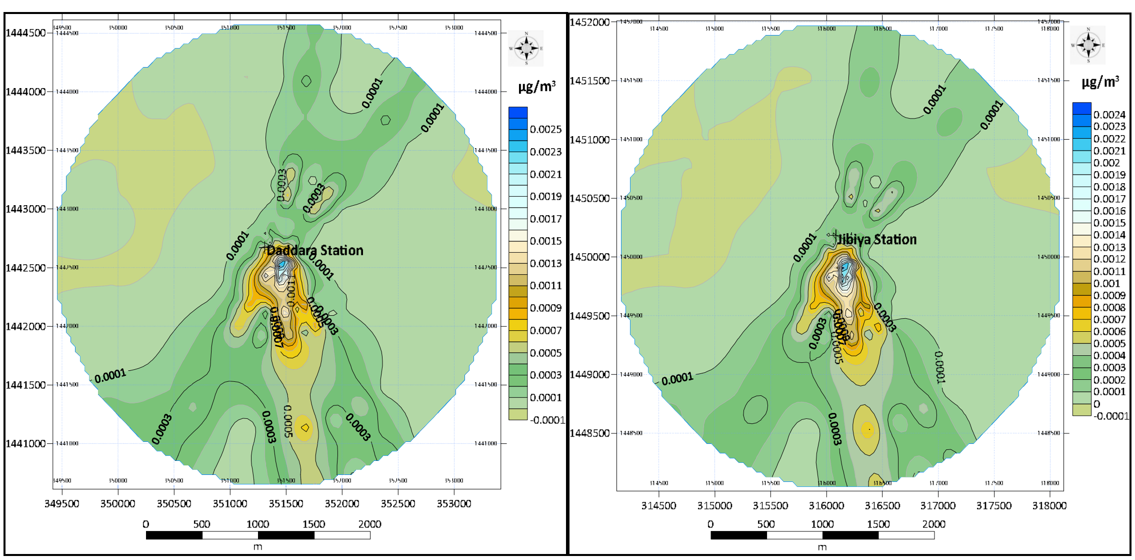


Figure 4. 33: Potential NOx concentrations around Daddara and Jibiya Stations

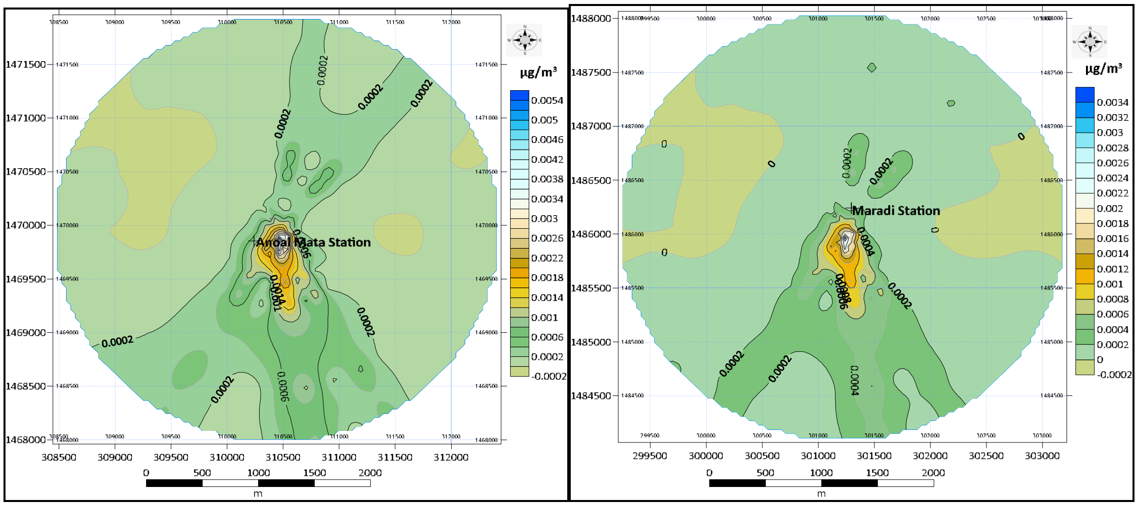


Figure 4. 34: Potential NOx concentrations around Anoal Mata and Maradi Stations

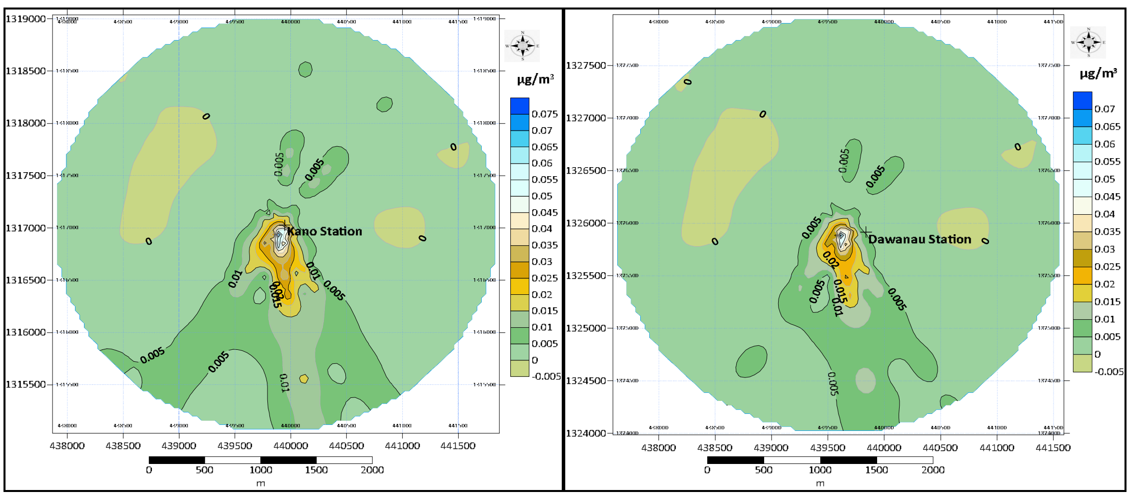


Figure 4. 35: Potential CO concentrations around Kano and Dawanau Stations

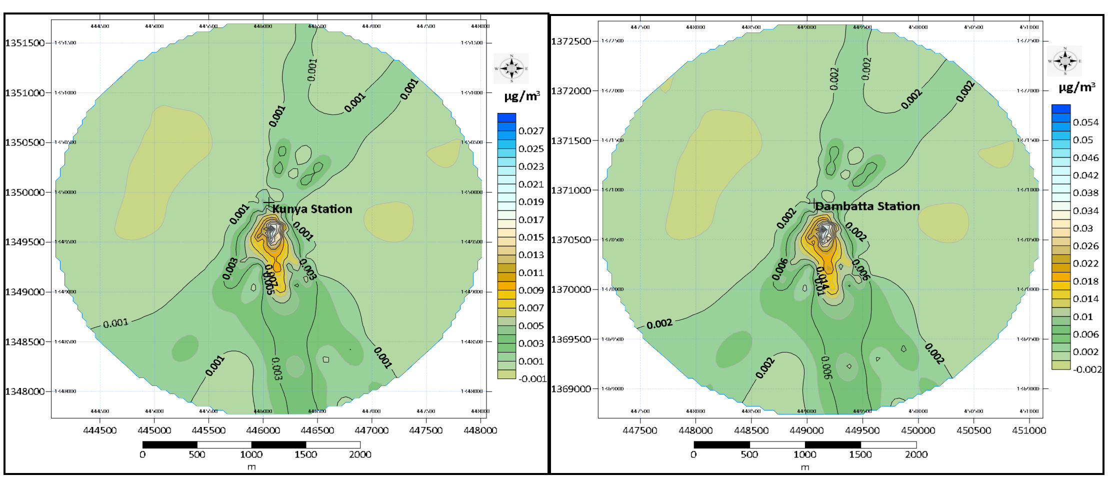


Figure 4. 36: Potential CO concentrations around Kunya and Dambatta Stations

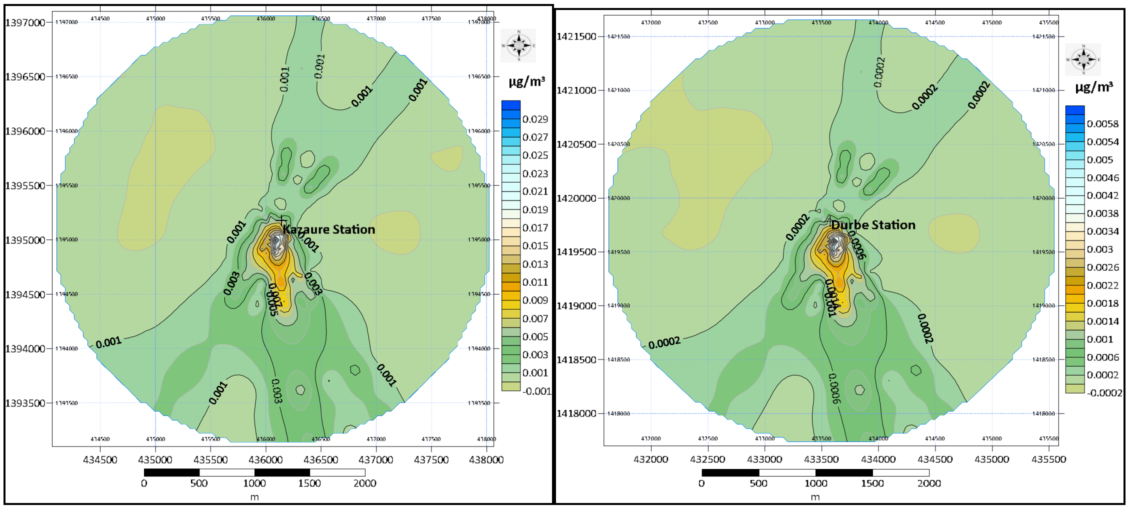


Figure 4. 37: Potential CO concentrations around Kazaure and Durbe Stations

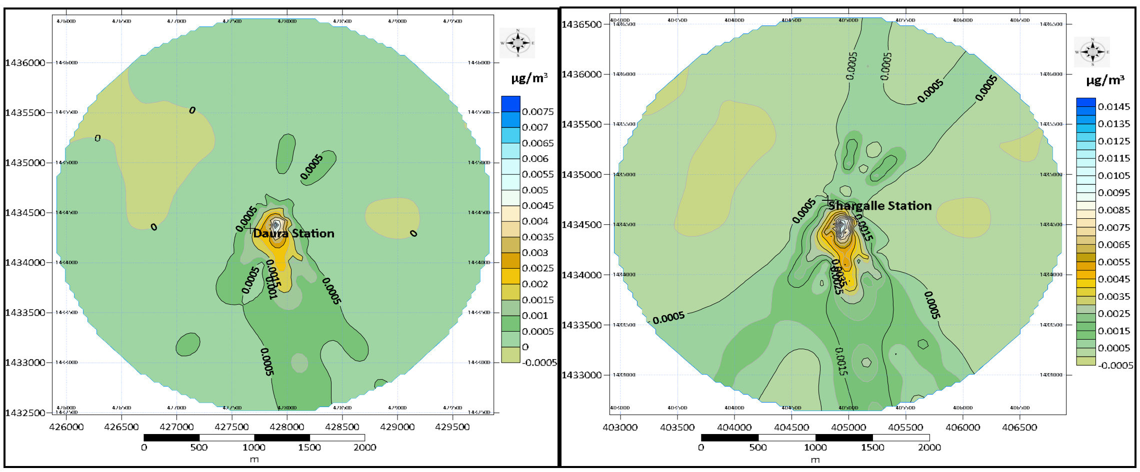


Figure 4. 38: Potential CO concentrations around Daura and Shagalle Stations

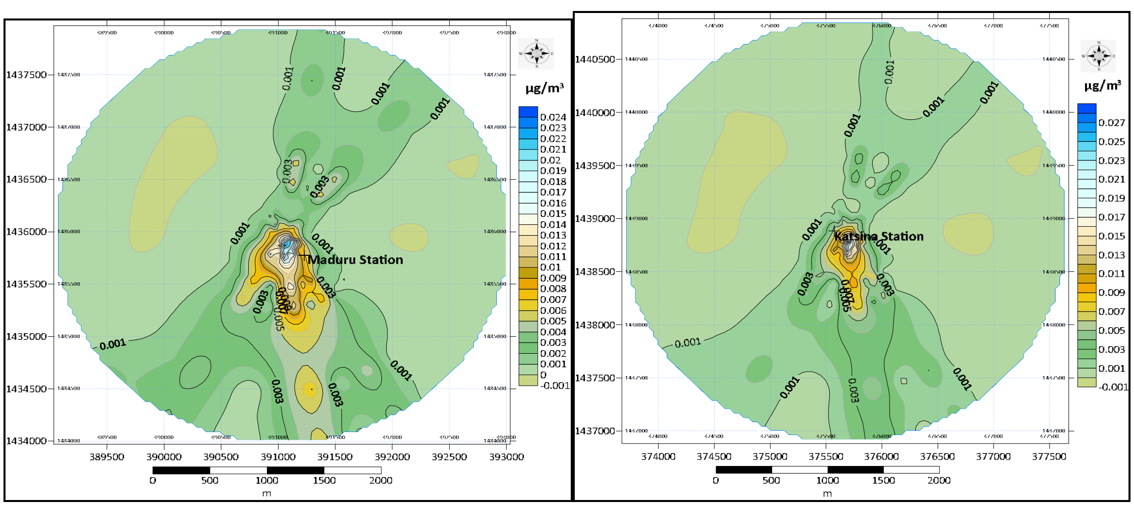


Figure 4. 39: Potential CO concentrations around Madura and Katsina Stations

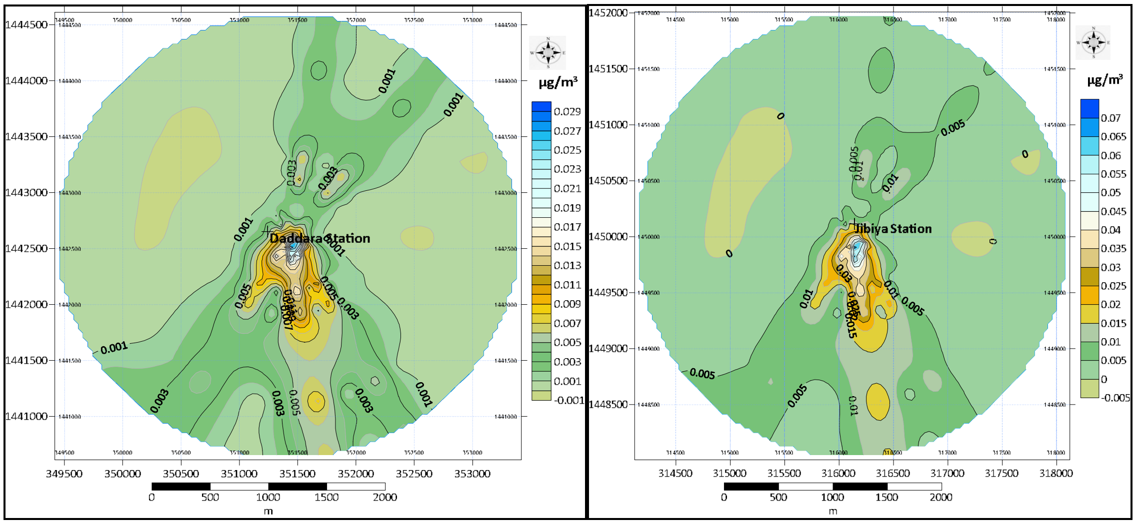


Figure 4. 40: Potential CO concentrations around Daddara and Jibiya Stations

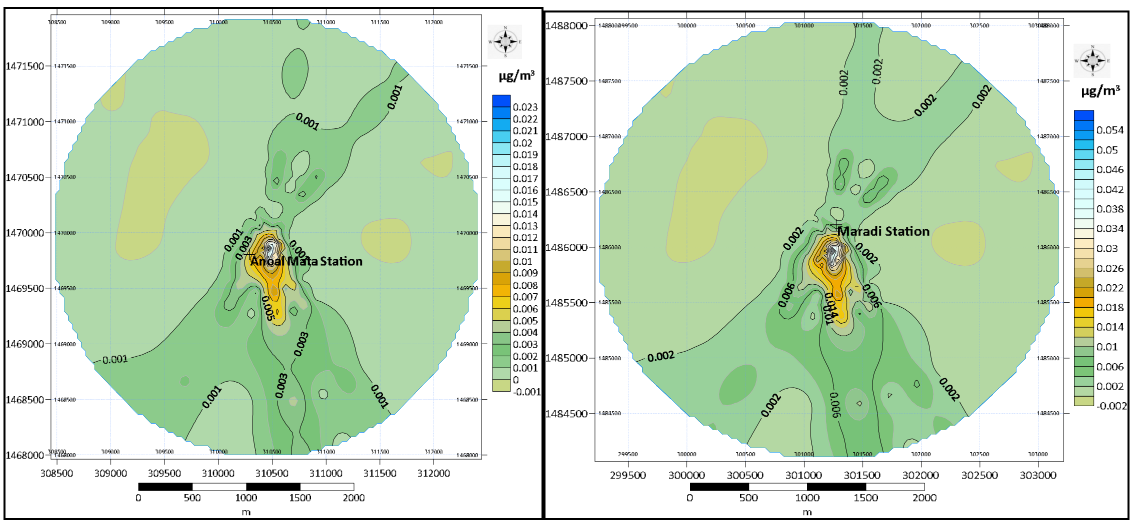


Figure 4. 41: Potential CO concentrations around Anoal Mata and Maradi Stations

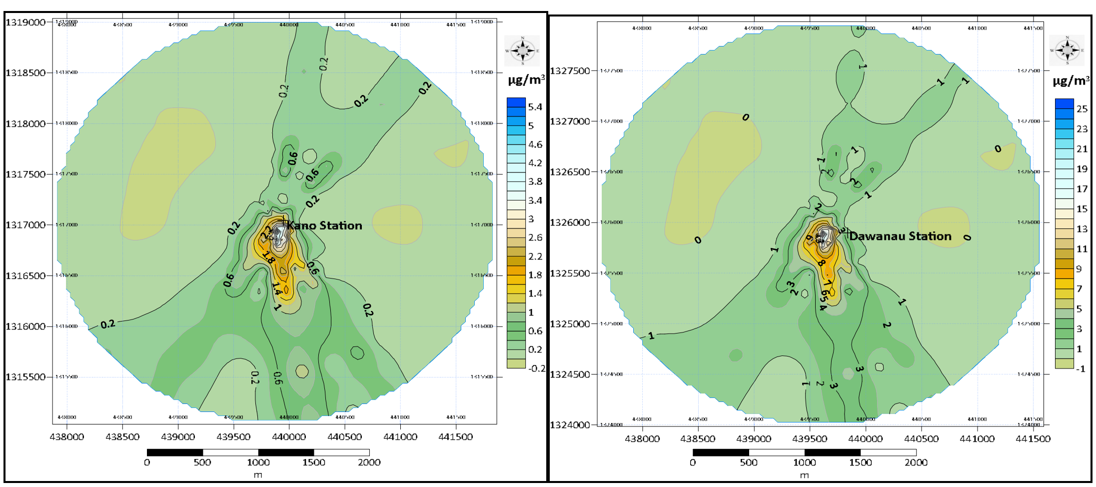


Figure 4. 42: Potential PM2.5 Concentrations around Kano and Dawanau Stations

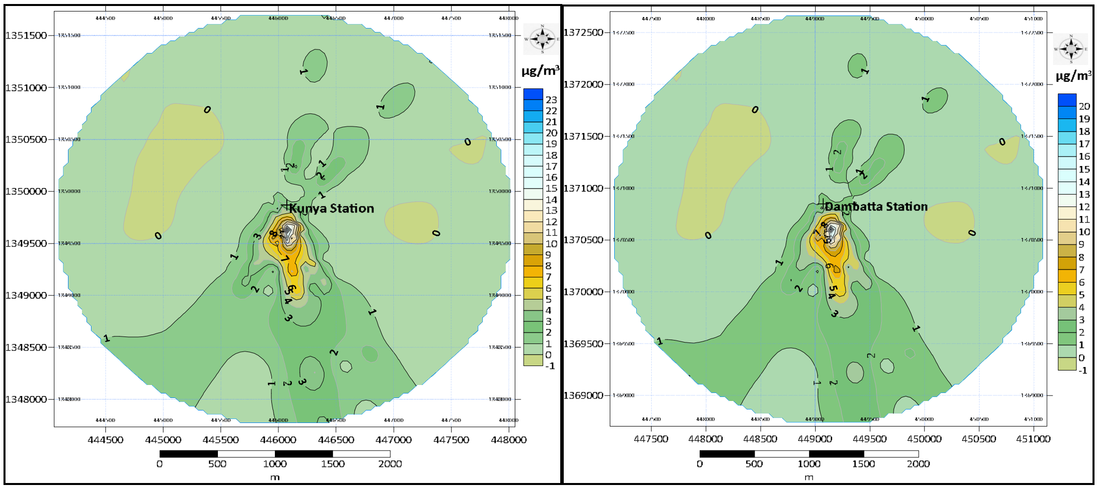


Figure 4. 43: Potential PM2.5 concentrations around Kunya and Dambatta Stations

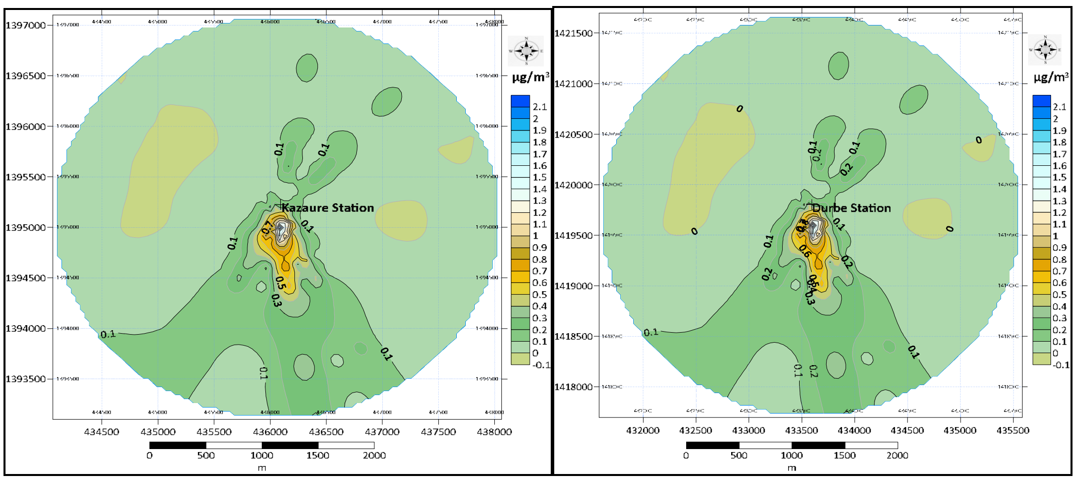


Figure 4. 44: Potential PM2.5 concentrations around Kazaure and Durbe Stations

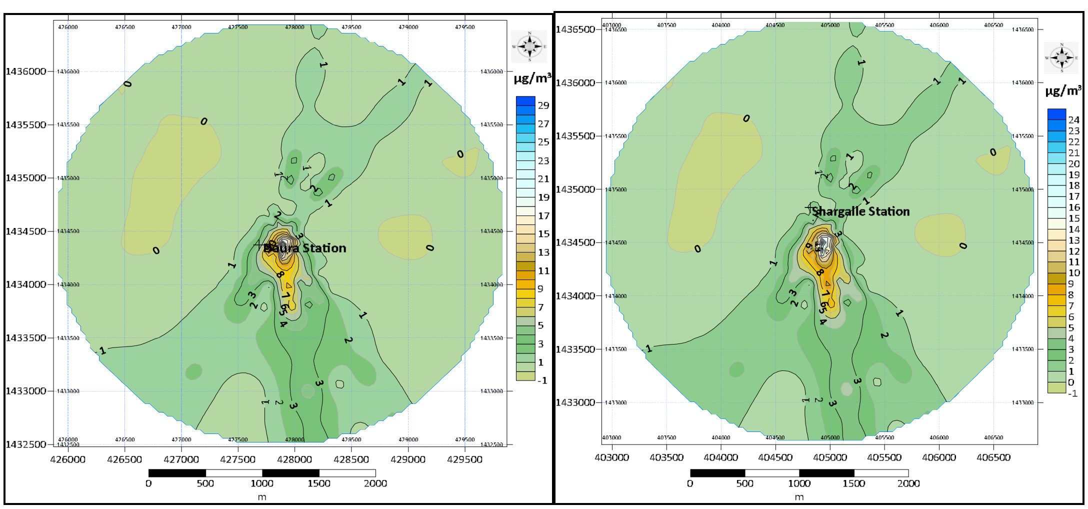


Figure 4. 45: Potential PM2.5 concentrations around Daura and Shargalle Stations

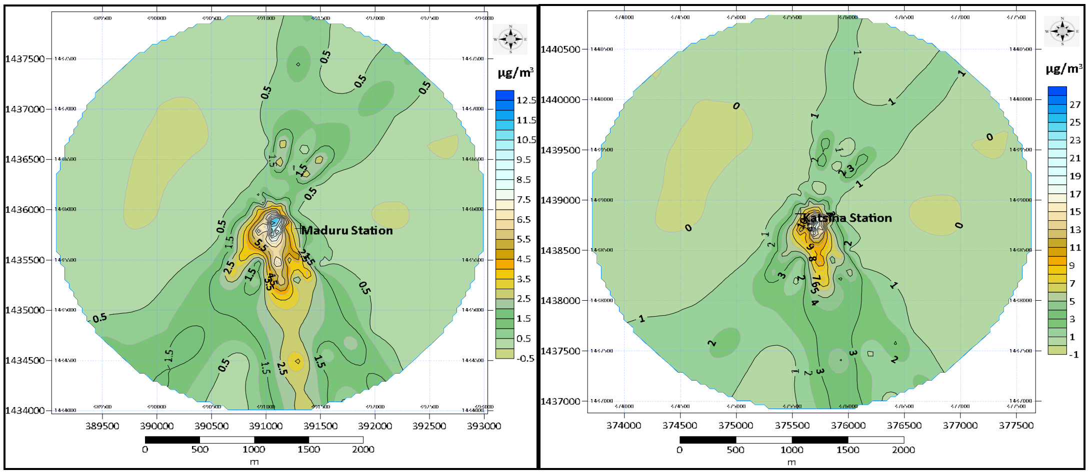


Figure 4. 46: Potential PM2.5 concentrations around Maduru and Katsina Stations

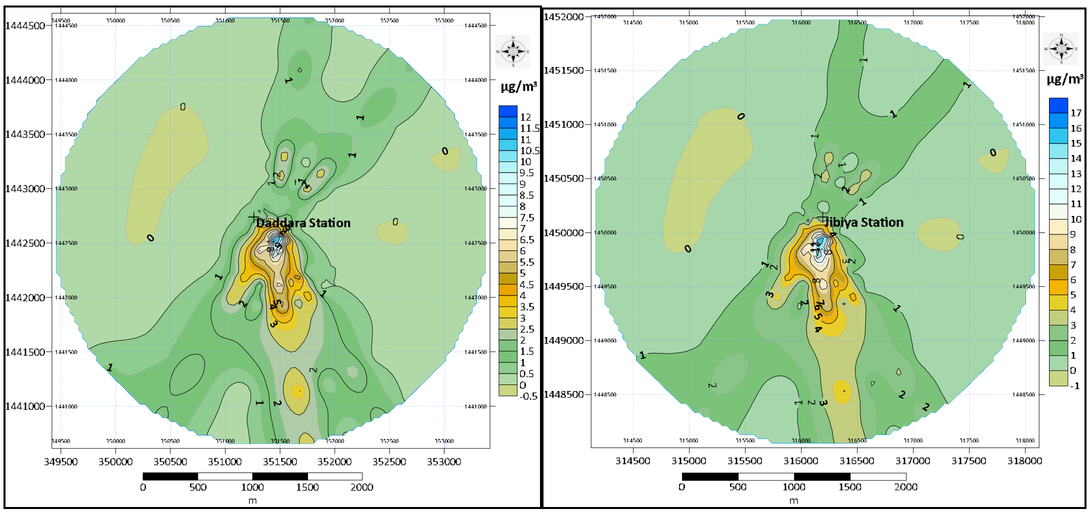


Figure 4. 47: Potential PM2.5 concentrations around Daddara and Jibiya Stations

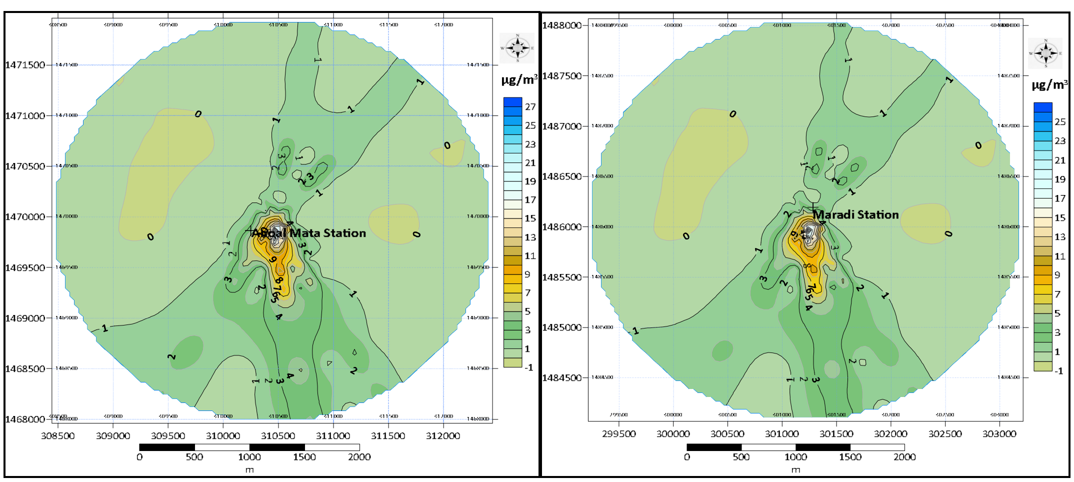


Figure 4. 48: Potential PM2.5 concentrations around Anoal Mata and Maradi Stations

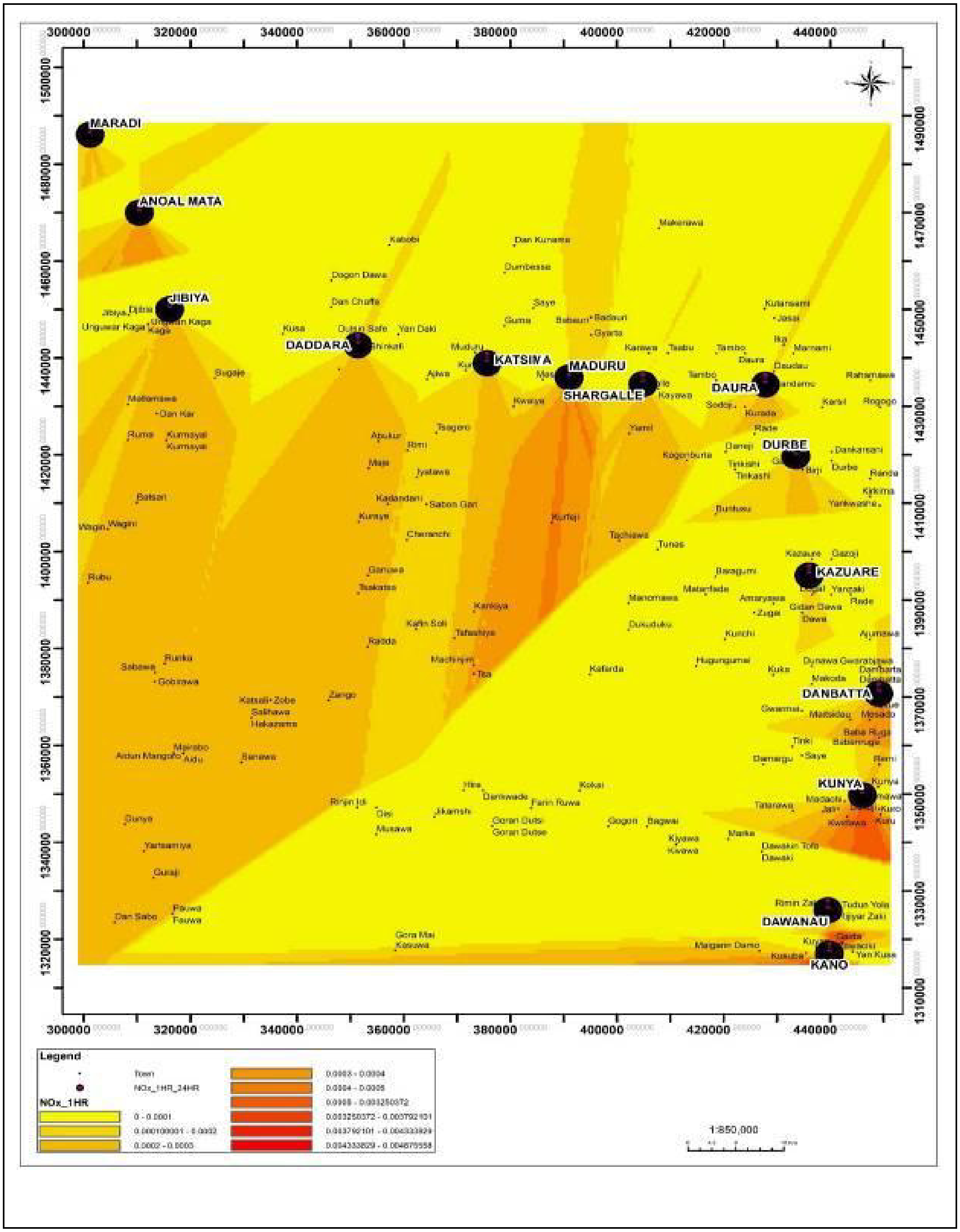


Figure 4. 49: 1-Hour Potential NOx concentrations across the Project Environment

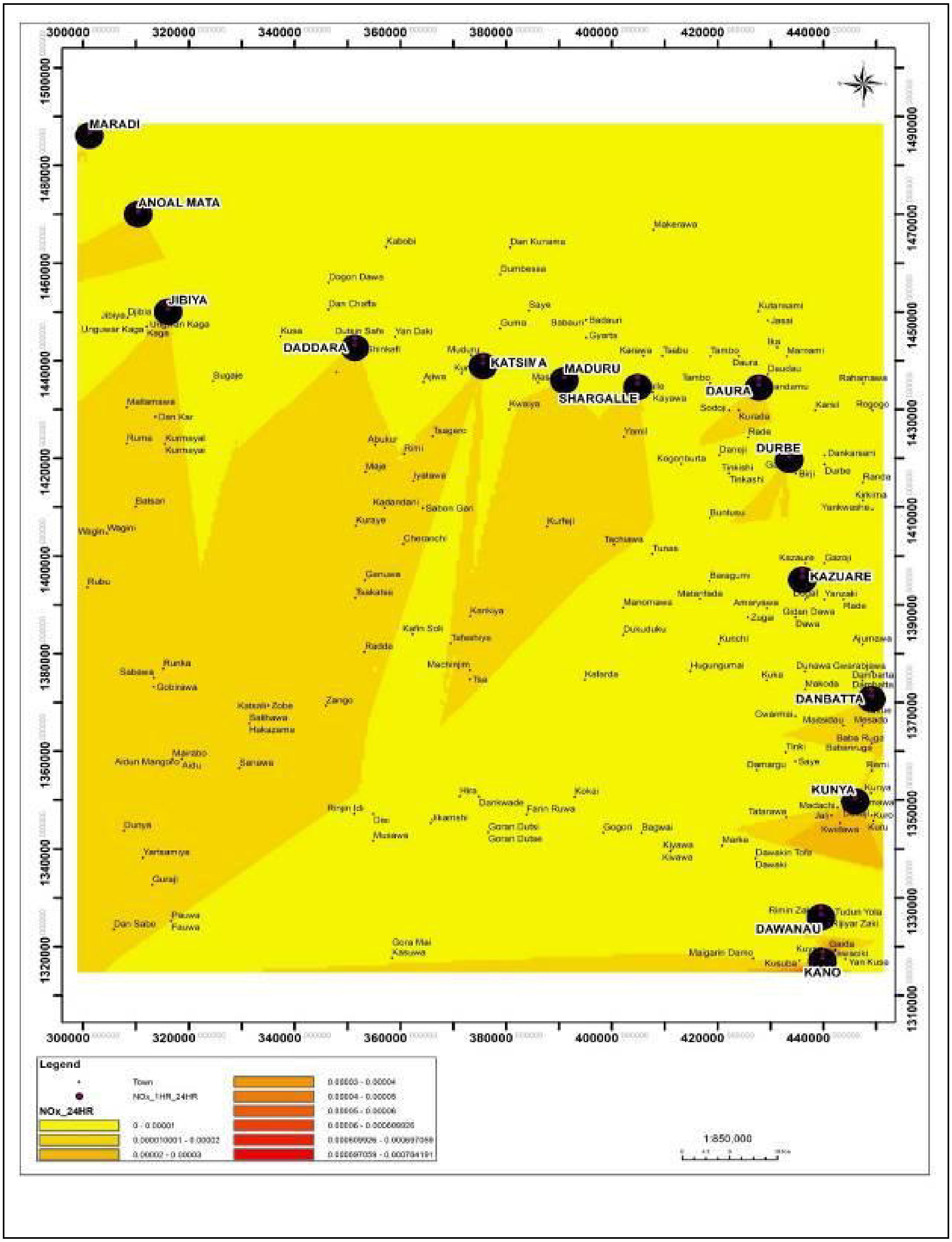


Figure 4.50: 24-Hour Potential NOx concentrations across the Project environment

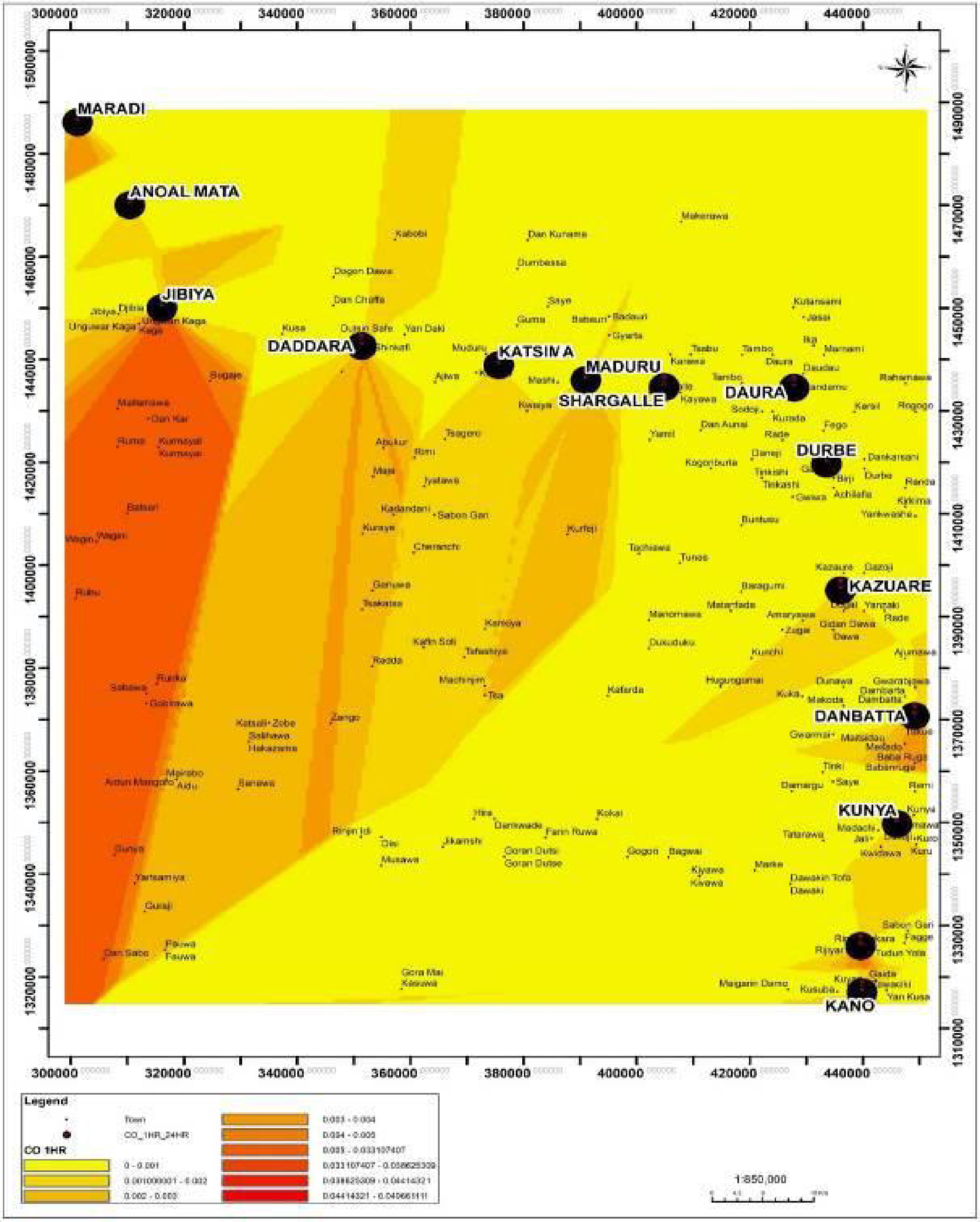


Figure 4.51: 1-Hour Potential CO concentrations across the Project Environment

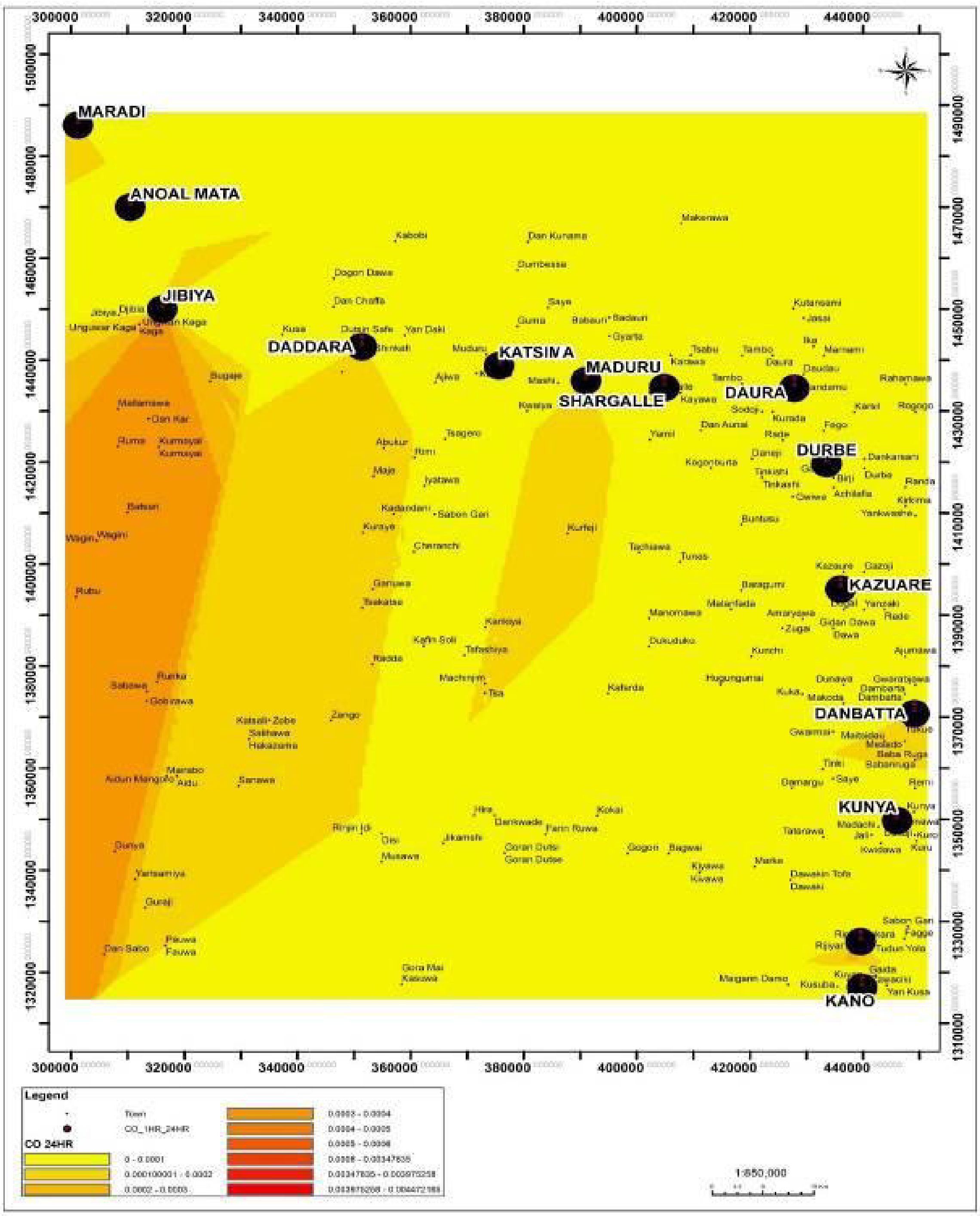


Figure 4.52: 24-Hour Potential CO concentrations across the Project environment

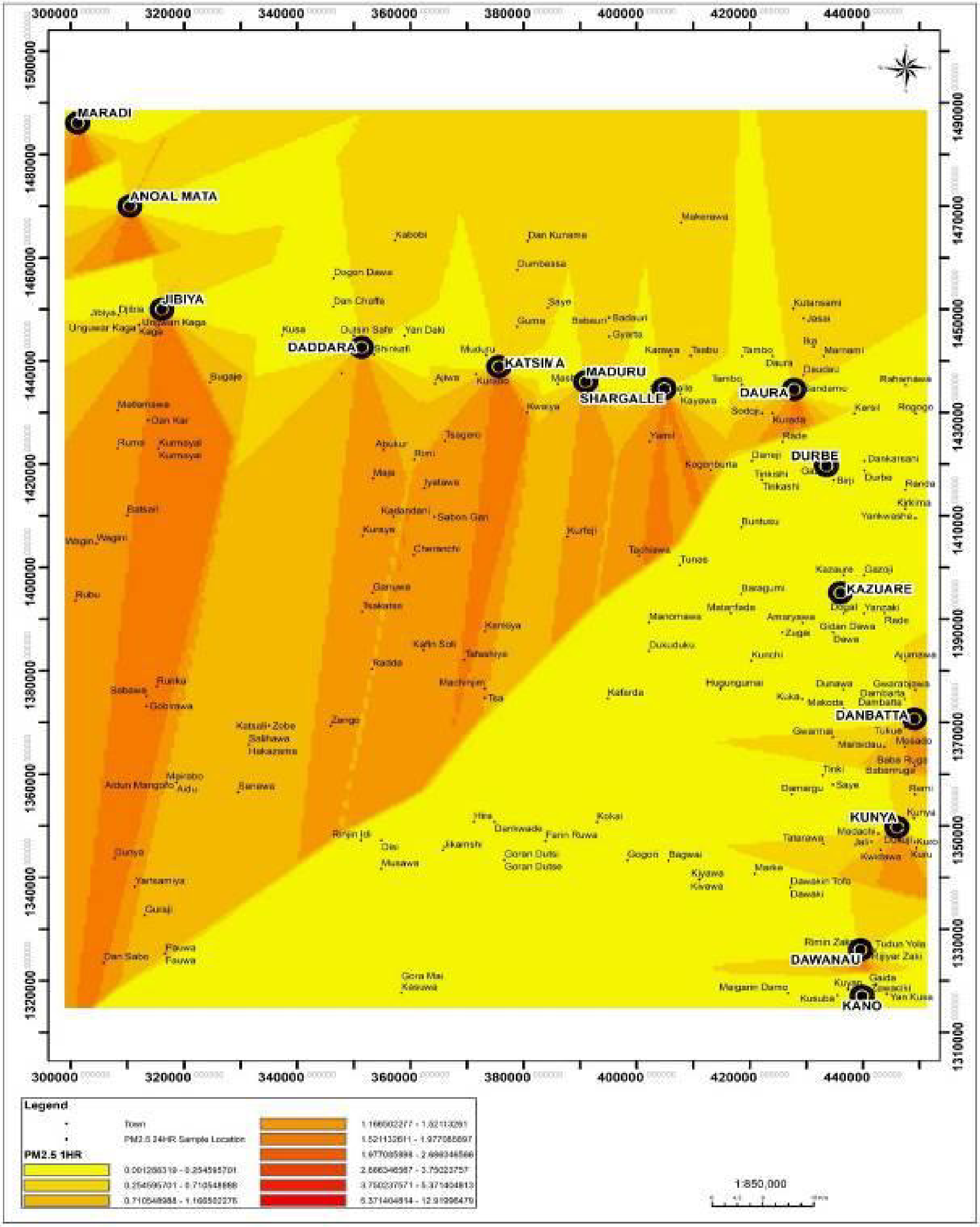


Figure 4.53: 1-Hour Potential PM2.5 concentrations across the Project environment

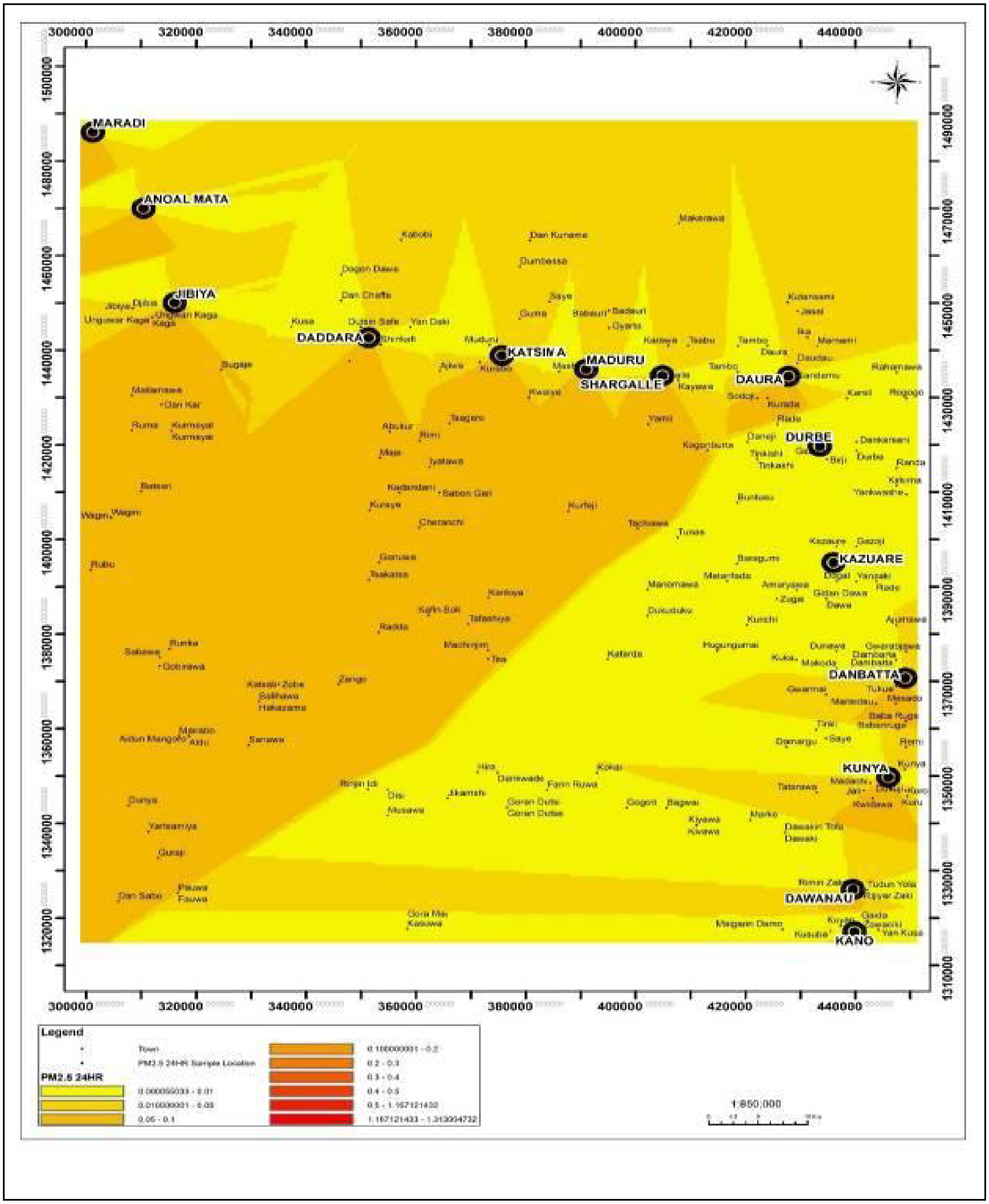


Figure 4.54: 24-Hour Potential PM2.5 concentrations across the Project environment

Conclusion: Results showed that pollutants' ground level concentrations were far below the set ambient regulatory limits for the averaging periods considered i.e. 1-hour and 24-hour. Modelling results revealed that ground level concentrations for nitrogen oxides (NO_x), carbon monoxide (CO) and particulate matter of size ($PM2_{.5}$) for the averaging time periods considered i.e. 1-hour and 24-hour were within the following range: 0-0.026 µg/m^3 and 0-0.002 µg/m^3; 0-0.08 µg/m^3 and 0-0.006 µg/m^3; and 0.0001-30.362 µg/m^3 and 0.00001-2.217 µg/m^3 for the pollutants and hours considered respectively. The modelling results indicated that the key receptors that will be impacted the most are within 100 – 500 m radius of emission source. Receptors greater than 1 km south-west and north-east of emission sources are the least impacted. The noise ambient level across the sampling stations were within the threshold limit (85 dBA) recommended by the FMEnv. Preferences that will further abate emissions of pollutants concentrations should be considered in view of the prevailing large and increasing population in the receptor areas.

4.3.3 Water Quality Assessment and Sediment Characterization

Water quality refers to the chemical, physical and biological characteristics of water based on the standard of its usage. Water is used extensively by humans for municipal, agricultural and industrial purposes with the different applications subject to different scientifically established quality criteria. Water, though an abundantly available substance on the earth surface requires conservation because freshwater accounts for only 3% of water on the surface of the earth and only about 1% is available for human use as surface and groundwater.

Surface water is water found on the surface of the earth crust, it originates mostly from rainfall and it includes rivers, ponds, lakes and streams. The quality of surface water is governed by its content of living organisms and by the amount of mineral and organic chemicals which it may have picked up during its formation. Surface water is continually in cycle receiving water through precipitation and losing water through evaporation, transpiration absorption and the soaking of water into the ground.

Groundwater is water that soaks into the soil and is stored in tiny spaces between rocks and particles of the soil. The surface water origin and the constant contact of groundwater with mineral rock imply that groundwater quality is sum of natural and anthropogenic influences.

pH: The pH of water is a measure of the acid - base equilibrium and in most natural waters is controlled by the carbon dioxide – bicarbonate – carbonate equilibrium. There are many factors that can affect pH in water, both natural and man-made. Most natural changes occur due to interactions with surrounding rock (particularly carbonate forms) and other materials. pH can also fluctuate with precipitation (especially acid rain) and wastewater or mining discharges.

Temperature: Temperature exerts a major influence on biological activity and growth. Temperature governs the kinds of organisms that can live in rivers and lakes. Fish, insects, zooplankton, phytoplankton, and other aquatic species all have a preferred temperature range. As temperatures get too far above or below this preferred range, the number of individuals of the species decreases until finally there is none. Temperature is also important because of its influence on water chemistry. The rate of chemical reactions generally increases at higher temperature. Water, particularly groundwater, with higher temperatures can dissolve more minerals from the surrounding rock and will therefore have a higher electrical conductivity. It is the opposite when considering a gas, such as oxygen, dissolved in the water. Warm stream water can affect the aquatic life in the stream. Warm water holds less dissolved oxygen than cool water and may not contain enough dissolved oxygen for the survival of different species of aquatic life.

Total Dissolved Solids: A total dissolved solid (TDS) is the term used to describe the inorganic salts and small amounts of organic matter present in solution in water. The principal constituents are usually calcium, magnesium, sodium, and potassium cations and carbonate, hydrogen carbonate, chloride, sulfate, and nitrate anions.

Electrical Conductivity: Electrical conductivity measures the ability of water to conduct an electrical current. Water in its pure state is a poor conductor of electricity, with the dissolution of charged chemicals (also known as salts) in water, electrical conductivity increases. Examples of charged ions that naturally occur in river water include calcium, potassium, chloride, sulphate and nitrate. Electrical conductivity increases with increasing temperature because solubility increases with temperature. For this reason, electrical conductivity is always reported at a reference temperature of 25 °C.

Turbidity: Turbidity is the amount of cloudiness in the water. This can vary from a river full of mud and silt where it would be impossible to see through the water (high turbidity), to a spring water, which appears to be completely clear (low turbidity). Silt, sand and mud, bacteria and other germs, chemical precipitates, can cause turbidity.

Total Suspended Solids and Total Dissolved Solids: Environmental waters may contain a variety of solid or dissolved impurities. Suspended solids refer to particles in water larger than 2 microns, while smaller particles, along with ionic species, are referred to as total dissolved solids. In considering waters for human consumption or other uses, it is important to know the concentrations of both suspended and dissolved solids. The most common pollutant in the world is "dirt" in the form of TSS.

Nutrients**:** Phosphorus (P) and nitrogen (N) are the primary nutrients that in excessive amounts pollute our lakes, streams, and wetlands. Nitrogen is essential to the production of plant and animal tissue. It is used primarily by plants and animals to synthesize protein. Nitrate (NO_3^-) and ammonium (NH^{4+}) are among the primary forms of nitrogen in natural waters and phosphates (PO_4^{3-}) are the most common form of phosphorus in natural waters. Phosphates are only moderately soluble and, compared to nitrate, are not very mobile in soils and groundwater. Phosphates tend to remain attached to soil particles, but erosion can transport considerable amounts of phosphate to streams and lakes.

Heavy Metals: Heavy metals are natural components of the Earth's crust. They cannot be degraded nor destroyed. Some heavy metals are essential to maintain the metabolism of the human body but can be toxic and dangerous at excessive concentrations typically occasioned by pollution. Heavy metal pollution of water has become a major environmental problem almost since the advent of agricultural and industrial revolution and today most water resources are still being contaminated with heavy metals released from domestic, industrial, and other man-made activities (Khare and Singh, 2002; Hayat and Javed, 2008)

Dissolved Oxygen: Dissolved oxygen is a measure of the amount of gaseous oxygen (as O_2) dissolved in water. Oxygen enters the river water from the atmosphere (via diffusion), from groundwater, and as a by-product of the photosynthesis of aquatic plants.

Biochemical Oxygen Demand (BOD): Biochemical oxygen demand (BOD), is a bioassay procedure that measures the dissolved oxygen (DO) consumed by bacteria from the decomposition of organic matter. Biochemical oxygen demand is an important water quality parameter because it greatly influences the concentration of DO that will be available to support other forms of aquatic life.

Total Coliforms: The term "total coliforms" refers to a large group of Gram-negative, rod-shaped bacteria that share several characteristics. The group includes thermo tolerant coliforms and bacteria of faecal origin, as well as some bacteria that may be isolated from environmental sources.

Escherichia coli (*E. coli*): *Escherichia coli* (*E. coli*) are gram-negative bacteria and are a type of fecal coliform bacteria commonly found in the intestines of animals and humans. E coli is capable of causing infection for which symptoms include nausea, vomiting, diarrhea, and fever.

Anions**:** Metal ions are dissolved in groundwater and surface water when water comes in contact with rock or soil containing the metals usually in the form of metal salts. Metals can also enter through anthropogenic means. The fate and transport of a metal in soil and groundwater depends significantly on the chemical form and speciation of the metal (Allen *et al.*, 1991).

Total Hydrocarbon (THC): The differing chemical and physical properties of petroleum hydrocarbons mean that they will behave differently in the environment. Persistence of petroleum hydrocarbon compounds in the environment is reflected by physical properties such as volatility, so that generally the persistence increases as the boiling point increases. The main processes affecting environmental concentrations are volatilization, biodegradation and dissolution in water.

4.3.3.1 Groundwater Quality of the Project Corridor

Groundwater pH: The pH of groundwater samples obtained during the wet season were slightly acidic during the period sampled. Specifically, the pH levels varied from 6.2 – 6.7 with an average of 6.48. The lowest measurement was obtained at Doka Borehole while the highest was at Ugwan kutsa well. During the dry season the pH levels varied from 6.3 – 6.95, with an average of 6.59. The lowest measurement was obtained at Zugumba Borehole while the highest was at Baba Ruga Borehole. There is only a slight seasonal variation observed in the groundwater samples, with a shift towards neutrality in the dry season samples. The national standard for drinking water put the acceptable range for pH at 6.5 – 8.0, a requirement that is not met by water samples from Mashi, Doka, Agangaro and Zuba (Appendix III).

Temperature: The temperature of groundwater samples obtained during the wet season ranged from 29.1 – 31.3°C during the period sampled. The lowest measurement was obtained at Gandu Dutse Well while the highest was at Agangaro borehole and Gurjiya well respectively. The temperatures observed for samples taken during the dry season ranged from 27.8 – 30.1 °C during the period sampled. The lowest measurement was obtained at Doka borehole while the highest was at Zuba well. The semi- arid climate of sampling site (Northern Nigeria) with temperatures ranging between 27 – 32°C reasonably suggests groundwater temperatures observed to be within limits.

Electrical Conductivity: The electrical conductivity of groundwater samples obtained for the wet season ranged from 126.2 – 303.2 µS/cm during the period sampled. The average measure value was 217.36 µS/cm. The lowest measurement was obtained at Doka borehole while the highest was at Gurjiya well. Values for the dry season ranged from 133 – 317.7 µS/cm during the period sampled. The average measure value was 210.95 µS/cm. The lowest measurement was obtained at Doka borehole while the highest was at Mashi

Borehole. Electrical conductivity in water poses no known health hazards, however for irrigation purposes; salinity hazard is to be considered.

Turbidity: The Turbidity of groundwater samples obtained during the wet season ranged from 20 – 60.5 NTU during the period sampled. The average measure value was 37.74 NTU. The lowest measurement was obtained at Agangaro borehole while the highest was at Jajira borehole. Turbidity values for the dry season ranged from 0 – 5 NTU during the period sampled. The average measure value was 1.63 NTU. The lowest measurement was obtained at Mashi borehole, Baba Ruga borehole and Durbi well while the highest was at Zuba well.

Total Dissolved Solids: The observed TDS in sampled groundwater for the wet season ranged from 54 – 136 mg/l during the period sampled. The average measured value was 91.44 mg/l. The lowest measurement was obtained at Doka borehole and the highest at Gurjiya Well. The dry season samples ranged from 41 – 149.5 mg/l. The average measured value was 85.5 mg/l during the period sampled. The lowest measurement was obtained at Doka borehole and the highest at Mashi Borehole. All water samples (including those from the wet and dry season) are within the 500 mg/l standard for drinking water.

Total Suspended Solids: The total suspended solids of groundwater samples during the wet season ranged from 5 – 34 mg/l. The average measured value was 17.22 mg/l. The lowest measurement was obtained at Agangaro borehole while the highest was at community before river Zakari well. The values for total suspended solids of groundwater samples during the dry season ranged from 0.87 – 5.6 mg/l. The average measured value was 2.73 mg/l. The lowest measurement was obtained at Mashi Borehole while the highest was at Doka borehole. The values are within the recommended limits for potable water.

Nitrate, Ammonium and Phosphate: Values obtained in wet season groundwater samples for nitrate ranged from 3.2 – 16.1mg/l during the period sampled. The average measure value was 7.90. The lowest measurement was obtained at Agangaro borehole while the highest was at Shargelle Katoge. Ammonium levels ranged from 0.32 – 8.7 mg/l with an average value of 2.13. The lowest value was obtained at Zuba and the highest value at Doka. While for phosphate the values ranged from 5.9 – 60.1 mg/l and an average measured value of 18.05 mg/l. The lowest value was obtained at Agangaro borehole and the highest at Shargelle Katoge.

The values for the dry season for nitrate ranged from 4.2 – 21.6 mg/l during the period sampled. The average measure value was 9.87 mg/l. The lowest measurement was obtained at Doka borehole, while the highest was at Durbi well. Ammonium levels ranged from 0.09 – 1.8 mg/l with an average value of 1.3 mg/l. The lowest value was obtained at Zuba borehole and the highest value at Zugumba borehole while for phosphate the values ranged from 0.2 – 2.7 mg/l and an average measured value of 1.15 mg/l. The lowest value was obtained at Mashi borehole and the highest at Zugumba borehole**.** The observed range for nitrate for both wet and dry season is within the recommended limits for drinking water.

Heavy Metals: Heavy metals measured in groundwater during the wet season ranged as follows Cadmium (Cd), 0.0001 – 0.008 mg/l; chromium (Cr) 0.00 – 0.62 mg/l (mean, 0.14 mg/l), Zinc (Zn) 0.00 – 0.27 mg/l (mean, 0.10 mg/l), Iron (Fe), 0.00 – 2.31 mg/l (mean, 1.14 mg/l), Lead (Pb), 0.01 – 0.119 mg/l and Copper (Cu), 0.01 – 2.78mg/l (mean, 0.55mg/l). For the dry season it ranged as follows: Cadmium (Cd), Not detected (mean, Chromium (Cr) 0.00 – 0.04 mg/l (mean, 0.01 mg/l), Zinc (Zn), 0.17 – 1.5 mg/l (mean, 0.86 mg/l), Iron (Fe), 0.04 – 1.82 mg/l (mean, 0.48mg/l), Lead (Pb), Not detected and Copper (Cu), 0.00 – 0.21mg/l (mean, 0.04mg/l). The water samples had heavy metals concentrations within the permissible limits for potable water.

Dissolved Oxygen: The observed Dissolved oxygen (DO) in sampled groundwater during wet season ranged from 4.4 – 6.2 mg/l during the wet season. The lowest measurement was obtained at Doka Borehole and the highest at Mashi borehole. The dry season samples ranged from 4.00 – 6.00mg/l, with an average of 4.92mg/l. The lowest measurement was obtained at Gurjiya well and the highest at Agangaro borehole. The low dissolved oxygen content of groundwater samples is consistent with the little/no diffusion from the atmosphere and the absence of photosynthesis. The DO of groundwater sample collected from Doka was slightly below the recommended limit for drinking water.

<u>Total Coliform</u>: Total coliform measurement in sampled groundwater for the wet season ranged from 2– 93 cfu/ml and averaged 39.44cfu/ml during the period sampled. The lowest measurement was obtained at Zuba well and the highest at Doka borehole. *E. coli* measurement in sampled groundwater ranged from 0 – 8 cfu/ml and averaged 1.0cfu/ml during the period sampled. The dry season sample ranged from 2– 13 cfu/ml and averaged 7.25 cfu/ml during the period sampled. The lowest measurement was obtained at Durbi and Zuba well and the highest at Gurjiya well. *E. coli* measurement in sampled groundwater ranged from 0 – <0.02 cfu/ml and averaged 0.0075 cfu/ml during the period sampled.

Some bacteriological contamination of the groundwater samples is evident though sample from Mashi, Baba Ruga and Durbi are the only sites with the likelihood of faecal contamination. The national standard for drinking water is that no T. coliform or *E. coli* must be detected in 100 ml sample of drinking water.

<u>Cations:</u> During the wet season Ca values recorded for groundwater ranged from 4.6 - 19.4 mg/l, (mean, 8.95 mg/l), the lowest value for Ca in groundwater was recorded at Mashi and highest at Baba Ruga. Mg varied from 2.12 – 8.92 mg/l (mean, 4.57 mg/l), the lowest value for Mg in groundwater was recorded at Durbi well and highest at Baba Ruga borehole. K recorded between 1.19 – 5.91 mg/l (mean, 3.39mg/kg), the lowest value for K in groundwater was recorded at Doka borehole and highest at Pangalle Wudil. Na, 20.7 – 62.3 mg/l (mean, 53.87 mg/kg), the lowest value for Na in groundwater was recorded at Gurjiya and highest at Mashi. Mn varied from 0 – 0.013 (mean, 0.01mg/l), the lowest value for Mn in groundwater was recorded at Doka and highest at Pangalle Wudil. During the dry season Ca values recorded for groundwater ranged from 5.2 -32.06 mg/l, (mean, 16.13mg/l), the lowest value for Ca in groundwater was recorded at Agangaro and highest at Mashi. Mg varied from 2.4 – 70.00 mg/l (mean, 20.37 mg/l), the lowest value for Mg in

groundwater was recorded at Doka and highest at Durbi. K recorded between 1.62– 5.19 mg/l (mean, 3.07mg/l), the lowest value for K in groundwater was recorded at Agangaro and highest at Durbi well. Na, 9.84 – 23.7 mg/l (mean, 17.52mg/l) the lowest value for Na in groundwater was recorded at Mashi and highest at Agangaro. Mn varied from 0 – 0.04 (mean, 0.01mg/l), the lowest value for Mn in groundwater was recorded at Mashi, Doka, Zuba and Gurjiya. The concentration of metals observed in groundwater samples indicated that groundwater has low level of metal concentration. Not minding the seasonal variation that led to higher concentrations of Calcium and Magnesium the WHO standard of 200 and 150 mg/l respectively for drinking water was still not exceeded.

Total Hydrocarbon (THC): THC values obtained for groundwater during the wet season ranged from 0- 3.2 mg/l; the lowest value being from Mashi, Baba Ruga and Durbi and the highest from Gurji well. For the dry season, THC was mostly undetected, the values ranged from 0 – 1 mg/l (Mean, 0.13 mg/). The presence of some hydrocarbon in water does not necessarily render water unwholesome, if within the threshold limit of 10.0 mg/l for potable water.

Table 4. 10: Summary of physicochemical and microbial properties of the groundwater samples

Parameters	Units	Wet season			Dry Season			FMEnv Threshold Limits*	
		Min.	*Max.*	*Mean*	*Min.*	*Max.*	*Mean*	*MDL*	*MPL*
pH		6.2	6.7	6.48	6.3	6.95	6.59	6.5 – 8.5	6.5-9.2
Temp	°C	29.6	31.3	30.51	27.8	30.1	28.78	<40	34
TDS	mg/L	54	136	91.44	41	149.5	85.5	500	1500
Conductivity	µS/cm	126.2	303.2	217.36	133	317.7	210.95	1000	
TSS	mg/L	5	34	17.22	0.87	5.6	2.73	500	
THC	mg/L	0	0.32	0.05	0	1	0.13	10.0	
DO	mg/L	4.4	9.9	7.3	4	6	4.92	7.5	
Nitrate	mg/L	3.2	16.1	7.9	4.2	21.6	9.87	45	50
BOD	mg/L	1.2	2.7	1.78	-	-		1-2	
Phosphate	mg/L	5.9	60.1	18.08	0.3	2.7	1.15	-	
Ammonium	mg/L	0.32	8.7	2.13	0.09	1.8	1.03		
Calcium	mg/L	4.88	19.4	8.95	5.2	32.06	16.13	75	200
Magnesium	mg/L	2.12	8.92	4.37	2.4	70	20.37	30	150
Potassium	mg/L	1.19	5.91	3.39	1.62	5.19	3.07		
Sodium	mg/L	20.7	62.3	33.87	9.84	23.7	17.52	20 – 50	
Lead	mg/L	0.01	0.119	0.04	0	0	0	0.05	
Total Iron	mg/L	0	2.31	1.14	0.04	1.82	0.48	0.3	
Copper	mg/L	0.01	2.78	0.55	0	0.21	0.04	0.05	1.5
Zinc	mg/L	0	0.27	0.1	0.17	1.5	0.86	5.0	

Manganese	mg/L	0	0.013	0.01	0	0.04	0.01	0.05	0.5
Cadmium	mg/L	0.001	0.008	0	0	0	0	0.01	
Chromium	mg/L	0	0.62	0.14	0	0.04	0.01	0.1	
T.Coliform	cfu/ml	2	93	39.44	2	13	7.25	0	10
E.coli	cfu/ml	0	8	1	0	0	0	0	0
THF	cfu/ml	3	89	42.67	2	3	2.25	0	

MDL – Maximum Desirable Limit; MPL – Maximum Permissible Limit

* The threshold limits cited are the national recommended limits for substances and characteristics affecting the acceptability of groundwater for domestic use; sourced from the World Health Organisation Criteria for Water Resources (Source: National Environmental (Surface and Groundwater Quality Control) Regulations, 2011).

4.3.3.2 *Surface Water Quality*

Surface Water pH**:** The pH of surface water samples obtained during the wet season ranged from slightly acidic to slightly alkaline during the period sampled. Specifically, the pH levels varied from 5.9 – 7.6 with an average of 6.61 (Table 4. 11). The lowest measurement was obtained at Marmara River downstream, Wudil while the highest was at Dam at Zakara. In the dry season, the pH levels varied from 6.1 – 7.8 with an average of 6.77 (Appendix III). The lowest measurement was obtained at Mamara River downstream, Wudil and Dam near Tsamoni while the highest was at SW (Dam at river Zakara).

Temperature**:** The temperature of surface water samples obtained during the wet season ranged from 29.8 – 31.6°C during the period sampled. The lowest measurement was obtained at Thomas dam while the highest was at Marmara River upstream, Wudil. The dry season however ranged from 28.2 – 29.4°C during the period sampled. The lowest measurement was obtained at Baba Ruga dam while the highest was at Marmara River upstream, Wudil.

Electrical Conductivity**:** The electrical conductivity of surface water samples taken during the wet season ranged from 131.8 – 497.3 µS/cm during the period sampled. The average measure value was 217.36 µS/cm. The lowest measurement was obtained at Thomas dam while the highest was at Muduru river. Dry season values ranged from 189.6 – 412.2 µS/cm during the period sampled. The average measure value was 284.1 µS/cm. The lowest measurement was obtained at Mamara river downstream, Wudil while the highest was at Muduru river.

Turbidity: The Turbidity of surface water samples for the wet season ranged from 19 – 63 NTU during the period sampled. The average measure value was 37.42 NTU. The lowest measurement was obtained at Duduru River downstream, Gaya while the highest was at Duduru River upstream, Gaya. The dry season values range from 5 – 15 NTU during the period sampled. The average measure value was 9.71 NTU. The lowest measurement was obtained at Duduru River upstream, Gaya while the highest was at Dam near Tsamoni.

Total Dissolved Solids: The observed TDS in sampled surface water for the wet season ranged from 67 – 275 mg/l during the period sampled. The lowest measurement was obtained at Thomas dam and the highest at Muduru River. The dry season values ranged from 67 – 275 mg/l and the average value was 170.14 mg/l during the period sampled. The lowest measurement was obtained at Thomas dam and the highest at Muduru River.

Total Suspended Solids: Total suspended solids of groundwater samples ranged from 8 - 36 mg/l. The average measured value was 18.67 mg/l. The lowest measurement was obtained at Duduru River downstream, Gaya while the highest was at Duduru River upstream, Gaya. Dry season values for total suspended solids of groundwater samples ranged from 3.5 – 10.6 mg/l. The average measured value was 6.5 mg/l. The lowest measurement was obtained at Moduru River upstream, Gaya while the highest was at dam near Tsamoni.

Nutrients (Nitrate, Ammonium and Phosphate): Values obtained from testing wet season surface water samples for nitrate ranged from 8.1 – 34 mg/l during the period sampled. The average measure value was 17.59 mg/l. The lowest measurement was obtained at Thomas dam, Baba Ruga dam and Muduru River respectively while the highest was at Marmara River downstream, Wudil. Ammonium levels ranged from 0.32 – 2.32 mg/l with an average value of 1.8 mg/l. While for phosphate, the values ranged from 1.8 – 34 mg/l and an average measured value of 20.84 mg/l. The lowest value was obtained at Dam near Tsamoni and dam at river Zakara and the highest at Thomas dam, Baba Ruga dam and Muduru river respectively Katoge.

Dry season values for nitrate ranged from 8.1 – 30.9 mg/l during the period sampled. The average measure value was 16.8 mg/l. The lowest measurement was obtained at Thomas dam, Baba Ruga dam and Muduru River respectively while the highest was at Marmara River downstream, Wudil. Ammonium levels ranged from 0.56 – 4.21 mg/l with an average value of 1.57 mg/l, the lowest value was obtained at Mamara River downstream and the highest value at Muduru River. While for phosphate, the values ranged from 1.1 – 11.5mg/l and an average measured value of 4.9 mg/l. The lowest value was obtained at Tsamoni and the highest at Baba Ruga dam.

Cations: Wet season surface water samples had alkaline earth metals Calcium (Ca), Magnesium (Mg), alkali metals Potassium (K) and Sodium (Na) and trace metal Manganese (Mn) in varying concentrations from the various location in the study area, as presented. Ca values recorded for groundwater ranged from 4.6 – 31.76 mg/l, (mean, 13.02 mg/l), Mg varied from 2.2 – 15.61 mg/l (mean, 5.99 mg/l), K recorded between 2.39 – 7.82 mg/l (mean, 4.45mg/l) Na, was between 24.3 – 38.9 mg/l (mean, 31.82mg/l), Mn varied from 0.002 – 0.019 (mean, 0.01mg/l). In the dry season the following was obtained Ca values recorded for groundwater ranged from 0.85 – 26.4 mg/l (mean, 12.77 mg/l), Mg varied from 1.0 – 13.5 mg/l (mean, 3.59 mg/l), K recorded between 1.63 – 8.26 mg/l (mean, 4.64mg/l), Na, was between 5.89 – 48.2 mg/l (mean, 17.61mg/l), Mn varied from 0.00 – 0.05 (mean, 0.02mg/l).

Dissolved Oxygen**:** The observed Dissolved oxygen (DO) in wet season samples of surface water ranged from 3.5 – 11.4 mg/l during the period sampled. The lowest measurement was obtained at Thomas dam, Baba Ruga dam and Muduru River respectively and the highest at Dam near Tsamoni and Dam at river Zakara. However, the dry season values ranged from 6.3 – 12.5 mg/l during the period sampled. The lowest measurement was obtained at Muduru River and the highest at Zakara dam.

Biochemical Oxygen Demand: The observed Biochemical oxygen demand (BOD) in wet season surface water samples ranged from 3.5 – 11.4 mg/l during the period sampled. The lowest measurement was obtained at Thomas dam, Baba Ruga dam and Muduru River respectively and the highest at Dam near Tsamoni and Dam at river Zakara. Dry season samples had values ranging from 2.1– 4.1 mg/l during the period sampled. The lowest measurement was obtained at Dam near Tsamoni, Dam at river Zakara, Thomas dam, Baba Ruga dam respectively and the highest at Mamara River downstream, Wudil.

Total Hydrocarbon: THC values obtained for surface water during the wet season ranged from 3- 108 mg/l (Mean, 51.44 mg/l). The dry season values ranged from 0 – 0.23 mg/l (Mean, 0.06 mg/l).

Heavy Metals: During the wet season Cadmium (Cd) values recorded for Surface water ranged from 0.0001 – 0.45mg/l (mean,0.12 mg//), Chromium (Cr) varied from 0.12 – 0.42mg/l (mean, 0.21mg/l), Zinc (Zn) measured 0.18 - 1.62 mg/l (mean, 0.54 mg/l), Iron (Fe) 0.00 – 1.68 mg/l (mean, 0.99 mg/l), Lead (Pb) 0.01 – 0.26mg/l (mean, 0.08 mg/l) and Copper (Cu) 0.15 – 0.75 mg/l (mean, 0.51 mg/l). During the dry season Cadmium (Cd) values recorded for Surface water ranged from 0.00 – 0.03mg/l (mean,0.01 mg/l), Chromium (Cr) varied from 0.00 – 0.38 mg/l (mean, 0.17 mg/l), Zinc (Zn) measured 0.16 – 2.12 mg/l (mean, 0.71 mg/l), Iron (Fe) 0.53– 2.4 mg/l (mean, 1.32 mg/l), Lead (Pb) 0.00 – 0.33mg/l (mean, 0.06 mg/l) and Copper (Cu) 0.03– 0.68 mg/l (mean, 0.26 mg/l).

Total Coliform: Total coliform measurement of wet season samples of surface water ranged from 30 – 93 cfu/ml and averaged 53.67cfu/ml during the period sampled. The lowest measurement was obtained at Duduru River downstream, Gaya and the highest at Thomas dam, Baba Ruga dam and Muduru River respectively. Dry season samples ranged from ranged from 21 - 105 cfu/ml and averaged 48.71 cfu/ml during the period sampled. The lowest measurement was obtained at Dam near Tsamoni and Baba Ruga dam and the highest at Mamara river downstream, Wudil.

E. coli: E coli measurement in sampled surface water during the wet season ranged from 0 – 15 cfu/ml and averaged 3.78 cfu/ml during the period sampled. The lowest measurement was obtained at Thomas dam, Baba Ruga dam and Muduru river respectively and the highest at Duduru river downstream, Gaya. While values for the dry season ranged from 0 – 9 cfu/ml and averaged2.57cfu/ml during the period sampled. The lowest measurement was obtained at Thomas dam, Baba Ruga dam) and the highest at Mamara river downstream, Wudil.

THF: THF measurement of wet season samples of surface water ranged from 3 – 108 cfu/ml and averaged 51.44 cfu/ml during the period sampled. The lowest measurement was obtained at Thomas dam, Baba Ruga dam and Muduru River respectively and the highest at Duduru River upstream, Gaya). Dry season samples ranged from ranged from 5 – 17 cfu/ml and averaged 9.86cfu/ml during the period sampled. The lowest measurement was obtained at Mamara river downstream, Wudil and the highest at Dam near Tsamoni.

Table 4. 11: Summary of physicochemical and microbial parameters of surface waters

Parameters	Wet season			Dry season			NESREA Limit
	Min.	Max.	Mean	Min.	Max.	Mean	
pH	5.9	7.6	6.61	6.1	7.8	6.77	6.5-8.5
Temp (°C)	29.8	31.6	30.62	28.2	29.4	28.73	34
TDS (mg/L)	67	275	153.56	67	275	170.14	
Electrical Conductivity (µS/cm)	131.8	497.3	319.6	189.6	412.2	284.1	
Turbidity (FTU)	19	63	37.42	5	15	9.71	
TSS (mg/L)	8	36	18.67	3.5	10.6	6.5	0.25
THC (mg/L)	0	0.033	0.02	0	0.23	0.06	10
DO (mg/L)	4.5	11.4	7.79	6.3	12.5	9.17	≥4, 6
Nitrate (mg/L)	8.1	34	17.59	8.1	30.9	16.8	9.1
BOD (mg/L)	1.8	4.1	2.41	2.1	4.1	2.63	3
Phosphate (mg/L)	1.8	34	20.84	1.1	11.5	4.9	3.5
Ammonium (mg/L)	0.32	2.32	1.8	0.56	4.21	1.57	2
Calcium (mg/L)	4.6	31.76	13.02	0.85	26.4	12.77	180
Magnesium (mg/L)	2.2	15.61	5.99	1	13.5	3.59	40
Potassium (mg/L)	2.39	7.82	4.45	1.63	8.26	4.64	50
Sodium (mg/L)	24.3	38.9	31.82	5.89	48.2	17.61	120
Lead (mg/L)	0.01	0.26	0.08	0	0.33	0.06	0.1
Total Iron (mg/L)	0	1.68	0.99	0.53	2.4	1.32	0.5
Copper (mg/L)	0.15	0.75	0.51	0.03	0.68	0.26	0.01
Zinc (mg/L)	0.18	1.62	0.54	0.16	2.12	0.71	0.2
Manganese (mg/L)	0.002	0.019	0.01	0	0.05	0.02	5
Cadmium (mg/L)	0.001	0.45	0.12	0	0.03	0.01	0.01
Total Chromium (mg/L)	0.12	0.42	0.21	0	0.38	0.17	0.5
Total Coliform (cfu/ml)	30	93	53.67	21	105	48.71	
E.coli (cfu/ml)	0	15	3.78	0	9	2.57	100
THF (cfu/ml)	3	108	51.44	5	17	9.86	

4.3.3.3 Sediment Physicochemical Qualities

Sediment pH: The pH of sediment samples obtained ranged from acidic to moderately alkaline during the period sampled. Specifically, for the wet season, the pH levels varied from 4.2 – 8.3 with an average of 6.98.Table 4. 12). The lowest measurement was obtained at Duduru river upstream, Gaya while the highest was at Marmara River downstream, Wudil and for the dry season the pH levels varied from 4.8 – 8.2 with an average of 6.41. The lowest measurement was obtained at Dam at river Zakara while the highest was at Duduru River upstream, Gaya (Appendix III)

Total Hydrocarbon: The THC of sediment samples measured in the wet season ranged from 0 – 6.1 with an average of 1.43. The lowest measurement was obtained at Dam near Tsamoni while the highest was at Wallawa River and that of the dry season ranged from 1.49 – 7.22 with an average of 3.22. The lowest measurement was obtained at Duduru River upstream, Gaya while the highest was at Muduru river.

Extractable Nutrients (Nitrate, Phosphate and Sulphate: In the wet season extractable Nitrate (NO_3-) varied from 5.13 – 14.5 mg/kg (mean, 8.42 mg/kg), Phosphate (PO_4^{3-}) recorded between 0.21 – 8.86 mg/kg (mean, 3.94 mg/kg) and values for Sulphate (SO_4^{2-}) ranged between 0.15 – 12.4 mg/kg (mean, 5.01mg/kg). In the dry season extractable Nitrate (NO_3-) varied from 1.6 – 11.7 mg/kg (mean, 4.57 mg/kg), Phosphate (PO_4^{3-}) recorded between 0.39– 11.8 mg/kg (mean, 4.68 mg/kg) and values for Sulphate (SO_4^{2-}) ranged between 0.2 – 4.8 mg/kg (mean, 2.93 mg/kg).

Heavy Metals: Total iron (Fe) values recorded for sediment samples during the wet season ranged from 0.34 – 13.5 mg/kg (mean, 3.15mg/kg), Copper (Cu) varied from 0.05 – 12.43 mg/kg (mean, 3.51 mg/kg), Zinc (Zn) measured 0.21 – 5.66 mg/kg (mean, 1.75 mg/kg), Manganese (Mn) 0.00 – 0.31 mg/kg (mean, 0.07 mg/kg), Lead (Pb) 0.04 – 0.4 mg/kg (mean, 0.16 mg/kg) and Nickel (Ni) 0.05 – 0.43mg/kg (mean, 0.22mg/kg). Cadmium (Cd) values ranged from 0.002 – 2 mg/kg (mean, 0.25mg/kg), Chromium (Cr) varied from 0.02 – 0.04mg/kg (mean, 0.03 mg/kg), Mercury (Hg) was not detected in any of the sediment samples. Dry season samples had values that ranged as follows, total iron,1.62 –28.4 mg/kg (mean, 11.64 mg/kg), Copper (Cu) varied from 0.38 – 1.66 mg/kg (mean, 0.98

mg/kg), Zinc (Zn) measured 0.11 – 0.69 mg/kg (mean, 0.27 mg/kg), Manganese (Mn) was undetected), Lead (Pb) 0.00 – 0.62 mg/kg (mean, 0.2mg/kg) and Nickel (Ni) was undetected. Cadmium (Cd) values ranged from 0.03 – 2 mg/kg (mean, 0.32 mg/kg), Chromium (Cr) varied from 0.01 – 0.13 mg/kg (mean, 0.04 mg/kg), and Mercury (Hg) was not detected in any of the sediment samples.

Polychlorinated Biphenyls (PCB: PCB values measured during the wet season ranged from 0 – 0.34 mg/kg (mean, 0.04mg/kg), while during the dry season it was undetected.

Remarks: Limits for the content of pollutants in sediment are the subject of legal norms throughout the world. Their values, however, differ depending on the differing influences the local biota as well as other locally determined factors. This variability makes the convergence of limit values across larger geographic areas undesirable. Limits should thus be based on the characteristics of the local benthic communities, hydrodynamic factors, as well as on both laboratory and in situ tests of toxicity and bioaccumulation, among others. An examination of the pH of sediment samples against the surface water samples showed that the pH of sediment samples varied from that of surface water samples an indication that the pH buffering mechanism of the surface water bodies have largely kept the pH within safe limits even at the Duduru river upstream, Gaya where the sediment pH was 4.2 during the wet season and Zakara with sediment pH of 4.8.

The total hydrocarbon content in sediment samples is generally higher than that observed in surface water samples, suggesting that hydrocarbon being not completely soluble had been preferentially adsorbed on sediment surfaces. The general trend with respect to nitrate and phosphate is that levels in sediment samples are lower than in water samples but for a few exceptions for nitrate at Duduru River upstream, Gaya and for phosphate at Wallawa 1 and kwatari mai kaho. Concentration of Zn, Cd and Fe found in surface water samples were generally higher than levels expected in water for domestic use. The presence of other heavy metals (Cu, Pb, Ni and Mn), albeit in concentrations lower than standards for wholesomeness in water is undesirable because of the tendency for bioaccumulation. All the water samples tested had Coliform counts and four each from wet and dry season had *E. coli* counts which indicate faecal contamination.

Table 4. 12: Summary of physicochemical and microbial properties of sediment samples

Parameters	Unit	Wet season			Dry season		
		Min.	Max.	Mean	Min,	Max.	Mean
PH (33.6 °C)		4.2	8.3	6.98	4.8	8.2	6.41
THC	mg/kg	0	6.1	1.43	0.49	7.22	3.22
Ext. Nitrate	mg/kg	5.13	14.5	8.42	1.6	11.7	4.57
Ext. Sulphate	mg/kg	0.15	12.4	5.01	0.2	4.8	2.93
Ext. Phosphate	mg/kg	0.21	8.86	3.94	0.39	11.8	4.68
Total Iron	mg/kg	0.34	13.5	3.15	1.62	28.4	11.64
Copper	mg/kg	0.05	12.43	3.51	0.38	1.66	0.98
Lead	mg/kg	0.04	0.4	0.16	0	0.62	0.2
Nickel	mg/kg	0.05	0.43	0.22	0	0	0
Zinc	mg/kg	0.21	5.66	1.75	0.11	0.69	0.27
Manganese	mg/kg	0	0.31	0.07	0	0	0
Chromium	mg/kg	0.02	0.04	0.03	0.01	0.13	0.04
PCB	mg/kg	0	0.34	0.04	0	0	0
Calmium	mg/kg	0.02	2	0.25	0.03	2	0.32
Mercury	mg/kg	0	0	0	0	0	0

4.3.4 Chemical and Microbial Characteristics of Soil Samples

Soil properties are reflections of the dominant factors of soil formation such as parent material, climate, organism, relief, and time. The strength and stability of soil are related to its physical and chemical properties. A soil with good characteristics is more stable. Notably, the influence of these factors are distinct, yet has interrelated effects on soil, overall, their combined effect give rise to specific soil characteristics (Bamikole *et al.*, 2020).

Soil pH: Soil pH is often referred to as the master variable of soil. It controls a wide range of physical, chemical, and biological processes and properties that affect soil fertility and plant growth. Soil pH, which reflects the acidity level in soil, significantly influences the availability of plant nutrients, microbial activity, and even the stability of soil aggregates. The type of parent material, weathering activity in the area, current agricultural practices and season of the year, often influences soil pH at various locations. The pH of the topsoil obtained mostly varies from moderately acidic, neutral to alkaline during the period sampled. Specifically, the pH levels varied from 5.60 – 10.80 with an average of 7.95±0.89

(Table 4. 14 and Table 4. 15). The lowest measurement was obtained at KMSS33 (*MR74 Sanda*) while the highest was at KMSS4 (*Katsinawa Dawanau Station*). The pH of the subsoil varies from strongly acidic to neutral to alkaline with values ranging from 5.20 – 10.80 with an average of 7.43±1.01. The lowest pH was obtained at KMSS44 (*MR9 Makurda*) while the highest was at KMSS32 (*MR17 Fago*)[Appendix III). The average values indicate that there was no significant variation in the pH levels between the top and sub soils.

Electrical Conductivity: The electrical conductivity (EC) of soils is a measure of their soluble salt content as determined from the saturated extract of the soils (Buol *et al.*, 2008). It is an indicator of nutrient availability and loss, soil texture, and available water capacity. From the soil's EC data, values recorded for the topsoil samples ranged from 100.00 to 2741.00 µS/cm with a mean of 1001.61± 780.06 µS/cm. The lowest and highest value was obtained at KMSS5- *KM63* and KMSS33 - *MR74 Sanda* respectively. The subsoil values ranged from 101.00 – 4990.00 µS/cm with an average of 1116.10 ± 1185.38 µS/cm in the season sampled. The lowest and highest values of EC in the subsoil was at KMSS5 - *KM63* and KMSS15 - *KM31 Toma Dam Area* respectively. In dry season, the electrical conductivity of the topsoil ranged from 73.66 µS/cm (recorded for the sample at the proposed Katsina station) to 3645.53 recorded for the sample at Sanda. The subsoil conductivity ranged from 60.90 to 4441.10 µS/cm (near Kayawa) with a mean value of 776.32 µS/cm.

Exchangeable Cations/Basic Metals: The concentrations of the exchangeable cation Calcium (Ca), Magnesium (Mg), Potassium (K) and Sodium (Na)) content of the soil samples from the various location in the study area is presented. Ca values recorded for topsoil ranged from 0.26 – 1112.10 mg/kg (mean, 164.41 ± 251.52 mg/kg), highest value for Ca in topsoil was recorded at a location near Jibiya. Mg varied from 0.16 – 4.70 mg/kg (0.56 ± 0.77 mg/kg), K recorded between 0.30 – 4.00 mg/kg (1.64 ± 0.62 mg/kg) and Na, 13.00 – 162.00 mg/kg (60.92 ± 43.52 mg/kg). The values for Ca in the subsoil ranged 0.34 – 650.00 mg/kg (mean, 134.32 ± 221.28 mg/kg) (high records were recorded at various locations). Mg recorded from 0.10 – 3.70 mg/kg (0.50 ± 0.61 mg/kg), K ranged between

0.40 – 2.60 mg/kg (1.50 ± 0.57 mg/kg) and Na, 17.00 – 287.00 mg/kg (82.74 ± 84.05 mg/kg). During this season, there was no evidence of bioaccumulation of any of these basic metals (Na, K, Mg and Ca) in the different strata of the soil within the study area as at the time of field investigation.

Soil Nutrients: Ammonium (NH_4+) values recorded for top soil ranged from 0.15 – 5.70 mg/kg (mean, 1.66 ± 1.59 mg/kg), Nitrate (NO_3-) varied from 0.29 – 28.00 mg/kg (9.00 ± 4.78 mg/kg) and Phosphate (PO_4^{3-}) recorded between 0.00 – 16.40 mg/kg (5.57 ± 3.70 mg/kg) while values for NH_4+ in the subsoil ranged between 0.14 – 6.10 mg/kg (mean, 1.37 ± 1.38 mg/kg), NO_3- recorded from 0.80 – 13.60 mg/kg (7.20 ± 3.33 mg/kg) and PO_4^{3-} ranged between 0.00 – 18.40 mg/kg (5.71 ± 4.24 mg/kg).

Heavy Metals: Heavy metals are natural components of the Earth's crust. They cannot be degraded nor destroyed. Some heavy metals are essential to maintain the metabolism of the human body but can be toxic and dangerous at excessive concentrations. Cadmium (Cd) values recorded for top soil ranged from 0.00 - 98.00 mg/kg (mean, 4.21 ± 16.94 mg/kg), Chromium (Cr) varied from 0.00 - 2.20 mg/kg (mean, 0.36 ± 0.57 mg/kg), Zinc (Zn) measured 0.00 - 3.00 mg/kg (mean, 0.92 ± 1.03 mg/kg), Iron (Fe) 0.00 - 540.00 mg/kg (mean, 22.45 ± 94.26 mg/kg), Lead (Pb) 0.00 – 7.50 mg/kg (mean, 1.41 ± 2.39 mg/kg) and Copper (Cu) 0.00 – 98.00 mg/kg (mean, 4.54 ± 17.02 mg/kg). Values obtained in the subsoil for the parameters include Cd values ranged from 0.00 – 54.00 mg/kg (mean, 2.66 ± 10.65 mg/kg), Cr varied from 0.00 - 2.20 mg/kg (mean, 0.32 ± 0.56 mg/kg), Zn measured 0.00 – 2.50 mg/kg (mean, 0.82 ± 0.90 mg/kg), Fe measured 0.00 - 650.00 mg/kg (mean, 19.36 ± 89.18 mg/kg), Pb was 0.00 – 8.20 mg/kg (mean, 1.39 ± 2.63 mg/kg) and Cu, 0.00 – 54.00 mg/kg (mean, 3.16 ± 10.57 mg/kg).

In dry season, cadmium was undetected at some locations and the maximum concentration recorded was 5.33 mg/kg for topsoil at a location near Agangaro while the mean is 0.39 mg/kg. The highest value of chromium recorded was 3.28 mg/kg with a mean value of 0.40 mg/kg. The maximum lead concentration detected in the topsoil was 4.90 mg/kg after Toma Dam area before Danbatta station. Topsoil with the highest copper value (8.18 mg/kg) was collected at Tsamga Dadawa while the mean concentration was 0.70 mg/kg across all the sampling stations. In the subsoil samples collected in dry season, the highest concentration of cadmium detected was 1.11 mg/kg (lower than the topsoil); the maximum concentration of chromium (2.83 mg/kg) was also lower than the topsoil maximum value. The values were detected from subsoil samples collected before the proposed Kazaure station and at Sada respectively. The maximum lead concentration recorded in the subsoil samples for the dry season was 3.19 mg/kg (at Sada) while copper concentration was 62.1 mg/kg.

Adequate references were made to heavy metal content in unpolluted soils as reported for different countries of the world and also indicated the normal range in unpolluted soils. This became necessary to make sound, scientific judgement about the extent of heavy metal contamination or otherwise of the soils studied.

Generally, when compared to the corresponding concentration in naturally occurring unpolluted soils (Table 4.12) as reported by Alloway (1991) the values are very low except for Cd which was higher at some locations in both top and subsoils. The results of heavy metal reported for soils in the study area show no evidence of heavy metal accumulation/bioaccumulation in the top and sub soils as at the time of field investigation.

Table 4. 13: Background levels of heavy metals in soils of different countries

Metal	Countries of the World			Normal range in unpolluted Soils
	*Netherlands	UK (Former GLC)[1]	FRG (NOEL)[2]	
Fe	-	-	-	-
Cr	100	0 – 100	100	5 – 1500
Pb	50	0 – 500	100	2 – 300
Zn	200	0 – 250*	300	1 – 900
Cu	50	0 – 100*	100	2 – 250
Cd	1	0 – 1	3	0.01 – 2.0

[1]GLC = Greater London Council; [2]FRG/NOEL = Federal Republic of Germany; *No Effect Limit.
Source: Alloway (1991).

<u>Total Petroleum Hydrocarbon (TPH) and Oil and Grease/ Organic Compounds</u>: In wet season, TPH ranged in the topsoil from 0.00 – 0.50 mg/kg (mean, 0.05 ± 0.11 mg/kg), and 0.00 – 0.35 mg/kg (average, 0.04 ± 0.07 mg/kg). The oil and grease content of the top-soil generally measured between 0.00 – 3.30 mg/kg (mean, 0.47 ± 0.70 mg/kg) and subsoil,

0.00 – 5.00 mg/kg (mean, 0.41 ± 0.84 mg/kg). The mean values indicate that subsoil concentrations of oil and grease are slightly lower when compared to those of the top-soil during the wet season.

Organic compounds in the study area were also within the threshold for their respective compounds. Values of 0.00 – 0.56 mg/kg (mean, 0.05 ± 0.12 mg/kg) and 0.00 – 0.87 mg/kg (mean, 0.05 ± 0.14 mg/kg), 0.00 – 1.70 mg/kg (mean, 0.04 ± 0.22 mg/kg) and 0.00 – 0.40 mg/kg (mean, 0.01 ± 0.06 mg/kg) for Phenols and Benzene in the top and subsoils respectively while Toluene recorded only 0.01 mg/kg for subsoil at KMSS30 (*MR20 Agangaro*).

The topsoil characteristics for dry season shows that the TPH values in the topsoil ranged from 0.00 to 0.63 mg/kg (mean 0.07 mg/kg); oil and grease ranged from 0.00 – 2.94 mg/kg (0.61 mg/kg); phenols ranged from 0.00 – 0.62 mg/kg (0.03 mg/kg) and benzene concentrations ranged from 0.00 – 1.97 mg/kg (0.05 mg/kg). In the subsoil samples for dry season; the maximum TPH concentration was 0.38 mg/kg (lower than the value recorded for topsoil) while oil and grease concentrations ranged from 0.00 – 3.29 (0.04 mg/kg). The mean values of phenols and benzene in the dry season subsoil samples are 0.04 mg/kg and 0.01 mg/kg respectively.

The values of TPH, oil and grease and other organic compounds recorded are suggested to be mostly biogenic, as there is no evidence of hydrocarbon/organic compound pollution of the soils within the study area as at the time of the sampling.

Microbial Properties of the Soils*:*

Total coliform count measured in wet season ranged between 8.00 and 98.00 CFU/g, with a mean of 46.96 ± 4.55 CFU/g, and 4.00 – 187.00 CFU/g, with a mean of 48.54 ± 29.98 CFU/g in the top and sub soil respectively while *E. coli* was nearly non-existent in the top and subsoil samples except in the topsoil analysis of KMSS53 (MR6 Mai Dabo-12), where it measured 1.00 CFU/g. Fungi and AMB counts were 13.00 - 91.00 CFU/g, mean 53.06 ±18.09 CFU/g, and 13.00 - 92.00 CFU/g, mean 47.18 ± 17.23 CFU/g in the top and sub soils sampled respectively. The AMB counts measured 23.00 - 165.00 CFU/g, with mean of 96.45 ± 44.96 CFU/g and 14.00- 430.00 CFU/g, with mean of 98.19 ± 9.82 CFU/g.

In dry season total coliform count measured ranged between 2.56 and 126.96 CFU/g, with a mean of 41.8 ± 2.34 CFU/g, and 2.75 – 230 CFU/g, with a mean of 42.56 ± 21.24 CFU/g in the topsoil and subsoil respectively while the maximum *E. coli* value recorded in topsoil and subsoil were 7.43 CFU/g and 7.80 CFU/g respectively. The highest Fungi counts were 122.85 CFU/g and 153.64 CFU/g for topsoil and subsoil respectively. The maximum AMB counts measured were 218.4 CFU/g and 593.4 CFU/g for topsoil and subsoil respectively.

The living soil is crucial to various soil, plant, and material processes such as plant and animal health, global food production, photosynthesis, biogeochemical cycles, biodiversity, and climate change. The diversity and population densities of soil microbes in samples that were collected at various sampling locations within the study area in both top and sub soil indicates total coliform, *E. coli*, AMB and Fungi were present.

Table 4. 14: Statistics of the Soil Chemical and Microbial Parameters (Wet Season)

SN	Parameters	Topsoil			Subsoil		
		Min	*Max*	*Mean*	*Min*	*Max*	*Mean*
1.	pH	5.60	10.80	7.95	5.20	10.80	7.42
2.	Conductivity	100.00	2741.00	1001.61	101.00	4990.00	1116.10
3.	Sodium	13.00	162.00	60.92	17.00	287.00	82.74
4.	Potassium	0.30	4.00	1.64	0.40	2.60	1.50
5.	Magnesium	0.16	4.70	0.56	0.10	3.70	0.50
6.	Calcium	0.26	1112.10	164.41	0.34	650.00	134.32
7.	Ammonium	0.15	5.70	1.66	0.14	6.10	1.37
8.	Nitrate	0.29	28.00	9.00	0.80	13.60	7.20
9.	Phosphate	0.00	16.40	5.57	0.00	18.40	5.71
10.	Cadmium	0.00	98.00	4.21	0.00	54.00	2.66
11.	Chromium	0.00	2.20	0.36	0.00	2.20	0.32
12.	Zinc	0.00	3.00	0.92	0.00	2.50	0.82
13.	Iron	0.00	540.00	22.45	0.00	650.00	19.36
14.	Lead	0.00	7.50	1.41	0.00	8.20	1.39
15.	Copper	0.00	98.00	4.54	0.00	54.00	3.16
16.	TPH	0.00	0.50	0.05	0.00	0.35	0.04
17.	Oil and Grease	0.00	3.30	0.47	0.00	5.00	0.41
18.	Phenols	0.00	0.56	0.05	0.00	0.87	0.05
19.	Benzene	0.00	1.70	0.04	0.00	0.40	0.01
20.	Total Coliform	8.00	98.00	46.96	4.00	187.00	48.54
21.	*E.coli*	0.00	1.00	0.01	0.00	0.00	0.00
22.	Fungi	13.00	91.00	53.06	13.00	92.00	47.18
23.	AMB	23.00	165.00	96.45	14.00	430.00	98.19

(Source: Allot Fieldwork 2021)

Table 4. 15: Statistics of the Soil Chemical and Microbial Parameters (Dry Season)

SN	Parameters	Topsoil	Subsoil

		Min.	Max.	Mean	Min.	Max.	Mean
1.	pH	4.70	9.87	7.17	4.37	10.35	6.74
2.	Conductivity (µS/cm)	73.66	3645.53	902.07	60.9	4441.1	776.32
3.	Sodium (mg/kg)	7.51	255.84	60.51	9.73	334.93	76.47
4.	Potassium (mg/kg)	0.23	6.28	2.00	0.24	3.93	1.82
5.	Magnesium (mg/kg)	0.00	3.17	0.52	0	4.02	0.5
6.	Calcium (mg/kg)	0.30	989.77	123.84	0.19	877.5	139.24
7.	Ammonium (mg/kg)	0.09	11.13	1.95	0.09	11.13	1.56
8.	Nitrate (mg/kg)	0.03	2.16	0.71	0	17.01	6.44
9.	Phosphate (mg/kg)	0.03	20.98	5.34	0	23.27	5.13
10.	Cadmium (mg/kg)	0.00	5.33	0.39	0	1.11	0.04
11.	Chromium (mg/kg)	0.00	3.28	0.40	0	2.83	0.35
12.	Zinc (mg/kg)	0.00	5.01	0.83	0	4.18	0.86
13.	Iron (mg/kg)	0.00	409.40	30.12	0	578.5	14.61
14.	Lead (mg/kg)	0.00	4.90	0.41	0	3.19	0.25
15.	Copper (mg/kg)	0.00	8.18	0.70	0	62.1	3.79
16.	TPH (mg/kg)	0.00	0.63	0.07	0	0.38	0.04
17.	Oil and Grease (mg/kg)	0.00	2.94	0.61	0	3.29	0.46
18.	Phenols (mg/kg)	0.00	0.62	0.03	0	0.51	0.04
19.	Benzene (mg/kg)	0.00	1.97	0.05	0	0.46	0.01
20.	Total Coliform (cfu/g)	2.56	126.96	41.81	2.75	230.01	42.56
21.	*E.coli* (cfu/g)	0.00	7.43	0.50	0	7.8	0.82
22.	Fungi (cfu/g)	0.00	122.85	60.90	14.24	153.64	54.28
23.	AMB (cfu/g)	0.00	218.40	98.03	10.8	593.4	98.59

(Source: Allot Fieldwork 2021)

4.3.5 Biodiversity Assessment

4.3.5.1 Vegetation Study

Generally, the natural vegetation across the three states, particularly around the Project corridor is characterised by Sahel and Sudan savannah. It has been significantly degraded by human activities such as farming, grazing and wood collection (Plate 4. 1) and charcoal production, while the existing vegetation within the project zone of influence covers approximately 4 % of the total land area. The situation has been aggravated by effects of climate change in the study area, which includes late rain and decline in the volume of annual rainfall in the study area.

Plate 4. 1: Grazing and wood collection are widespread practices in the project area

The vegetation of the project area is dominated by grasses and shrubs with an average height of 1.5 metres. These plant species are considered as the cultural vegetation in the project corridor. Common trees across the entire stretch of the study area include *Adansonia digitata* (African baobab tree or locally referred to as *Kuka* in Hausa); *Anogeissus leiocarpus* (African birch; known in Hausa as *Marke* or *Kojoli* in Fulani language); *Diospyros mespiliformis* (Jackal berry / ebony, which is called *Kanya* in Hausa and *Balchi* in Fulani).

Other plant species that are widespread in the study area are *Azadirachta indica* (Neem, commonly known as *Dogon yaro* among the locals) and *Khaya senegalensis* (*Madaci* in Hausa and *Dalehi* in Fulani) and *Tamarindus indica* (locally referred to as *Tsamiya*). Edible cash crops such as cashew and mango were encountered at different parts along the route. Also, cowpea, groundnut, maize, millet, onion, rice and sorghum are widely cultivated in the project area.

Specifically, Jigawa State lies mostly within the Sudan savannah and Sahel (marginal) savannah vegetation belt; an ecological zone with proximity to the fringes of the fast-encroaching Sahara Desert. It is the last vegetation zone in the extreme northern part of the country, close to Lake Chad, characterized by sparsely distributed stunted trees, shrubs and short grasses of about 1m high in-between sand dunes. Additionally, there are traces of Guinea savannah vegetation found in parts of the southern districts, and particularly in areas such as Jigawa Tsadar, Ruru and Unguwar Ya. The original vegetation has long been removed, giving rise to farm parkland of vegetation. Due to annual cultural land clearing, almost all the original tree species have been removed; and only few trees exist. *Azadirachta indica* has naturalised in Jigawa State, to the extent of replacing the original native trees, especially in villages; and Acacia species tend to be abundant across the state. From the secondary data available, there are forests, shelterbelts and grazing reserves in the State. These include Farin Dutse Forest Reserve, Dabi Forest Reserve, Garin-Gabas and Mele.

The existing vegetation has an abundance of grasses and herbs and few clumped or scattered trees. In dry season, the grasses were observed to be pale brown and stunted owing to their inability to withstand the harsh climatic condition whilst some thorny plants were observed to be green during dry season. Dominant tree species associated with the vegetation include *Acacia* spp. (especially *A. albida*), *Ziziphus* spp., *Balanites aegyptiaca*, *Azadirachta indica* and *Adansonia digitata*, while common grasses are *Andropogon spp., Cenchrus biflorus* and *Vetiveria nigritana*.

The Kano vegetation pattern is similar to that of Jigawa State; mainly savanna and climatically defined into Sahel and Sudan savanna. The vegetation cover is now altered as a result of climate change and human activities. The vegetation primarily consists of shrubs and dense grasses with sparsely distributed trees. The most part of the land has been disturbed and degraded through intensive agriculture and grazing while some near river banks are converted to intensive rain-fed agricultural land by the farmers in the area.

In Katsina State, the vegetation pattern along the project corridor is predominantly Sahel and Sudan savannah, and this is observable in places like Daddara, Jibiya and Maduru. It consists of scattered trees with sparse shrubs and grass. The vegetation type in the southern part of the state is Guinea savannah while Sudan savannah vegetation pattern is more pronounced in the central part of the state. Generally, the plant species have adapted to the harsh climatic condition of the project area. The trees have long tap roots with thick barks, and these features help them to tolerate long period of dry season. In addition, the grasses have long durable roots which remain underground after bush burning, which was common in the study area. *Adansonia digitata, Azadirachta indica* and *Parkia biglobosa* are widespread and usually planted to mitigate desert encroachment and erosion. The plants that are the most threatened or vulnerable are the medicinal and economic trees and shrubs.

Almost all the lands are cultivated along the route, and as a result, flora species diversity is low and many of the plant species earlier identified in the Savanna are reducing in population, especially those with value in health care and edible qualities such as *Khaya*

Senegalensis. Large trees are few in the dryland ecosystems such as exist in Jigawa State while only shrubs and small trees with a wild variety of grasses predominate. These plants have highly adjusted to the aridity of the zone (drought-resistant) and are useful to the community either as food, livestock feed or medicinal purpose. Generally, during the dry season, the grasses in the project area are usually dry and brown, and bush fires are often are of common occurrence. The underground parts of the grasses survive the dry season and fires and grow again when the rain comes.

Across the sampling stations, a total of 48 taxa of plants belonging to 25 families were encountered during the study. Most of the encountered taxa serve as herbs and food for livestock or the people in the project area. The physiognomy of most of the sampling stations is characterized by cultivated farmland and open vegetation of scanty trees with similar anthropogenic factors. Sampling station 12 had the highest diversity; having the highest number of plant species (16) while stations 3 and 17 had the least number of plant species (Table 4.16).

Table 4. 16: Sampling locations and plant species encountered

Sampling Location	Species Encountered	Family	Local Name	Freq.
SS1 Lat. 11.81107 Long. 8.83758	*Adansonia digitata*	Bombacaceae	*Kuka*	4
	Hyphaene thebaica	Arecaceae	*Kaba*	6
	Guiera senegalensis	Combretceae	*Sabara (h),*	5
	Azadirachta indica	Mimosoideae	*Maina*	11
	Lannea acida	Anacardiaceae	*Faru*	12
	Leptadenia hastate	Asclepiadaceae	*Yadiha*	5
	Piliostigma thonningii	Caesalpinioideae	*Karogo*	19
	Acacia laeta	Mimosoideae		7
SS2 Lat. 11.82142 Long. 8.863390	*Azadirachta indica*	Mimosoideae	*Maina*	8
	Balanites aegyptiaca	Zygophyllaceae	*Aduwa*	7
	Diospyros mespiliformis	Ebenaceae	*Kanya*	3
	Borassus aethiopum	Mimosoideae	*Giginya*	4
	Prosopis africana	Arecaceae	*Kirya*	7
	Tamarindus indica	Combretceae	*Tsamiya*	10
	Piliostigma thonningii	Caesalpinioideae	*Karogo*	8
	Cissus quadrangularis	Vitaceae	*Sasarinkura(h)*	7
	Mangifera indica	Anacardiaceae	*Mongoro*	3
SS3 Lat. 11.81088 Long. 8.852601	*Adansonia digitata*	Bombacaceae	*Kuka*	3
	Borassus aethiopum	Arecaceae	*Giginya*	2
	Leptadenia hastate	Asclepiadaceae	*Yadiha*	6
	Guiera senegalensis	Combretceae	*Sabara*	12

Sampling Location	Species Encountered	Family	Local Name	Freq.
	Piliostigma thonningii	Caesalpinioideae	*Karogo*	10
SS4 Lat. 11.81786 Long. 8.85635	*Terminalia laxiflora*	Combrtaceae	*Maji(h)*	2
	Parkia biglobosa	Mimosoideae	*Dorawa*	3
	Diospyros mespiliformis	Ebenaceae	*Kanya(h), Nelbi(f)*	4
	Prosopis africana	Mimosoideae	*Kirya*	6
	Tamarindus indica	Mimosoideae	*Tsamiya*	9
	Vitex doniana	Verbenaceae	*Dinya(h), Nelbi(f)*	13
	Azadirachta indica	Meliaceae	*Maina*	5
	Balanites aegyptiaca	Zygophyllaceae	*Aduwa*	3
	Guiera senegalensis	Combretceae	*Sabara (h),*	2
	Dicoma tomentosa	Asteraceae	-	13
	Euphorbia hirta	Euphorbiaceae	*Arira(h)*	10
SS5 Lat. 11.922005 Long. 8.448766	*Cissus quadrangularis*	Vitaceae	*Sasarinkura(h)*	5
	Leptadenia hastate	Asclepiadaceae	*Yadiha*	9
	Dichrostachys cinerea	Mimosoideae	*Faraakiya*	5
	Balanites aegyptiaca	Zygophyllaceae	*Aduwa*	10
	Guiera senegalensis	Combretaceae	*Sabara (h),*	15
	Adansonia digitata	Bombacaceae	*Kuka*	7
	Euphorbia hirta	Euphorbiaceae	*Arira(h)*	>500
SS6 Lat. 11.989849 Long. 8.446430	*Eucalyptus camaldulensis*	Myrtaceae		5
	Azadirachta indica	Meliaceae	*Maina*	2
	Balanites aegyptiaca	Zygophyllaceae	*Aduwa*	5
	Adansonia digitata	Bombacaceae	*Kuka*	2
	Guiera senegalensis	Combretceae	*Sabara (h),*	2
	Piliostigma thonningii	Caesalpinioideae	*Karogo*	3
	Citrus aurantium	Rutaceae	Bàbbán lèèmúú	2
SS7 Lat. 12.025505 Long. 8.441111	*Eucalyptus camaldulensis*	Myrtaceae		6
	Azadirachta indica	Meliaceae	*Maina*	5
	Adansonia digitata	Bombacaceae	*Kuka*	8
	Vitex doniana	Verbenaceae	*Dinya(h), Nelbi(f)*	9
	Cissus quadrangularis	Vitaceae	*Sasarinkura(h)*	5
	Leptadenia hastate	Asclepiadaceae	*Yadiha*	11
SS8 Lat. 12.032796 Long. 8.440317	*Diospyros mespiliformis*	Ebenaceae	*Kanya(h), Nelbi(f)*	5
	Calotropis procera	Asclepiadaceae	*Tumpafiya*	3
	Azadirachta indica	Meliaceae	*Maina*	4
	Hyphaene thebaica	Arecaceae	*Kaba*	3
	Piliostigma thonningii	Caesalpinioideae	*Karogo*	11
	Anogeissus leiocarpus	Combretaceae	*Mareke*	5
	Senna occidentalis	Caesalpinioideae	*Tabsahi*	46
	Vigna subterranea	Fabaceae	Bíídì	17
SS9 Lat. 12.171028 Long. 8.482753	*Anacardium occidentale*	Anacardiaceae	*Dankaju*	11
	Anogeissus leiocarpus	Combretaceae	Mareke	7
	Azadirachta indica	Meliaceae	*Maina*	4
	Borassus aethiopum	Arecaceae	*Giginya*	6
	Daniellia oliveri	Caesalpinioideae	*Maji*	4
	Ficus sp.	Moraceae		4

Sampling Location	Species Encountered	Family	Local Name	Freq.
	Hyphaene thebaica	Arecaceae	*Goriba*	5
	Mangifera indica	Anacardiaceae	*Mongoro*	5
	Phoenix dactylifera	Arecaceae	*Dabino*	12
	Pliostigma thonningii	Caesalpinioideae	*Karogo*	5
	Vitellaria paradoxum	Sapotaceae	*Kadanyahan*	2
	Vetiveria sp.	Grass		25
	Abutilon mauritianum	Malvacea	*Ambru*	5
SS10 Lat. 12.337338 Long. 8.54489	*Senna occidentalis*	Caesalpinioideae		23
	Guiera senegalensis	Combretaceae	*Sabara*	10
	Piliostigma thonningii	Caesalpinioideae	*Karogo*	2
	Diospyros mespiliformis	Ebenaceae	*Kanya*	1
	Balanites aegyptiaca	Zygophyllaceae	*Aduwa*	1
	Leptadenia hastate	Asclepiadaceae	*Yadiha*	19
	Digitaria exilis	Poaceae	*Áccà*	>500
SS11 Lat. 12.381041 Long. 8.528535	*Guiera senegalensis*	Combretaceae	*Sabara*	10
	Piliostigma thonningii	Caesalpinioideae	*Karogo*	10
	Diospyros mespiliformis	Ebenaceae	*Kanya*	3
	Balanites aegyptiaca	Zygophyllaceae	*Aduwa*	1
	Acacia sp.	Mimosoideae		2
	Senna occidentalis	Caesalpinioideae		>500
SS12 Lat. 12.577381 Long. 8.452205	*Adansonia digitata*	Bombacaceae	*Kuka*	6
	Azadirachta indica	Meliaceae	*Maina*	28
	Borassus aethiopum	Mimosoideae	*Giginya*	9
	Terminalia laxiflora	Combrtaceae	*Maji(h)*	5
	Combretum micranthum	Combretaceae	*Fárár géézàa*	18
	Lannea acida	Anacardiaceae	*Faru*	11
	Leptadenia hastate	Asclepiadaceae	*Yadiha*	15
	Ipomea carnea	Convolvulaceae		>500
	Balanites aegyptiaca	Zygophyllaceae	*Aduwa*	12
	Cissus quadrangularis	Vitaceae	*Sasarinkura(h)*	4
	Prosopis Africana	Mimosoideae	*Kirya*	11
	Tamarindus indica	Combretceae	*Tsamiya*	4
	Guirea senegalensis	Meliaceae	*Sabara*	6
	Senna occidentalis	Caesalpinioideae	*Tabsahi*	89
	Andasonia digitata	Bombacaceae	*Kuka*	2
	Vitex doniana	Verbenaceae	*Dinya(h), Nelbi(f)*	7
SS13 Lat. 12.430856 Long. 8.538597	*Adansonia digitata*	Bombacaceae	*Kuka*	5
	Borassus aethiopum	Arecaceae	*Giginya*	5
	Leptadenia hastate	Asclepiadaceae	*Yadiha*	23
	Prosopis Africana	Arecaceae	*Kirya*	12
	Guiera senegalensis	Combretceae	*Sabara*	5
	Piliostigma thonningii	Caesalpinioideae	*Karogo*	10
	Abutilon mauritianum	Malvaceae	*Ambru*	19
SS14 Lat. 12.477350	*Cissus quadrangularis*	Vitaceae	*Sasarinkura(h)*	4
	Parkia biglobosa	Mimosoideae	*Dorawa*	3
	Piliostigma thonningii	Caesalpinioideae	*Karogo*	7

Sampling Location	Species Encountered	Family	Local Name	Freq.
Long. 8.524357	*Diospyros mespiliformis*	Ebenaceae	*Kanya(h)*	2
	Tamarindus indica	Mimosoideae	*Tsamiya*	5
	Euphorbia hirta	Euphorbiaceae	*Arira(h)*	17
	Balanites aegyptiaca	Zygophyllaceae	*Aduwa*	5
	Guiera senegalensis	Combretceae	*Sabara (h),*	2
	Dicoma tomentosa	Asteraceae	-	9
SS15 Lat. 12.631928 Long. 8.397941	*Cissus quadrangularis*	Vitaceae	*Sasarinkura*	5
	Adansonia digitata	Bombacaceae	*Kuka*	4
	Dichrostachys cinerea	Mimosoideae	*Faraakiya*	3
	Balanites aegyptiaca	Zygophyllaceae	*Aduwa*	7
	Cassia tora	Leguminosae	Tafasa	>250
	Terminalia laxiflora	Combrtaceae	*Maji(h)*	5
SS16 Lat. 12.648825 Long. 8.385869	*Dichrostachys cinerea*	Mimosoideae	*Faraakiya*	5
	Balanites aegyptiaca	Zygophyllaceae	*Aduwa*	3
	Cassia tora	Leguminosae	Tafasa	
	Adansonia digitata	Bombacaceae	*Kuka*	6
	Eucalyptus camaldulensis	Myrtaceae		7
	Azadirachta indica	Meliaceae	*Maina*	3
	Diospyros mespiliformis	Ebenaceae	*Kanya*	3
SS17 Lat. 12.825678° Long. 8.388035	*Eucalyptus camaldulensis*	Myrtaceae		10
	Azadirachta indica	Meliaceae	*Maina*	8
	Adansonia digitata	Bombacaceae	*Kuka*	7
	Cassia tora	Leguminosae	Tafasa	55
	Centaurea praecox	Asteraceae	Danji	12
SS18 Lat. 12.868011 Long. 8.384744°	*Anogeissus leiocarpus*	Combretaceae	*Mareke*	6
	Senna occidentalis	Caesalpinioideae	*Tabsahi*	19
	Cassia tora	Leguminosae	Tafasa	35
	Cissus quadrangularis	Vitaceae	*Sasarinkura(h)*	13
	Diospyros mespiliformis	Ebenaceae	*Kanya(h), Nelbi(f)*	6
	Tamarindus indica	Mimosoideae	*Tsamiya*	9
	Azadirachta indica	Meliaceae	*Maina*	5
SS19 Lat. 12.868011 Long. 8.384744	*Ocimum basilicum*	Lamiaceae	*Doodaya*	6
	Parkia biglobosa	Mimosoideae	*Dorawa*	3
	Piliostigma thonningii	Caesalpinioideae	*Karogo*	3
	Diospyros mespiliformis	Ebenaceae	*Kanya(h), Nelbi(f)*	5
	Prosopis africana	Mimosoideae	*Kirya*	25
	Tamarindus indica	Mimosoideae	*Tsamiya*	11
	Vitex doniana	Verbenaceae	*Dinya(h), Nelbi(f)*	14
	Azadirachta indica	Meliaceae	*Maina*	3
	Balanites aegyptiaca	Zygophyllaceae	*Aduwa*	7
	Guiera senegalensis	Combretceae	*Sabara (h),*	12
	Dicoma tomentosa	Asteraceae	-	24
	Euphorbia hirta	Euphorbiaceae	*Arira (h)*	10
SS20 Lat. 12.999795	*Calotropis procera*	Asclepiadaceae	*Tumpafiya*	4
	Azadirachta indica	Meliaceae	*Maina*	7
	Hyphaene thebaica	Arecaceae	*Kaba*	5

Sampling Location	Species Encountered	Family	Local Name	Freq.
Long. 8.320829	*Diospyros mespiliformis*	Ebenaceae	*Kanya*	5
	Balanites aegyptiaca	Zygophyllaceae	*Aduwa*	7
	Leptadenia hastate	Asclepiadaceae	*Yadiha*	9
	Saccharum spontaneum	Poaceae	*Àbóókín kíbíyàà*	>500
SS21 Lat. 12.982226 Long. 8.202866	*Azadirachta indica*	Meliaceae	*Maina*	5
	Piliostigma thonningii	Caesalpinioideae	*Karogo*	11
	Guiera senegalensis	Combretaceae	*Sabara*	13
	Acacia sp.	Mimosoideae		4
	Balanites occidentalis	Caesalpinioideae	*Aduwa*	8
	Senna occidentalis	Caesalpinioideae		93
SS22 Lat. 12.975659 Long. 8.122695	*Asparagus africanus*	Liliaceae		14
	Mangifera indica			11
	Balanites aegyptiaca	Zygophyllaceae	*Aduwa*	8
	Parkia biglobosa	Mimosoideae	*Dorawa*	4
	Piliostigma thonningii	Caesalpinioideae	*Karogo*	9
	Guiera senegalensis	Combretaceae	*Sabara*	12
	Diospyros mespiliformis	Ebenaceae	*Kanya*	3
SS23 Lat. 12.993519 Long. 7.899520	*Terminalia laxiflora*	Combrtaceae	*Maji(h)*	9
	Lannea acida	Anacardiaceae	*Faru*	8
	Leptadenia hastate	Asclepiadaceae	*Yadiha*	13
	Ipomea carnea	Convolvulaceae		67
	Guiera senegalensis	Combretaceae	*Sabara (h),*	10
	Combretum micranthum	Combretaceae	Fárár géézàa	12
SS24 N/A	*Azadirachta indica*	Mimosoideae	*Maina*	8
	Balanites aegyptiaca	Zygophyllaceae	*Aduwa*	10
	Terminalia laxiflora	Combrtaceae	*Maji(h)*	8
	Lannea acida	Anacardiaceae	*Faru*	14
	Ipomea carnea	Convolvulaceae		36
	Wissadula amplissima	Malvaceae		55
SS25 Lat. 13.020632 Long. 7.791419	*Eucalyptus camaldulensis*	Myrtaceae		31
	Adansonia digitata	Bombacaceae	*Kuka*	12
	Azadirachta indica	Meliaceae	*Maina*	13
	Borassus aethiopum	Mimosoideae	*Giginya*	14
	Ziziphus mauritiana	Rhamnaceae	*Magarya*	8
	Prosopis africana	Arecaceae	*Kirya*	16
	Guiera senegalensis	Combretceae	*Sabara*	25
SS26 Lat. 13.021553° Long. 7.776357°	*Sterculia setigera*	Sterculiaceae	*Kukuki*	21
	Piliostigma thonningii	Caesalpinioideae	*Karogo*	24
	Leptadenia hastate	Asclepiadaceae	*Yadiha*	31
	Cissus quadrangularis	Vitaceae	*Sasarinkura(h)*	3
	Adansonia digitata	Bombacaceae	*Kuka*	12
	Azadirachta indica	Meliaceae	*Maina*	20
SS27 Lat. 13.045928 Long. 7.629821	*Eucalyptus camaldulensis*	Myrtaceae		18
	Dichrostachys cinerea	Mimosoideae	*Faraakiya*	6
	Balanites aegyptiaca	Zygophyllaceae	*Aduwa*	7
	Azadirachta indica	Meliaceae	*Maina*	10

Sampling Location	Species Encountered	Family	Local Name	Freq.
	Diospyros mespiliformis	Ebenaceae	*Kanya*	10
	Bridelia ferruginea	Euphorbiaceae	*Kirni*	10
SS28 Lat. 13.042840 Long. 7.527273	*Tamarindus indica*	Mimosoideae	*Tsamiya*	16
	Azadirachta indica	Meliaceae	*Maina*	17
	Senna occidentalis	Caesalpinioideae	*Tabsahi*	>500
	Cassia tora	Leguminosae	Tafasa	>100
	Cissus quadrangularis	Vitaceae	*Sasarinkura(h)*	21
	Anogeissus leiocarpus	Combretaceae	*Mareke*	4
SS29 Lat. 13.092870 Long. 7.404454	*Cassia tora*	Leguminosae	Tafasa	23
	Dichrostachys cinerea	Mimosoideae	*Faraakiya*	19
	Hyphaene thebaica	Arecaceae	*Kaba*	16
	Diospyros mespiliformis	Ebenaceae	*Kanya*	7
	Balanites aegyptiaca	Zygophyllaceae	*Aduwa*	8
	Leptadenia hastate	Asclepiadaceae	*Yadiha*	16
	Azadirachta indica	Meliaceae	*Maina*	5
	Piliostigma thonningii	Caesalpinioideae	*Karogo*	14
SS30 Lat. 13.100730 Long. 7.337833	*Guiera senegalensis*	Combretaceae	*Sabara*	17
	Calotropis procera	Asclepiadaceae	*Tumpafiya*	18
	Azadirachta indica	Meliaceae	*Maina*	28
	Adansonia digitata	Bombacaceae	*Kuka*	5
	Alchornea cordifolia	Euphorbiaceae	Bambami	13
	Borassus aethiopum	Mimosoideae	*Giginya*	12
SS31 Lat. 13.109683 Long. 7.309678	*Leptadenia hastate*	Asclepiadaceae	*Yadiha*	14
	Delonix regia	Fabaceae		7
	Tamarindus indica	Combretceae	*Tsamiya*	5
	Senna occidentalis	Caesalpinioideae	*Tabsahi*	115
	Bridelia ferruginea	Euphorbiaceae	*Kirni*	8
	Guirea senegalensis	Meliaceae	*Sabara*	12
SS32 Lat. 13.109683 Long. 7.309678°	*Prosopis africana*	Mimosoideae	*Kirya*	7
	Diospyros mespiliformis	Ebenaceae	*Kanya*	6
	Azadirachta indica	Meliaceae	*Maina*	10F
	Cassia tora	Leguminosae	*Tafasa*	>500
	Eucalyptus camaldulensis	Myrtaceae	Turare	6
	Parkia biglobosa	Mimosoideae	*Dorawa*	2
	Piliostigma thonningii	Caesalpinioideae	*Karogo*	10
SS33 Lat. 13.116697 Long. 7.289776	*Cissus quadrangularis*	Vitaceae	*Sasarinkura(h)*	12
	Piliostigma thonningii	Caesalpinioideae	*Karogo*	5
	Anogeissus leiocarpus	Combretaceae	*Mareke*	2
	Combretum aculeatum	Combretaceae	Geeza	10
	Balanites aegyptiaca	Zygophyllaceae	*Aduwa*	3
	Terminalia laxiflora	Combrtaceae	*Maji(h)*	4
	Guiera senegalensis	Combretceae	*Sabara (h),*	3
SS34 Lat. 13.100539 Long. 7.234923	*Azadirachta indica*	Meliaceae	*Maina*	4
	Euphorbia hirta	Euphorbiaceae	*Arira(h)*	13
	Adansonia digitata	Bombacaceae	*Kuka*	7
	Balanites aegyptiaca	Zygophyllaceae	*Aduwa*	12

Sampling Location	Species Encountered	Family	Local Name	Freq.
	Leptadenia hastate	Asclepiadaceae	*Yadiha*	9
	Cassia tora	Leguminosae	*Tafasa*	>500
	Piliostigma thonningii	Caesalpinioideae	*Karogo*	17
	Diospyros mespiliformis	Ebenaceae	*Kanya*	5
	Hyphaene thebaica	Arecaceae	*Kaba*	7

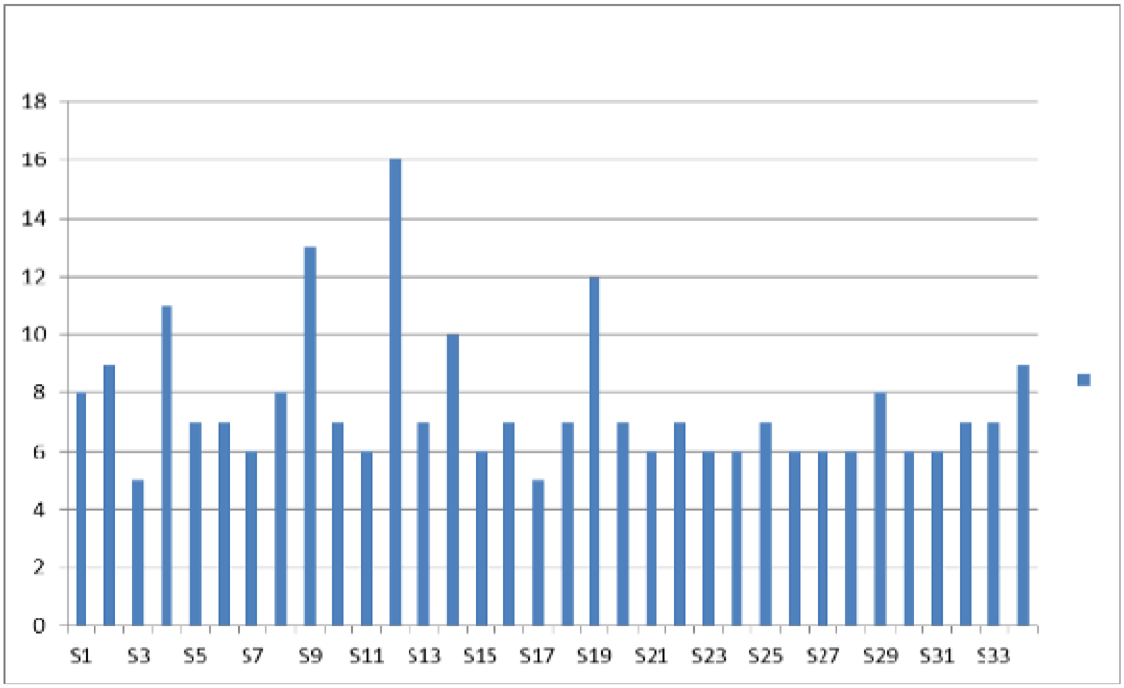


Figure 4. 55: Plant Species Richness across sampling stations

Some Plant Species of the Study Area


Plate 4.2a: *Ipomea carnea*


Plate 4.2b: *Azadirachta indica* (Hausa; Maina)


Plate 4.2c: *Borassus aethiopum* (Bámbààmíí or Giginya)


Plate 4.2d: *Calotropis procera* (Sodom apple - Tùmfááfìiyáá)


Plate 4.2e: *Delonix regia* (Daurawa)


Plate 4.2f: *Acacia nilotica* (Kayaa)


Plate 4.2g: *Combretum aculeatum* (Geeza)


Plate 4.2h: *Mangifera indica* (Mango)


Plate 4.2i: *Tamarindus indica* at flowering stage


Plate 4.2j: Tiger nut (*Cyperus esculentus*) within a Daura community


Plate 4.2k: Water lettuce encountered in the project area


Plate 4.2l: *Cassia tora* (Tafasa)

Plate 4. 2: Some of the encountered plant species in the study area

Species Abundance and Dominance

Cultivated crops such as millet, rice, etc. dominated most of the sampling stations. Forty-eight different plant species were encountered in the study area, from Dutse to Jibiya - Maradi border area. *Cassia tora* is the most abundant of the plant species encountered (over 2,413) followed by *Senna accidentalis* (1385), *Ipomea carnea* (603), *Euphorbia hirta* (564), *Saccharum spontaneum* (500) and *Digitaria exilis* (500). Others were less than 250 in terms of abundance. The least abundant plants encountered, especially with abundance less than 10 were *Citrus aurantium, Vitellaria paradoxum, Daniellia oliveri, Ficus sp., Ocimum basilicum, Delonix regia and Ziziphus mauritiana* (Table 4. 17).

Plate 4.3a: Tomatoes are cultivated along the project area

Plate 4.3b: Rice is a predominantly cultivated crop in the project area

Plate 4.3c: Cultivated sorghum in the project area

Plate 4.3d: Harvested millet in the study area

Plate 4. 3: Some cultivated plants (crops) and farmlands in the project area

The most frequently encountered plant species along the route were *Azadirachta indica*, which was observed at 24 of the 34 sampling locations. Others were *Balanites aegyptiaca (19), Piliostigma thonningii (17), Guiera senegalensis (16), Diospyros mespiliformis (15), Adansonia digitata (14), and Leptadenia hastate (13).* The least encountered plant species were *Alchornea cordifolia, Anacardium occidentale, Asparagus africanus, Centaurea praecox, Citrus aurantium, Daniellia oliveri, Delonix regia and Ficus sp.* Other flora species encountered at only one sampling location were *Ocimum basilicum, Phoenix dactylifera, Vetiveria sp., Vigna subterranean, Vitellaria paradoxum, Wissadula amplissima and Ziziphus* *mauritiana.* Although *Saccharum spontaneum* and *Digitaria exilis* were two of the most abundant, each of them was also encountered at only one location (Table 4. 17).

Table 4. 17: Plant species abundance, conservation status and frequency of occurrence

Reference: The IUCN Red List of Threatened Species. Version 2021-3. <https://www.iucnredlist.org>)

- A – Abundance of plant species at all sampling locations
- Freq. – Frequency of occurrence of the plant species (that is, the total number of sampling points the plant species were encountered).
- Percentage Frequency (%Freq.) =

$$\frac{\text{Freq of Occurrence}}{\text{Total No of sampling stations}} \times 100$$

From the study, millet, groundnut, rice, guinea corn, etc, which are introduced through planting and farming activities were encountered and exempted from the data presented in the Table below. Also, the following plant species with edible fruits were encountered: *Anacardium occidentale*, *Balanites aegyptiaca*, *Borrasus aethiopicum*, *Mangifera indica*, and *Tamarindus indica*, among others. Of these species, 41% (13 species) are used for medicine, 19% (7 species) are edible fruits and 16% (5 species) are used for medicine and as fodder. Details of the local names and economic uses of the encountered species are shown in Table 4. 18.

Table 4. 18: Economic importance of the encountered plant species

S/N	Species Encountered	Habit	Economic Importance
1	*Acacia sp.*	Tree	Fencing
2	*Adansonia digitata*	Tree	Edible leaf, Fodder
3	*Anacardium occidentale*	Tree	Edible Fruit
4	*Anogeissus leiocarpus*	Tree	Medicine, Fodder
5	*Asparagus africanus*	Shrub	Medicine
6	*Azadirachta indica*	Tree	Medicine, Fodder
7	*Balanites aegyptiaca*	Shrub	Edible Fruit
8	*Borassus aethiopum*	Tree	Edible Fruit
9	*Calotropis procera*	Shrub	Domestic use
10	*Cissus quadrangularis*	Shrub	Medicine

S/N	Species Encountered	Habit	Economic Importance
11	*Daniellia oliveri*	Tree	Medicine
12	*Dicoma tomentosa*	Herb	Medicine
13	*Dichrostachys cinerea*	Tree	Medicine
14	*Diospyros mespiliformis*	Tree	Edible Fruit
15	*Eucalyptus camaldulensis*	Tree	Medicine
16	*Euphorbia sp.*	Shrub	Medicine
17	*Ficus sp.*	Tree	Medicine
18	*Guiera senegalensis*	Shrub	Medicine, Fodder
19	*Hyphaene thebaica*	Tree	Edible Fruit
20	*Lannea acida*	Tree	Medicine
21	*Leptadenia hastata*	Creeper	Edible leaf, Fodder
22	*Mangifera indica*	Tree	Edible Fruit, Fodder
23	*Parkia biglobosa*	Tree	Edible Fruit, Fodder
24	*Phoenix dactylifera*	Tree	Edible Fruit
25	*Piliostigma thonningii*	Tree	Medicine
26	*Prosopis africana*	Tree	Medicine, Fodder
27	*Senna occidentalis*	Shrub	Medicine
28	*Tamarindus indica*	Tree	Edible Fruit, Fodder
29	*Terminalia laxiflora*	Tree	Medicine
30	*Vetiveria spp.*	Grass	Fodder
31	*Vitellaria paradoxum*	Tree	Medicine
32	*Vitex doniana*	Tree	Medicine, Fodder

Plant Family Distribution and Diversity

The most diverse families encountered were the Anacardiaceae, Arecaceae and Caesalpinioideae families with three plant species. The plant species of the Anacardiaceae family are *Anacardium sp., Mangifera indica* and *Lannea acida.* The three plant species of the Arecaceae family are *Phoenix dactylifera, Hyphaene thebaica* and *Borassus aethiopum* while *Daniellia oliveri, Senna occidentalis*, and *Piliostigma thonningii* belonged to the Caesalpinioideae family. Two plant species are of the Asteraceae family (*Centaurea praecox* and *Dicoma tomentosa*) (Figure 4. 56). The plant family distribution shows that the most abundant plant species encountered were of the Leguminosae family; occuring 2,413 times; followed by Caesalpinioedeae (1,562) and Poaceae (1,025). The least were Rutaceae and Sapotaceae (2), Moraceae (4) and Lamiaceae (6) as well as Rhamnaceae (8) (Figure 4. 57).

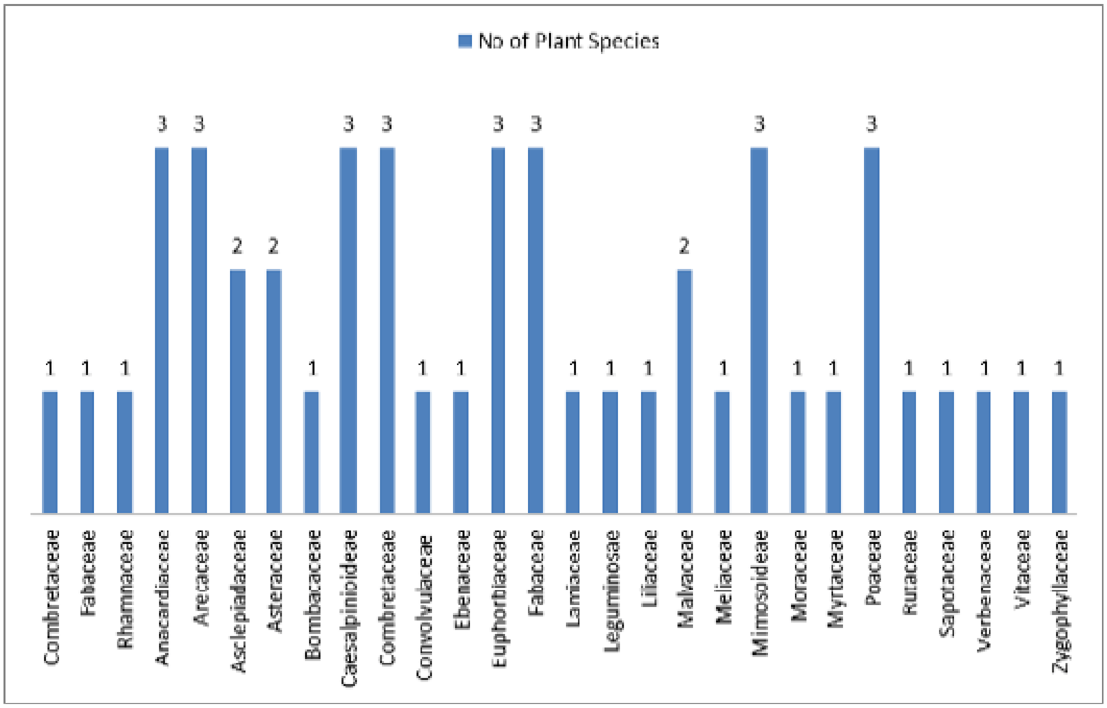


Figure 4. 56: Plant families and number of plant species

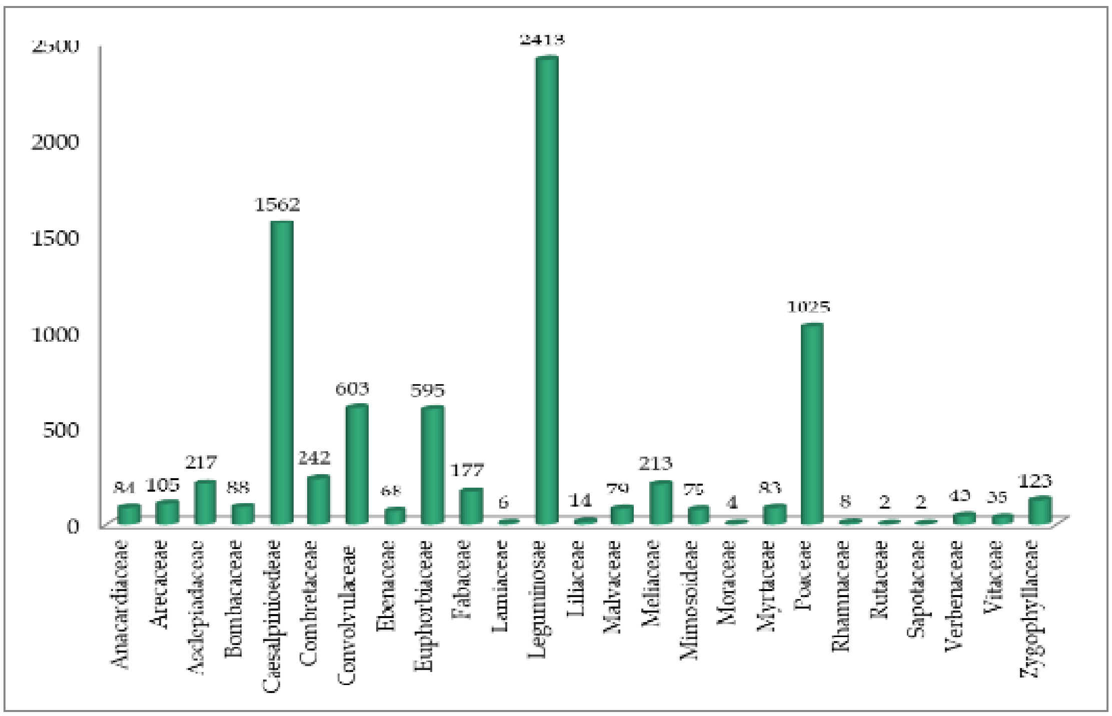


Figure 4. 57: Family distribution across the study area

4.3.5.2 *Fauna (Animal) species of the Project Area*

The vegetation type in any given environment determines the fauna that thrives in that environment. Ecologically, the animal population plays an important role in the transfer of food energy and cycling of essential elements in the savannah ecosystem. The study area is endowed with a wide range of animal species. They vary from small arthropods like mites and ticks to very large, domesticated mammals like the camel and donkey. The Phylum Arthropoda are the most the invertebrate community and these include a wide range of insects, spiders, etc. Various groups of vertebrates, especially reptiles and birds are widespread in the region.

Wildlife and Domesticated Animals

The study area is endowed with a wide variety of (wild and domesticated) animal species. They vary from small arthropods like mites and ticks to very large mammals like the camel and donkey. The Phylum Arthropoda dominated the invertebrate community and is represented by insects such as butterflies. Various groups of vertebrates were reported to be present, and they included amphibians, reptiles, birds and mammals. Of the species of vertebrate wildlife identified, the avifauna, reptiles and mammals were the dominant groups. The mammals reported to occur in the area were mainly browsers or grazers including medium-sized mammals such as goats, sheep and rodents (small mammals) like *Thryonomys swinderianus* (Cutting grass), *Xerus erythropus* (ground squirrel).

Plate 4. 4: Common ecosystem type and physiognomy of some parts of the project corridor

The presence of faunal species in the study area is highly variable and dependent on the complex relationship between animal's behavioural adaptations and the biophysical environment. Consequently, there is a high degree of variation in determining the composition of species in faunal assemblages. Results of fauna assessment carried out indicate low fauna diversity, especially wild animals except a varied bird species found to be predominant in the area. None of the fauna species recorded in the Project site and the surrounding environment belongs to the IUCN threatened category. Essentially, while it may be said that the listed fauna species can be found in the region, it is not an exhaustive list of the fauna endemic to the area.

The low fauna diversity could be attributed to low vegetation cover and extensive farmlands which are a clear indication that primary vegetation and natural habitats have been cleared for cultivation. The fauna species found within the project site at the time of survey include invertebrates such as arthropods (ants, termites, and beetles) and amphibians such as *Bufo bufo*, vertebrates such as reptiles (lizards, and savannah monitor), found in the scrubland microhabitat dominated by Acacia trees. Domestic animals are visibly predominant, especially cattle, goats, sheep, guinea fowl and dogs. Specifically, the animal species encountered during the survey include birds (> 75), butterfly (>20), lizards (>50), Grasshoppers and locust (>200), Cattle (>1000), Ants and Wasps (>100).

Generally found in the project area are birds (pigeons, cattle egrets, pied crow, and dove) and domestic mammals such as (cattle, sheep, donkey, goat and camel) as well as insects such as grasshoppers. The Plates below show some fauna species encountered at the project site and immediate surroundings during the survey.

 Plate 4.5a: Termite mound encountered in the study area	 Plate 4.5b: Fire ant nest
 Plate 4.5c: Domesticated bovine used for conveyance of loads in the project area	 Plate 4.5d: Camel is a common domesticated animal in the project area
 Plate 4.5e: *Hypolimnas misippus encountered in the study area*	 Plate 4.5f: *Bulbucus spp* Source: http://www.romyocon.net/**

	
Plate Plate 4.5g: Sheep encountered close to the proposed route	Plate 4.5h: Goats are common domestic animals in the study area

Plate 4. 5: Common wild and domesticated animals in the project area

** *Bulbucus sp.* image captured on field unclear

Plate 4. 6: Baobab as habitat for birds in the study area

Plate 4. 7: An unidentified bird encountered near the planned rail route

The project area has high avian abundance and diversity and this could be attributed to the richness of seed-bearing grasses, grains, fruits and insects in the open vegetation of the area. The common bird types include the Francolin *Francolinus spp,* African swiff *Apus affinis*, Eagles *Haliaetus vocifer*, Egrets *Bublcus spp,* and many others. Reptilian fauna endemic in the area includes lizard (*Agama agama*), Geko (*Hemidactylus* species), monitor lizard (*Varanus exanthematicus*), chameleon (*Chamaeleo dilepis*), and snakes (*Natrix anoscopis)*. Insects, arachnids and myriapods as well as other species such as earthworms *Eudrilus euginae*, and few snails *Archachatina marginata* were found. Some insect species of this area are of economic importance, serving as food sources, crop pests and disease vectors of man and animals. These include aphids, grasshoppers, and honeybees (Table 4. 19).

Table 4. 19: Inventory of fauna species within the study area and conservation status

SN	Scientific Name	Family	Common name	Local name	IUCN Status
1.	*Agama agama*	Agamidae	Agama Lizards	Sari	LC
2.	*Aphis melifera*	Apedae	Honey bees	Zuma	NE
3.	*Aslauga spp.*	Lycaenidae	Butterflies	Filofilo	NE
4.	*Aviceda cuculoides*	Accipitridae	African cuckoo-hawk	Atu	LC
5.	*Bitis spp.*	Culubridae	Snake	Sawannachyi	LC
6.	*Bos Taurus*	Bovidae	Cattle	Nama	LC
7.	*Bufo regularis*	Bufonidae	Toad	Quado	LC
8.	*Bulbucus spp*	Ardeidae	Egret	Zalbe / Balbela	LC
9.	*Buteo spp.*	Sagittariidae	Buzzard	Sayia	LC
10.	*Canis familarae*	Canidae	Dogs	Kare	LC
11.	*Capra sp.*	Bovidae	Goat	Akuya	LC
12.	*Cataloipus spp.*	Acrididae	Grasshopper	Fara	NE
13.	*Columba spp.*	Columbidae	Pigeon/Dove	Hasbiya	LC
14.	*Crochothemis spp.*	Libellulidae	Dragonfly	Filofilo	NE
15.	*Dorylus spp.*	Formicidae	Soldier ants	Tura	NE
16.	*Falco spp.*	Falconidae	Kestrel	Hasbiya	LC
17.	*Formica spp.*	Formicidae	Ants	Rina/Dila	NE
18.	*Hypolimnas misippus*	Nymphalidae	Butterfly (Danaid egg-fly)	Malam buɗe ido	LC
19.	*Oecophylla spp.*	Formicidae	Tailor Ants	Tura	NE
20.	*Ovis aries*	Bovidae	Sheep	Rago	LC
21.	*Palpopleura lucia*	Libellulidae	Dragonfly	Filofilo	NE
22.	*Paracyphononyx spp.*	Pompilidae	Wasps	Rina	NE
23.	*Passer spp.*	Passeridae	Sparrow	Hundu	LC
24.	*Phoeniculus spp*	Phoeniculidae	wood hopper	Hundu	LC
25.	*Scolopendra spp.*	Scolopendridae	Centipedes	Bsariba	NE

SN	Scientific Name	Family	Common name	Local name	IUCN Status
26.	*Stephanocrates spp.*	Scarabaeidae	Beetles	Serikinkaye	NE
27.	*Thryonomis swiderianus*	Thryonomyidae	Grass cutter	Busi	LC
28.	*Xerus erythropus,*	Anomaluridae	Squirrel	Kurege	LC
29.	*Zonocerus Variegatus*	Pyrgomorphidae	Grasshoppers	Kaya	NE
30.	*Ploceus cucullatus*	Ploceidae	Weaver birds	Hundu	LC

NE- Not evaluated, LC-Least concerned

Reference: The IUCN Red List of Threatened Species. Version 2021-3. <https://www.iucnredlist.org>)

Assessment of Terrestrial Fauna Species

Animals are exploited in the study area as source of protein and other essential nutrients, drugs, leather, hide and skin, cultural use which make them invaluable to human subsistence. Trade and consumption of different types of fauna species are a common practice in the study area. Other uses of animal species include hide and skin, plume, and feathers for diverse economic purposes. Livestock farming is equally common in the study area, which includes cattle, sheep, goats and domestic fowl, dogs, cats, horses, and camels. In spite of people's dependence on different animals which are endemic in the State, there are no known species within the project area that have reached ***Threatened or*** and ***Endangered*** status according to IUCN criteria.

4.3.5.3 Ecologically Important Features in the Study Area

Nigeria has experienced a rapid increase in the number and size of protected areas in the 20th century. Protected areas such as forest reserves are established for the purpose of conservation of valuable environmental/ecological resources. For the purpose of this assessment, certain ecosystems and ecological components are considered critical and would require more careful attention during project implementation. These include the following:

Forest Reserves: The proposed rail line will pass through some forest reserves (Figure 4.58). The forest reserves that will be directly impacted by the project are:

- Shakwadina Forest Reserve
- Gasartani Forest Reserve
- Gwiwa Korel Forest Reserve
- Daura Forest Reserve
- Damangu Forest Reserve
- Nasarawa Forest Reserve
- Dutsin Kuba Forest Reserve

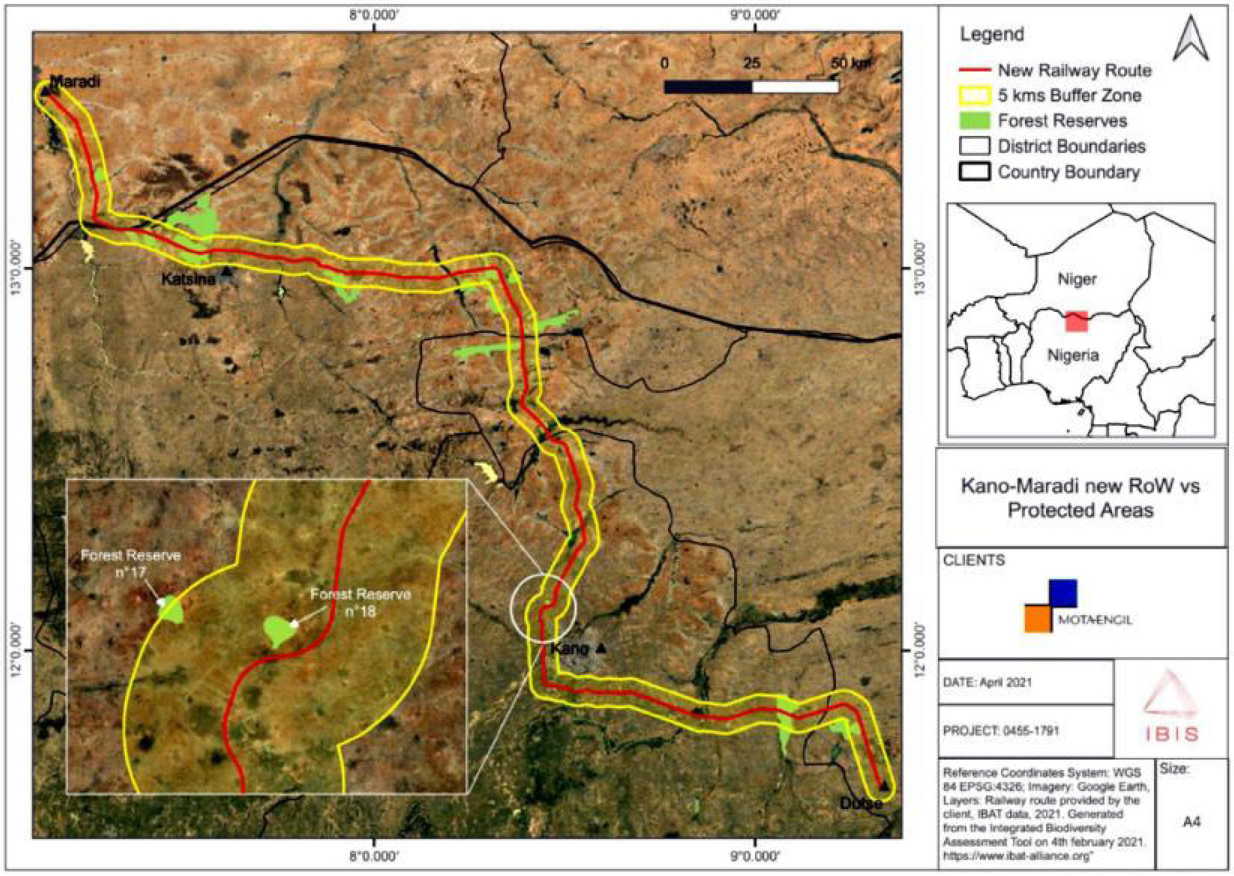


Figure 4. 58: Map showing the railway route and potentially impacted forest reserves
Source: Mota-Engil (2021)

The Gasartani, Gwiwa Korel and Daura Forest Reserves are classified as IUCN Category IV, Dutsin Kuba is IUCN category III while Shakwadina, Damangu and Nasarawa Forest Reserves are not classified. Forest Reserves in the study area that are not directly impacted are Madatai, Sandami, Kaboni, Warwade, Kaibaki South, Kaibaki North, Kaya, Forest Reserve n°17 and Forest Reserve n°18. Most of the forest reserves are being used for grazing and partly cultivated as observed during the field study. People in adjacent communities utilise the forest as a source of fuel wood, wild fruits/vegetables, pasture for livestock, herbs for treatment of diseases and for hunting. Other Forest Reserves in the study area also include Gurbin Baure Forest Reserve, around Kusa, Jibiya Local Government Area of Katsina State, Dan Issa Forest Reserve which shares boundary with Jibiya; Mazanya Forest Reserve, also in

Jibiya, Kabakawa Forest Reserves (located near Katsina metropolis) and Rumah/Kukar Jangarai Forest Reserve. Along the Dutse branch, the new route will bypass the Warwade Forest to the north.

Apart from *Adansonia digitata*, most of the trees in the Forest Reserves are short and generally below 20 m. The trees have adapted to the long dry season condition through shedding of their leaves and development of long tap root system. It is worth mentioning that *Acacia nilotica* is widespread at Gwiwa Korel Forest Reserve. The plants identified are medicinal and economic plant taxa that are vulnerable, threatened with extinction in the future, or for which there is some conservation concern, that is, the Near Threatened category (Table 4. 20).

Table 4. 20: Predominant plant species in the IUCN classified Forest Reserves in the Project Area

Species	Family	Local Name	Local Assessment	Global Assessment	Daura	Dutsin Kuba	Gasartani	Gwiwa Korel
Acacia nilotica	Fabaceae	Bagaruwa	NT	NE	√	√	√	√
Acanthospermum hispidum	Asteraceae	Yawo	VU	NE	√	√	√	√
Adansonia digitata	Malvaceae	Kuka	VU	NE	√	√	√	√
Adenium obesum	Apocynceae	Karya	EN	NE	√	√	-	√
Albizia chevalieri	Fabaceae	Katsari	VU	NE	√	-	-	√
Allium sativum	Amaryllidaceae	Tafarnuwa	NT	NE	√	√	√	√
Annona senegalensis	Annonaceae	Gwandar daji	EN	NE	√	√	√	√
Aristolochia albida	Aristolochiaceae	Duman dutsi	VU	NE	-	√	√	√
Artemisia annua	Asteraceae	Tazargade	VU	NE	√	√	√	-
Balanites aegyptiaca	Zygophyllaceae	Aduwa	EN	NE	√	√	√	√
Boerhavia diffusa	Nyctaginaceae	Babba jibji	NT	NE	√	-	√	√
Bombax brevicuspe	Bombacaceae	Kurya	CR	VU	√	-	√	-
Borassus aethiopum	Arecaceae	Giginya	NT	NE	√	√	√	√
Calotropis procera	Apocynaceae	Tumfafiya	NT	NE	√	√	√	√
Ceiba pentandra	Malvaceae	Rimi	CR	NE	√	√	√	√
Centaurea perrottetii	Asteraceae	Surandi	VU	NE	√	√	√	√
Cissus populnea	Vitaceae	Loda	EN	NE	-	-	√	√
Citrus aurantiifolia	Rutaceae	Lemun tsami	EN	NE	√	√	√	√
Cleome gynandra	Cleomaceae	Gasaya	NT	NE	√	√	√	
Cochlospermum tinctorium	Cochlospermaceae	Rawaya	EN	NE	-	√	-	√
Combretum micranthum	Combretaceae	Geza	VU	NE	√	√	√	√
Commiphora	Burseraceae	Baazana	EN	NE	-	√	√	

Species	Family	Local Name	Local Assessment	Global Assessment	Daura	Dutsin Kuba	Gasartani	Gwiwa Korel
kerstingii								
Cordia africana	Boraginaceae	Alilliba	CR	NE	√	√	√	√
Cyperus rotundus	Cyperaceae	Aya-aya	NT	LC	√	√	√	√
Dactyloctenium aegyptium	Poaceae	Guda gude	VU	NE	√	-	-	-
Datura metel	Solanaceae	Zakami	VU	NE	√	√	√	√
Digitaria debilis	Poaceae	Harkiya	NT	NE		√	√	√
Diospyros mespiliformis	Ebenaceae	Kanya	VU	LC	√	-	√	√
Eleusine indica	Poaceae	Tuji	VU	LC	-	-	-	√
Entada Africana	Fabaceae	Tawatsa	CR	NE	√	√	√	
Euphorbia poissonii	Euphorbiaceae	Tunya	CR	NE	√	√	√	√
Faidherbia albida	Fabaceae	Gawo	VU	NE	√	-	√	-
Ficus platyphylla	Moraceae	Gamji	EN	NE	√	√	-	√
Ficus thonningii	Moraceae	Cediya	VU	NE	√	√	-	√
Gardenia aqualla	Rubiaceae	Gaude	CR	NE	√	√	√	√
Gossypium barbadense	Malvaceae	Kada 'yarkarfi	VU	NE	√	√	√	√
Grewia mollis	Malvaceae	Dargaza	VU	NE	-	√	√	√
Guiera senegalensis	Combretaceae	Sabara	VU	NE	√	√	√	√
Hibiscus sabdariffa	Malvaceae	Sobo	VU	NE	-	-	-	-
Hyphaene thebaica	Arecaceae	Goruba	VU	LC	√	√	-	√
Ipomoea asarifolia	Convolvulaceae	Duman kada	NT	NE	√	√	√	√
Isoberlinia doka	Fabaceae	Doka	VU	LC	√	√	√	√
Jatropha curcas	Euphorbiaceae		NT	NE			-	-
Khaya senegalensis	Meliaceae	Madacci	VU	VU	√	√	√	-

Species	Family	Local Name	Local Assessment	Global Assessment	Daura	Dutsin Kuba	Gasartani	Gwiwa Korel
Lannea acida	Anacardiaceae	Faru	VU	NE	√			√
Lawsonia inermis	Lythraceae	Lalle	EN	NE	√	√	√	√
Ludwigia octovalvis	Onagraceae	Shashatau	CR	NE		√	√	
Mangifera indica	Anacardiaceae	Mangoro	NT	DD	√	√		√
Moringa oleifera	Moringaceae	Zogale	NT	NE	√	√	√	√
Neocarya macrophylla	Chrysobalanaceae	Gawasa	EN	NE	√	√	√	√
Nymphaea lotus	Nymphaeaceae	Bado	VU	NE	√	√	√	√
Ocimum basilicum	Lamiaceae	Daddoya	LC	NE	√	√	√	√
Opilia amentacea	Opiliaceae	Rugaggada	EN	NE	√	√	√	√
Parkia biglobosa	Fabaceae	Dorawa	VU	NE	√	√	√	√
Pavonia hirsute	Malvaceae	Zamarke	EN	NE	√	√	√	√
Pavonia senegalensis	Malvaceae	Tsu	CR	NE	√			
Peristrophe bicalyculata	Acanthaceae	Tubanin dawaki	VU	NE	√	√	√	√
Phoenix dactylifera	Arecaceae	Dabino	VU	NE	√	√	√	√
Prosopis africana	Fabaceae	Kirya	CR	NE			√	
Ptercarpus erinaceus	Fabaceae	Madobiya	VU	NE	√	√	√	√
Rourea coccinea	Connaraceae	Tsamiyar kasa	VU	NE	√	√	√	√
Sclerocarya birrea	Anacardiaceae	Danya	EN	NE	√	√	√	√
Scoparia dulcis	Plantagineaceae	Ruma fada	VU	NE	√	√	√	√
Senegalia ataxacantha	Fabaceae	Sarkakiya	VU	NE	√	√	√	√
Senegalia Senegal	Fabaceae	Dakwara	VU	NE	√	√	√	√

Species	Family	Local Name	Local Assessment	Global Assessment	Daura	Dutsin Kuba	Gasartani	Gwiwa Korel
Sida ovata	Malvaceae	Miyar tsanya	LC	NE		√	√	√
Sterculia setigera	Malvaceae	Kukkuki	CR	NE	√		√	√
Stereospermum kunthianum	Bignoniaceae	Sansami	VU	NE	√	√	√	√
Striga hermonthica	Orobanchaceae	Gogai	VU	NE	√	√	√	√
Strychnos spinosa	Loganiaceae	Kokiya	EN	NE	√	√	√	√
Tamarindus indica	Fabaceae	Tsamiya	EN	NE	√	√	√	√
Terminalia avicennioides	Combretaceae	Baushe	CR	NE	√			√
Urelytrum giganteum	Amaryllidaceae	Jema	CR	NE	√	√	√	√
Vachellia nilotica	Fabaceae	Bagaruwa	EN	NE	√	√	√	√
Vernonia amygdalina	Asteraceae	Shuwaka	EN	NE			√	√
Vitellaria paradoxa	Sapotaceae	Kadanya	CR	VU		√	√	
Vitex doniana	Lamiaceae	Dinya	VU	NE	√	√	√	√
Ziziphus jujuba	Rhamnaceae	Magarya	CR	LC	√		√	√
Ziziphus spina-christi	Rhamnaceae	Kurna	EN	NE	√	√	√	√

4.3.5.4 *Identified Species of Conservation Importance*

During the study, there was no encounter with any animal species that are either threatened, endangered or critically endangered. Most of the animals encountered are insects and birds listed in Table 4. 19.

In the preliminary study, seven Critically Endangered flora and fauna species were identified and reported to be within the Project's Area of Influence especially in some parts of Katsina. These are *Saxicolella marginalis*, slender-snouted crocodile (*Crocodylus cataphractus* or *Mecistops cataphractus*), black rhino, hooded vulture (*Necrosyrtes monachus*), white-backed vulture (*Gyps africanus*), Ruppell's vulture (*Gyps rueppelli*) and white-headed vulture (*Trigonoceps occipitalis*). In Jibiya, locals confirmed *Trigonoceps occipitalis* and *Gyps africanus* are occasionally encountered at the traditional medicine stalls; and some are reportedly brought from in from Niger Republic. Other species of conservation importance in the study area, which are categorised as endangered are Egyptian vulture (*Neophron oercnopterus*), Lappet-faced vulture or Nubian vulture (*Torgos tracheliotos*), Bateleur (*Terathopius ecaudatus*), Martial Eagle (*Polemaetus bellicosus*), Secretarybird (*Sagittarius serpentarius*). Ruppell's vulture and Egyptian vulture are known to gather in globally significant numbers at a particular site and time in their lifecycle for feeding and breeding (or rest during migration).

Also reported to have existed or possibly still existing in the project area is the African Spurred Tortoise (*Centrochelys sulcate*). It is one of the largest terrestrial chelonians in the world, the largest extant continental tortoise, and the largest tortoise in Africa (Trape *et al.* 2012, Petrozzi *et al*. 2020b). Males are larger than females, and may exceed 100 kg in body mass, with a straight carapace length (SCL) of up to 86.0 cm in males and 57.8 cm in females, and a curved carapace length reaching 101.0 cm in males and 67.0 cm in females. The species is especially linked to habitat with periodic or intermittent streams and rivers. In Nigeria, it is known only from undefined localities of dry savannas situated in the northern most territories at the border with Niger. A study carried out during 2013 and 2014, mainly in the months of November to February established the presence of the tortoise in parts of Northern Nigeria (Petrozzi *et al*., 2015). The presence was established based on random searches throughout Northern Nigeria, mostly guided by interviews with local people reporting their own recent observation of the tortoise.

Plate 4. 8: *Centrochelys sulcata*, the African Spurred Tortoise
Source: https://www.iucnredlist.org/species/163423/1006958#habitat-ecology)

Overall, the authors located seven sites of potential presence of the species in Nigeria within two distinct vegetation zones of Short Grass Savanna (Zone II) and Woodland & Tall Grass Savanna (Zone III). In the seven localities, eight individual animals were encountered. Five (5) captive and three (3) apparently free ranging animals. Even though in most cases, the tortoise is kept as pet and many caged *C. sulcata* may occasionally escape and continue to live in the wild.

Two of the sightings of two adults were said to be sighted within the project area in Ungongo (Kano State) and Katsina (Katsina State). One young animal was sighted in Nkae, Borno State. All of which are within the short-grass savanna vegetation zone. Additional sightings (2) were also found in Zunfur and Magumeri (Borno State – 5 & 6) being near the limits of marginal Savanna Vegetation Zone. Two southernmost records (Nos 1 & 2) which would considerably extend the known range of the species towards the Nigerian South into the Woodland and tall grass Savanna Vegetation Zone (III) refer to captive individuals. During the ESIA field survey however, no sighting of the tortoise was encountered. Interviews carried out with hunters also did not reveal presence of the tortoise in Kano and Katsina. Most respondents suggested possible presence around the dam area in Jibiya, but no tortoise was encountered during the field survey in the reported area.

Notes on Critical Habitat and Extinction of Fauna Species

If Critical habitat is triggered during project implementation, the rail Project shall avoid impacts to ensure no net loss of the critically endangered species. However, none was encountered at the study locations including the forest reserves.

Extinction of vultures is a threat to ecosystem functions as epidemics are likely to break out where carcasses are left to undergo natural microbial degradation. In addition, the reported presence of threatened, critically endangered species and endangered species in the project area of influence implies that the vegetation within the RoW could be serving as habitat of significant importance to these species.

4.3.5.5 Piscifauna Species of the Project Area

Almost all natural bodies of water bear fish life, the exceptions being extremely hot thermal ponds and salty lakes, such as the Dead Sea in Asia and the Great Salt Lake in North America. Fishes are of study interest for many reasons, the most important being their relationship with and dependence on the environment. This resource, once thought unlimited, is now realized to be finite and in delicate balance with the biological, chemical, and physical factors of the aquatic environment (Parenti, 2015). Pollution and alteration of the aquatic environment may result from human activities which may impact heavily on fish population. Fishing is commonly practiced in communities and settlements along the bank of River Hadejia and at Jibiya in Katsina State.

Plate 4. 9: Fishing boats at the river bank in Hushin buku, Jibiya, Katsina State
Source: Allott (2021)

Plate 4. 10: A boy returning from fishing at Jibiya Dam, Hushin buku village, Jibiya
Source: Allott (2021)

Based on information available in different literatures as well as field observation in local markets at Wudil and Katsina as well as the fishing point at Hadejia River bank in Wudil and Jibiya Dam, the common fish species in the project area are as listed in Table 4. 21.

Table 4. 21: Common fish species in the study area

Species	Family	Common/Local Name	IUCN Red List Status
Distichodus rostratus	Distichodontidae	Grass eater	Least Concern
D. engycephalus	Distichodontidae	Perch	Least Concern
D. brevipinnis	Distichodontidae	Ka'maa	Least Concern
Gymnarchus niloticus	Gymnarchidae	Frankfish, electric fish, Aba aba	Least Concern
Hepsetus odoe	Hepsetidae	African pike	Least Concern
Ichthyoborus besse	Distichodontidae	-	Not Evaluated
Protopterus annectens	Protopteridae	Mudfish, Lungfish	Least Concern
Malapterurus electricus	Malapteruridae	African Electric catfish	Least Concern
Bagrus bayad	Bagridae	Bayad, Black Nile Catfish	Least Concern
B. filamentosus	Bagridae	Silver Catfish	Data Deficient
Chrysichthys auratus	Claroteidae	Golden Nile Catfish	Least Concern
C. nigrodigitatus	Claroteidae	Mudfish	Least Concern
Auchenoglanis biscutatus	Claroteidae	Black spotted catfish	Least Concern
A. occidentalis	Claroteidae	Bubu, Giraffe Catfish	Least Concern
Lates niloticus	Latidae	Nile perch	Least Concern
Alestes nurse	Alestidae	-	Least Concern
Micralestes acutidens	Alestidae	Elongated Robber	Least Concern
Hemichromis bimaculatus	Cichlidae	African jewelfish	Least Concern
H. fasciatus	Cichlidae	Banded jewelfish	Least Concern
Tilapia zillii	Cichlidae	Redbelly Tilapia	Least Concern
Sarotherodon galilaeus	Cichlidae	Mango Tilapia	Not Evaluated
Oreochromis niloticus	Cichlidae	Nile Tilapia	Not Evaluated

[Source: Matthes (1990) and ALLOTT (2021)]

4.3.6 Land Use Assessment

The land use layer displays a coverage map of Landuse/Landcover (LULC) derived from November 2020 Landsat 8 multispectral imagery at 30 m resolution. The maps provide information on the general landcover in the study area and could be used in conservation planning, food security, and hydrologic modelling, among other things. The datasets were created by expert classification of the multispectral image using the visible RGB, Near Infrared, and short-wave infrared bands. The classification is followed by recoding and accuracy assessment (Table 4. 22). Map views are set to the local government level or at similar scales along the length of the rail line and the class definitions are as follow:

Waterbody: The waterbodies in the land use map includes an extensive area predominantly covered with water at satellite pass. It contains little to no sparse vegetation, no rock outcrop, nor built-up features. Examples include relatively large rivers, ponds, lakes etc.

Grassland: An open area covered in homogenous grasses with little to no taller vegetation. Examples include natural grasses and fields with sparse to no tree cover, open savanna with few to no trees, parks/golf courses/lawns, pastures etc.

Cultivation: Humans planted/plotted cereals, grasses, and crops not at tree height. Examples include corn, wheat, soy, fallow plots of structured land.

Shrubland/Woodland: A mixture of tiny clusters of plants or single plants dispersed on a landscape that shows exposed soil or rock; shrub-filled clearings within forests that are clearly not taller than trees or with short, sparse trees. Examples include moderate to a sparse cover of bushes, shrubs and tufts of grass, savannas with very sparse grasses, trees or other plants.

Built-up: Built-up area consists of human-made structures; major road and rail networks, large homogenous impervious surfaces including parking structures, office buildings and residential housing. Examples include a cluster of houses, dense villages/towns/cities, paved roads, asphalt.

Bare surface: It is an extensive area of soil (or cleared vegetation) with very sparse to no vegetation, large areas of sand and deserts with no to little vegetation. Examples include exposed soil, desert and dunes, dry salt flats/pans, dried lakebeds, mines.

Rock outcrop: Exposed rock with little or no vegetal cover of any sort. Areas on mountains/hills covered with vegetation were classified based on land cover.

Table 4. 22: Accuracy Assessment of Land Use / Landcover

Error Matrix							
Classified Data	Builtup	Grassland	Cultivation	Shrubland /Woodland	Baresurface	Waterbody	Rockoutcrop
Builtup	10	0	1	0	1	0	0
Grassland	0	22	2	3	0	0	0
Cultivations	4	6	89	0	5	0	0
Shrubland/Woodland	0	2	0	11	0	0	0
Baresurface	0	1	5	0	17	0	0
Waterbody	0	0	1	0	2	8	0
Rockoutcrop	0	1	0	0	0	0	4

Accuracy Totals					
Class	Reference	Classified	Number	Producers	Users
Name	Totals	Totals	Correct	Accuracy	Accuracy
Builtup	14	12	10	71.43%	83.33%
Grassland	32	27	22	68.75%	81.48%
Cultivations	98	104	89	90.82%	85.58%
Shrubland/Woodl	14	13	11	78.57%	84.62%
Baresurface	25	23	17	68.00%	73.91%
Waterbody	8	11	8	100.00%	72.73%
Rockoutcrop	4	5	4	100.00%	80.00%
Totals	195	195	161		
Overall Classification Accuracy = 82.56%					
Kappa (K^) Statistics					
Overall Kappa Statistics = 0.7444					
Conditional Kappa for each Category.					
Class Name				Kappa	

Allott (Nigeria) Limited

Built-up	0.8204
Grassland	0.7785
Cultivations	0.7101
Shrubland/Woodland	0.8343
Bare surface	0.7008
Waterbody	0.7156
Rock outcrop	0.7958

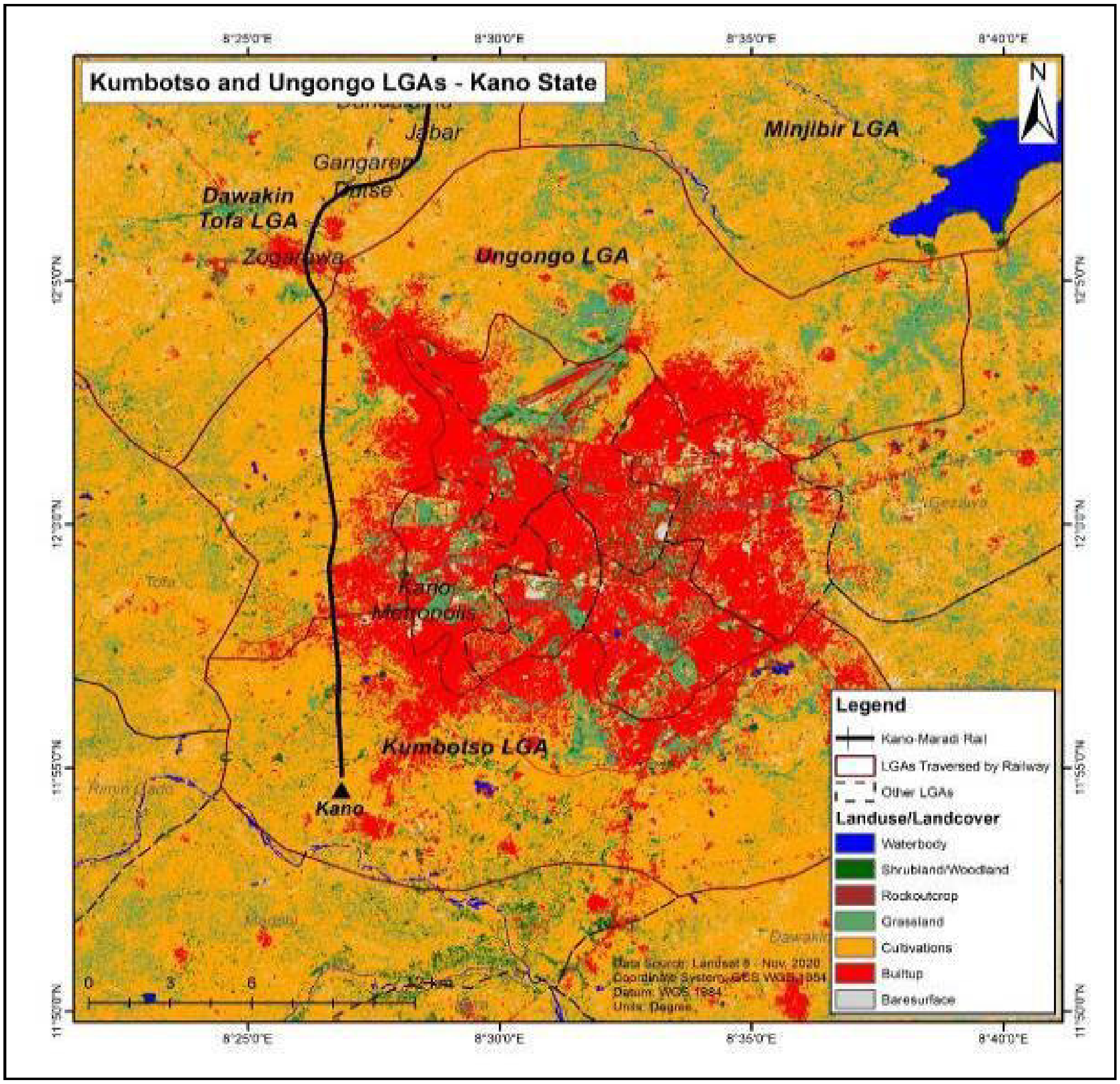


Figure 4. 59: Land use /land cover map along the rail alignment in Kumbotso and Ungongo LGAs

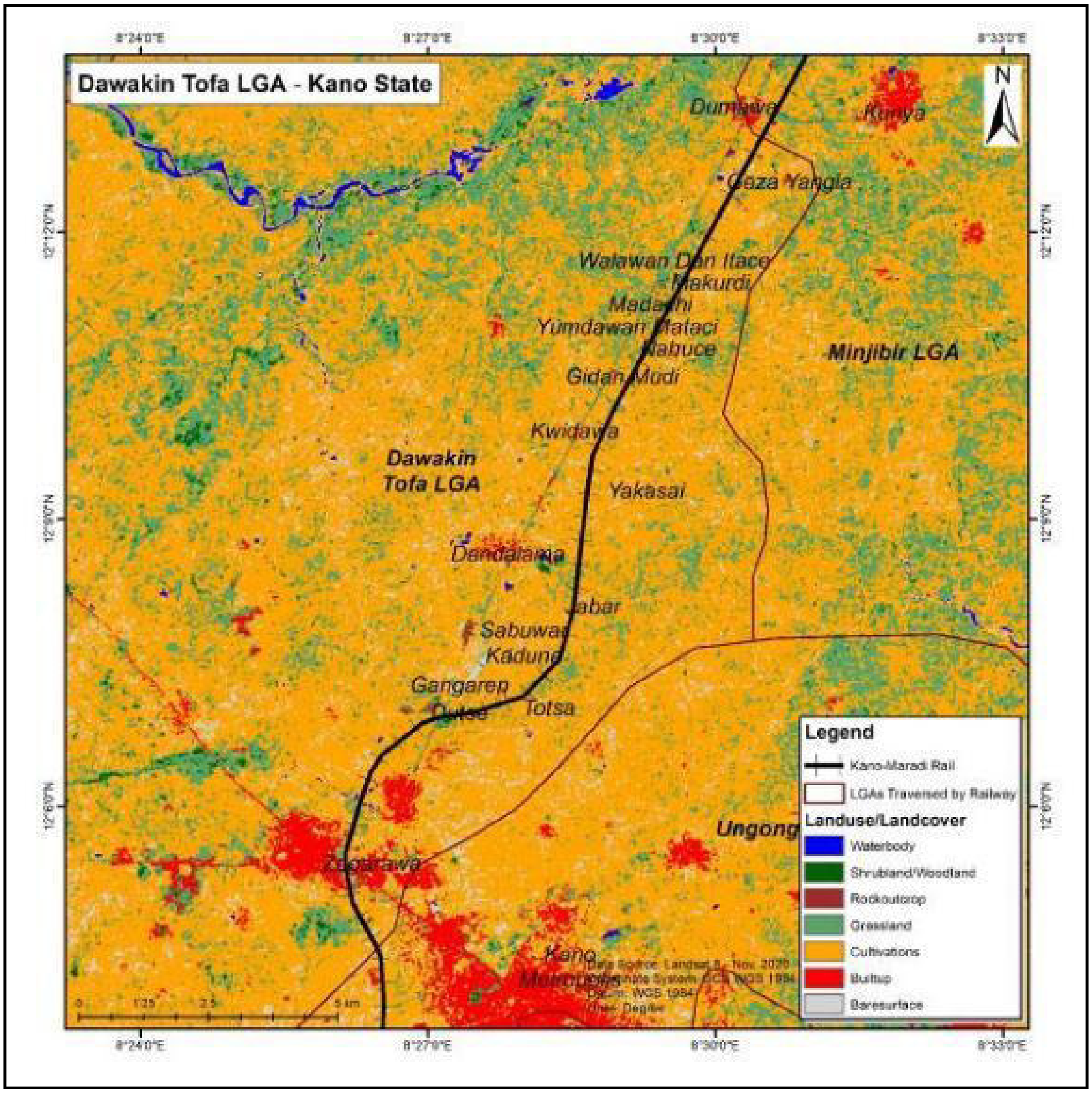


Figure 4. 60: Land use /land cover map along the rail alignment in Dawakin Tofa LGA

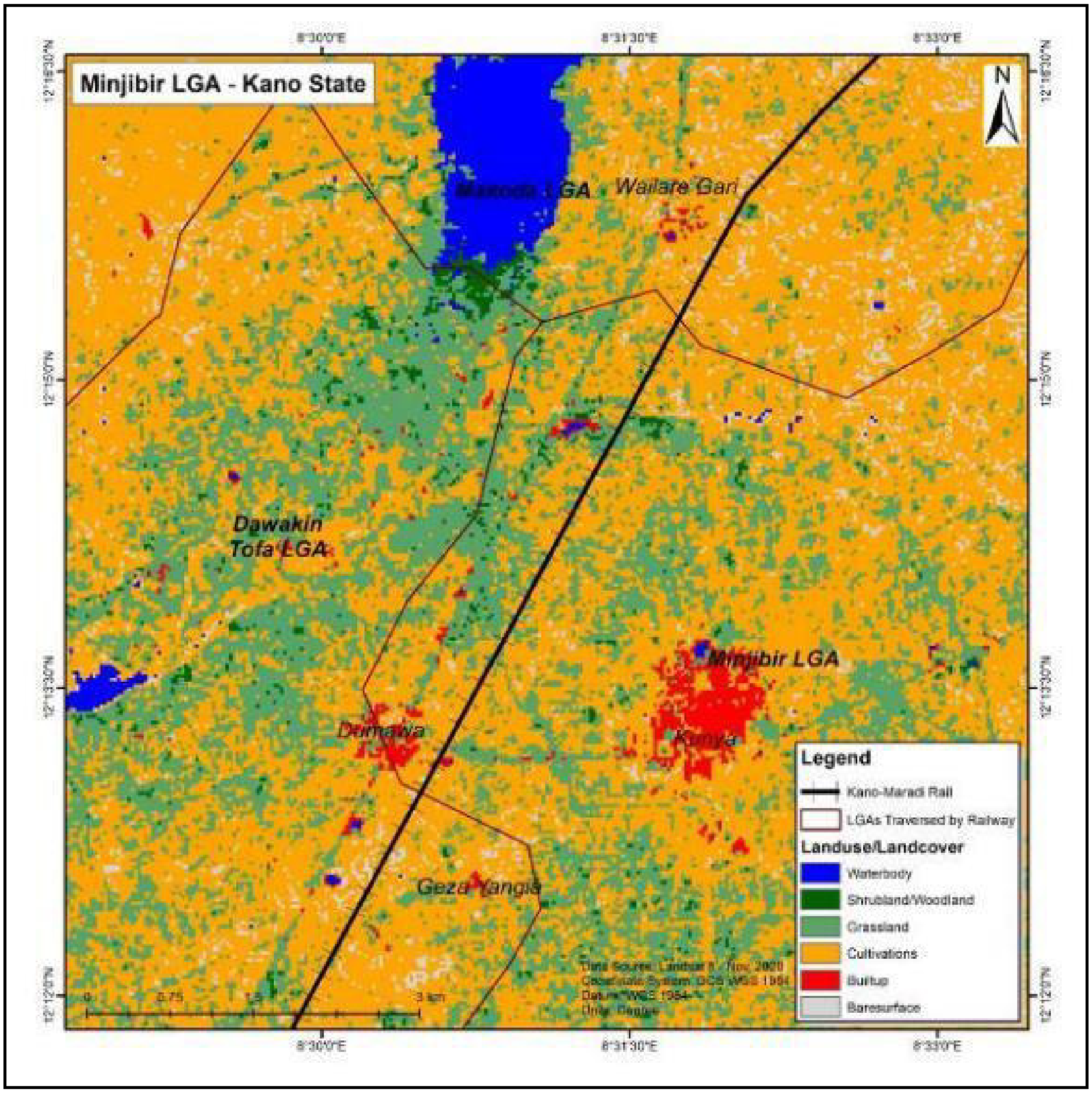


Figure 4. 61: Land use /land cover map along the rail alignment in Minjibir LGA

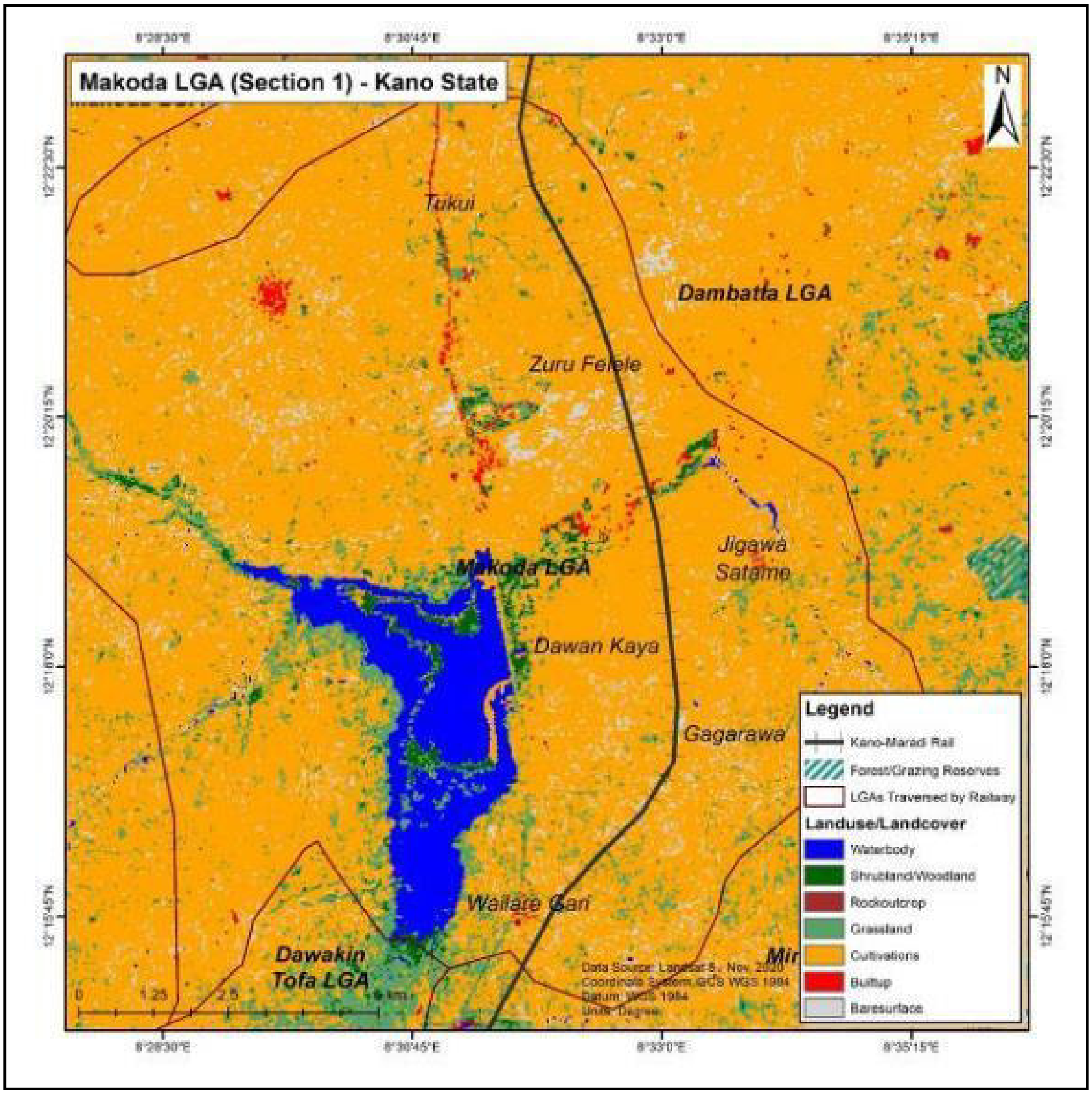


Figure 4. 62: Land use /land cover map along the rail alignment in Makoda LGA

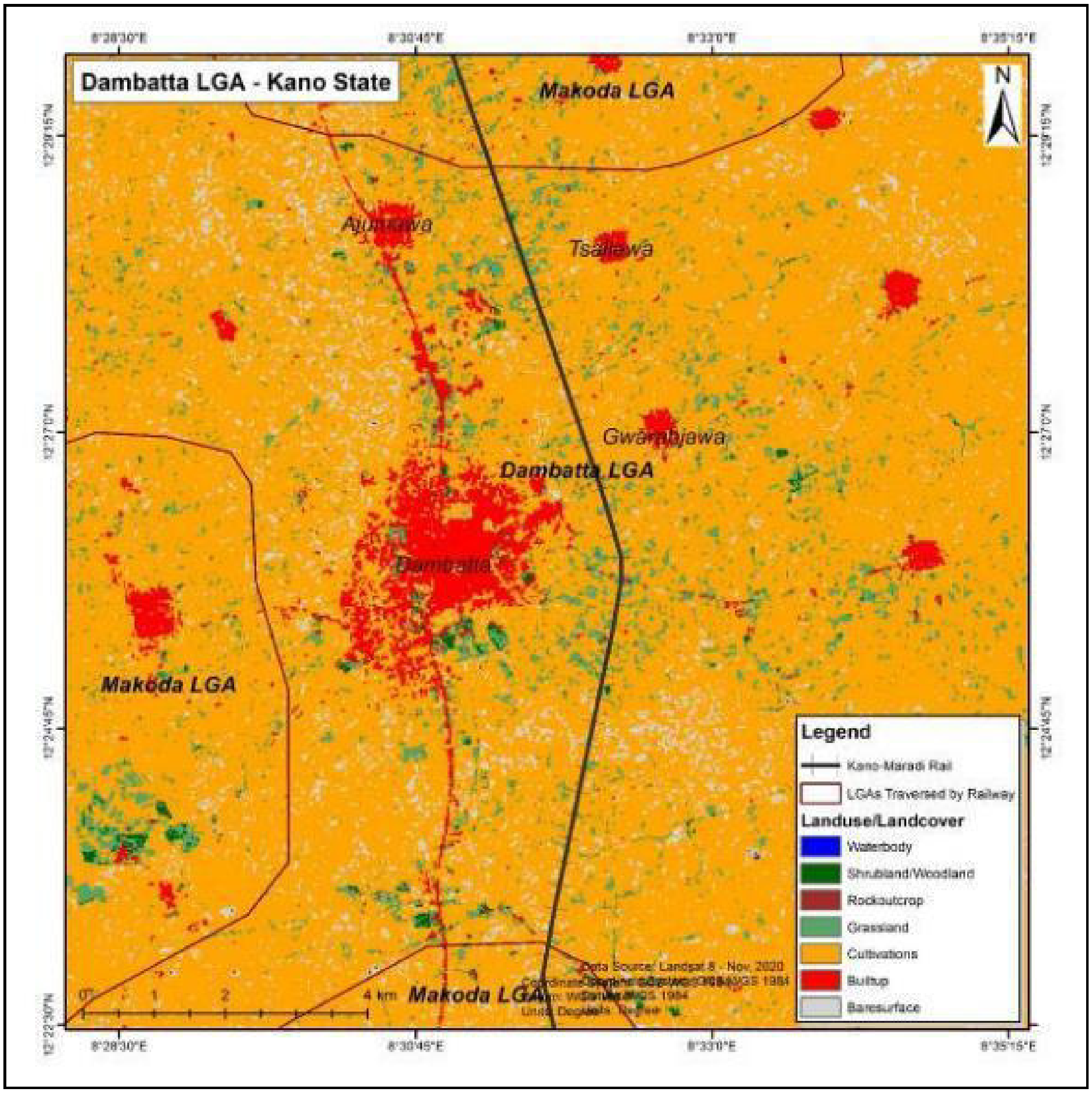


Figure 4. 63: Land use /land cover map along the rail alignment in Danbatta LGA

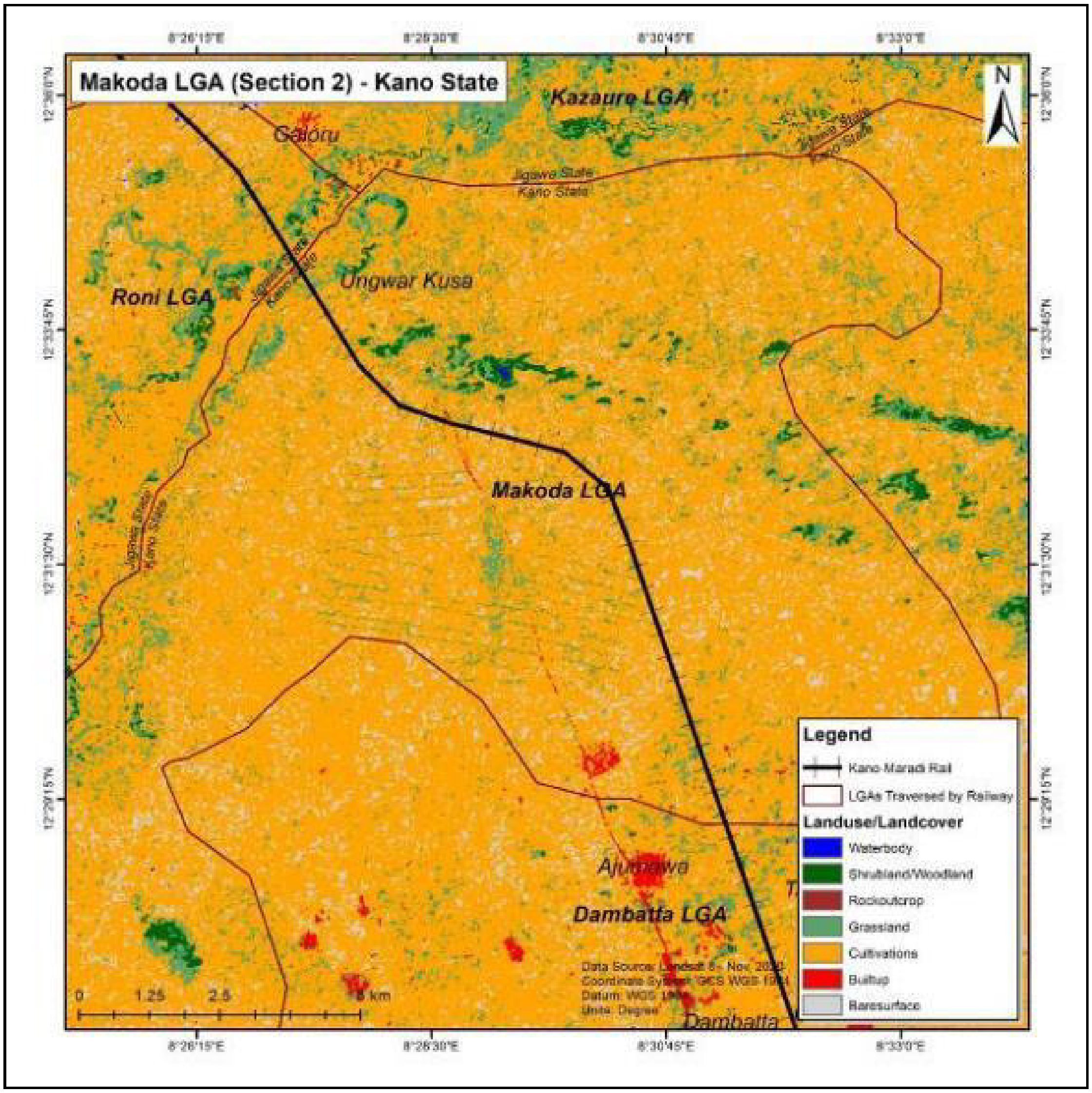


Figure 4. 64: Land use /land cover map along the rail alignment in Makoda LGA

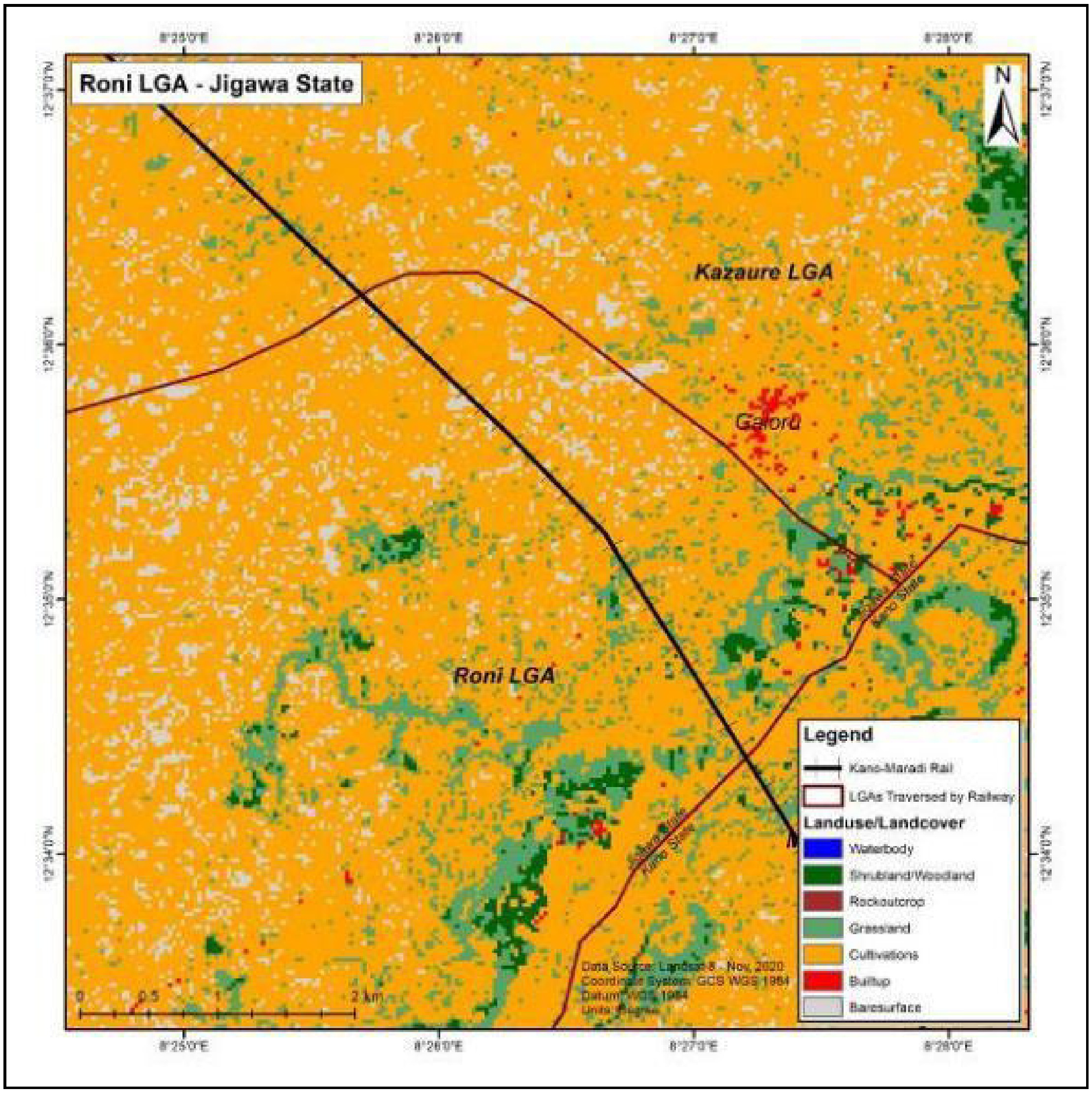


Figure 4. 65: Land use /land cover map along the rail alignment in Roni LGA

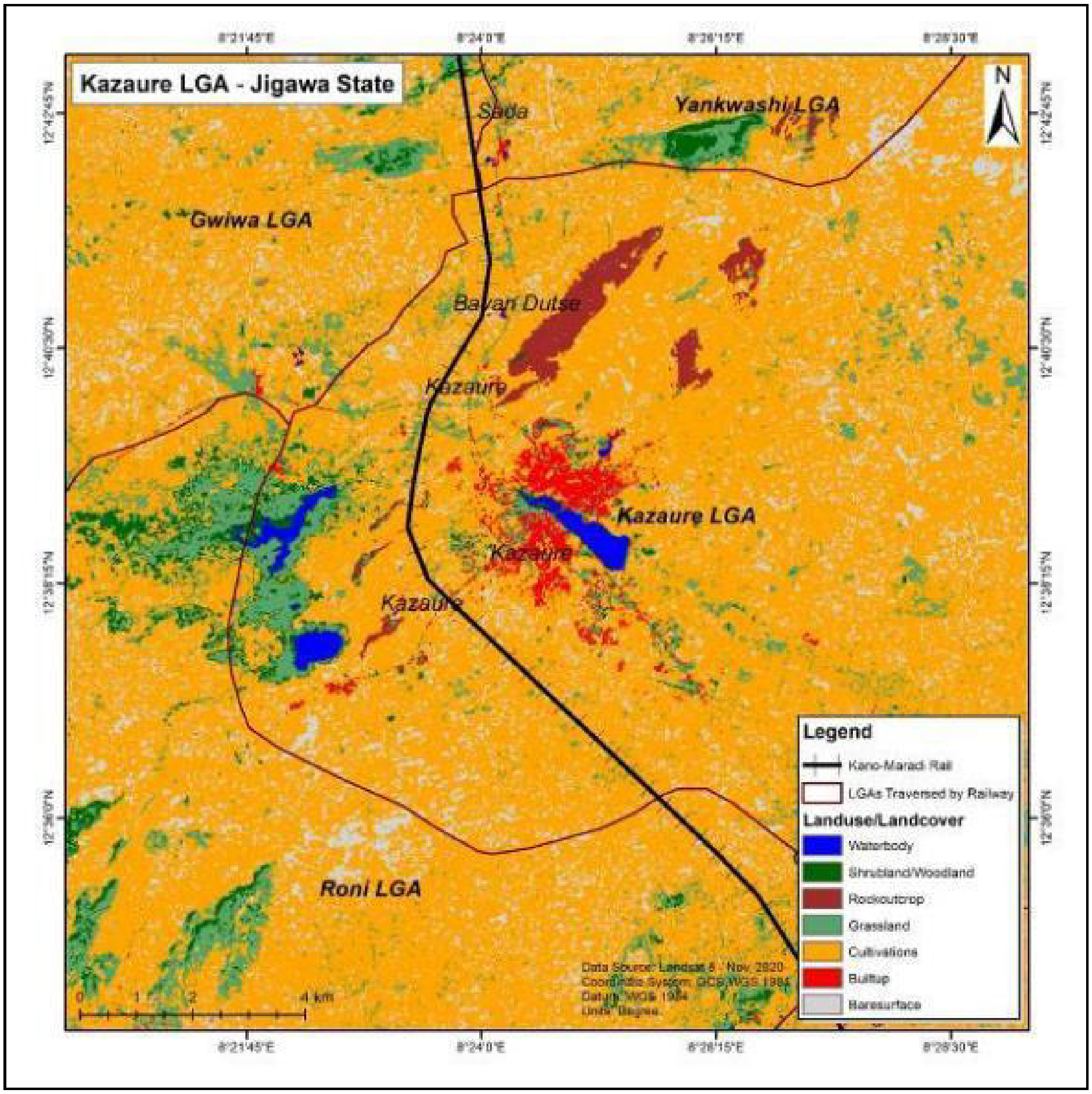


Figure 4. 66: Land use /land cover map along the rail alignment in Kazaure LGA

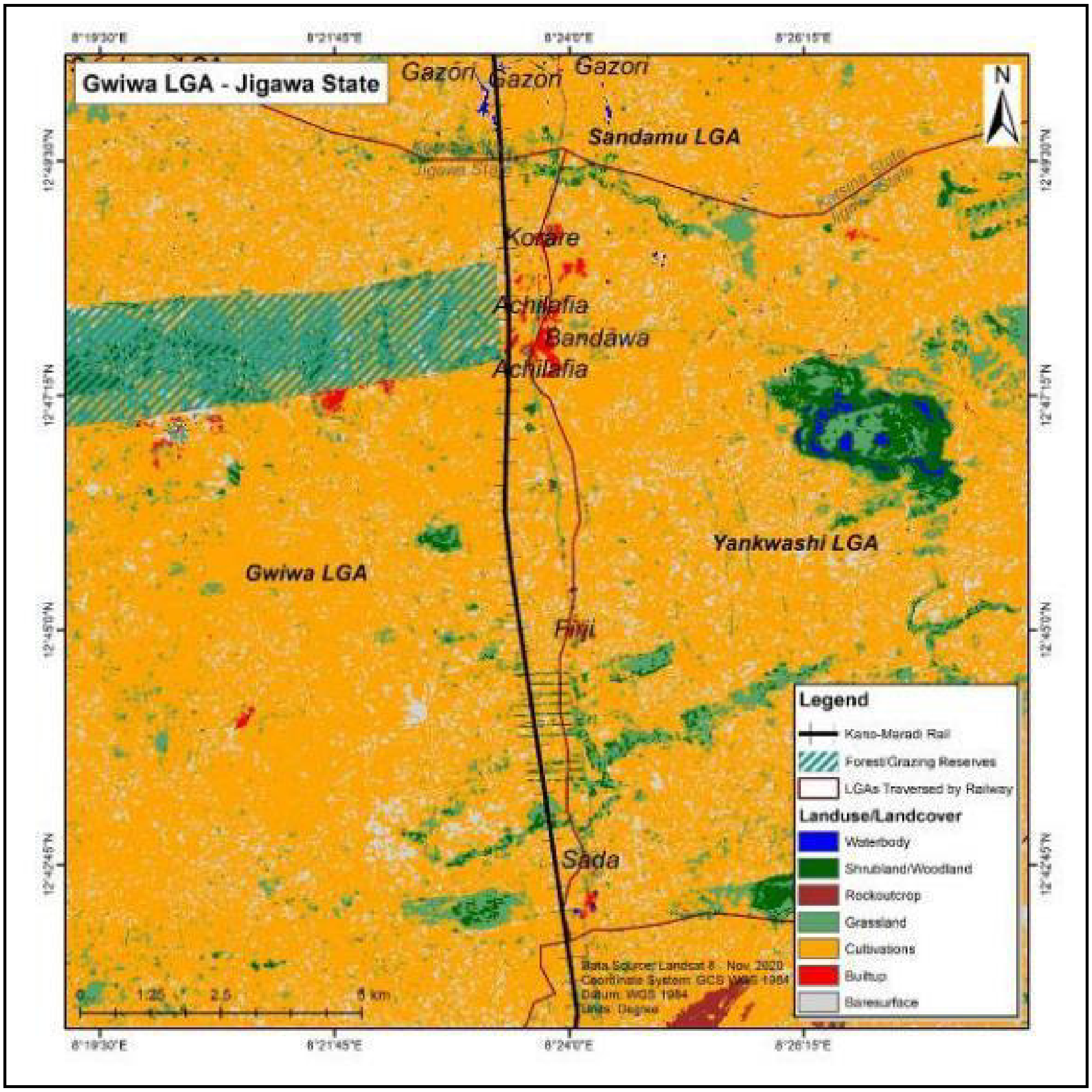


Figure 4. 67: Land use /land cover map along the rail alignment in Gwiwa LGA

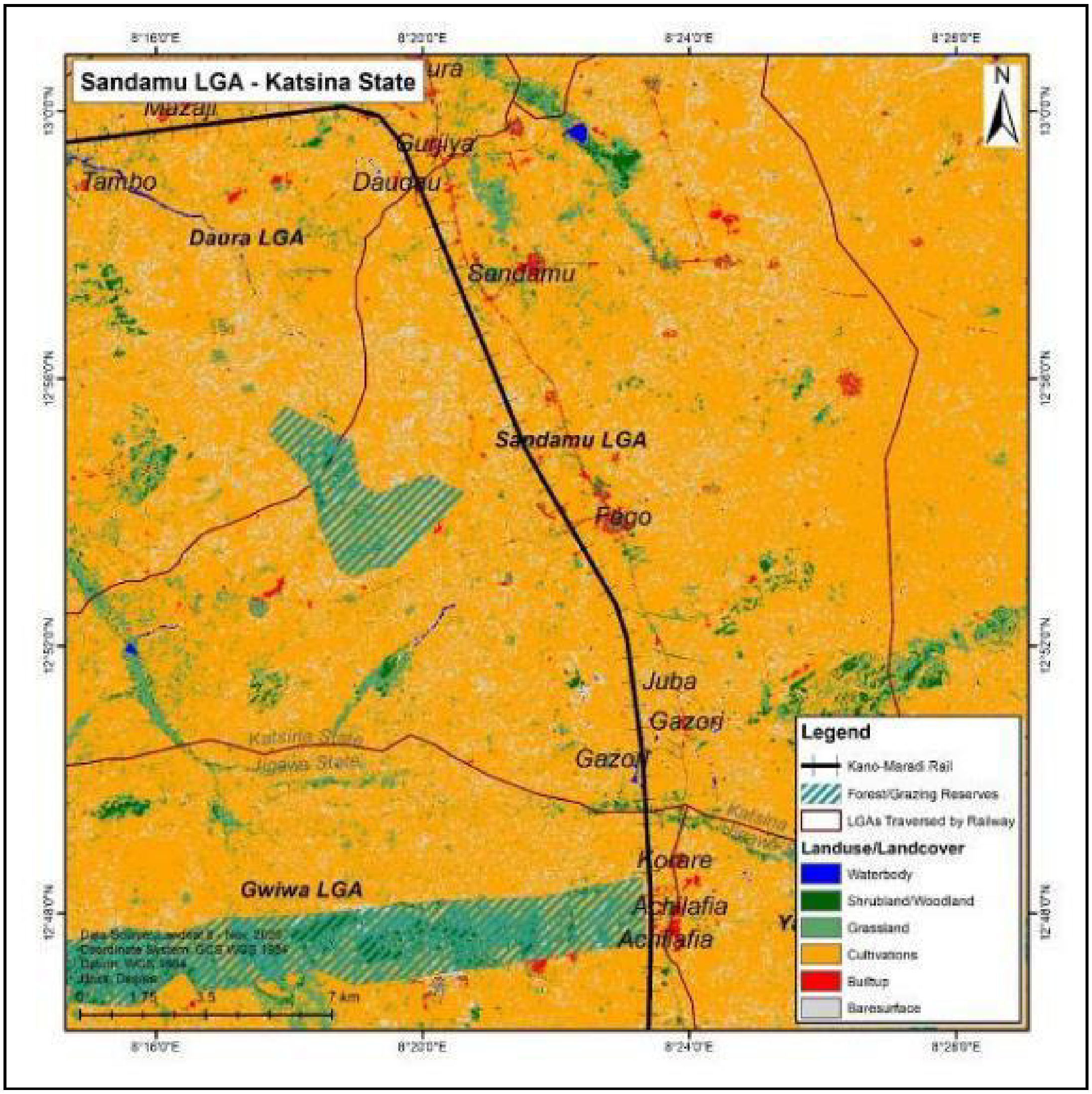


Figure 4. 68: Land use /land cover map along the rail alignment in Sandamu LGA

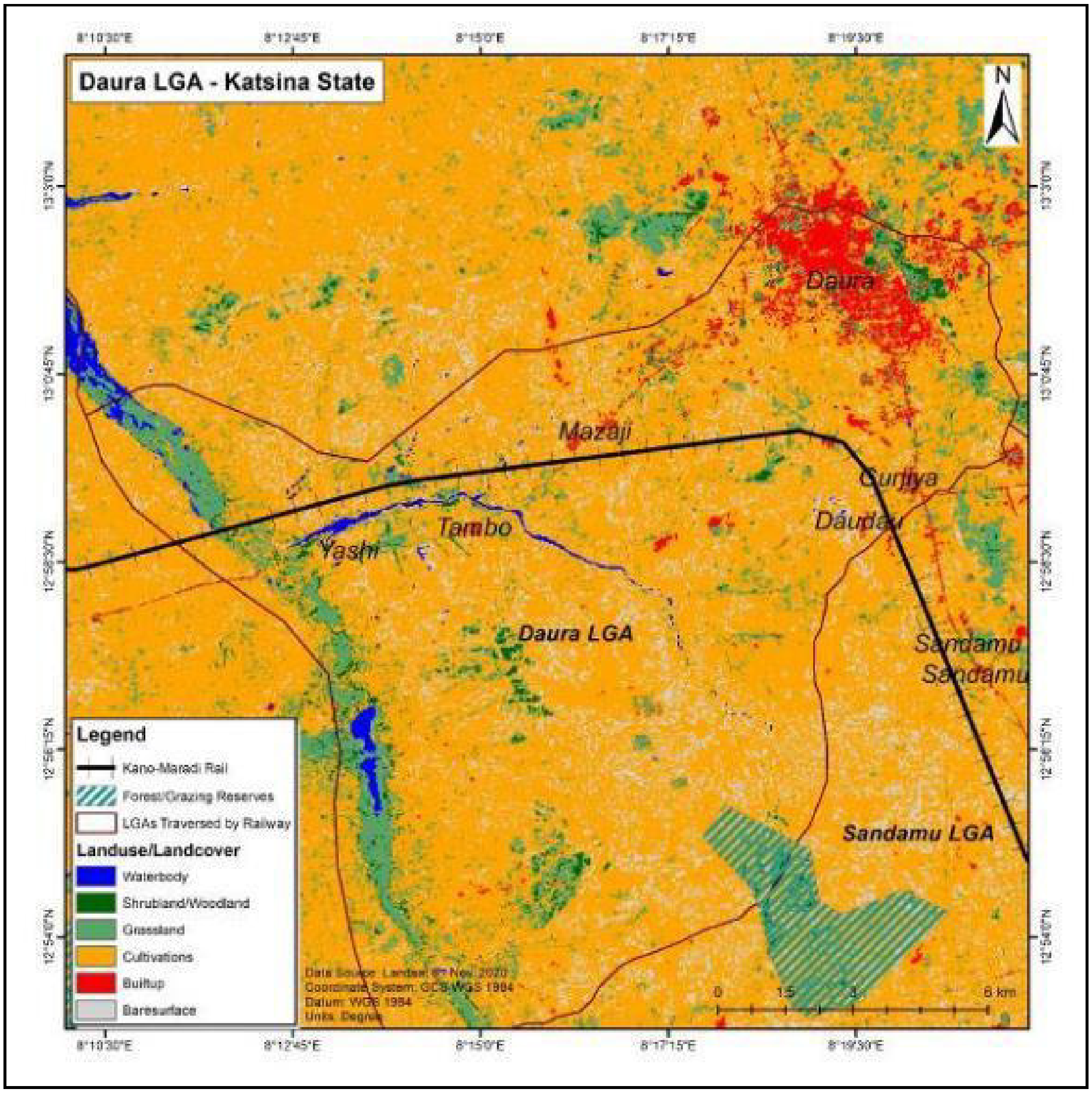


Figure 4. 69: Land use /land cover map along the rail alignment in Daura LGA

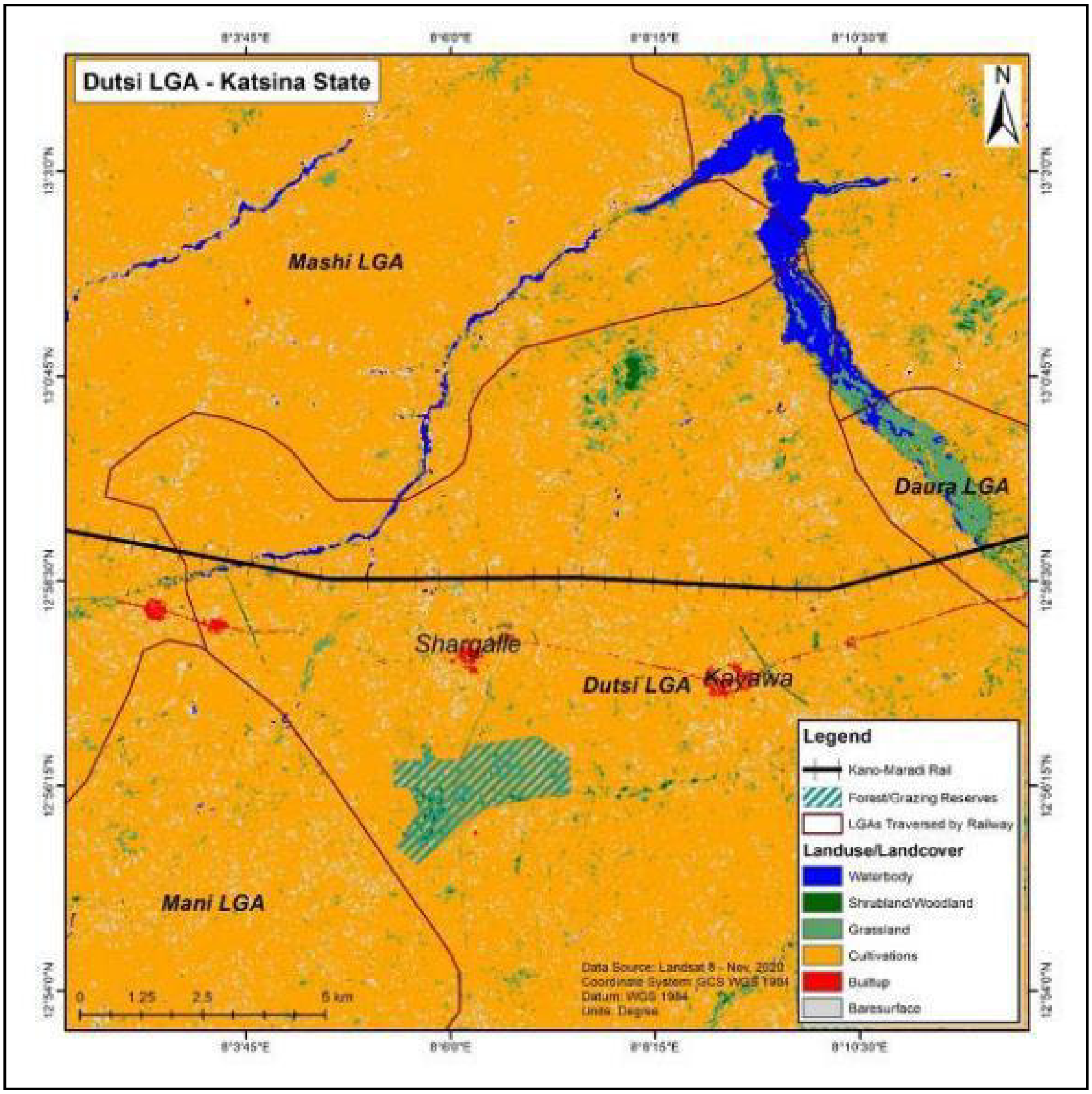


Figure 4. 70: Land use /land cover map along the rail alignment in Dutsi LGA

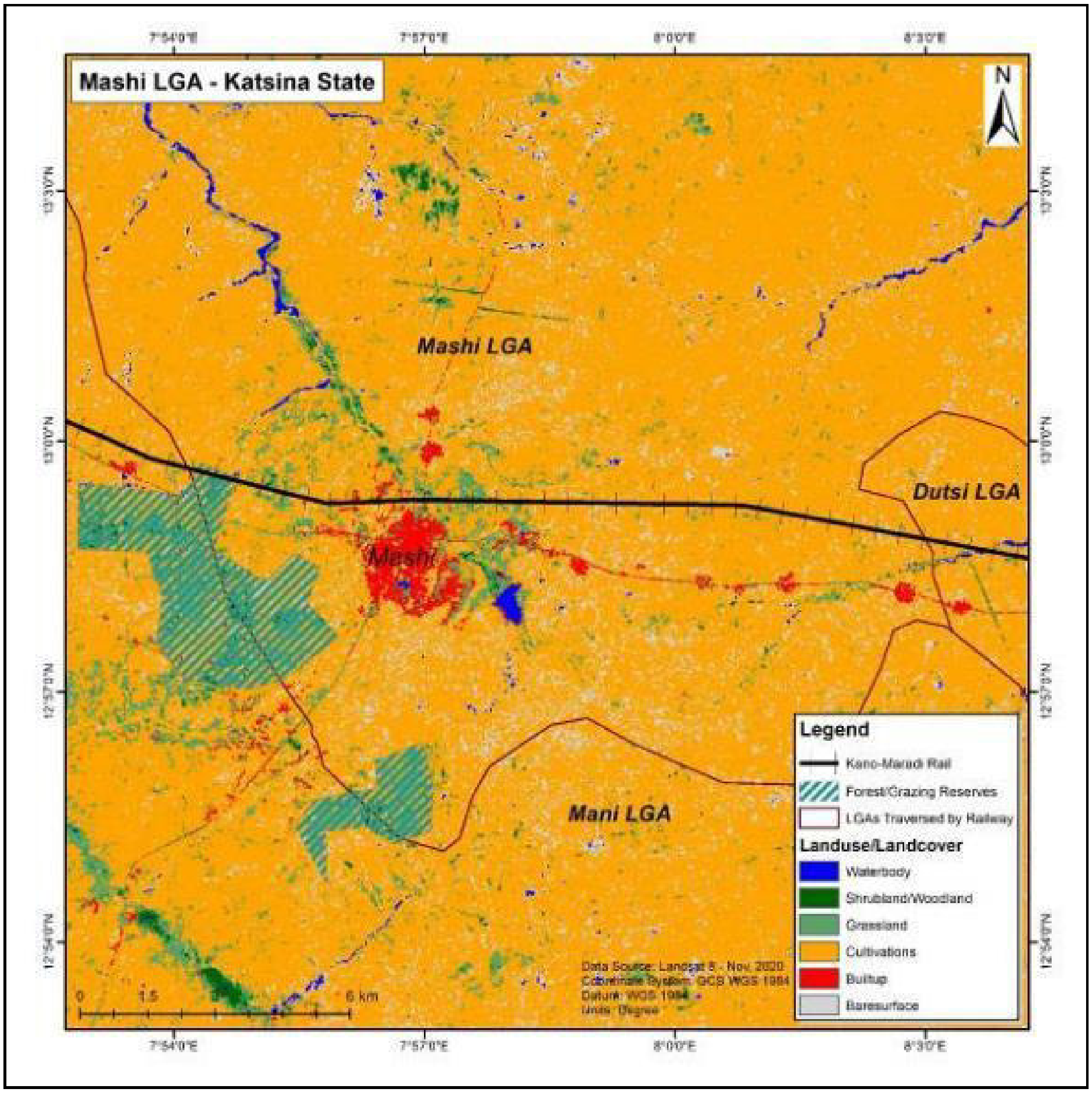


Figure 4. 71: Land use /land cover map along the rail alignment in Mashi LGA

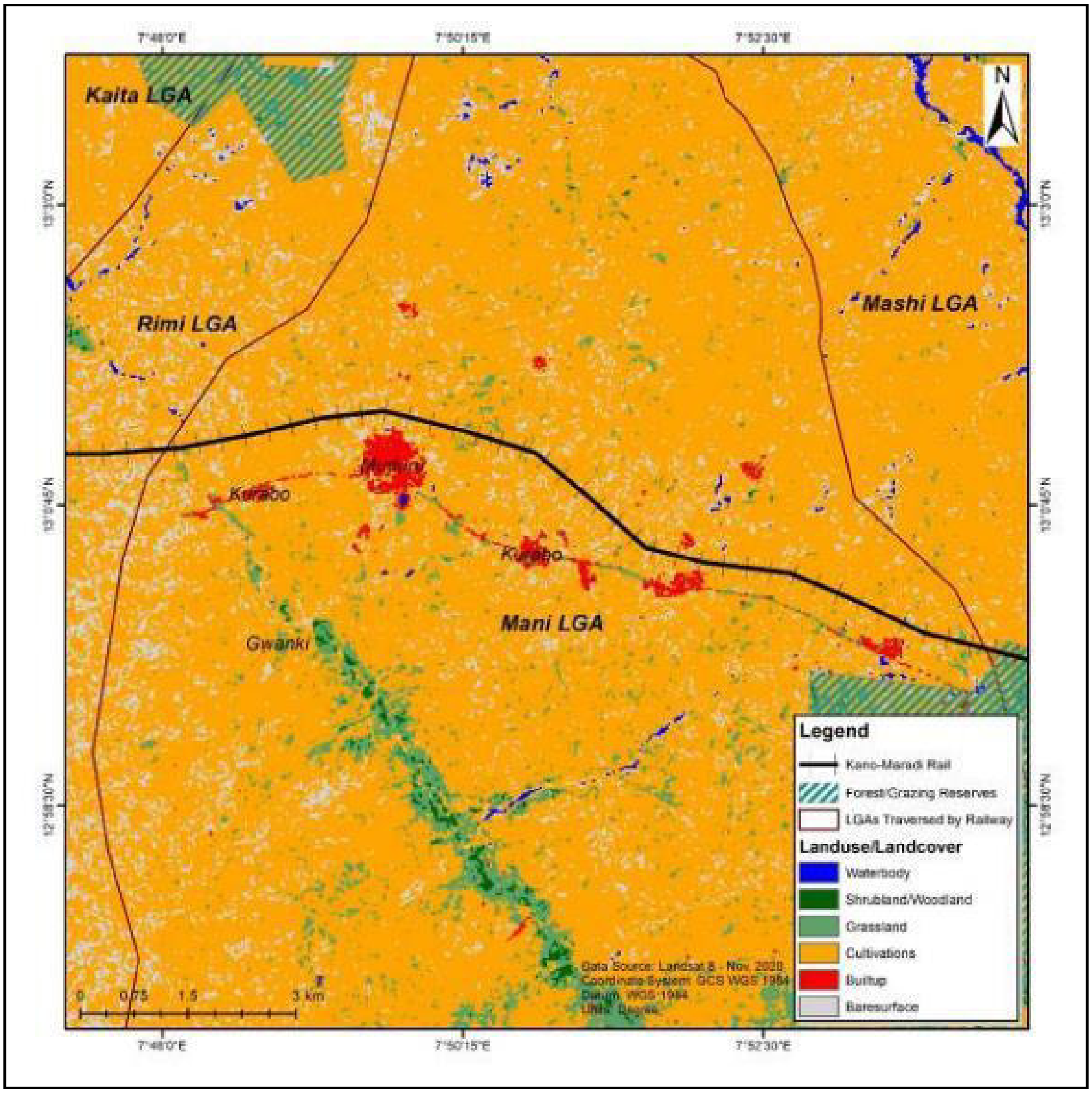


Figure 4. 72: Land use /land cover map along the rail alignment in Mani LGA

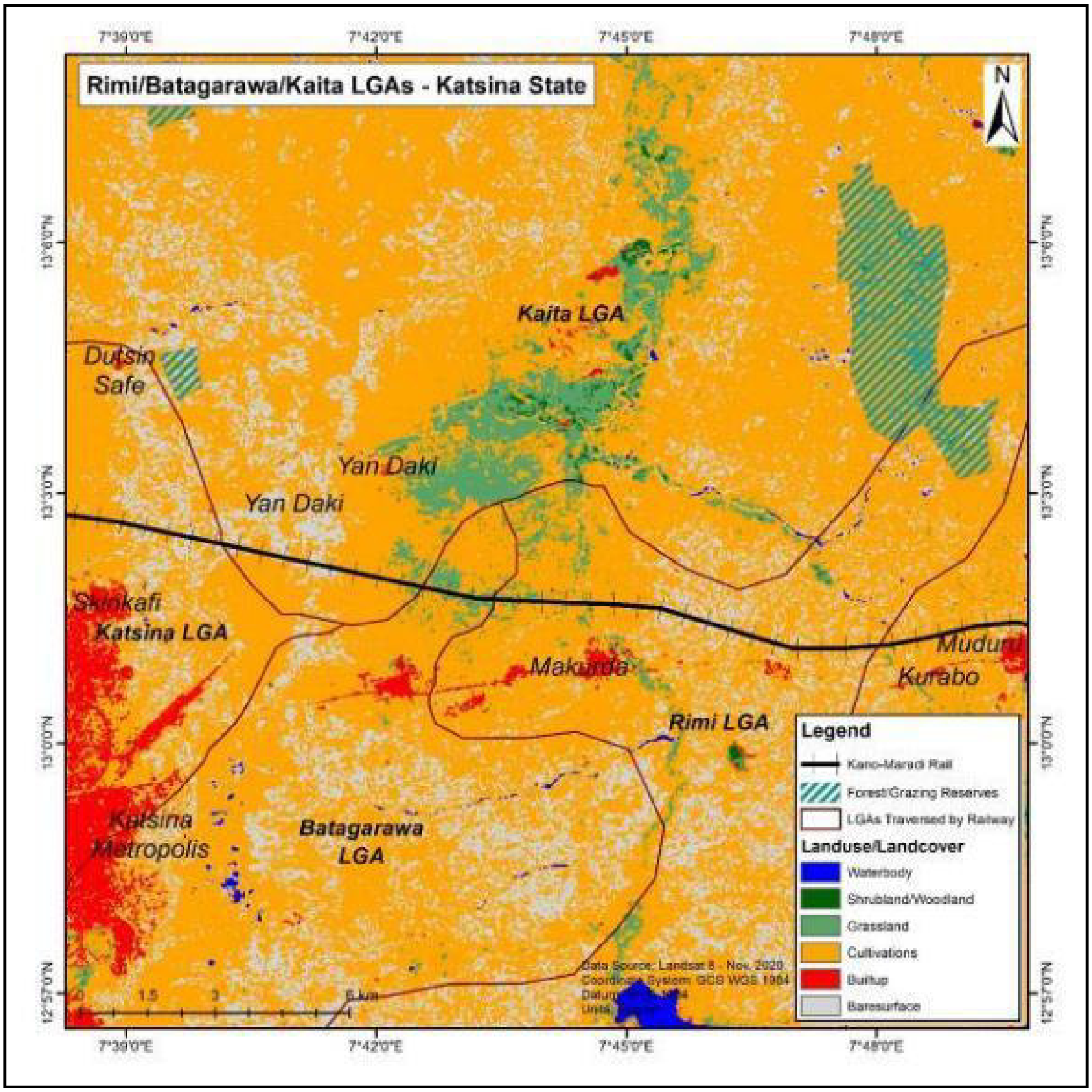


Figure 4. 73: Land use /land cover map along the rail alignment in Rimi/Batagarawa/Kaita LGAs

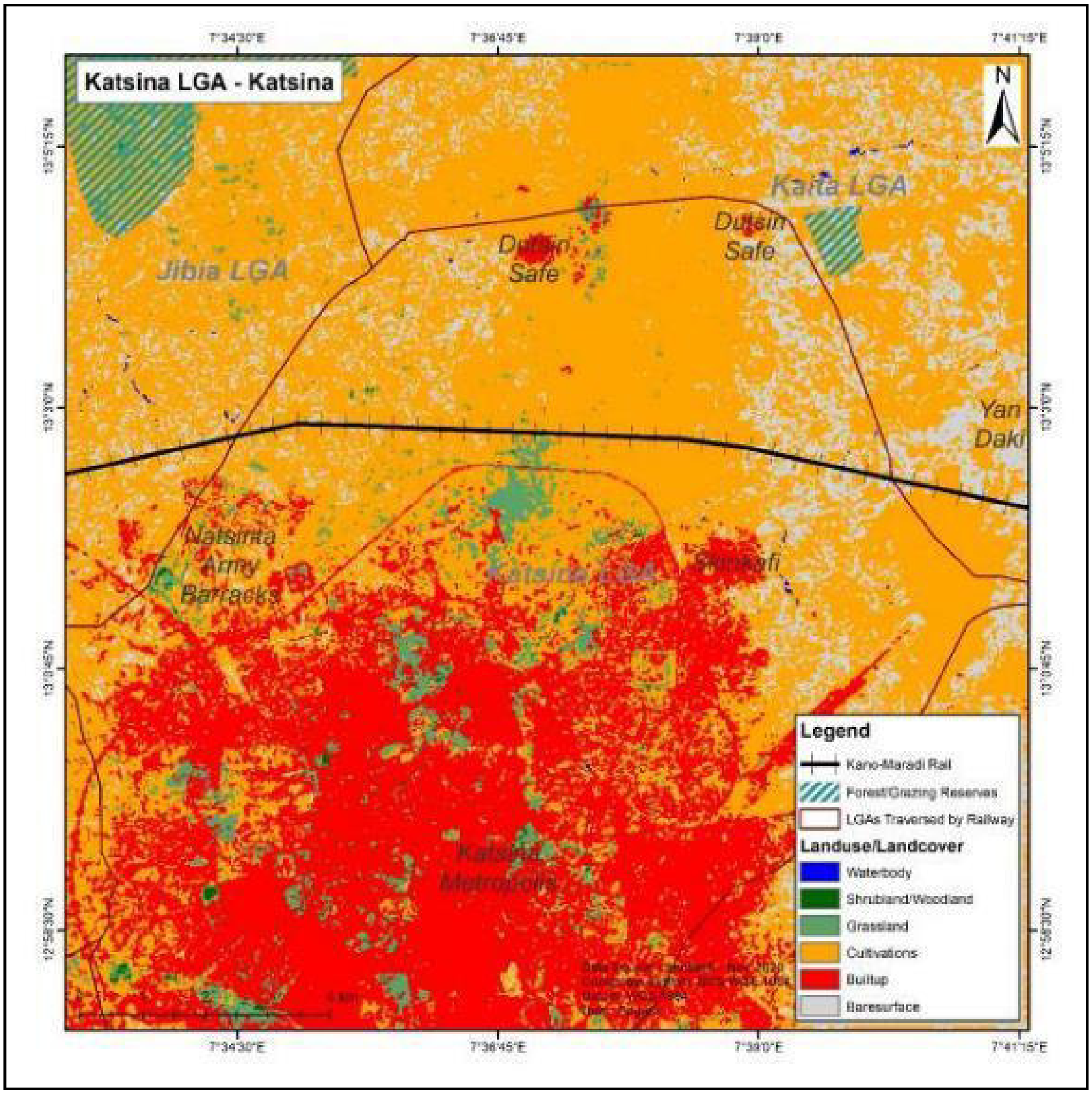


Figure 4. 74: Land use /land cover map along the rail alignment in Katsina LGA

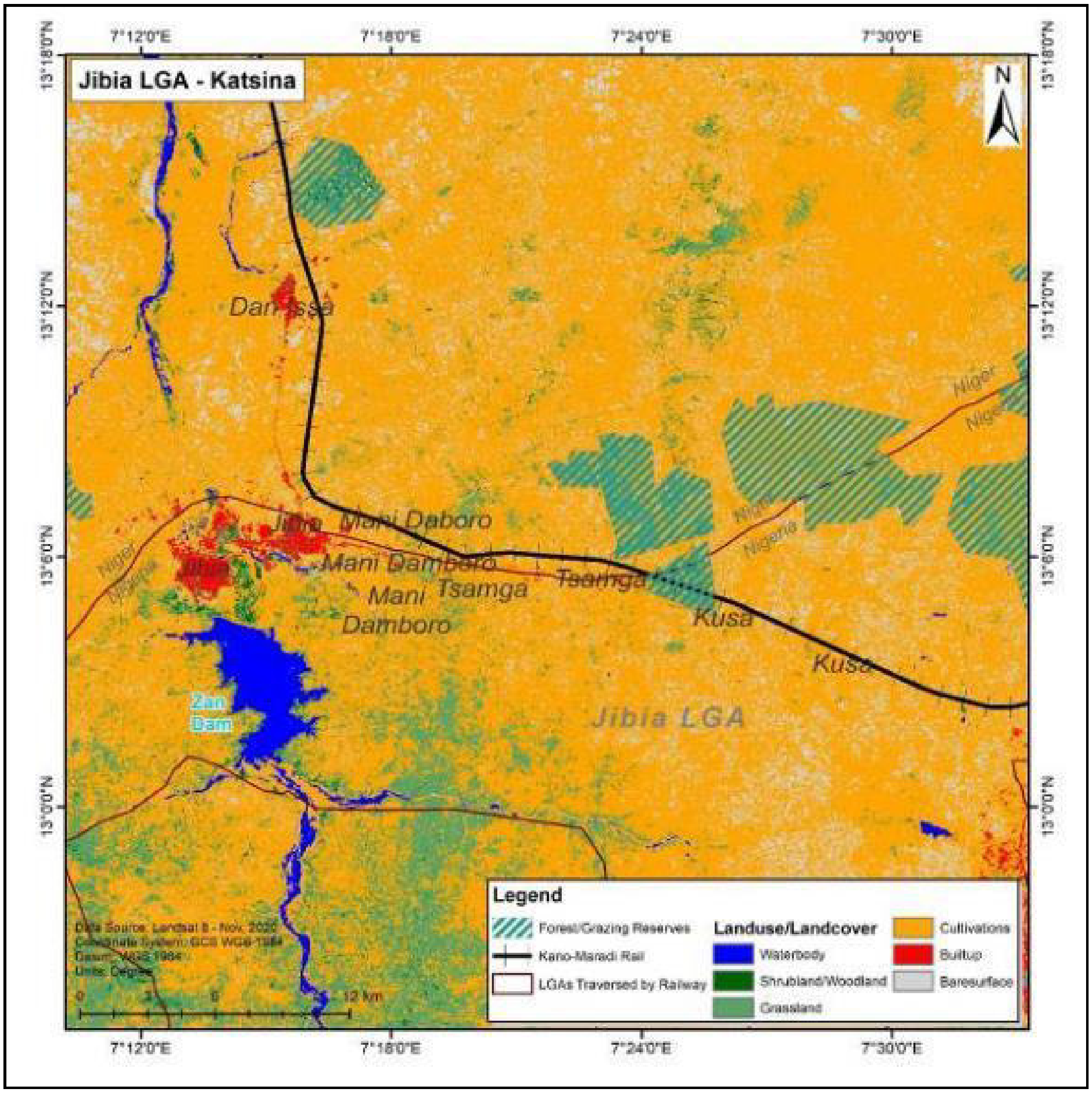


Figure 4. 75: Land use /land cover map along the rail alignment in Jibiya LGA

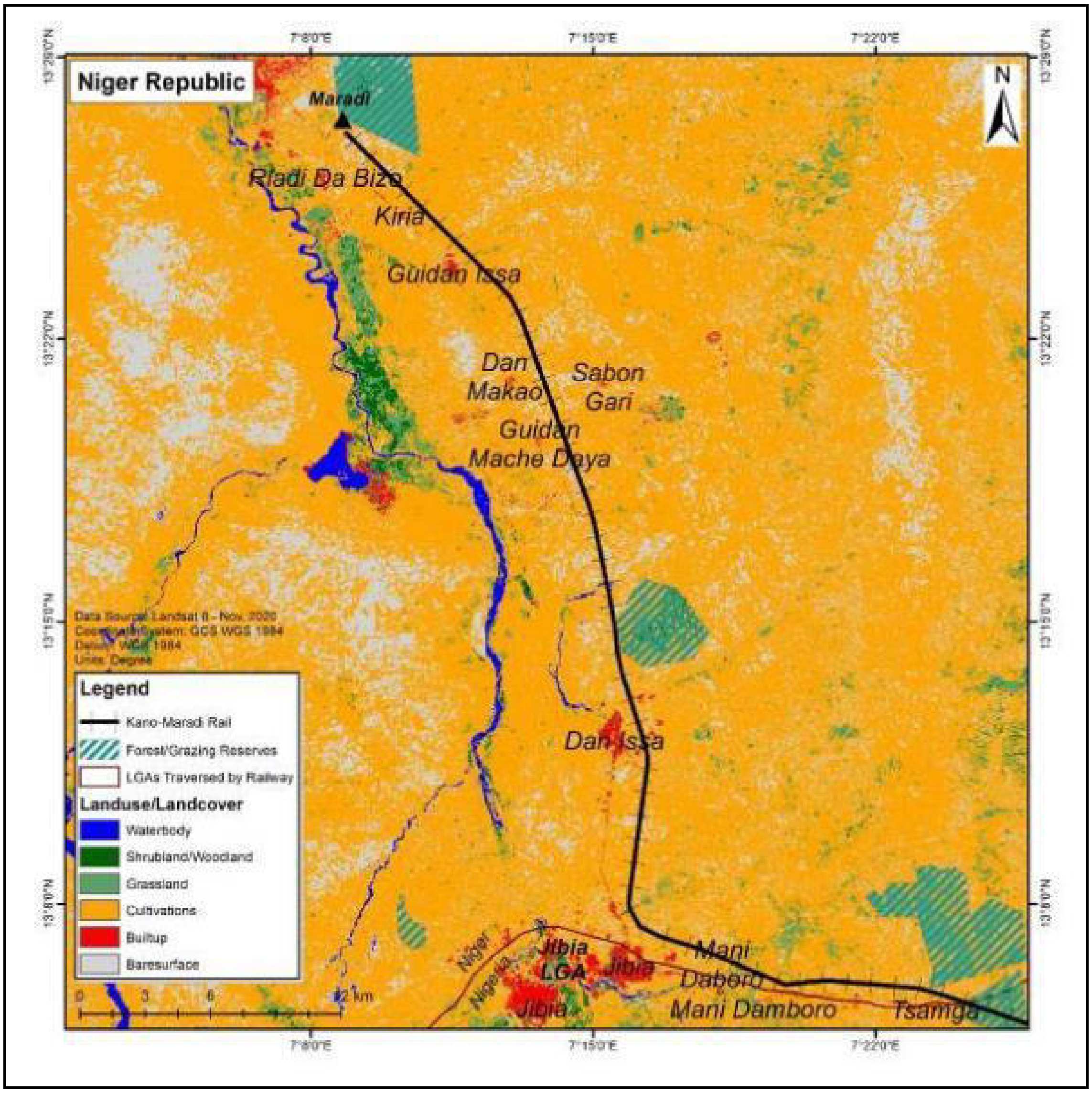


Figure 4. 76: Land use /land cover map along the rail alignment in Maradi Region, Niger Republic

4.3.7 Traffic Assessment

Traffic assessment focused on the federal highways, which link Dutse to Kano, and Kano to Jibiya. The two major highways along the project corridor are the Wudil (Kano) – Dutse Road and Dawanau (Kano) - Katsina road.

***Wudil – Dutse*:** This road is A237 federal highway of approximately 100-km road – partly single carriageway and mostly dual carriageway; connecting Kano city in Kano State with Shuwarin at the newly-constructed interchange in Jigawa (Figure 4. 77). The Shuwarin Interchange further distributes vehicular traffic to connect Dutse, Bauchi, Potiskum, Damaturu, Maiduguri. The Wudil section of the road is busier compared to the Shuwarin axis of the route. The road passes through Wudil, Kausani, Yar Gaya, Kongila, Dundum, Gano, Gaya, and Dundubus, The Dundubus – Shuwarin axis is a dual carriageway, which `has been recently rehabilitated.

Kano – Katsina Road: This road is an A9 federal highway generally known as IBB Way; connecting the capital cities of Kano and Katsina states. The road passes through Dawanau, Badume, Bichi, Tsanyawa, and Mutum Daya. Other major towns along the route are Gidan, Kankia, Cheranchi and Abukur (Figure 4. 78; Plates 4.13 and 4.14). The Kano – Katsina highway is an international route that leads to the border town of Jibiya; the town sharing international border with Niger Republic. The road connects Maradi; the proposed terminal point of the Kano – Maradi rail project.

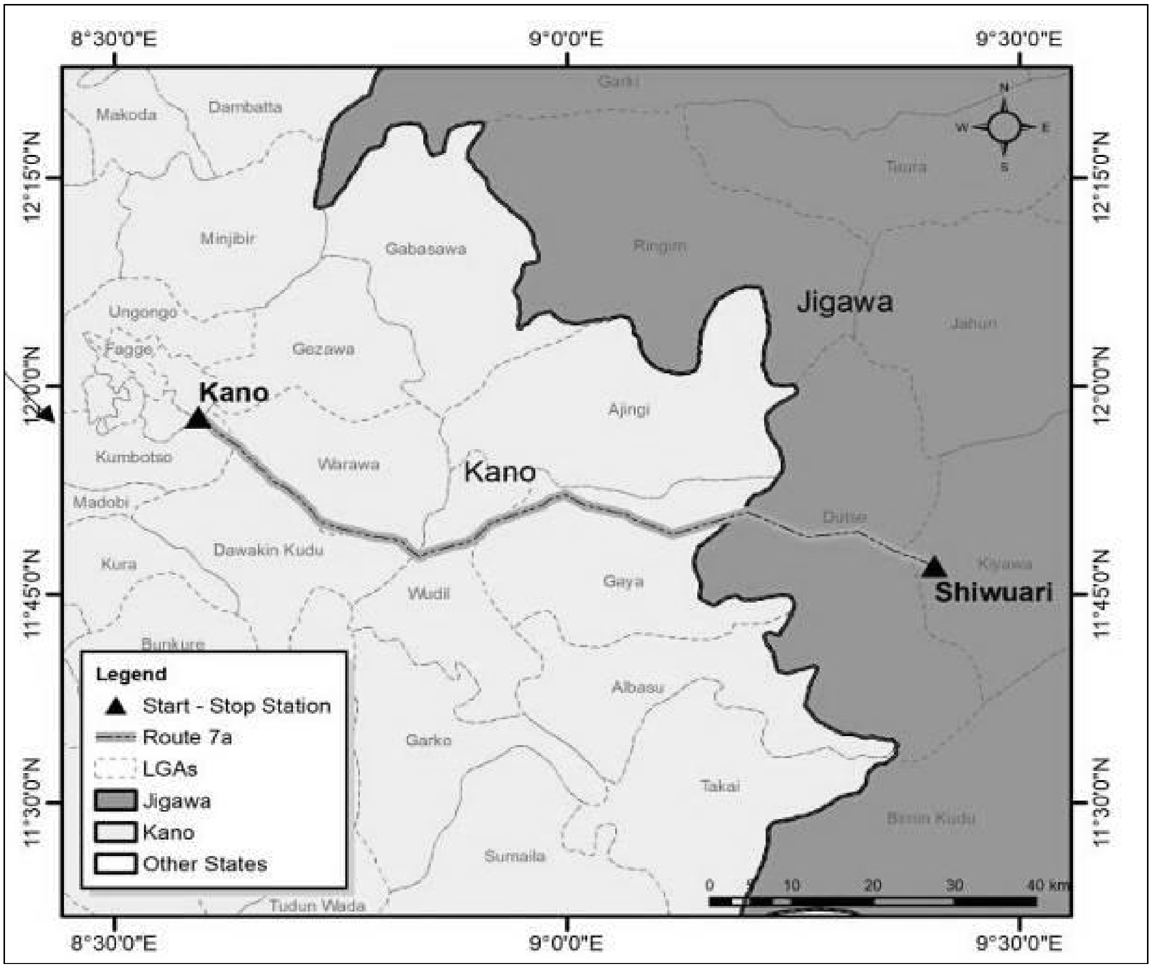


Figure 4. 77: Map showing the existing road from Kano to Jigawa State

Plate 4. 11: A section of Kano to Dutse Road

Plate 4. 12: Aerial photograph of Kano to Dutse road showing traffic flow at Wudil

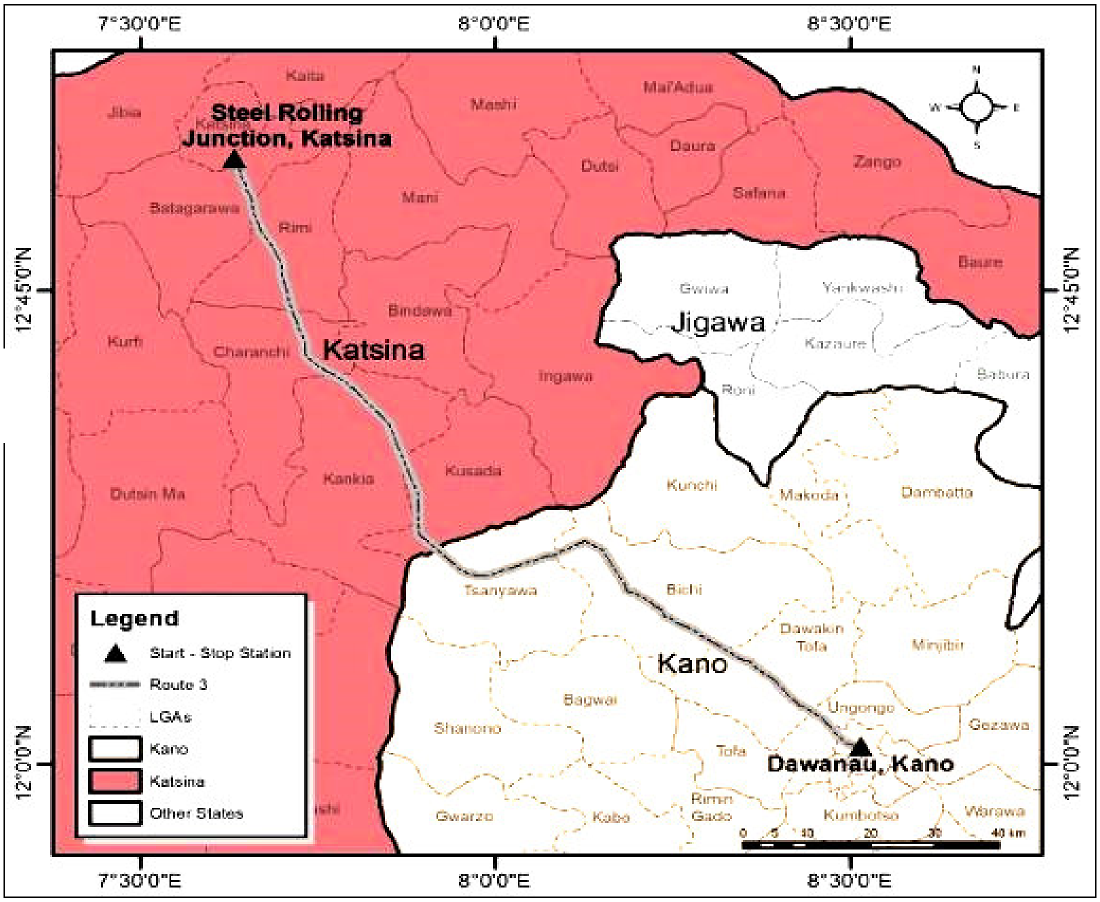


Figure 4. 78: Map showing Dawanu (Kano) to Katsina Road


Plate 4. 13: A section of Kano – Katsina road


Plate 4. 14: Dawanau aerial view showing the traffic flow

4.3.7.1 Preliminary Study

Previous traffic study carried out in 2017 in the project area, as documented in the Feasibility Studies for the Project, focused on traffic survey along the A9 Katsina - Jibiya Expressway, the Katsina - Daura Road and the A2, in the segment of the project corridor from Daura to Kano (Figure 4. 79). The methodology used for the survey was Traffic Simulation Algorithm, in addition to Origin – Destination interviews, traffic counts and travellers' interviews.

Figure 4. 79: Map showing locations of preliminary traffic survey

<u>Dumawa Traffic Survey Station</u>

At Dumawa, the daily average number of motorcycles towards Kazaure were 912; car was 1388; bus/SUV was 663 and lorry was 32. The average number of trucks towards Kazaure was 24. Cars had the highest frequency for the week with a total of 9,716 while trucks were the least frequent with a total of 24 (Figure 4. 80). Towards Kano, the average daily volume of cars was 1358, bus was 592 and truck was 20. Equally, car had the highest number of traffic (9,509) while truck had the least (143). The total volume of traffic for the week at Dumawa was 40,778. Highest volume of vehicular movement was observed on Saturday at Dumawa on both directions, while the least was Sunday towards Kano and Monday towards Kazaure (Figure 4. 81 and Figure 4. 82).

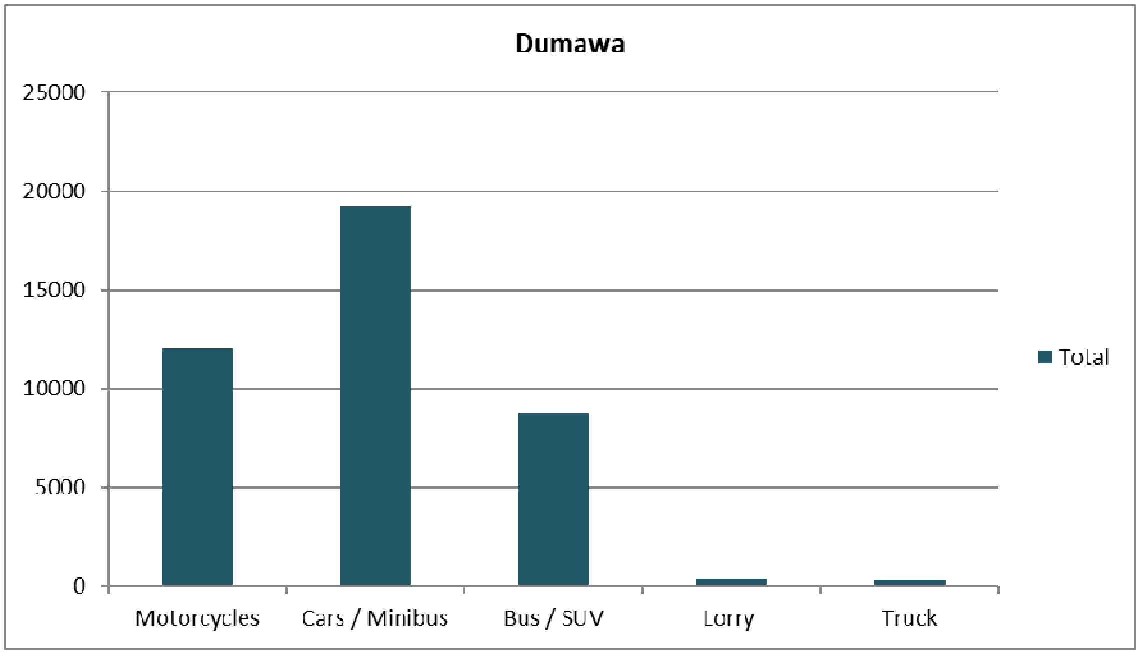


Figure 4. 80: Traffic pattern at Dumawa to Kazaure and Kano per week

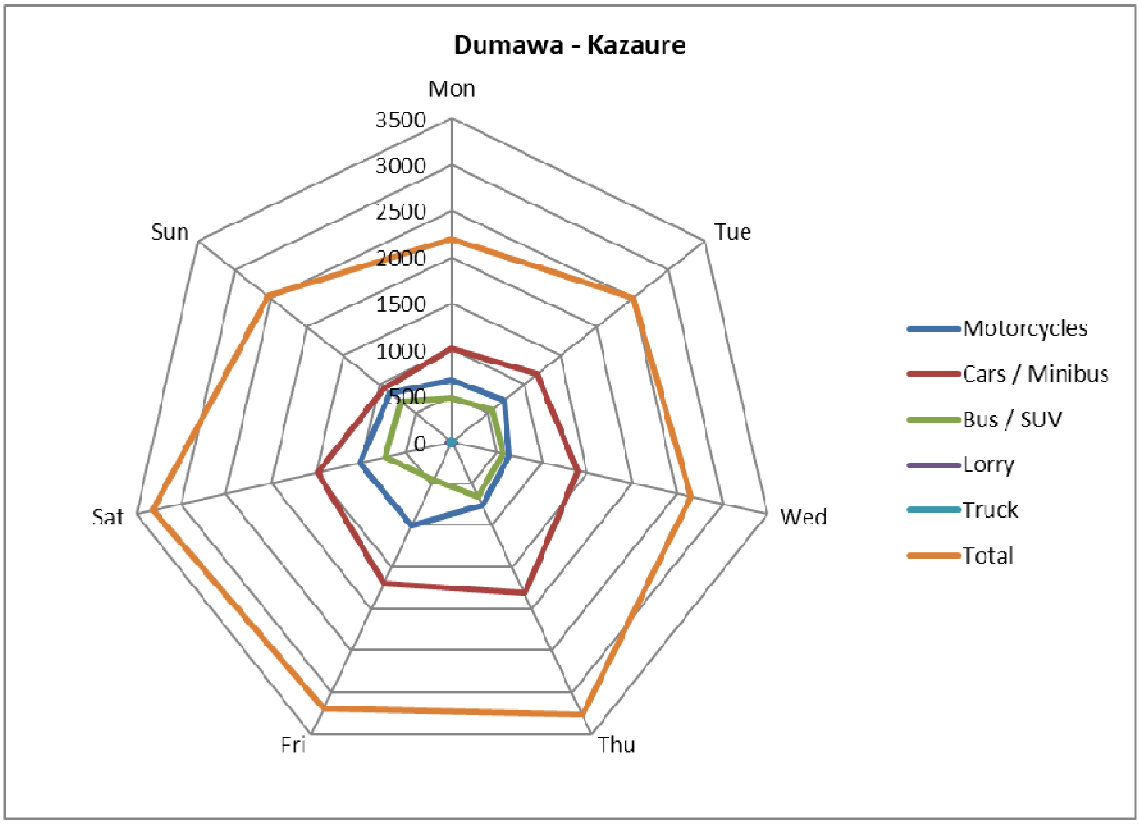


Figure 4. 81: Daily traffic pattern and volume from Dumawa to Kazaure

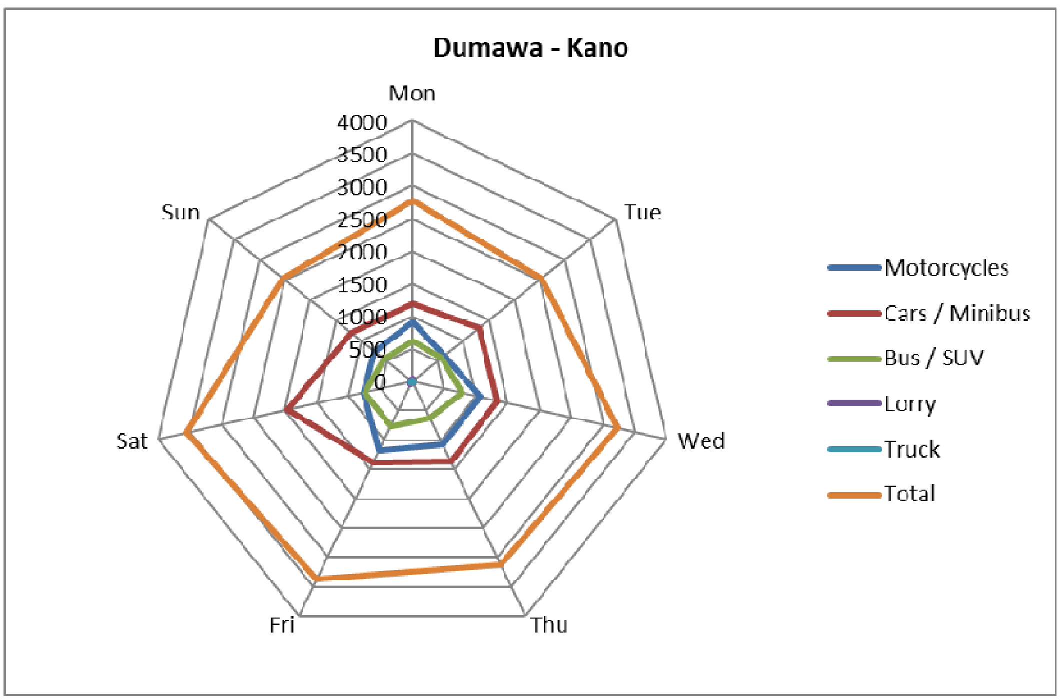


Figure 4. 82: Daily traffic pattern and volume from Dumawa to Kano

Katundu Traffic Survey Station

At Katundu, the average daily volume of motorcycle was 668, cars were 853, bus was 340, lorry was 16 and truck was 20. The total volume of vehicular movement was 26,541. Car had the highest volume of traffic (11940) at Katundu towards Kazaure and Kano. The vehicle type with the lowest frequency on that axis was lorry with a total weekly volume of 15, 751. At Katundu, the day with the least vehicular movement towards Kazaure was Saturday while the highest was Wednesday. Towards Kano, the day with the highest vehicular movement was Sunday while the least was Wednesday.

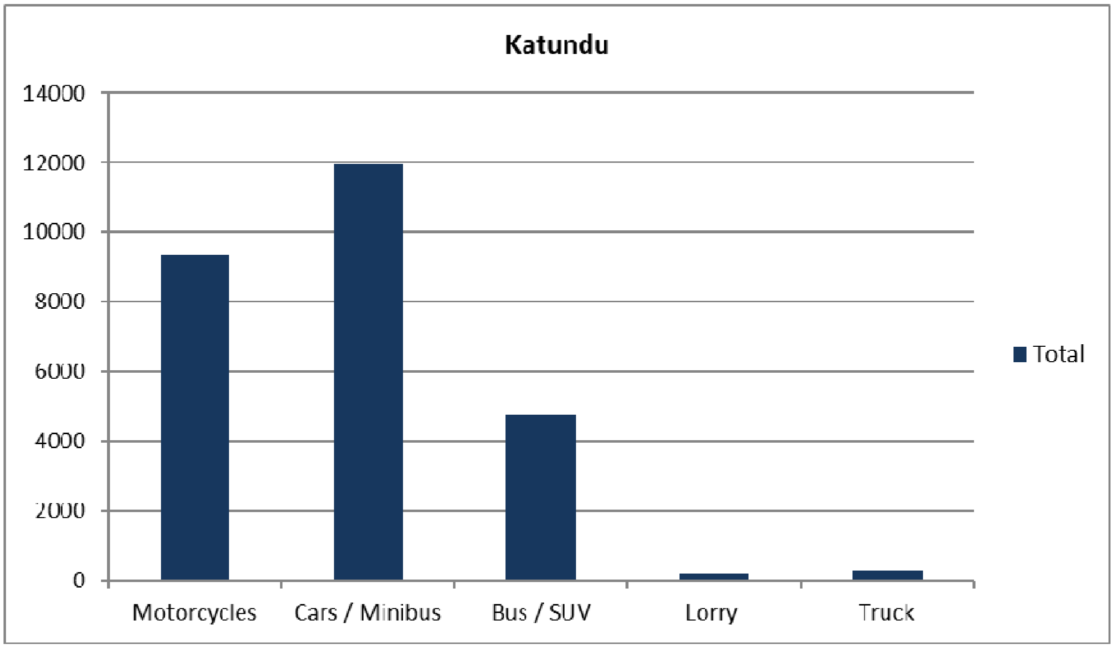


Figure 4. 83: Traffic pattern at Katundu to Kano and Kazaure

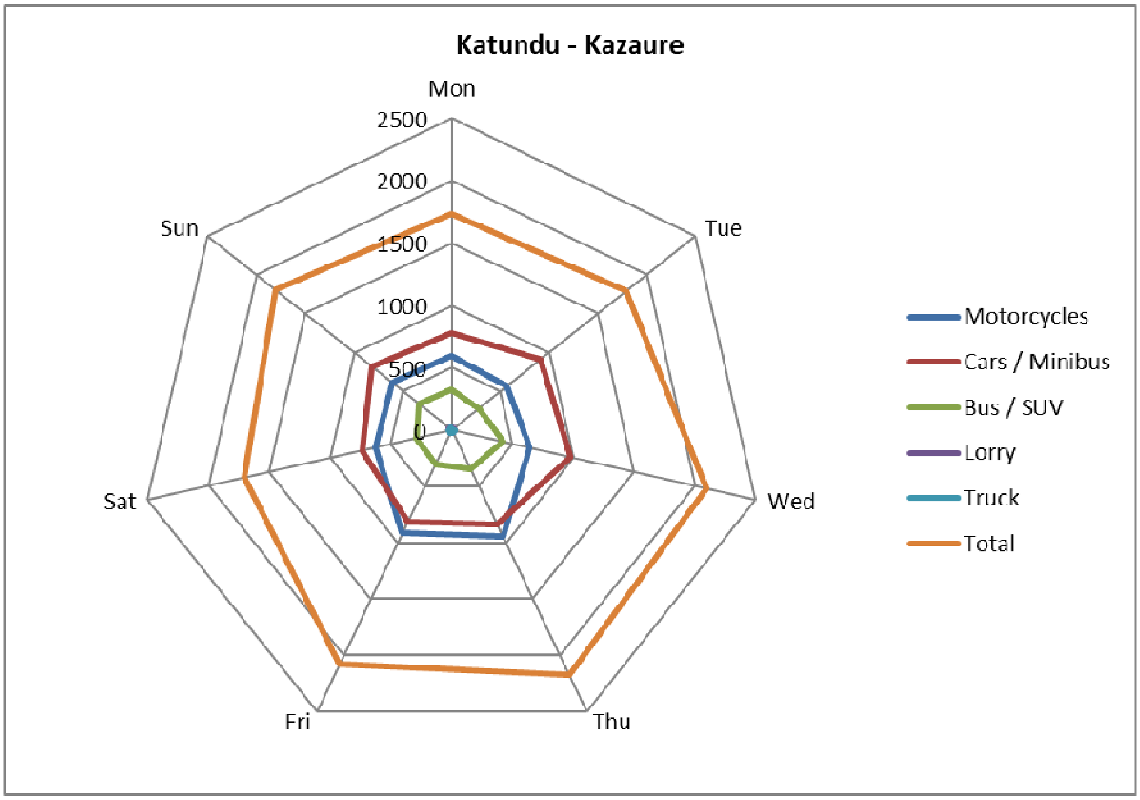


Figure 4. 84: Daily traffic pattern and volume from Katundu – Kazaure

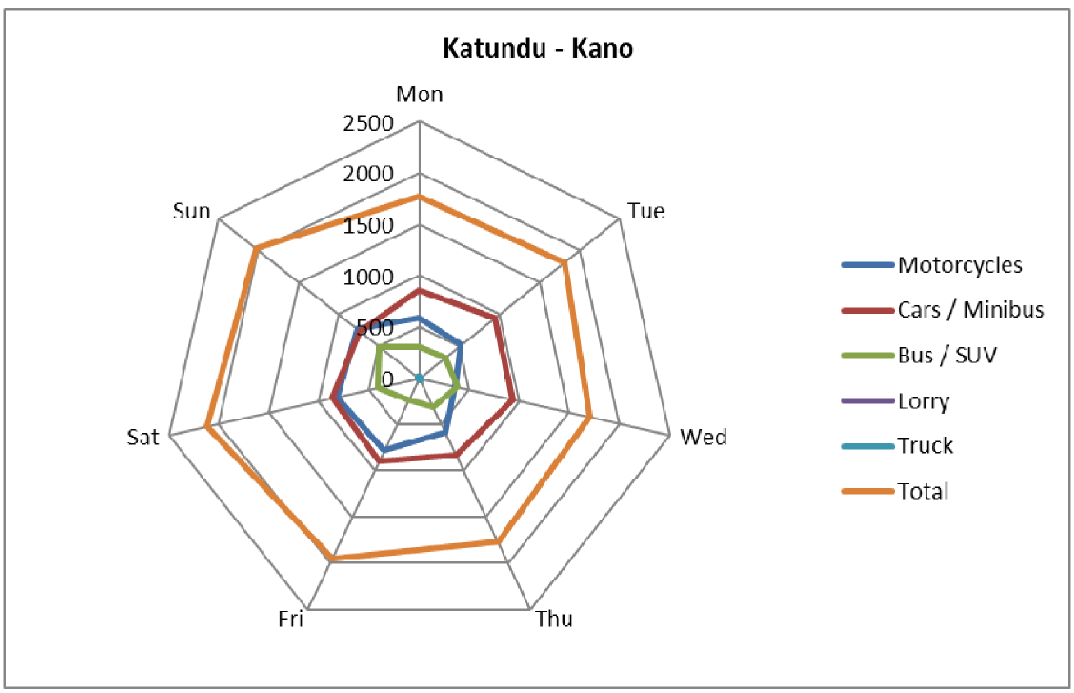


Figure 4. 85: Daily traffic pattern and volume from Katundu to Kano

Fego Survey Station

The traffic survey at Fego showed that cars were the most frequent vehicles to Kazaure and Kano with a total volume of 12,346 per week and an average of 882 per day. To Kazaure, an average daily traffic of 843 cars was recorded while the cars in the direction of Kano were 920 per day. The total number of lorries and heavy-duty trucks, which passed through the survey station towards Kano and Kazaure in a week was 399 and 319 respectively. At Fego survey station, the least vehicle movement towards Kazaure was observed on Saturday while the highest was Wednesday. Towards Kano, the highest volume of vehicle was observed on Thursday while the least was Monday.

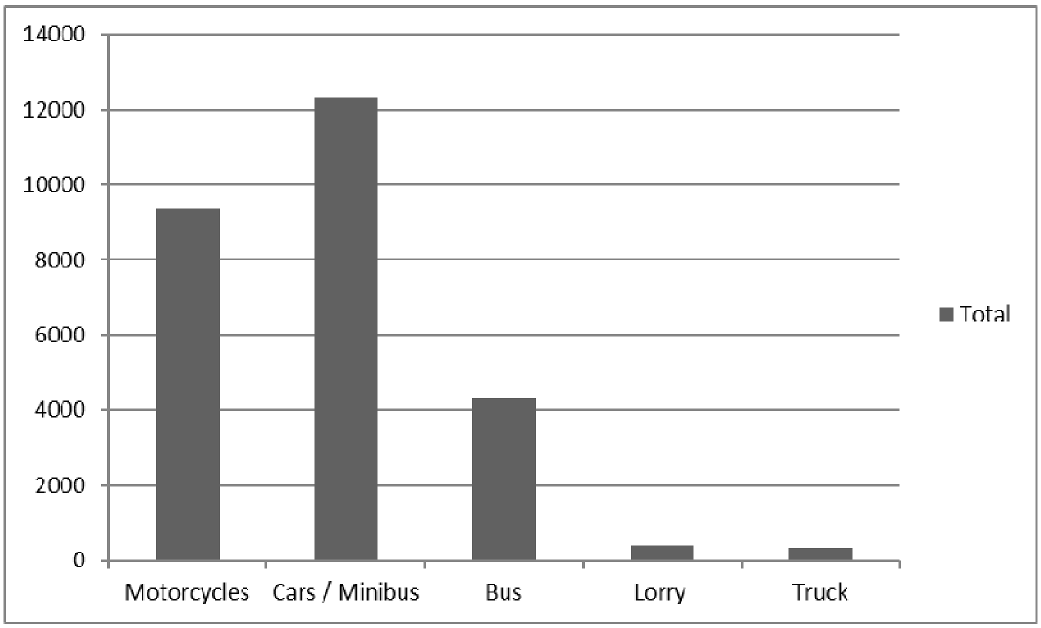


Figure 4. 86: Traffic pattern at Fego to Kano and Kazaure

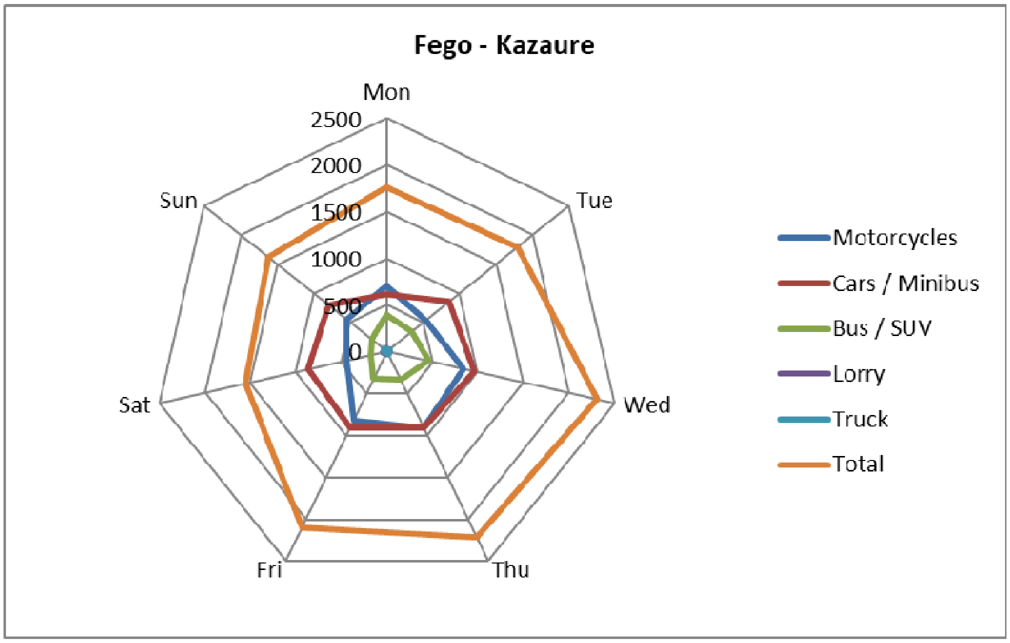


Figure 4. 87: Daily traffic pattern and volume from Fego – Kazaure

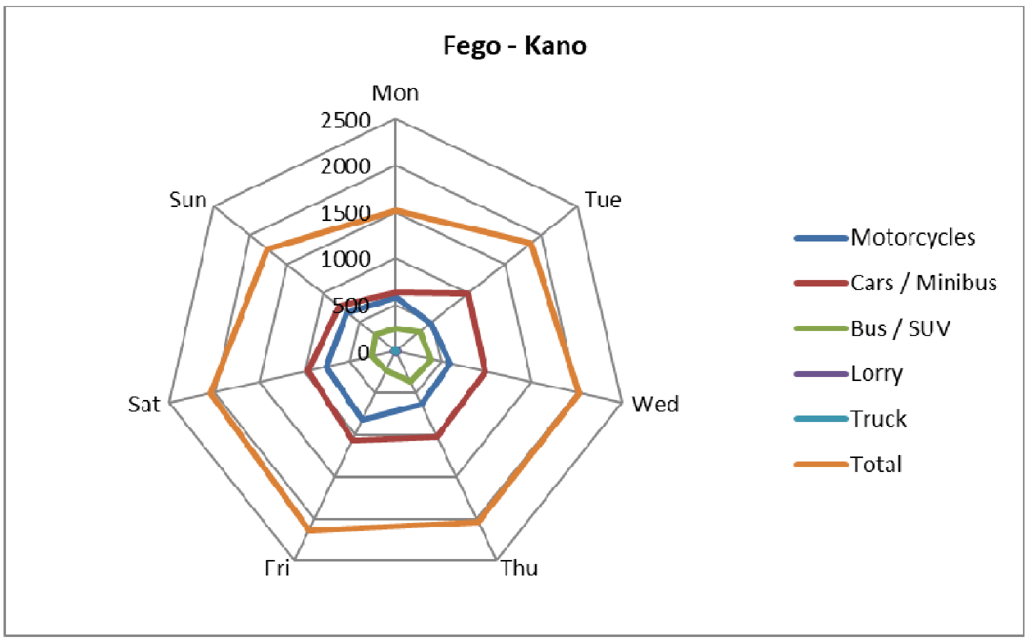


Figure 4. 88: Daily traffic pattern and volume from Fego – Kano

Makurda Traffic Survey Station

At Makurda, the average daily volume of motorcycle was 757, car was 901, bus was 133, lorry was 24 and truck was 13. The total volume of vehicular movement was 25,588. Car had the highest volume of traffic (12,615) at Makurda. The vehicle type with the lowest frequency on that axis was truck with a total weekly volume of 179. The least vehicular movement towards Kazaure was Sunday while the highest was Wednesday. Towards Kano, the day with the highest vehicular movement was Saturday while the least was Tuesday.

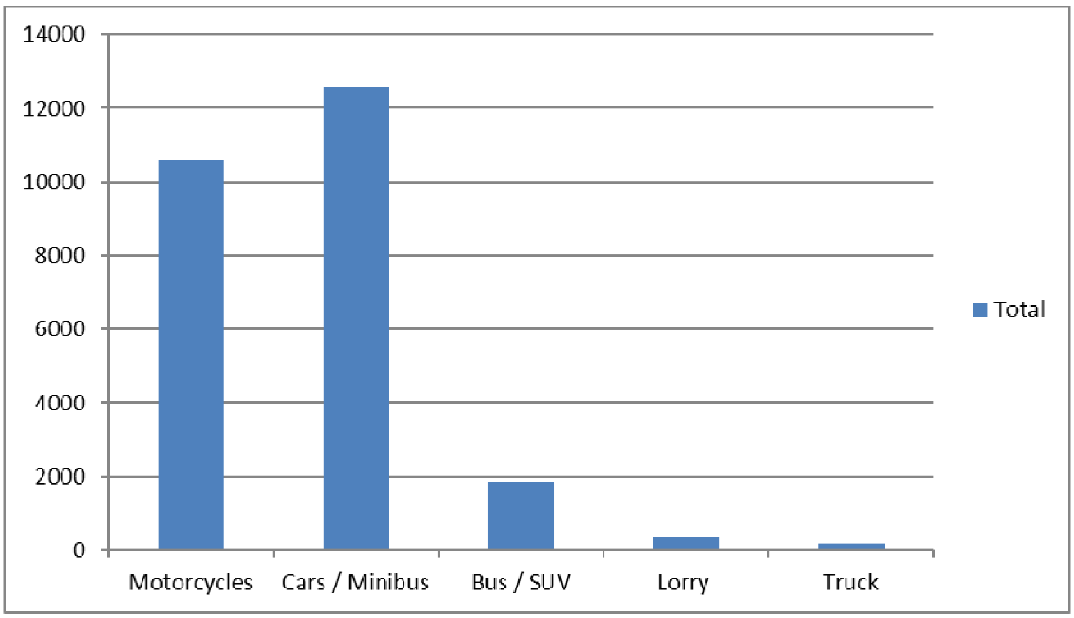


Figure 4. 89: Vehicular traffic pattern in Makurda per week

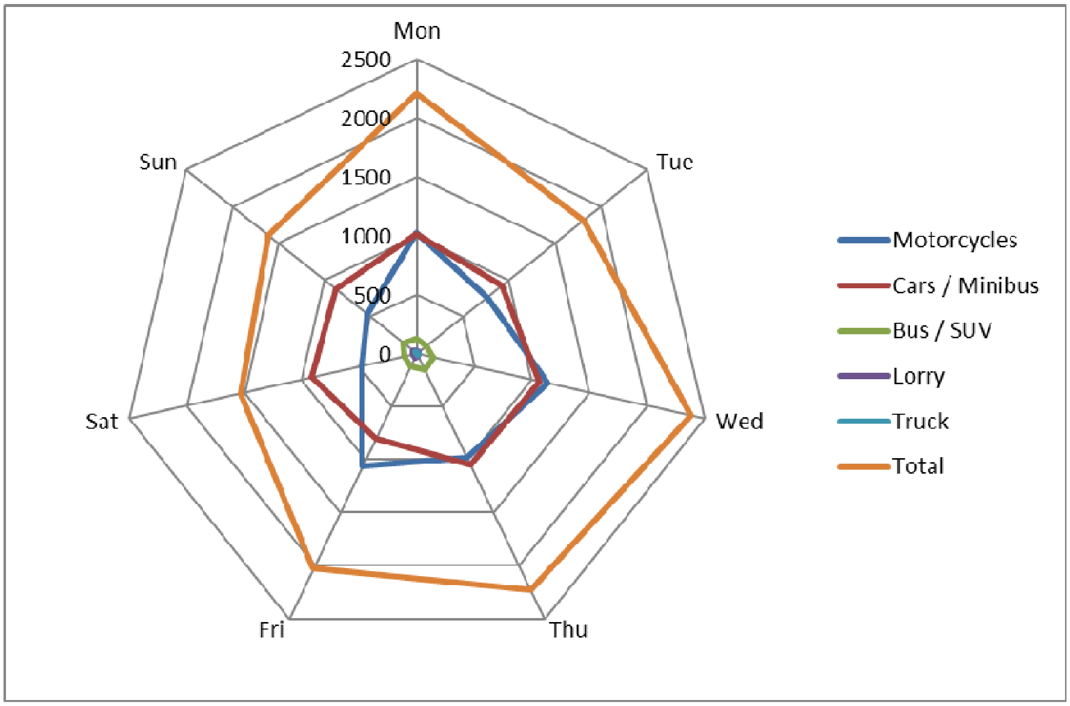


Figure 4. 90: Daily traffic pattern and volume from Makurda to Kazaure

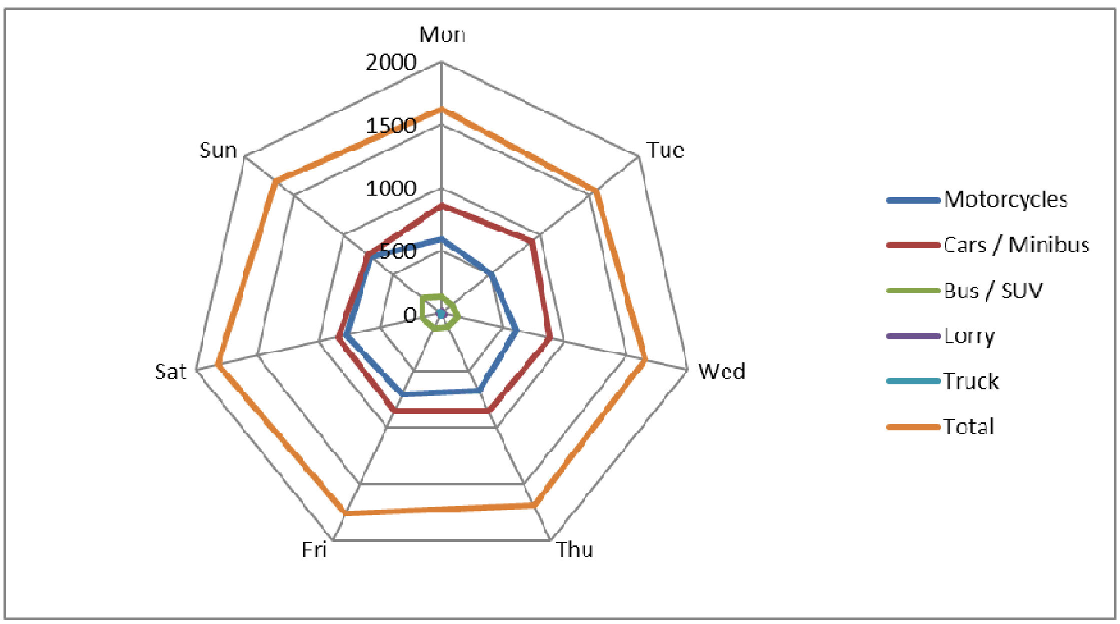


Figure 4. 91: Daily traffic pattern and volume from Makurda to Kano

4.3.7.2 *Supplementary Traffic Study*

In addition to the initial traffic survey locations, additional study was carried out at two strategic locations: Wudil – Dutse and Danmana (Kano) – Jibiya (Katsina). The traffic survey conducted at Wudil – Dutse and Kano – Katsina Roads, an area under the zone of influence of the proposed rail line was meant to show the nature of traffic activities around the project area and the likely implications. The Traffic count helps to derive detailed traffic characteristics around the project area. The method employed to accomplish this was the manual classified count (MCC)- which involve the observer counting the number of vehicles passing and classifying them according to vehicle type (e.g., Trucks, Motorbikes, Heavy goods vehicles etc). All the activities relating to the count were carried out between the hours of 7 am to 7 pm. Vehicles were classified into four categories:

1. Cars and minibuses- minivans, salon cars
2. Buses / SuVs – Vans, pickup trucks, commercial buses, Executive buses.
3. Lorries and trucks (these were combined due to low volume of traffic in previous study)
4. Tricycle / Motorcycles.

The survey was carried out from Monday, October 11 to Saturday, 17, 2021.

<u>Wudil – Dutse Results</u>

The peak hour for motorcycle was 9 to 10 am followed by 6 - 7 pm. The period of least movement was 3 - 4 pm. Sunday had the least of movement while Monday was the highest. Car had the highest volume of movement between 7 and 8 am while the least was 6 to 7 pm. The highest traffic was observed on Monday was the least was on Sunday. Bus traffic was highest between 3 and 4 pm and lowest between 2-3pm. The day with the highest traffic was Monday was the least was Friday. The highest traffic of trucks was observed between 4 and 5 pm while the lowest was 11 am to 12 noon. The day with the highest traffic was Sunday while the least was Monday.

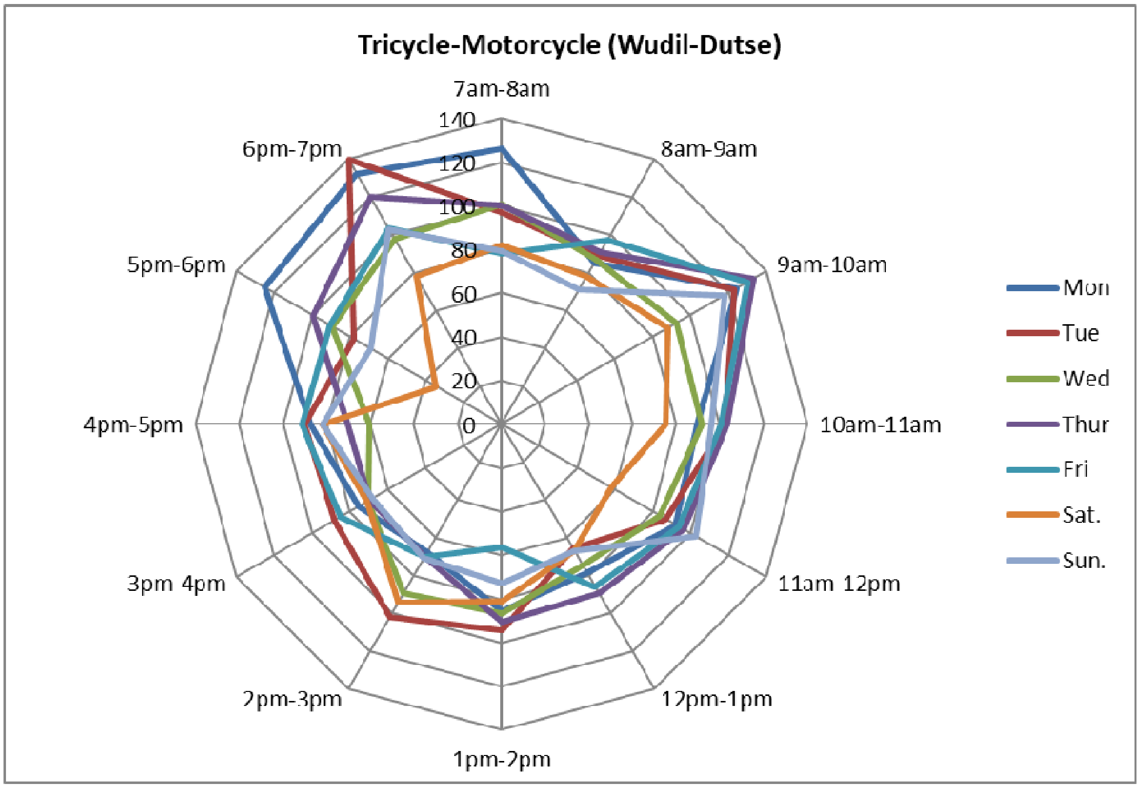


Figure 4. 92: Tricycle traffic at Wudil

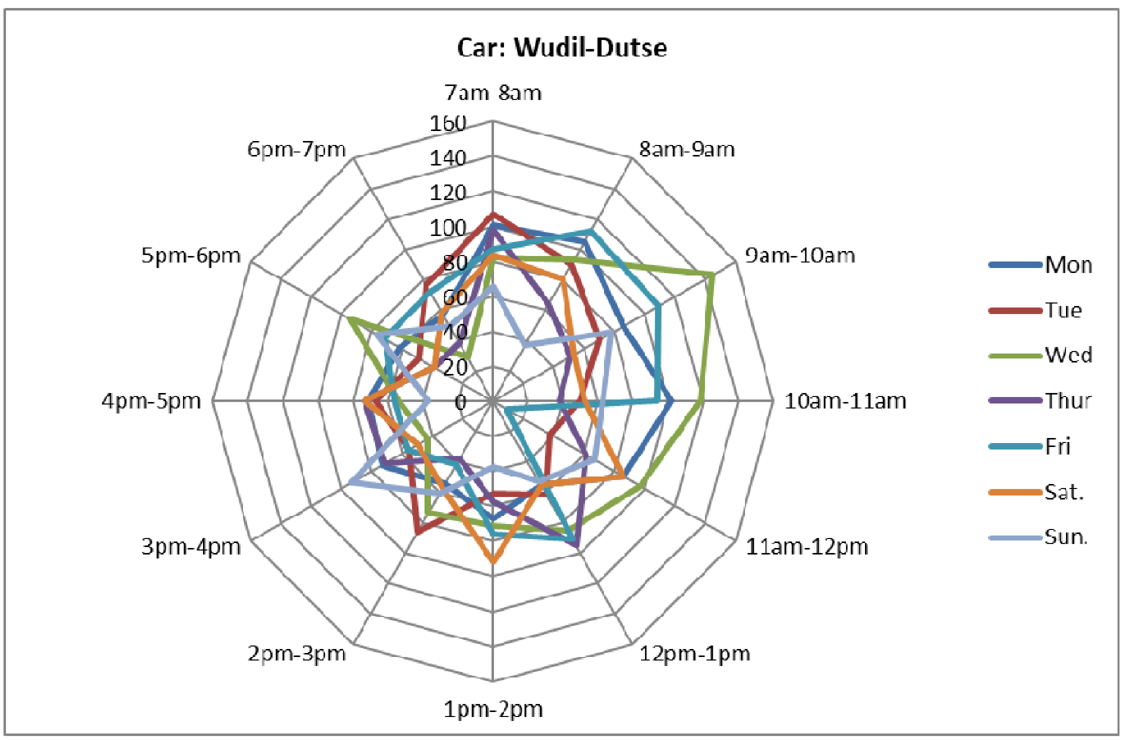


Figure 4. 93: Car traffic flow at Wudil

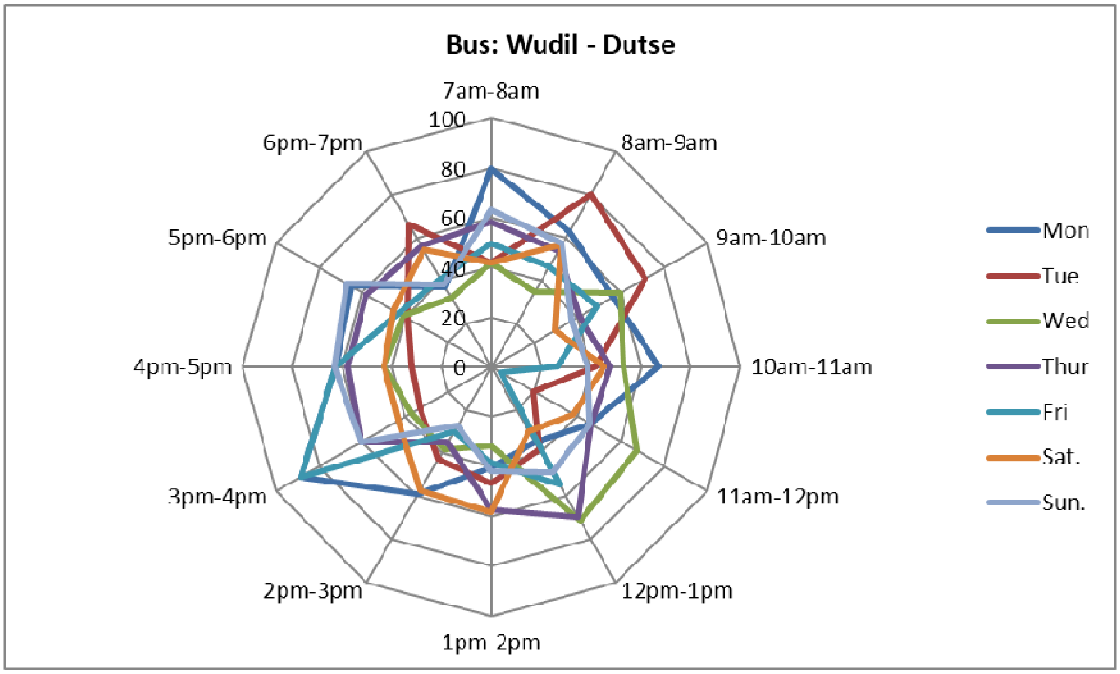


Figure 4. 94: Bus traffic flow at Wudil

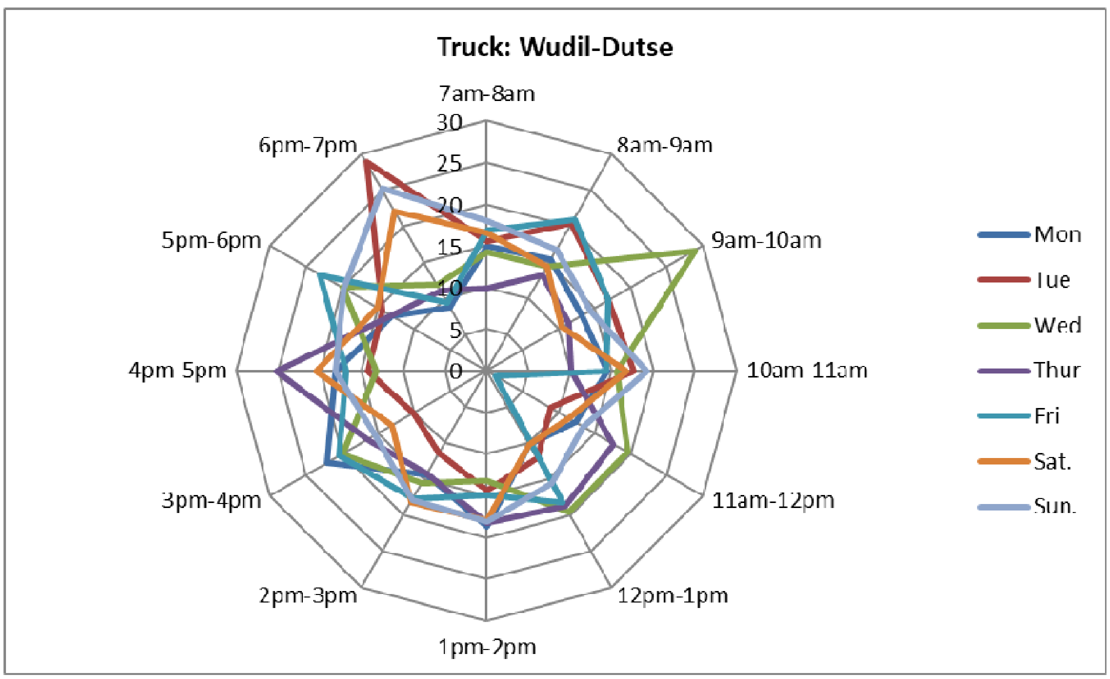


Figure 4. 95: Truck traffic flow at Wudil

Dawanu – Katsina Results

The peak period for motorcycle and tricycle at Dawanu was 8 am to 9 am while the least traffic was observed between 5 and 6 pm. The highest traffic was observed on Thursday and Sunday while the least traffic was observed on Monday. Car had the highest frequency between 8 am and 9 am while the least was between 4 and 5 pm. Wednesday had the highest traffic while Sunday had the least traffic for cars. The highest traffic for buses was observed between 3 pm and 4 pm while the lowest was observed between 11 am and 12 noon. Monday was the peak day for bus movement while Wednesday had the least bus traffic. The highest traffic for trucks was observed between 7 am and 8 am and 5 pm and 6 pm while the lowest traffic was observed between 11 am and 12 noon. Friday had the least traffic while Sunday had the highest traffic for trucks.

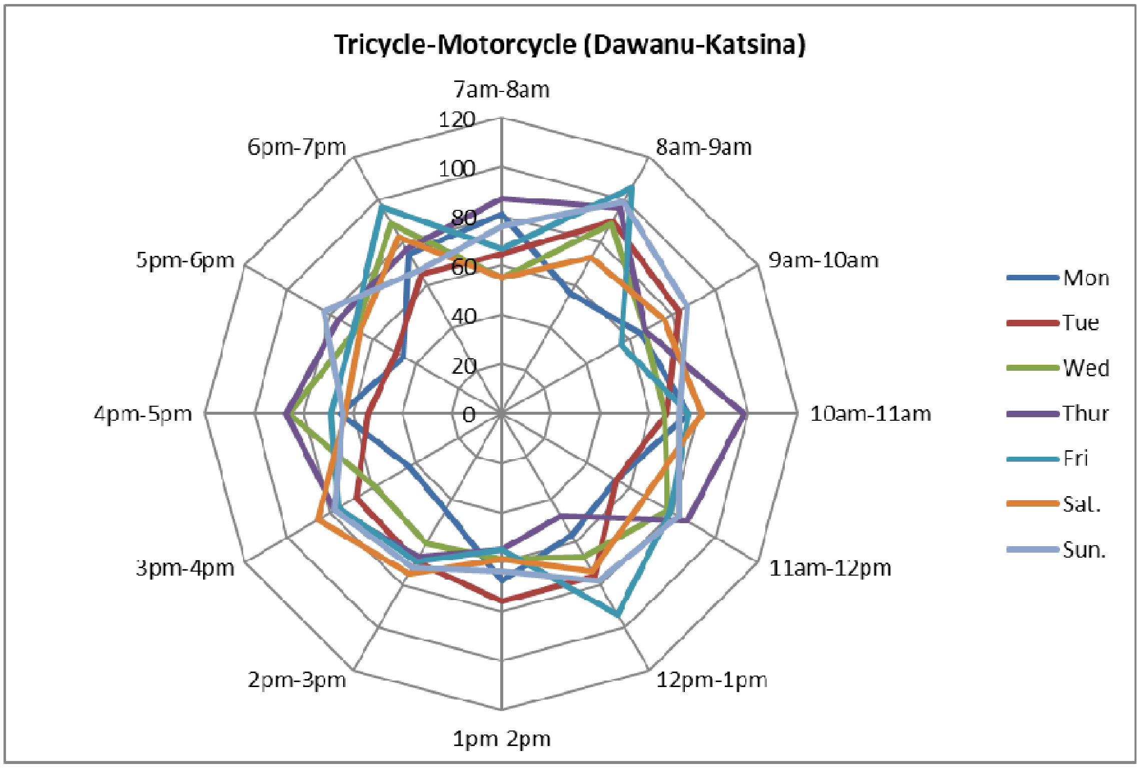


Figure 4. 96: Tricycle traffic flow at Dawanu

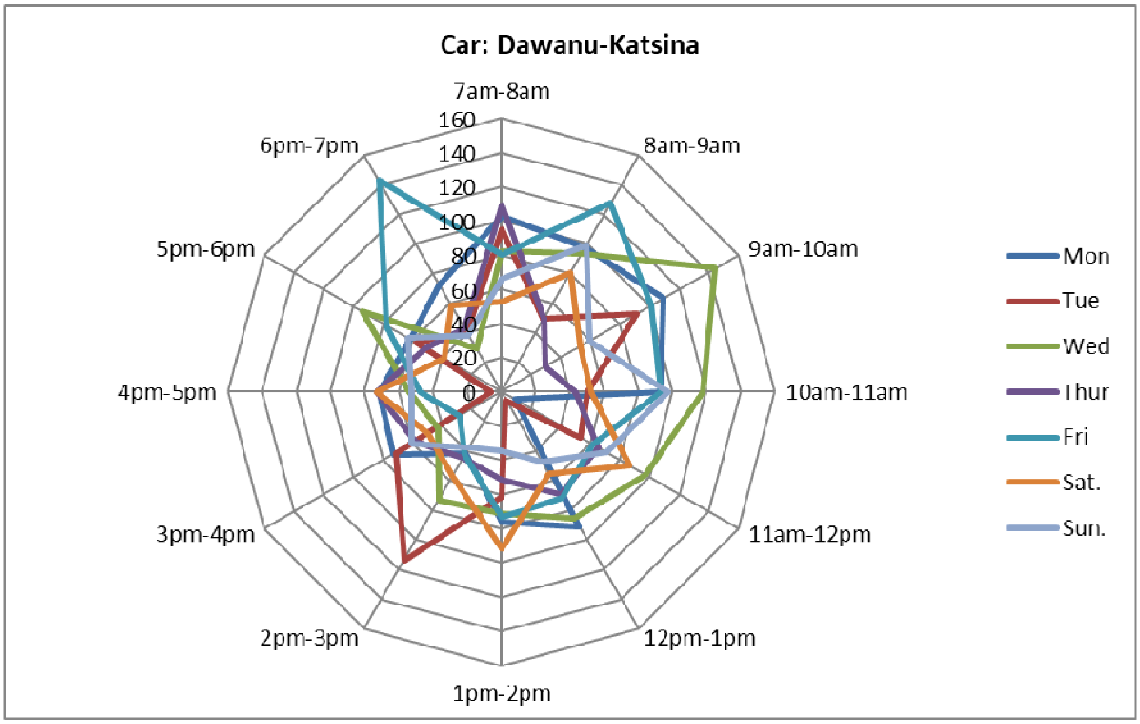


Figure 4. 97: Car traffic flow at Dawanu

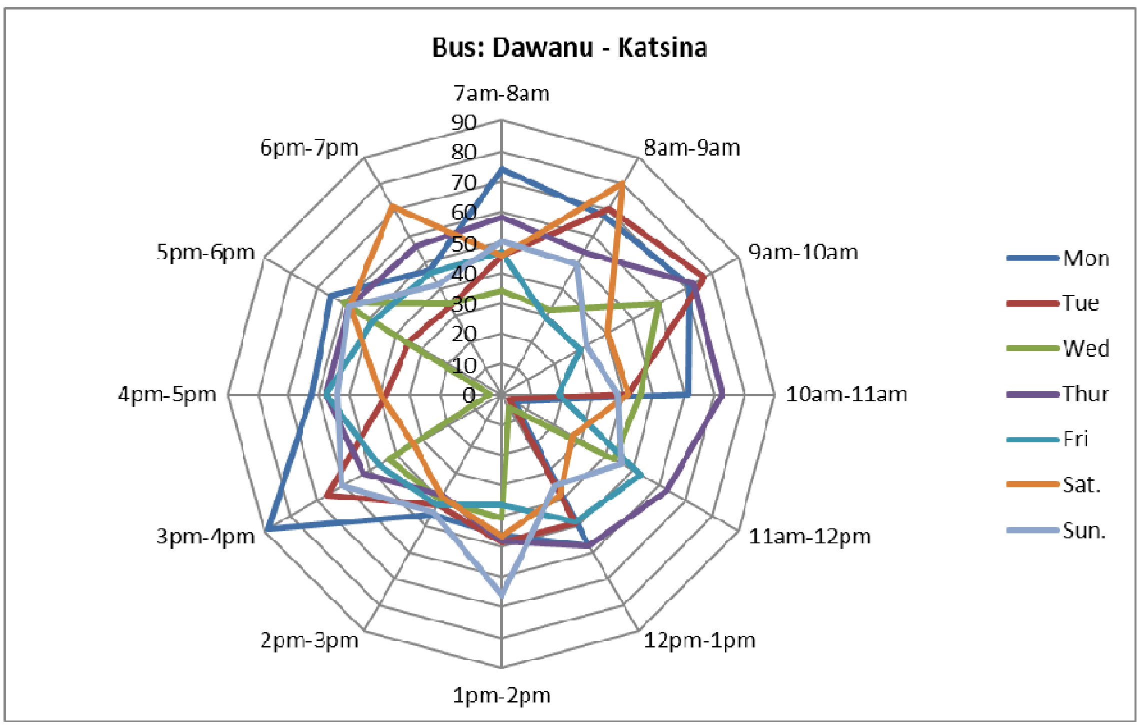


Figure 4. 98: Bus traffic flow at Dawanu

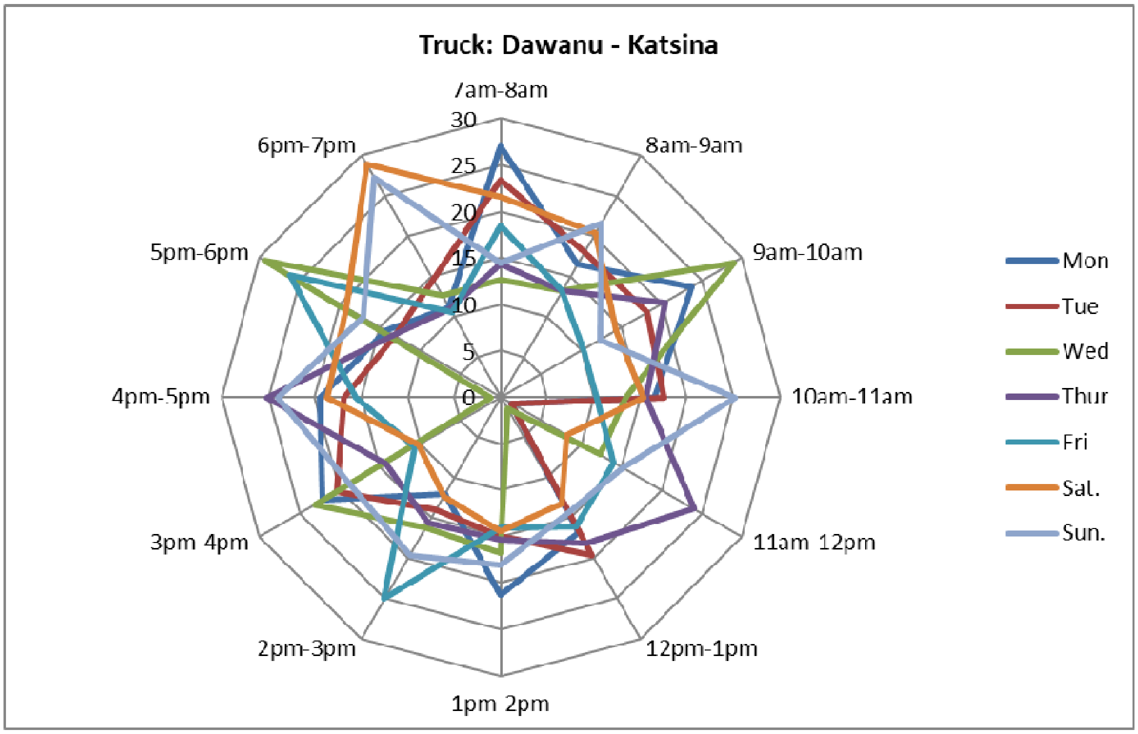


Figure 4. 99: Truck traffic flow at Dawanu

The most frequently used means of transportation were tricycles and motorcycle while truck had the least frequency.

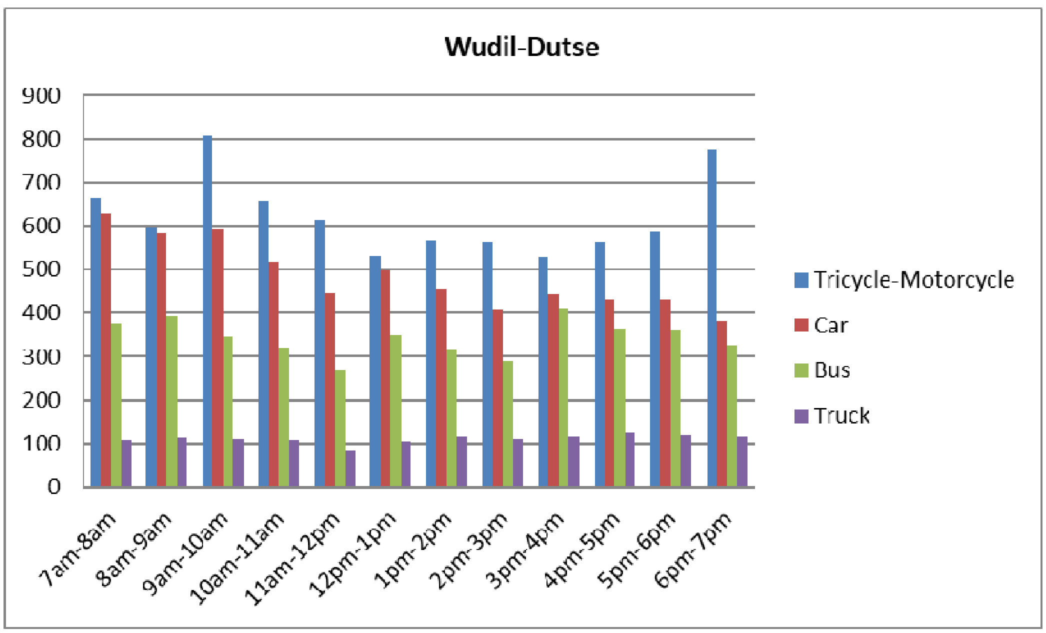


Figure 4. 100: Daily traffic flow pattern at Wudil – Dutse Road

4.3.8 Ecosystem Services Assessment

The concept of ecosystem services has been developed to explain the benefits that natural ecosystems provide for its immediate human communities. Ecosystem services are typically classified into one of the following four categories:

- Provisioning services— the goods or products obtained from ecosystems, such as food, fibres, fuel (e.g. wood, biomass), timber, medicine, and freshwater.
- Regulating services— the benefits obtained from an ecosystem's regulation or control of natural processes, such as pollination, climate regulation, disease control, erosion prevention, water purification and flow regulation, and protection from natural hazards.
- Cultural services— the non-material benefits obtained from ecosystems, such as recreation, aesthetic enjoyment, sacred sites and sense of place.
- Supporting services— the natural processes required to maintain all other ecosystem services, such as soil formation, nutrient cycling and primary production.

Ecosystem types in the project area were observed and classified accordingly in the relevant sections especially on biodiversity studies. They include largely tropical grassland, shrub land and waterbodies.

Tropical grassland: The tropical grassland, otherwise known as savannah ecosystem (in contrast with forest ecosystem, in which trees predominante in number over other life forms), have grasses as the most numerous plants, with trees and shrubs present in quantities which vary with the type of savanna vegetation. The woody species when present, are usually few in terms of the number of species. They are generally scattered among grasses, which together with the numerous species of shrubs, constitute the herbaceous plants of the ground stratum in the savanna. The grasses are mostly perennial grasses and they occur in bunches and tuffs. This is an adaptation against fire because when the grass is burnt, the inner culms are not affected. They begin regeneration when the rainy season begins again. The savanna vegetation is not uniform, the variation in rainfall determines the nature of the savanna.

Grazing animals exert pressure on the savannah ecosystem, and this is capable of altering the balance between woody plants and grasses in a savanna—in either direction, depending on their feeding habits. Grass-eating animals may overgraze and push the grass component of the vegetation toward local extinction. However, high population of these animals cannot eliminate woody plant species, whose upper branches are out of their reach. Subsequent regeneration favours the woody plants, which will become denser and shift the profile of the vegetation from savanna to forest.

Shrubland: Another ecosystem type observed along the rail project corridor is the shrubland, otherwise known as scrubland or brush. It is a plant community dominated by shrubs, often also including grasses, herbs and geophytes. Shrubland may either occur naturally or be the result of anthropogenic activities. It is predominant in some parts of the area and largely a transitional community that occurs temporarily as a result of a disturbance, such as fire.

Water Resources: The project area is located on two main hydrographic basins: the first one is the Sokoto river basin and the Hadejia river basin. The railway line also crosses the subbasins of the Rivers Jakara, Thomas, Gari, Tuwari, Sabke, Jaruka, Havsani and Gada. These are important sources of freshwater for domestic and irrigation pruposes. Fishing is also commonly practiced in communities and settlements along the river banks. The water bodies also serve recreational purposes including swimming, nature watch, sports etc.

Assessment of the ecosystem services in the project area focused on three key ecosystem services, namely:

- Provisioning Services
- Regulating Services
- Cultural Services

4.3.8.1 Provisioning Services

The ecosystems in the project area provide a wide range of provisioning services to the residents. Some of the provisioning services are listed below.

- The predominant benefits derived from the ecosystems in the project area is extensive food production. The wetlands along the River Hadejia, for example, supports livelihood activities and a wide range of biodiversity. Due to the vulnerability of the project area to drought and prolonged dry season, wetlands are used for agricultural purposes (usually for cultivation of rice, sorghum and other cereals); as source of water for livestock and human consumption. In addition, most of the surface water bodies serve as source of domestic water for residents of the project area.
- The pastoralists also depend on available forage, which grow naturally in the project area as sources of food for their livestock. This is prominent in Shuwarin – Wudil axis, as well as Danbatta, Daura and Kazaure axes of the project area.
- An equally common benefit the residents of the project area derive from the natural ecosystem is fuelwood, extensively used as source of fuel for cooking; especially in the rural communities of the project area.
- Additionally, many plant species identified in the project area are used for medicinal purposes by the people.
- The people also depend on varied ecosystem including rocky terrains and river bodies for sand, gravel and other building materials.
- It is equally noteworthy that fishing is a common practice that provides significant source of protein for residents in some of the communities around the rivers and dams along the project corridor.

4.3.8.2 *Regulating Services*

The regulating services are significantly disrupted due to extensive farming and grazing activities, which makes the project area susceptible to erosion and drought. Regulating services are mostly guaranteed by forest reserves in the project area and very few uncultivated lands which serve as control against natural disaster such as flood or drought. Bees, which are good pollinators, are commonly captured and kept for honey production in the project area; and baobab trees are mostly used for this purpose.

4.3.8.3 Cultural Services

The different ecotypes within the project area provide diverse cultural services including recreation such as swimming in the rivers, nature watch, burial grounds and sense of belonging. The potential impacts of the implementation of this railway project on the identified ecosystem services will be evaluated in subsequent chapter with the overall objective of minimising or eliminating such impacts.

Plate 4. 15: Food production is a predominant ecosystem benefit derived from the project area

Plate 4. 16: Irrigation farming is widespread along the Hadejia River bank

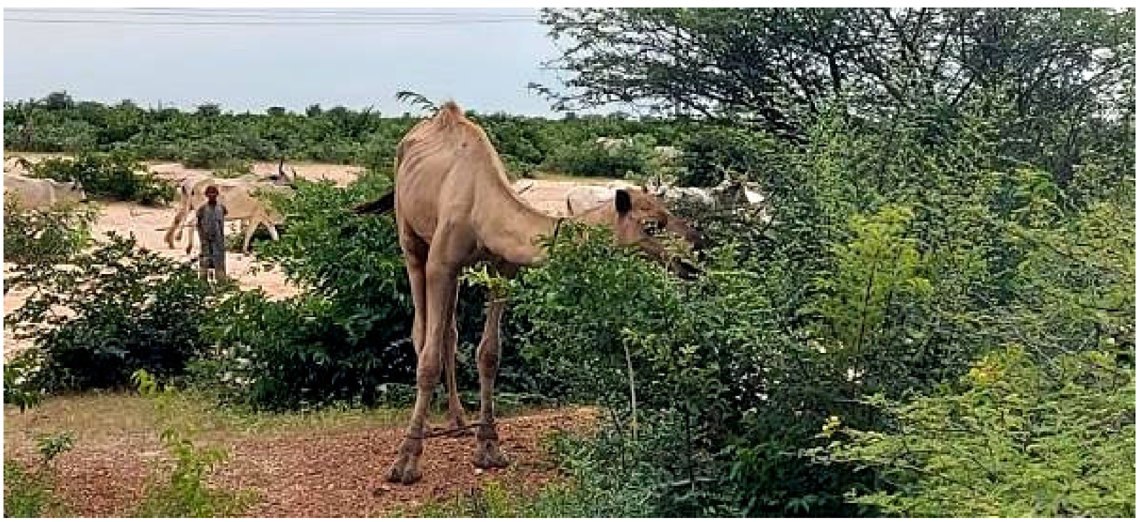


Plate 4. 17: A young pastoralist with herd of cattle and camel grazing in Daura area

Plate 4. 18: Most rivers in the project area serve as source of water for cattle and domestic purposes

Plate 4. 19: Firewood collected from forest in the project area

4.3.9 Climate Change Assessment

4.3.9.1 Introduction

Climate change affects various human and natural systems and poses a serious challenge to economic development and ecosystem sustainability. Adverse effects, as well as, potential benefits, should therefore be considered in decision making about proposed developmental projects, policies, plans and programmes. Addressing risks and opportunities is essential for taking decisions that will remain robust under future conditions, when many climate change impacts are expected to become even more significant. It is important to consider climate change in the development of railway projects. High temperatures may cause rail tracks to expand and buckle, while frequent and severe heat waves may require track repairs or speed restrictions to avoid derailments. It will also affect the design and operation conditions of the cabins. Heavy precipitation could also lead to delays and disruption, and tropical storms and cyclones can also flood or leave debris on railways, disrupting rail travel. Damages from flooding may require rail lines to be rebuilt or tracks raised in line with projected weather conditions.

4.3.9.2 National Policy on Climate Change

Nigeria signed the Paris Agreement in September 2016 and ratified it in March 2017, and therefore committed to reducing its GHG emissions. In its Nationally Determined Contribution (NDC), the country pledged an unconditional 20% reduction on Business as Usual (BAU) emissions by 2030, and a 45% conditional commitment which could be achieved with financial assistance, technology transfer and capacity building. This shows a strong national commitment to be part of the international effort to achieve the long-term temperature goal set by the Paris Agreement of "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels. Leveraging its NDC, Nigeria is integrating into its national development agenda, a transition to a low-carbon development pathway because of the tremendous benefits it holds for sustainable national development.

The vision of Nigeria's policy on Climate Change Policy, is low-carbon, climate-resilient Nigeria, and a mission of ensuring sustainable development and a climate proofed economy through multi-stakeholder engagement. The goal of the policy is to promote a low-carbon, climate-resilient and gender-responsive sustainable socio-economic development, which is expected to:

i. reduce Nigeria's vulnerability to climate change impacts,
ii. prove its social, economic, and ecological resilience.
iii. reduce greenhouse gas emissions,

iv. increased awareness of climate change impacts and adaptation and mitigation measures,

v. enhance and strengthen research, innovation and technology development and transfer and systematic observations,

vi. enhance capacity to implement climate change related interventions at national, state and community levels, and

vii. mainstream climate change and its cross-cutting issues in national development.

A major objective of the goal of Nigeria's Climate Change Policy is the implementation of adaptation and mitigation measures with co-benefits and SDG focused outcomes that promote low-carbon development in the country and reduce the vulnerability of Nigerians to the impacts of climate change.

4.3.9.3 Methodology

Desk reviews: Climate change studies are ongoing exercises being undertaken by various research institutes, governments, as well as nongovernment bodies. Desk reviews draw attention to many of the issues in vulnerability assessment and adaptation related to transport infrastructure where others have already explored those questions.

Consultations with stakeholders and experts: Broad-based representative consultation help ensure a wide range of perspectives on climate change and vulnerabilities. The key stakeholders usually possess first-hand knowledge about the extent to which climate stressors affect or can affect the project. Experts can provide substantive information on the identification and analysis of vulnerabilities while engineers will be able to provide information or analysis related to sensitivity, including design and construction standards relevant to climate impacts and adaptive capacity information.

Thinkhazard: A general perspective of natural hazards and risks in project area are derived from a web-based tool, ThinkHazard. ThinkHazard is a simple and quick yet robust analytical tool that enables development specialists to determine for a given project location the potential likelihood of 11 natural hazards, and what actions they should take to make their project resilient. The tool analyses hazard under current climate conditions and also provides guidance from IPCC on how climate change may alter hazard frequency and intensity into the future.

4.3.9.4 Climatic Conditions in Project Area

Nigeria's climate is very variable across the country, being tropical and humid in the south and semi-arid in the north, essentially when some areas of the North are already part of the Sahara Desert. Therefore, the precipitation varies from 1500-4000 mm per year in the south, to 500-1000 mm in the extreme north. The new railway will be located in the north and it goes through two main cities which are Kano and Katsina. In these cities, the total annual precipitation for the period of 1990-2020 ranged between 506-1872 mm and 259.8-1389.1 mm respectively. Moreover, the climate is marked with high humidity and two differentiated seasons: wet and dry. The first one, goes from May to September, and the latter from October until April. Finally, given that the study area is part of the desert, temperatures are very high during the day (33.8°C on average in Katsina and 33.4°C on average in Kano) and colder during the night (19°C on average in Katsina and 20.3°C on average in Kano). Therefore, in the colder months, there can be differences of temperature along the day up to 16.3°C in Kano and 18.6°C in Katsina (See more detailed description of Climatic Conditions in Project area in appropriate section above).

4.3.9.5 Climate Change Influence

Although the subject of Climate Change is not consensual it is now widespread the idea that we are witnessing a climate change with a faster pace than the occurred till the 20th century. The projected Climate Changes (from Hulme et al., 2001 cited by Mota-Engil Africa, Preliminary Design Report, 2021) for Africa are:

- Warming ranges from 0.2˚C to 0.5˚C per decade;
- 5-20% increase in precipitation from December-February (wet months);
- 5-10% decreased in precipitation from June-August (dry months).

According to deK4D - Knowledge, evidence and learning for development – Climate change in Nigeria: impacts and responses, in Nigeria there is evidence of the impacts of climate change arising from:

- Increases in temperature;
- variable rainfall (decreasing rainfall amount in the continental interiors, increasing rainfall in the coastal areas);
- sea level rise, flooding, and erosion;
- drought and increasing desertification;
- land degradation;
- extreme weather events (thunderstorms, lightning, landslides, floods, droughts, bush fires); and
- affected freshwater resources and loss of biodiversity.

In "National adaptation strategy and plan of action on climate change for Nigeria – BNRCC -2011", "The projected changes in rainfall vary across the country, with the A2 scenario suggesting a wetter climate in the south, but a drier climate in the northeast. For the 2046- 2065 period the projected change ranges from an average increase of 15 cm annually in the south to an average decrease of 7.5 cm annually in the north. Although projected annual rainfall increases in some parts of the country and decreases in others, all areas show increases in rainfall during at least some part of the years." In fact, in the region where the railway will be located, short grass savanna, is likely to be indicative of an increase of extreme rainfall events – storm and floods. Following the referred studies and projections it is possible to conclude that there is a significant probability of some increase on the rainfall between 5% and 20% for the rainy months in the project area.

4.3.9.6 *Likelihood of Natural Hazards*

For the project area, the likelihood of natural hazards such as River flood, water scarcity, extreme heat, wildfire and urban flood is identified with risk levels categorized as high in the project affected States with exception of Urban Flood risk being categorised to be of Medium Risk. The images shown in Figure 4. 101, Figure 4. 102, and Figure 4. 103 are reproduced from the ThinkHazard webpage for the Project Affected States (Kano, Katsina and Jigawa) (https://thinkhazard.org/en/report/2223-nigeria).

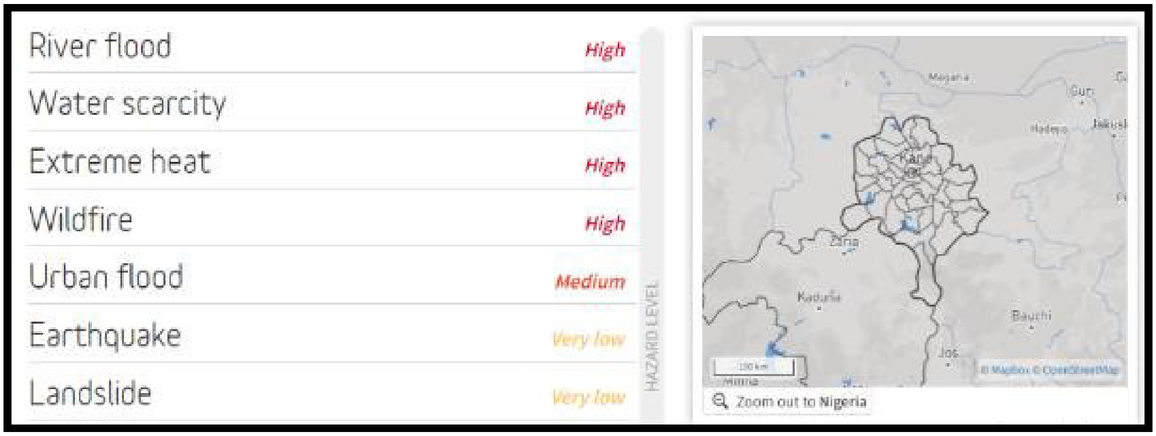


Figure 4. 101: Likelihood of Natural Hazard in the Project Area (Kano)

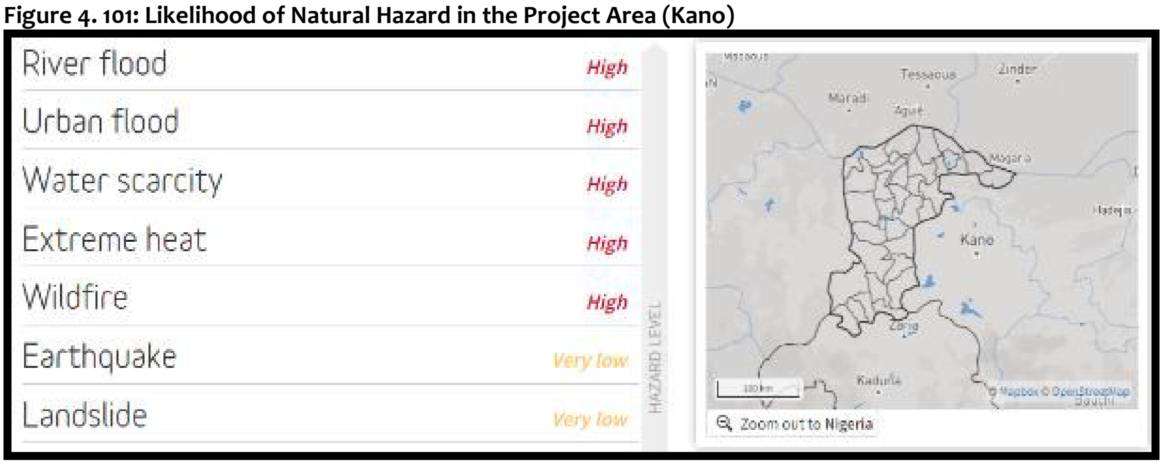


Figure 4. 102: Likelihood of Natural Hazard in the Project Area (Katsina)

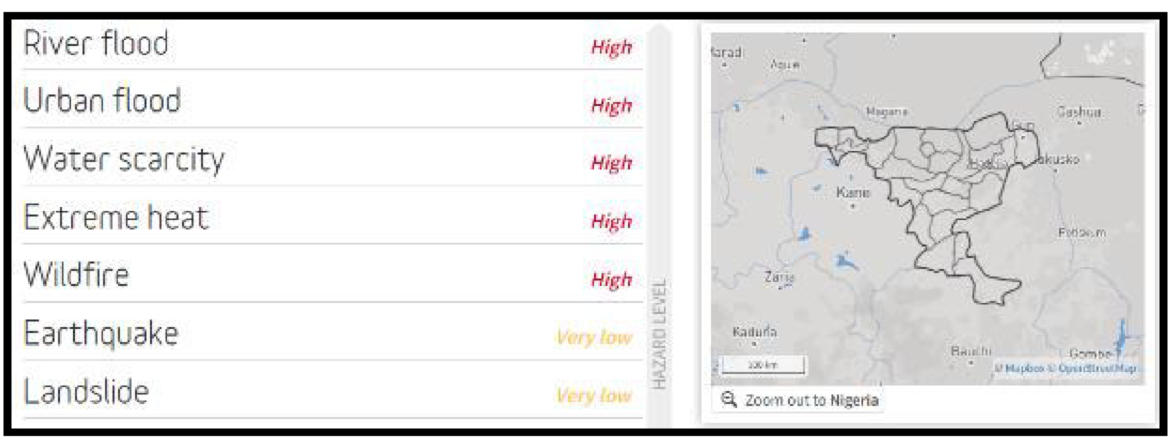


Figure 4. 103: Likelihood of Natural Hazard in the Project Area (Jigawa)

Urban Flood

In the project area, urban flood hazard is classified as medium to high based on modelled flood information currently available. This implies that potentially damaging and life-threatening urban floods are expected to occur at least once in the next 10 years. Project planning decisions, project design, and construction methods must therefore consider the level of urban flood hazard.

Wildfire

In the project area, the wildfire hazard is classified as high. This implies that there is greater than a 50% chance of encountering weather that could support a significant wildfire that is likely to result in both life and property loss in any given year. Based on this information, the impact of wildfire must be considered in all phases of the project, in particular during design and construction. Project planning decisions, project design, construction and emergency response planning methods should consider the high level of wildfire hazard. It is also important to note that damage can not only occur due to direct flame and radiation exposure but may also include ember storm and low-level surface fire. In extreme fire weather events, strong winds and wind born debris may weaken the integrity of infrastructure. It would be prudent to consider this effect in the design and construction phase of the project.

Water Scarcity

In the project area, water scarcity hazard is classified as high. This means that droughts are expected to occur on average every 5 years. Based on this information, the impact of drought must be considered in all phases of the project, in particular its effect on personnel and stakeholders, and during the design of buildings and infrastructure. Project planning decisions, project design, and construction methods must consider the level of water scarcity.

River Flood

In the project area, river flood hazard is classified as high based on modelled flood information. This means that potentially damaging and life-threatening river floods are expected to occur at least once in the next 10 years. Project planning decisions, project design, and construction methods must take into account the level of river flood hazard.

Extreme Heat

In the project area, extreme heat hazard is classified as high. This implies that prolonged exposure to extreme heat, resulting in heat stress, is expected to occur at least once in the next five years. Project planning decisions, project design, and construction methods must take into account the level of extreme hazard. According to the most recent assessment report of the Intergovernmental Panel on Climate Change (IPCC, 2013), continued emissions of greenhouse gases will cause further warming, and it is virtually certain that there will be more frequent hot temperature extremes over most land areas during the next fifty years. Warming will not be regionally uniform. In the project area being Semi-Arid in nature and part of the Sahara Desert, the temperature increase in the next fifty years may be slightly lower than the worldwide average, but still significant. It would be prudent to design projects in this area to be robust to global warming in the long-term.

4.3.9.7 Exposure, Sensitivity and Risk Appraisal

Two major types of climate-related risks to surface transport infrastructure, be it rail or road, are those driven by long-term changes in temperature and precipitation. The impacts driven by changing weather conditions possess the potential to accelerate deterioration, severe damages and risks, traffic interruption, and accidents, which eventually can disrupt economic activities.

Climate vulnerability has been traditionally understood in terms of a relationship between exposure, sensitivity, and adaptive capacity. Climate change vulnerability levels are influenced by variables such as geographic location, the local environment, and the ability of assets owner to both respond to events and adapt their assets in advance.

Due to direct exposure to forces of nature, rail infrastructures and operations are vulnerable to many different types of weather conditions. These forces of nature are highly likely to be exacerbated under climate change. Some of the effects of climate change on rail infrastructures/assets are outlined below:

- Rise in air temperature and temperature extremes can accelerate buckling of rail tracks.
- Rise in temperature extremes impacts on concrete construction practices, including thermal expansion affecting rail bridge and elevated viaduct expansion joints.
- Changes in rainfall, temperature, and evaporation patterns can alter the moisture balances in rail track bed foundations and formations.
- Rise in the water table can lead to the reduction of the structural strength of the formations, leading to damages to earthworks, embankments, and drainage systems.
- Precipitation increase and increase in intense precipitation events can cause overloading of drainage systems, causing backups, flooding, and track formation washouts.
- Changes in seasonal precipitation and river flow patterns induce increased risk of floods from runoff, landslides, slope failures, and damage to rail track formation and bridges.
- Storms and more frequent extreme weather conditions can bring about increased flooding, greater probability of infrastructure failures, erosion of rail track foundation and bridge supports, bridge scour, reduced clearance under bridges, wind damage to roofs of stations, lighting, overhead cables, rail signals, and other tall structures.

These potential effects call for careful consideration of rail design, construction, and maintenance to achieve lasting benefits of the project as presented in subsequent relevant sections of this ESIA report.

4.3.9.8 Adaptation Measures

Most of the existing guidelines for Climate Proofing Investment in the Transport Sector are generally grouped into engineering (structural) options and non-engineering options as shown in Figure 4. 104.

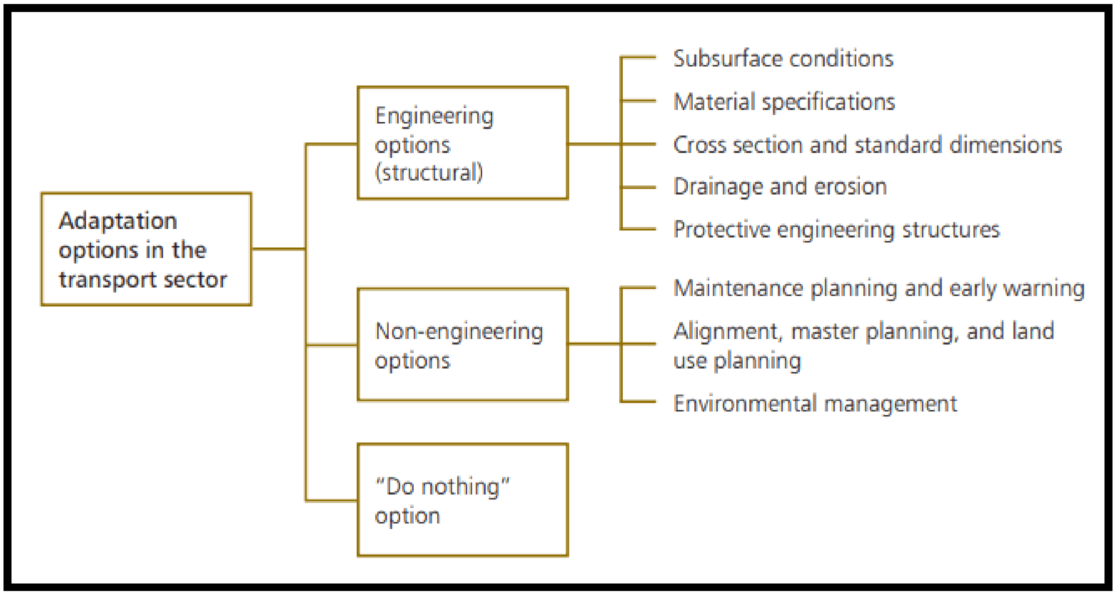


Figure 4. 104: Nature of Adaptation Options in the Transport Sector
Source: Asian Development Bank. Guidelines for Climate Proofing Investment in the Transport Sector. 2014

Adaptation options from the structural point of view look at design standards of vital project components that may be compromised by climate change, which include (i) subsurface materials, composition, stability, and strengths; (ii) material specifications in terms of physical properties and behaviour under environmental severity; (iii) cross-sections and dimensions of project elements; (iv) drainage and erosion considerations responsive to changes in future rainfall and runoffs or floods; and (v) other protective engineering structures (ADB, 2014).

Non-engineering options of climate change adaptation for the project looks at various processes of adjusting to changing climate and its cascading impacts, which include (i) maintenance planning and early warning, (ii) master planning including land use planning, and (iii) environmental management plan.

The Social and Environmental Management Plan (SEMP) for this project will address the effects of project activities on the immediate environment and environmental quality issues and recommends risk mitigation or adaptation measures to be considered at the project design and construction phases. These are properly documented in relevant chapter of this ESIA report.

4.3.10 Geology and Geotechnical Studies

4.3.10.1 Regional Geology

Geologically, the study area forms part of the basement complex of Northern Nigeria; with lithology under three main categories which include undifferentiated migmatite complex of Proterozoic to Archean origin, metavolcanic-sedimentary rocks of Late Proterozoic age, and older granite complex of late Precambrian – Lower Palaeozoic age, also known as pan-African granite. All these rocks have been affected and deformed by the pan-African thermometric event. The rock is generally weathered into reddish micaceous sandy clay to clay materials (Figure 4. 105).

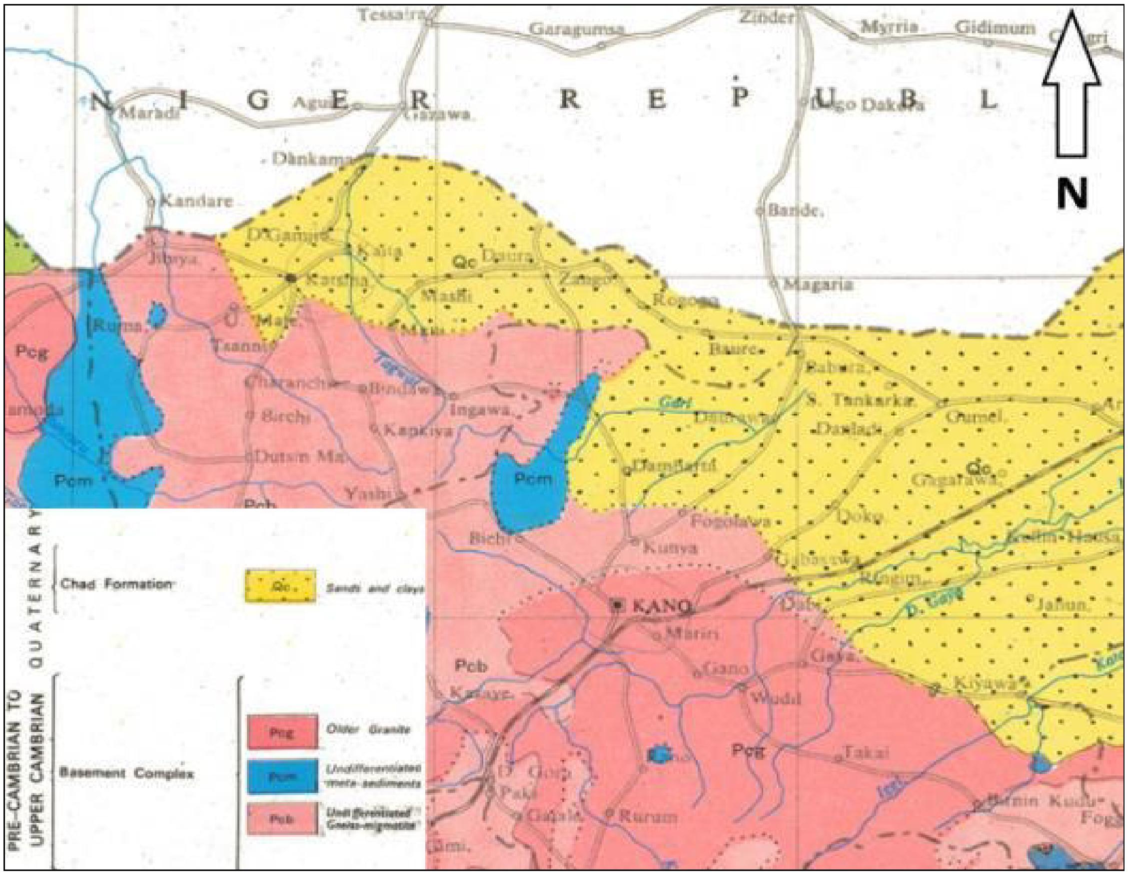


Figure 4. 105: Extract of the geological map of Nigeria, published in 1984 by the Nigeria Geological Survey
(Source: Preliminary Design Report, Mota-Engil Africa, 2021)

The project area is underlain by rocks and younger sediments of the Chad Formation, which are of the Quaternary age. Much of the ground is covered by superficial deposits of fine sand, which have been swept into a series of low dunes. The Chad sediments are concealed by sand dunes and the sandy beds are formed over the impervious clays of the Chad Formation and the main source of water in the dry season.

The clays and sands of the Chad Formation consist of well-bedded and compacted materials, which have been tested to have a load-bearing capacity of 3-5kg/sq cm; this gives the area good stability. In the area surrounding the town, three main groups of soils are found:

- Ferruginous tropical soils on sandy material of hydromorphic material
- Ferruginous tropical soils on sandy material and sandy dunes.
- Ferruginous tropical soils on sandy material/undifferentiated

The soils are comparatively recent in origin. They are generally sandy at the top, compact at depth with often hardpans. Aeolian deposits from the Sahara Desert form a substantial part of the soils. The mixing of the subsoil in these deposits has given rise to the clayey subsoil, which dominates the area.

The area is a vast open plain developed on young sedimentary rocks of the Chad Formation, which mainly consists of clays with some sand horizons and gravels. Clay is, therefore, the dominant soil, which is dark in most of the area as a result of an accumulation of organic matter. The clays become plastic where exposed on the surface and saturated with water during the rainy season. The dark clay of the area dries up in the dry season, giving rise to a hard and brittle surface with numerous cracks (mud cracks). In the usually flooded floors of the river valley, heavier soils with high clay content occur. The soil in the region mainly consists of sandy and silty soil in the upland areas and loamy-sands in the depressions.

The geology and geotechnical characteristics of the Nigeria railway line Kano-Maradi and Kano-Dutse are well documented in the preliminary design report by Mota-Engil Africa (2021). This report characterized the project area geologically and geotechnically based on the results obtained in the preliminary geological-geotechnical survey.

4.3.10.2 Geomorphology

The railway alignment cuts across varying terrain of fairly level to a gentle sloppy terrain. There are sections with a fairly sloppy topography. Some few locations lie within built-up areas and roads, where the natural topography must have been altered during construction activities. But the generalized topography is of a rolling terrain of fairly level to a gentle slope, with some cases of a fairly sloppy terrain.

Along the project corridor, Dutse (which in Hausa language means ‘rock’), is characterized by apparent outcrops of rock formations. These include noticeable irregular piles of huge boulders resulting from highly jointed elements of granite gneiss as well as balanced rocks, also referred to as precarious boulders (which are naturally occurring geological formations featuring a large rock or boulder, sometimes of substantial size, resting on other rocks or bedrock). The Dutse Hills are a major part of the larger granite chain of the southern part of Jigawa State. The mountains and their surroundings are covered in scattered rock pieces and comprise spectacular inselbergs, balanced rocks and other related features (Plate 4. 20).

Plate 4. 20: Outcrop of rock formations in Dutse, Jigawa State

4.3.10.3 Topography

The railway alignment cuts across mainly a varying terrain of fairly level to a gentle sloppy terrain, there are sections with a fairly sloppy topography. Some few locations lie within built up area and roads, where the natural topography must have been altered during construction activities. But the generalized topography is of a rolling terrain of fairly level to a gentle slope, with some cases of a fairly slopy terrain. The alignment in most cases runs through farm land and plain area, passing through small settlement and villages in some area and running parallel with road in few locations. The starting point is from the built-up environment of Kano metropolis.

4.3.10.4 *Geotechnical Survey and Laboratory Tests*

A geotechnical investigation of the project corridor was carried out prior to the ESIA study. Trial pits were excavated at designated locations along the railway alignment to a maximum depth of 3 metres. This was done to examine and visualize the subgrade strata along the route and obtain bulk samples for analysis. Other geotechnical investigations carried out include the standard penetration test (STP), soil deformation test, compaction tests, soil classification test. A comprehensive geotechnical report, *"Geotechnical Investigation Report for the Proposed Kano - Maradi - Dutse Railway Line Project (September, 2021)"* was prepared by Liscon Geotechnical Limited and submitted to Mota Engil and the Federal Ministry of Transportation.

Plate 4. 21: Rotary drilling and rock coring process during geotechnical survey
(*Source: Liscon Geotechnical Limited, 2021*)

Plate 4. 22: Some of the trial pits excavated during geotechnical study
Source: Liscon Geotechnical Limited (2021)

4.3.10.5 *Summary of Geotechnical Findings*

Kano – Daura - Maradi Section

The overburden formation between Kano and Maradi consists of silty sand, clayey sand, concretionary laterite, sandy clayey gravel, silty clay, sandy clay, gravelly sand, fine to coarse sand and gravelly clayey sand. These are further underlain by weathered and fresh basement rock which were confirmed in the boring locations. Based on the outcome of preliminary geotechnical studies and the different subsoil strata encountered from the boreholes and trial pits, the subsurface profile within Kano – Daura section of the alignment consists of stable soil strata in most locations as they were observed not to be readily collapsing in all locations as the excavated side walls are stable without support. Thicker zones of topsoil and organics and agricultural biowaste can be presumed to be present in few locations as a result of farming activities. Previous studies show that the subsoil along the proposed rail route is typically fine to medium grained and consists of layers of silty sand, sandy clays, silty clay, clayey sand, concretionary laterite, sandy clayey gravel, fine, medium to coarse sand and gravelly clayey sand within the various probed depths.

Kano – Dutse Section

The overburden formation along this section of the rail route consists of silty sand, clayey sand, concretionary laterite, sandy clayey gravel, silty clay, sandy clay, gravelly sand and fine to coarse sand. These are further underlain by weathered and fresh basement rock which were confirmed at different points within 0.0 –18.0 m depth and 3.0 m; being the maximum depth. The subsoil observed along the route are typically fine to medium-grained and consists of layers of silty sand, sandy clays, lateritic soils, clayey sand, gravelly sand and fine to medium sand within the shallow depth of excavation at 3.0 m. The overburden soils encountered were found to be underlain by weathered and fresh granitic rock at varying depth of 12.70 to 18.0 m termination depth. The trial pits logging details show the soil profile along the route as discussed below:

Silty Sand**:** Layer of permeable loose silts mixed with fine-medium grained sandy material found to be clayey in some location or occurring with gravels in some locations, as encountered at depths between 0.0 – 4.20 m between Kano and Daura and 0.0 to 3.0 m between Dutse and Kano as well as Daura and Jibiya-Maradi.

Lateritic Soil**:** These are layers of lateritic material in composition of sands and clay with iron stones. The composition varies based on indurations' process which makes some to have more clay and in some cases in concretionary state. It's mainly a composition of sand, silts and consolidated clay of low plasticity and gravels. In most locations within the route, they are found to be concretionary or hard pan form. Between kano and Daura, these are proved within depth of 0.2 to 3.0 m between Dutse and Kano, 0.10 – 3.0m, and found to be pronounced while between Daura and Maradi, these are proved within depth of 0.15 – 3.0 m.

Sand: Layers of fine to medium grained sandy materials, they are found to be coarse grained in some layers and found to be pronounced within the boring locations and the fine to medium sand mixed with silts were observed in some trial pits points. They occur at depth between 0.0 – 3.0 m.

Sandy Clay/Silty Clay: These are usually sandy and silty materials mixed with moderate to low plasticity clay of soft to firm consistence, as observed between 0.0 – 3.0 m between Kano and Jibiya while between Dutse and Kano, it was observed between 0.13 – 3.0 m.

Weathered Rock: Layers of highly weathered rocks were encountered at depth between 10.10 – 13.50 m between kano and Daura and 1.0 to 3.0 m between Daura and Jibiya-Maradi; 12.7 and 18 m between Dutse and Kano.

Fresh Rock: Fine – medium grained fresh granitic rock origin of Felspathic Granite with very high bearing pressure at depth between 13.50 – 16.50 m where rock coring was carried, and these were found to be in sound intact state, underlying the various strata and expected to be discontinuous considering geology of the area.

Sandy Clayey Gravels: This comprises of dense to very dense and mostly greyish to brownish in colour. Composite of sand and clay with gravelly soils, the gravels are of sub angular to sub rounded grains and of a medium to coarse grain, which are observed at depth between 7.0 and 21.0 m.

Clayey Sand: It comprises of layers of medium grained sandy materials mixed with clay of low plasticity and were found to contain silts and gravels in few strata as proved at depth between 0.0 and 3.0 m in trial pits, extending up to depth of 8.80 – 21.0 m at some boring locations. Between Dutse and Kano, layers of medium grained sandy materials mixed with clay of low plasticity were found to contain silts and gravels in few strata as observed at depth between 0.0 and 3.0 m, and it extends up to depth of 7.10 – 10.0 m at boring locations in previous studies. The following figure, Figure 4. 106, presents a distribution, along with the drilled depth, of N_{SPT} obtained in the considered boreholes. The N_{SPT} values were grouped considering the limits of compactness since the occurring soils are predominantly clayey-sandy.

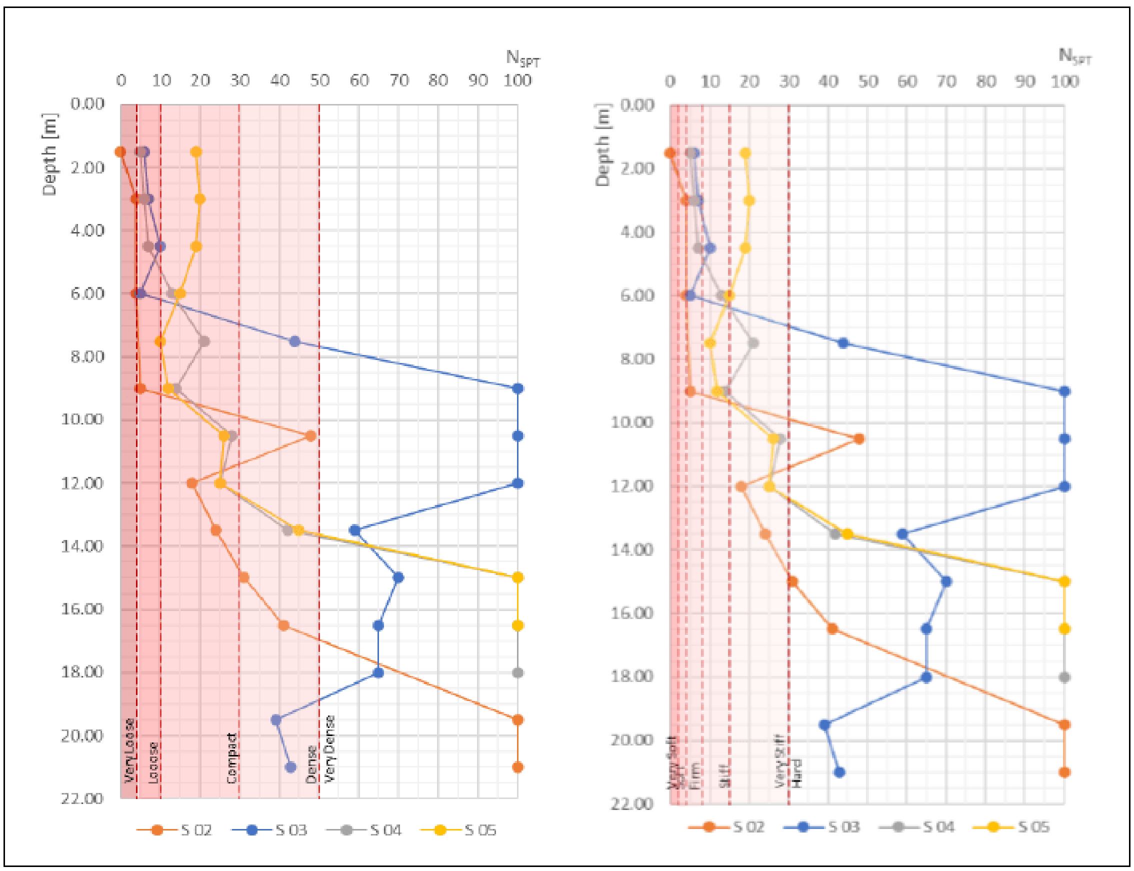


Figure 4. 106: SPT values recorded along the boreholes. Compactness in the left and consistency in the right

Source: Preliminary Design Report, Mota-Engil Africa, 2021)

In the Kano-Maradi section, despite the boreholes S02 and S03 showing different values of N_{SPT}, in Figure 4. 107, it is observed a similar tendency in the terrain's behaviour: a higher N_{SPT} value is obtained between 9.5 m and 10 m, followed by a much lower one between 12 m and 14 m. From 14 m depth on, in the borehole S03 it is obtained ever-decreasing values, unlike as borehole S02 where is registered an increasing values trend. The sandy units identified to follow the mentioned tendency, varying between very loose and very dense. The clayey units identified show a slightly increasing trend, from very soft clay to hard.

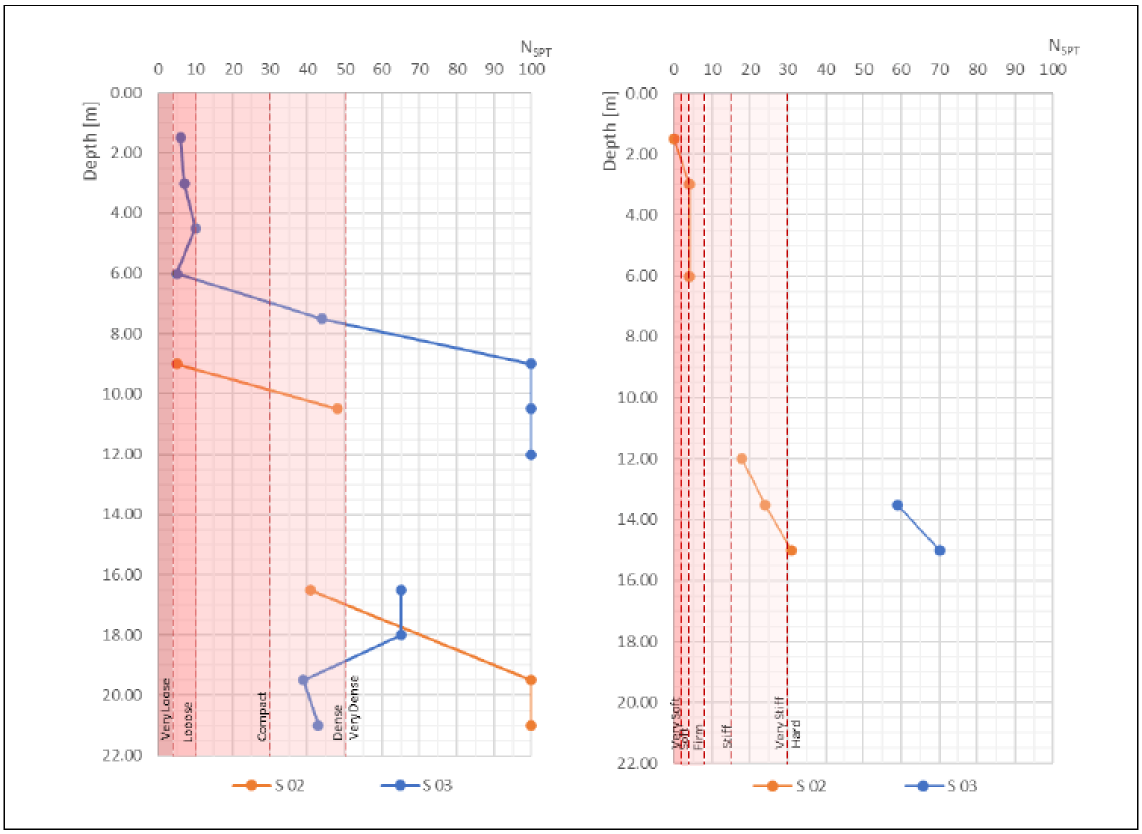


Figure 4. 107: SPT values recorded along the boreholes So₂ and So₃ in the Kano-Maradi section. Compactness in the left and consistency in the right

(Source: Preliminary Design Report, Mota-Engil Africa, 2021)

In the Kano-Dutse section, in Figure 4. 108, a slight discrepancy of values is observed up to 6 m depth, noting very similar N_{SPT} values – refusal at 15 m depth; these show an increasing trend until the end of the surveys. The sandy units identified to follow the mentioned tendency, varying between very loose and very dense. A clayey unit is identified in borehole S04 at 1.50 m depth, relating to very soft clay.

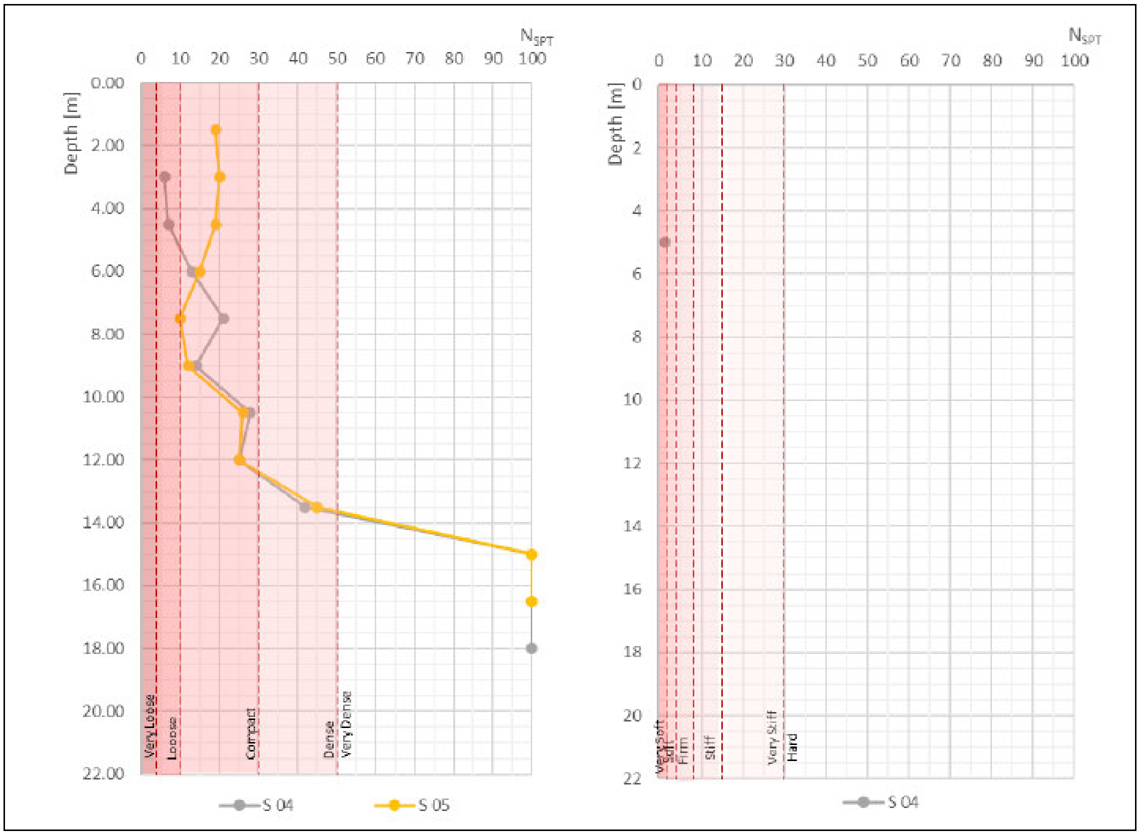


Figure 4. 108: SPT values recorded along the boreholes S04 and S05 in the Kano-Dutse section. Compactness in the left and consistency in the right
(Source: Preliminary Design Report, Mota-Engil Africa, 2021).

4.3.10.6 Characterization of the Geotechnical Units

The summary of the main geotechnical characteristics of the lithological types predominant along the railway line based on the surface geological reconnaissance, through aerial photography, and on the geotechnical surveys and tests (in situ and laboratory) are provided as follow:

Clay Unit (G2c)

The trial pits and boreholes allowed the identification of clay layers of depths up to 3.0 m (in trial pits) and 15.0 m (in boreholes), being described as very soft to hard brownish-grey to greyish brown sandy silty to gravelly sandy clay. The boreholes show N_{SPT} values of 22 blows average. The mentioned mechanical survey allowed the sample collecting and therefore laboratory characterization. Eleven samples were tested, and the following results were obtained:

QSi classification QS1
ASTM classification .... Mostly CL (82%)
AASHTO classification .... Mostly A-6 (73%)
Fines content (#200 ASTM sieve) .... 35.6% to 86.7 (69.3% average)
Liquid limit .... 30% to 47% (37.6% average)
Plasticity index .... 11% to 22% (15.6% average)
Moisture content .... 9% to 43% (21.1% average)
γ_d máx (Proctor Modified) .... $1.7g/cm^3$ to $2.3g/cm^3$ ($1.9g/cm^3$ average)
w_{opt} (Proctor Modified) .... 13.4% to 16.8% (15.1% average)
CBR soaked .... 9% to 22% (16.8% average)
CBR unsoaked .... 37% to 54% (48.3% average)

Figure 4. 109 shows a set of graphs illustrating the distribution of the different soil classifications.

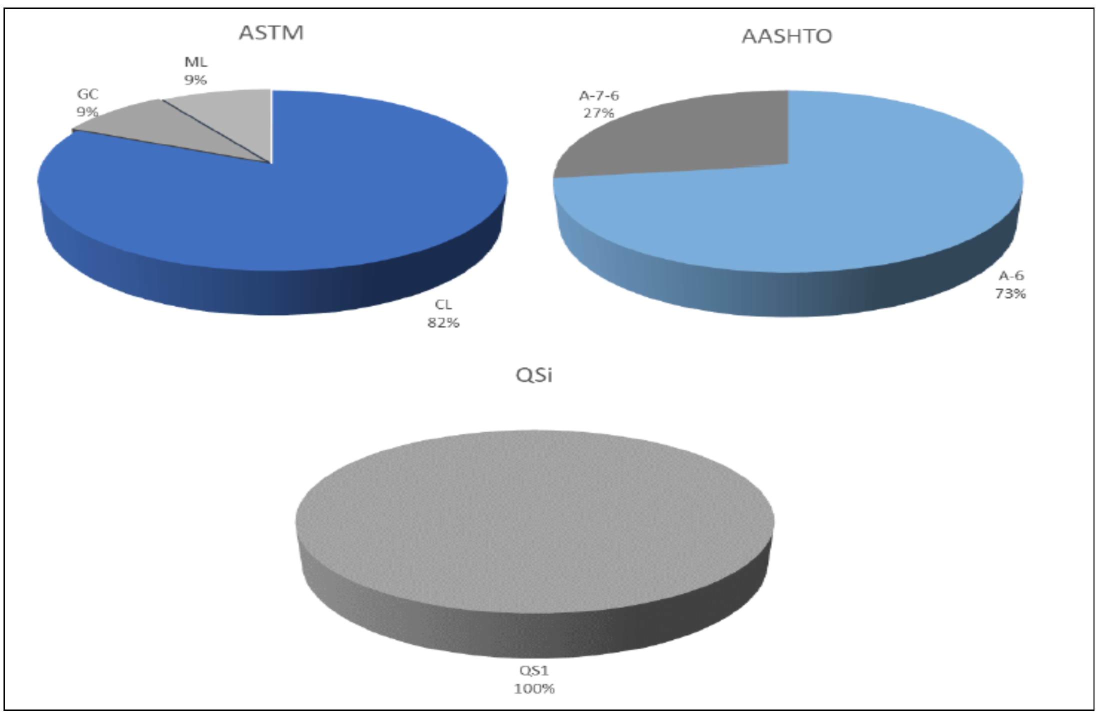


Figure 4. 109: Soil classification systems – Clay unit (G2C)
(Source: Preliminary Design Report, Mota-Engil Africa, 2021)

Sand Unit (G2B)

The trial pits and boreholes allowed the identification of sand layers of depths up to 3.0 m (in trial pits) and 21.0 m (in boreholes), being described as loose to very compact greyish brown, brownish grey to reddish silty, clayey to gravelly sand. The boreholes show N_{SPT} values varying between 5 and 100 blows (27 blows average). The mentioned mechanical survey allowed the sample collecting and therefore laboratory characterization. Fourty-five samples were tested, and the following results were obtained:

QSi classification .... Mostly QS1 (80%)

ASTM classification .... Mostly SC (49%) and SM (22%)

AASHTO classification .... Mostly A-2-4 (42%) and A-4 (31%)

Fines content (#200 ASTM sieve) .... 5.8% to 60.4% (30.4% average)

Liquid limit .... 0% to 48% (11.6% average)

Plasticity index .... 0% to 18% (2.3% average)

Moisture content .... 3% to 42% (11.0% average)

γ_d máx (Proctor Modified) .... 1.7g/cm^3 to 2.1g/cm^3 (1.9g/cm^3 average)

w_{opt} (Proctor Modified) .... 8.6% to 14.3% (11.6% average)

CBR soaked .... 7% to 31% (13.8% average)

CBR unsoaked .... 20% to 80% (43.4% average)

Figure 4. 110 shows a set of graphs illustrating the distribution of the different soil classification system for sand unit.

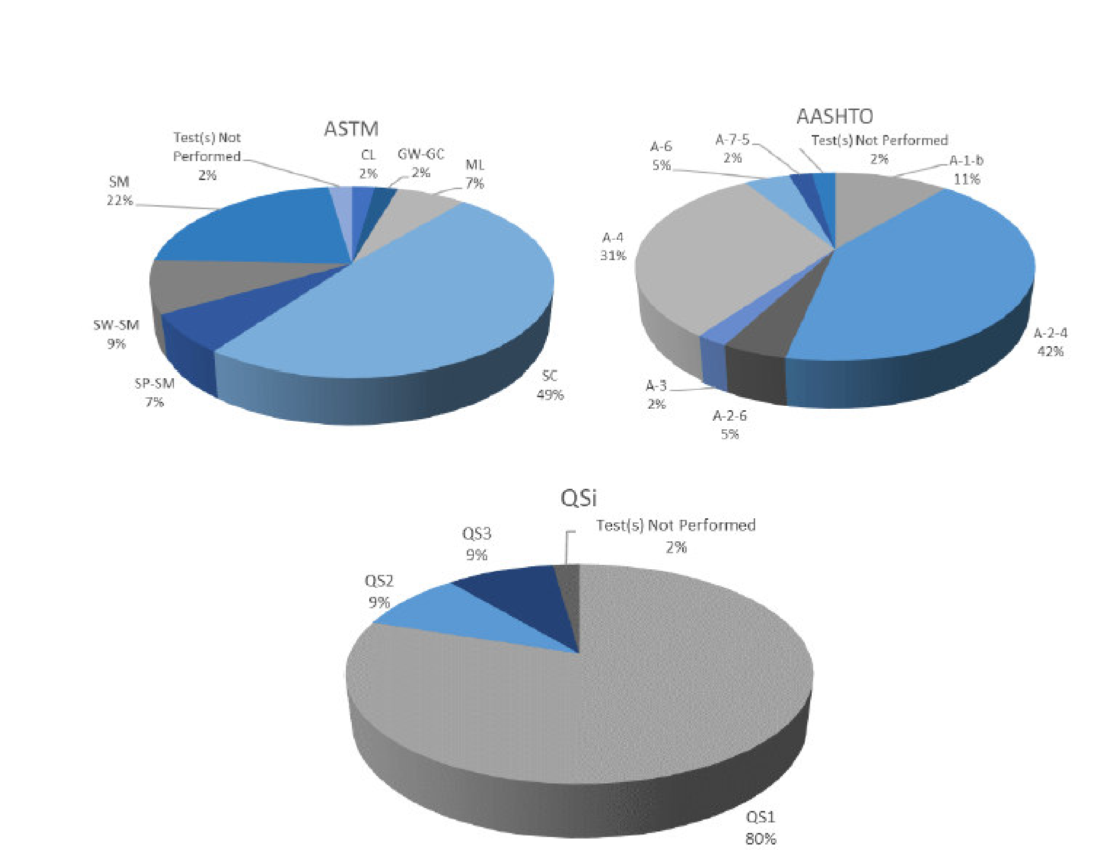


Figure 4. 110: Soil classification systems – Sand unit (G2B)
(Source: Preliminary Design Report, Mota-Engil Africa, 2021)

Gravel Unit (G2A)

The trial pits and boreholes allowed the identification of gravel layers of depths up to 3.0 m (in trial pits) and 18.0 m (in boreholes), being described as compact to very compact greyish brown, brownish grey to reddish-brown clayey sandy gravel. The boreholes show N_{SPT} values varying between 44 and 100 blows (79 blows average). The mentioned mechanical survey allowed the sample collecting and therefore laboratory characterization. Nine samples were tested, and the following results were obtained:

QSi classification .... Mostly QS1 (56%)

ASTM classification .... Mostly SC (45%)

AASHTO classification .... Mostly A-2-6 (45%)

Fines content (#200 ASTM sieve) .... 2.2% to 36.6% (19.5% average)

Liquid limit .... 0% to 38% (21.4% average)

Plasticity index .... 0% to 16% (7.0% average)

Moisture content .... 3% to 15% (10.8% average)

γ_d máx (Proctor Modified) .... 1.9g/cm^3 to 2.2g/cm^3 (2.0g/cm^3 average)

w_{opt} (Proctor Modified) .... 8.5% to 16.0% (11.8% average)

CBR soaked .... 17% to 33% (28.4% average)

CBR unsoaked .... 65% to 84% (76.3% average)

The following figure (Figure 4. 111) shows a set of graphs illustrating the distribution of the different classifications.

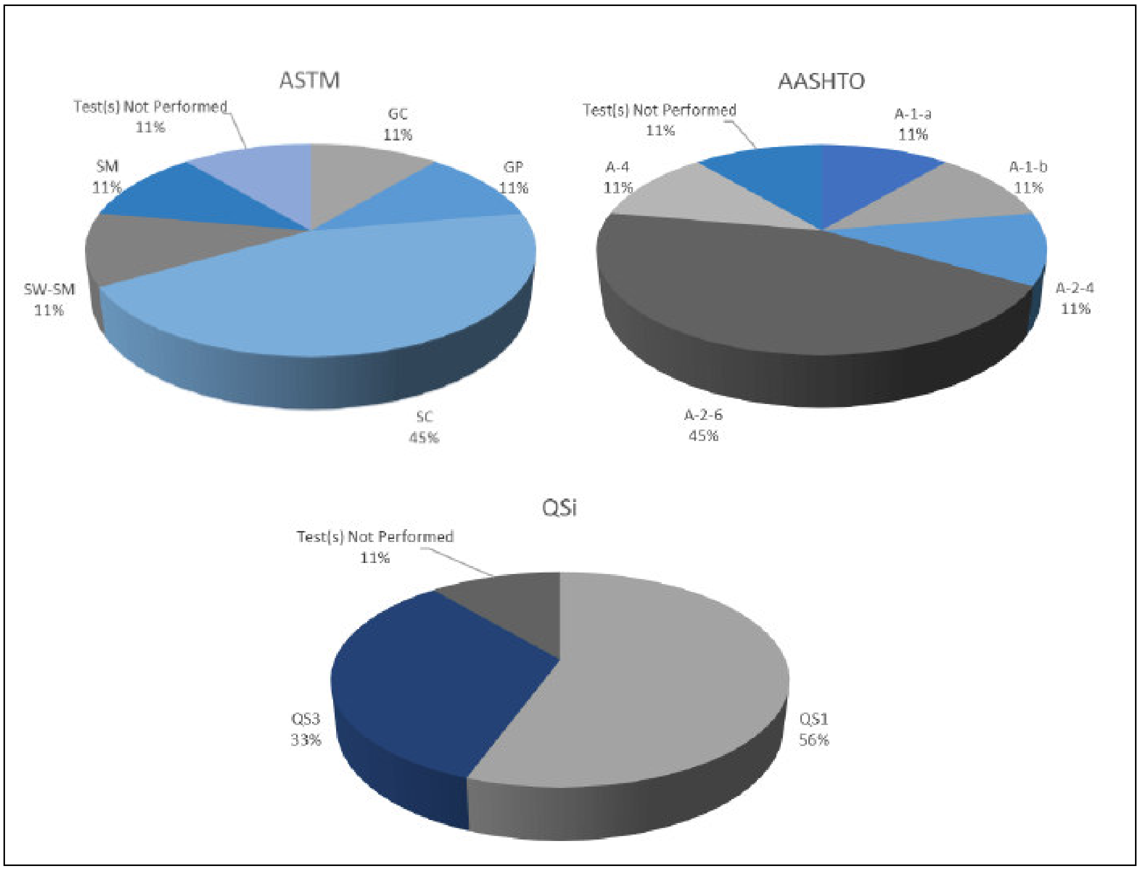


Figure 4. 111: Soil classification systems – Gravel unit (G2A)
(Source: Preliminary Design Report, Mota-Engil Africa, 2021)

Laterite Unit (G1D)

The trial pits allowed the identification of laterite layers of depths up to 3.0 m (in trial pits), being described as reddish-brown, greyish brown to brownish grey concretionary laterite. The mentioned mechanical survey allowed the sample collecting and therefore laboratory characterization. Nine samples were tested, and the following results were obtained:

QSi classification ....Mostly QS1 (61%)

ASTM classification .... Mostly SC (56%)

AASHTO classification .... Mostly A-2-6 (44%) and A-2-4 (39%)

Fines content (#200 ASTM sieve) .... 5.1% to 33.2% (19.6% average)

Liquid limit .... 0% to 37% (30.5% average)

Plasticity index .... 0% to 17% (9.7% average)

Moisture content .... 3% to 15% (9.1% average)

γ_d máx (Proctor Modified) .... 1.8g/cm^3 to 2.2g/cm^3 (2.0g/cm^3 average)

w_{opt} (Proctor Modified) .... 7.9% to 15.7% (12.4% average)

CBR soaked .... 17% to 36% (27.7% average)

CBR unsoaked .... 52% to 72% (80.5% average)

The following figure (Figure 4. 112) shows a set of graphs illustrating the distribution of the different classifications.

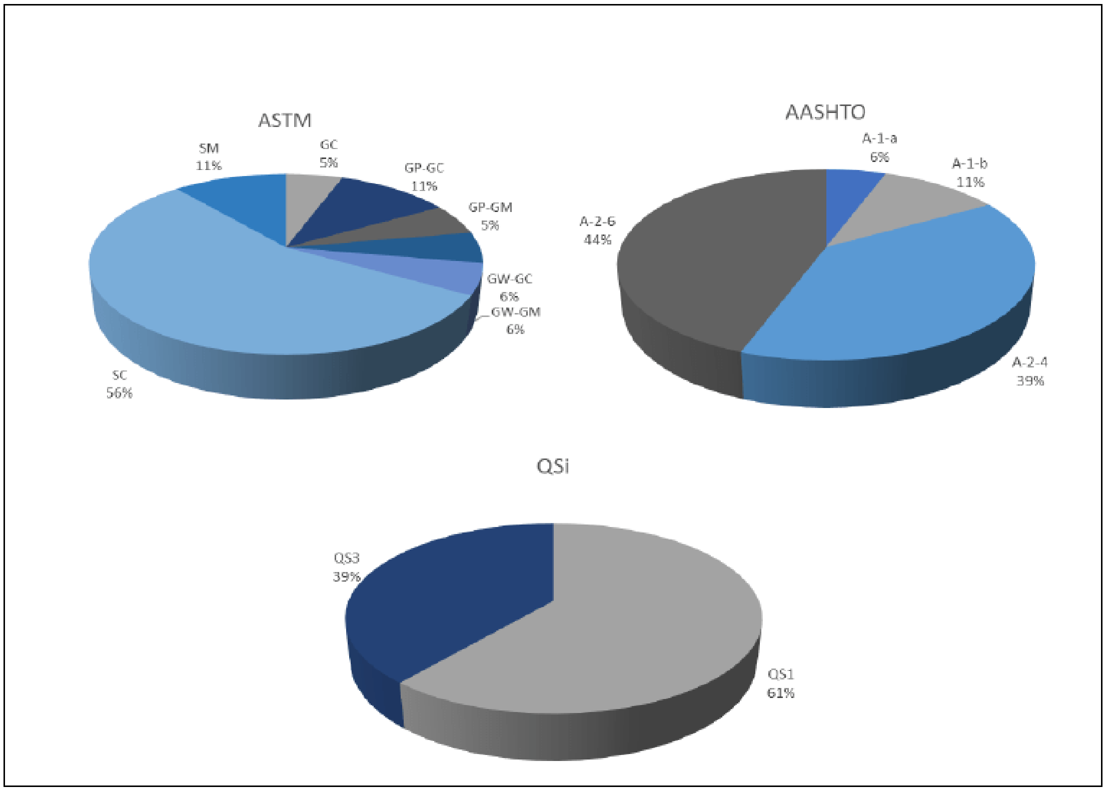


Figure 4. 112: Soil classification systems – Laterite unit (G1D)
Source: Preliminary Design Report, Mota-Engil Africa, 2021)

Decomposed Rock I Unit (GIC)

The trial pits allowed the identification of decomposed rock (from trial pits) layers of depths up to 3.0 m, being described as brownish-grey to pinkish greyish brown decomposed weathered rock. The mentioned mechanical survey allowed the sample collecting and therefore laboratory characterization. Nine samples were tested, and the following results were obtained:

QSi classification .... Mostly QS1 (60%)

ASTM classification .... SC

AASHTO classification .... Mostly A-2-6 (44%) and A-2-4 (39%)

Fines content (#200 ASTM sieve) ....13.4% to 34.6% (22.3% average)

Liquid limit ....0% to 39% (7.8% average)

Plasticity index .... 0% to 14% (2.8% average)

Moisture content .... 6% to 15% (9.4% average)

γ_d máx (Proctor Modified) .... 1.8g/cm^3 to 2.0g/cm^3 (1.9g/cm^3 average)

w_{opt} (Proctor Modified) .... 10.8% to 15.1% (12.5% average)

CBR soaked .... 13% to 23% (17.8% average)

CBR unsoaked .... 52% to 72% (59.0% average)

The following figure (Figure 4. 112) shows a set of graphs illustrating the distribution of the different classifications.

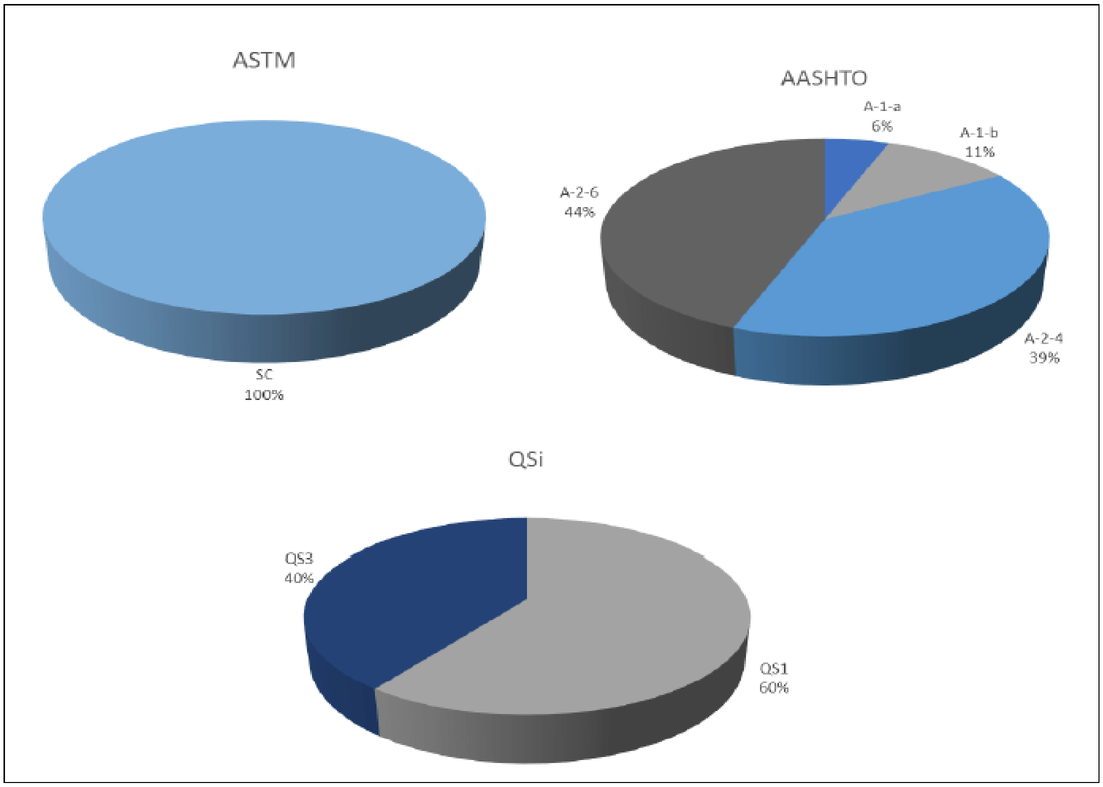


Figure 4. 113: Soil classification systems – Decomposed rock I unit (G1C)
Source: Preliminary Design Report, Mota-Engil Africa (2021)

<u>Decomposed Rock II Unit (G1B)</u>

The boreholes allowed the identification of gravel layers of depths up to 18.0 m (in boreholes), being described as very dense to dense greyish brown to brownish-grey decomposed weathered rock. This mechanical survey shows N_{SPT} values varying between 25 and 100 blows (81.4 blows average). The mentioned mechanical survey allowed the sample collecting and therefore laboratory characterization. Nine samples were tested, and the following results were obtained:

QSi classification ....QS1 (50%) and QS3 (50%)

ASTM classification .... SC (50%) and SW-SM (50%)

AASHTO classification .... A-1-b (50%) and A-2-4 (50%)

Fines content (#200 ASTM sieve) .... 8.9% to 34.2% (21.6% average)

Liquid limit ....Non-plastic

Plasticity index ....Non-plastic

Moisture content ....10% to 15% (12.5% average)

Figure 4. 114 shows a set of graphs illustrating the distribution of the different classifications.

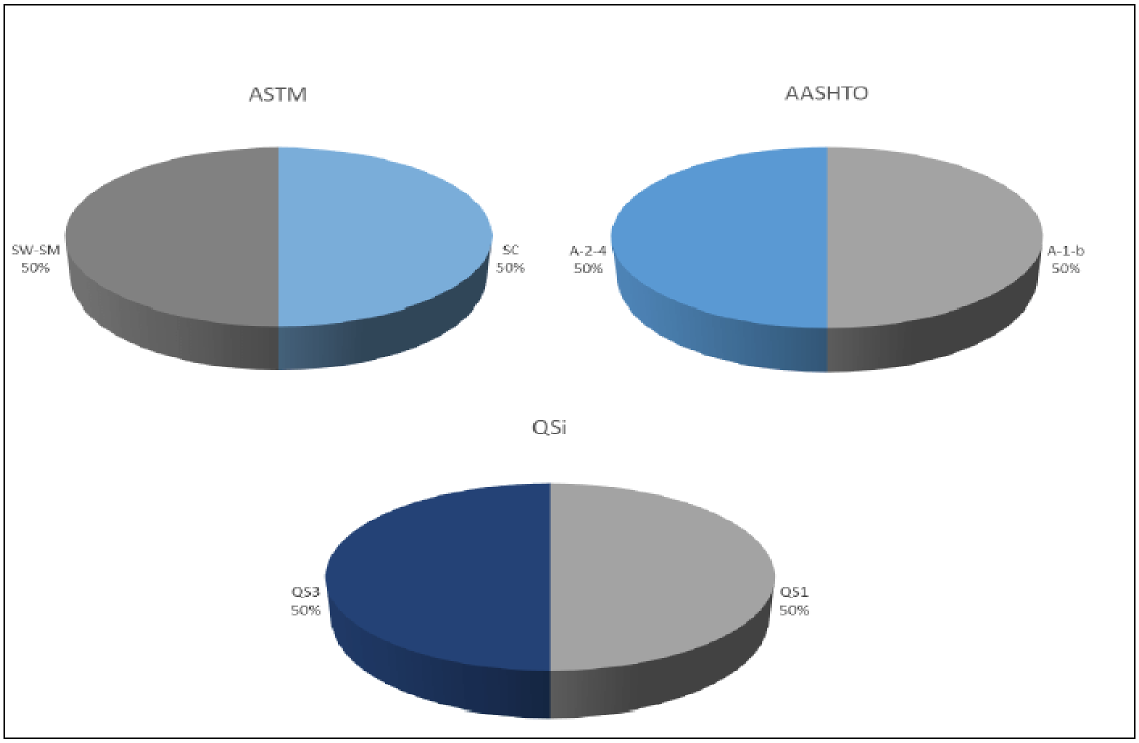


Figure 4. 114: Soil classification systems – Decomposed rock II unit (G1B)
(Source: Preliminary Design Report, Mota-Engil Africa, 2021)

Fresh Rock Unit (G1A)

The geophysical survey reveals a variable horizon starting at 15 m depth (SP 537, V_p), characterized by longitudinal velocities (V_p) above 2000 m/s; the transversal velocities (V_s) are above 600 m/s. Along the alignment, the depth of occurrence of this horizon varies. In the minor section Daura-Maradi, it is expected the referenced depth to be reduced, i.e this unit is expected to be closer to the surface. The nature of this unit, according to geological maps of Nigeria and Niger, is igneous, metamorphic, or sedimentary, depending on the location.

4.3.11 Hydrology and Hydrogeology

Nigerian hydrology network is divided into two major river systems, the Niger-Benue and Chad systems, to which most of the flowing waters make their way. The distribution of the 8 hydrological areas according to the Nigerian Hydrological Services Agency (NIHSA) is provided in Figure 4. 115.

Figure 4. 115: Hydrological map of Nigeria (FAO, 2021)

According to the British geological survey, the railway alignment occurs along with two major aquifers, as presented in Table 4. 23 and Figure 4. 116. The railway project area will be located on two main hydrographic basins: the first one is the Sokoto river basin which is tributary of Niger River, and the second one is included in the Chad river system, and it is the Hadejia river basin which is tributary of Komadougou Yobé river that as mentioned, is the main tributary of lake Chad. More specifically, the railway line will cross the subbasins of the following rivers: Jakara, Thomas, Gari, Tuwari, Sabke, Jaruka, Havsani, Gada and Hadejia. These rivers are characterized for having flow only in the wet season, and little or no water in the dry season. Additionally, some of the rivers like Jakara, Thomas, and Gari, among others, have dams in their course for irrigation purposes.

Table 4. 23: Aquifers Type, Productivity, and General Description

Type	Natural Acquifers	Productivity	General description
Sedimentary intergranular – moderate to high	Chad, Kerri-Kerri and Gombe Formations	Moderate to high	The Chad formation can be unconfined or confined depending on local conditions. deeper sandstone layers are often confined and can be artesian. Yields of between 2.5 and 30 l/s are quoted. The water table depth is often between 10 and 15 m. Recharge is usually directly from rainfall.
Basement	Chad, Kerri-Kerri and Gombe Formations (Basement Aquifers)	low to moderate	Basement rocks can form local aquifers if the degree of weathering and/or fracturing is sufficient. crystalline and coarse-grain rocks, such as gneiss and migmatite, become sandy on weathering, thus preferentially forming aquifers. argillaceous meta-sedimentary rocks tend to be become clayey with low permeability when weathered, forming aquitards. Overall, basement aquifers tend not to be high-yielding. they typically vary in thickness from 10 to 25 m, with water table depth varying from about 5 to 15 m. Boreholes tend to be drilled to depths between 10 and 70 m, depending on local conditions. Recharge is usually directly from rainfall.

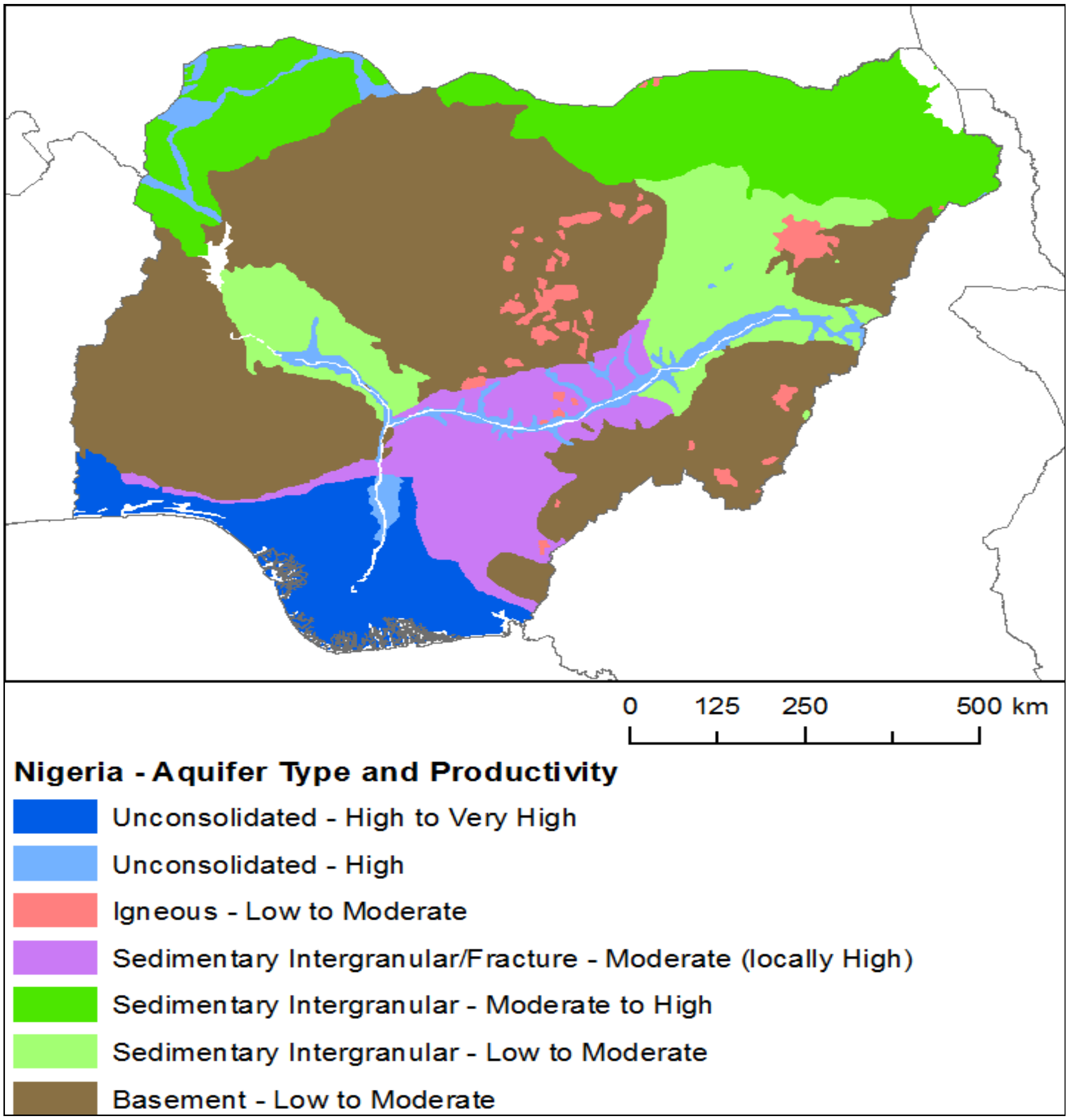


Figure 4. 116: Extract of the hydrogeological map of Nigeria, published by British Geological Survey

Relief

The study area consists mainly of plains with elevations ranging between around 350 m and 520 m as it can be seen in Figure 4. 117. The region's average elevation is around 420 meters above sea level, and a part of it is soaked in the rainy season. In the northern area, the project line is located in the Sudanian Savannah region.

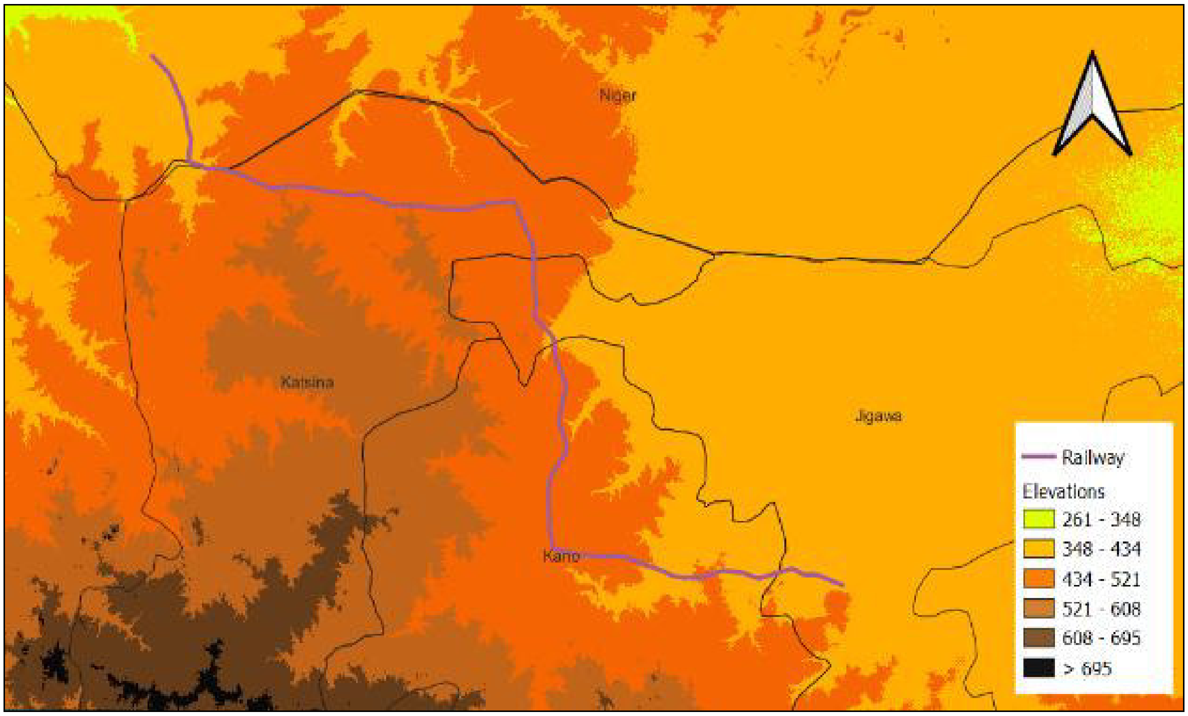


Figure 4. 117: Elevation map of Nigeria
(Source: Preliminary Design Report, Mota-Engil Africa, 2021

Soil Morphology

The soil in the project area is comparatively recent in age, composed mainly of brown and reddish-brown soils and laterite, while juvenile and hydromorphic soil occur along the alluvial channel complexes. In general, the soils in the region have aeolian deposits from the Sahara Desert, they are sandy at the top, and compact at depth with often hard pans.

Catchment Delimitation and Features

Given the lack of information regarding the topography, and raster archives, the boundaries of the basins area were drawn manually using satellite images and available online cartography, following the contour lines wherever they are visible, or finding the highest points with the help of Google Earth. Additionally, previous studies were also used for support. Figure 4. 118 presents the resultant basin boundaries.

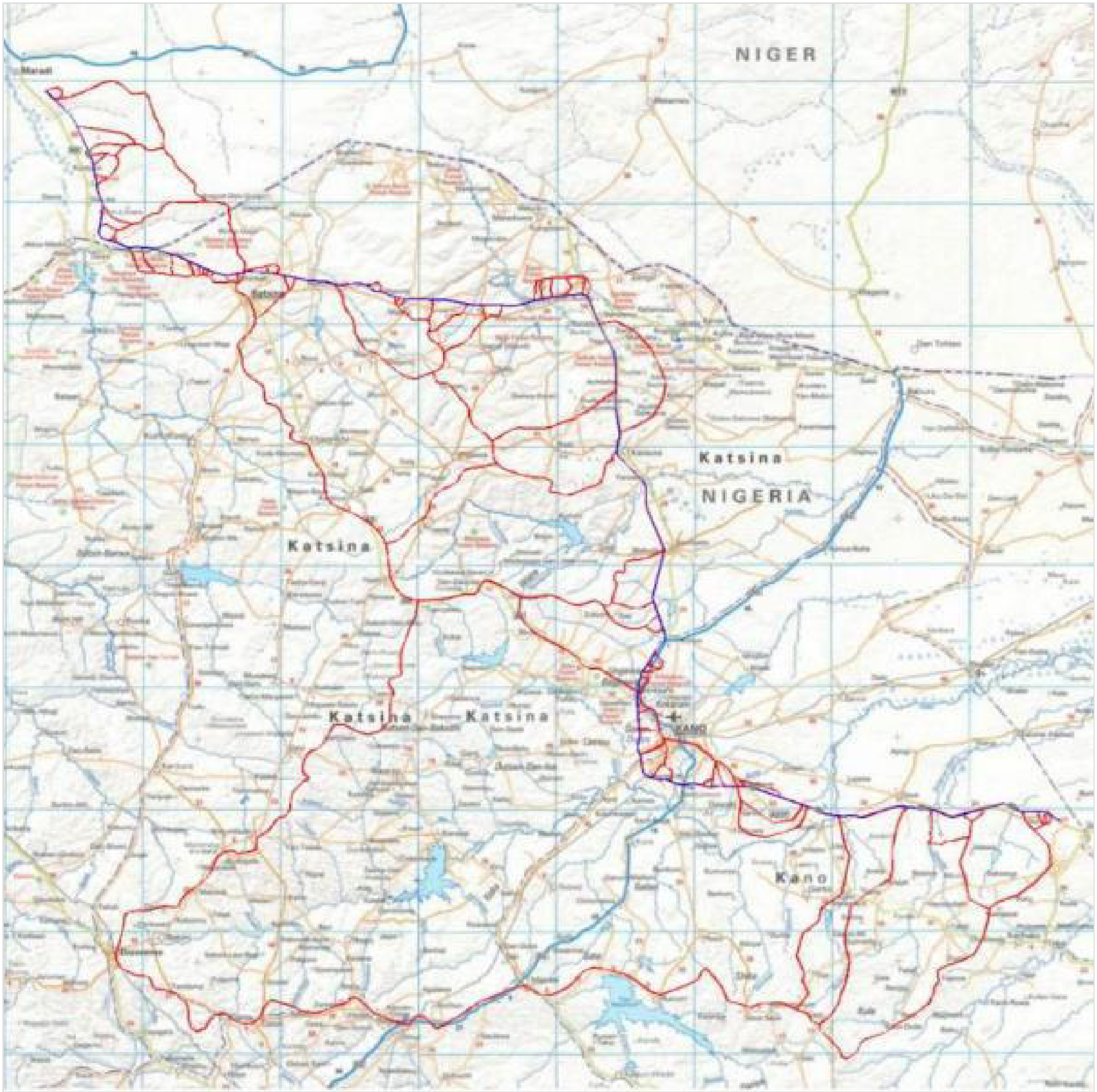


Figure 4. 118: Boundaries of the basins along the new railway
(Source: Preliminary Design Report, Mota-Engil Africa, 2021)

Return Periods

The return period is the long-term average of intervals between successive exceedances of rainfall magnitudes. This parameter should be adopted according to the infrastructure's importance, the risk of collapse and the consequences for people. The return periods to adopt are the following ones:

- 20 years for the railway longitudinal drainage system;
- 25 years for the small streams with flows till $5m^3/s$ (circular pipes);

- 50 years for moderated to critical situations with flows between 5 to 100 m^3/s (box culverts);
- 100 years for very critical and risky specific situations with flows higher then 100 m^3/s (bridges).

Concentration Time

The time of concentration is defined as the time needed for water to flow from the most remote point in a watershed to the control section. For the calculation of this parameter, it was considered the average value obtained from the Kirpich and Temez empirical formulas. The first one is recommended for basins up to 400 km^2, main length up to 80 km and slops between 0.002 and 0.02, besides it's designed for soil use in crops mainly. All of these characterize the majority of the basins of the study. On the other hand, the Temez is more flexible as to the area of the basin (from 1 km^2 to 3000 km^2) as well as for times of concentrations from 15 minutes to 24 hours. However, it has the perk of considering the spatial variability of the rainfall and it introduces a uniformity coefficient, which ends up in reducing the overestimations that could arise. The empirical formulas considered are:

Kirpich

$$T_c = \frac{1}{53} * \frac{L^{0.71}}{i^{0.38}}$$

Temez

$$T_c = 0.3 \times \frac{L}{J^{0.25}}$$

Being:

Tc (hours): Time of concentration;

L (km): Length of main water line;

J (m/m): Average slope of main water line;

Table 4. 25 present the results of the time of concentration for the present study.

Table 4. 24: Basins along the Dutse-Kano Railway

Basin	Kirpich (h)	Temez (h)	Average (h)
0	0.89	1.16	1.02
1	0.65	0.88	0.77
2	0.57	0.84	0.70
5	0.71	0.96	0.83
6	1.36	1.79	1.58
7	1.90	2.26	2.08
8	2.54	3.91	3.22
9	8.48	11.57	10.02
10	1.94	2.43	2.19
11	6.12	7.94	7.03
12	20.01	29.56	24.79
13	12.50	21.71	17.11
14	39.53	63.22	51.38
15	7.88	11.20	9.54
16	5.37	8.67	7.02
17	0.55	0.99	0.77
19	0.54	0.80	0.67
20	1.72	2.97	2.34
21	0.62	0.86	0.74
22	0.38	0.56	0.47
23	5.25	6.96	6.11
24	2.36	2.88	2.62
25	2.11	2.73	2.42

(Source: Preliminary Design Report, Mota-Engil Africa, 2021).

Table 4. 25: Basins along the Kano-Katsina Railway

Basin	Kirpich (h)	Temez (h)	Average (h)
26	1.16	1.87	1.51
27	1.75	2.83	2.29
28A	0.53	0.93	0.73
28B	0.35	0.62	0.48
29	0.93	1.53	1.23
30A	0.52	0.73	0.63
30B	0.39	0.75	0.57
31	0.29	0.58	0.43
32	0.95	1.62	1.28
33	10.31	16.60	13.46
34	3.52	5.44	4.48
35	3.26	5.43	4.34
36	18.68	30.01	23.99
37	9.06	14.57	11.81
38	11.94	13.55	12.74
39	1.44	1.80	1.62
40	2.06	2.42	2.24
41	1.53	2.64	2.09
42	1.71	3.07	2.39
43	1.52	2.70	2.11
44	20.18	24.21	22.19
45	1.67	2.47	2.07
46	3.12	5.51	4.31
47	2.45	4.29	3.37
48	1.65	3.10	2.38
49	0.99	1.42	1.20
50	0.16	0.32	0.24
51	0.69	1.24	0.97
52	7.76	12.78	10.27
53	19.51	27.77	23.64
54	0.67	1.17	0.92
55	3.75	6.60	5.17
56	0.32	0.62	0.47
57	0.35	0.62	0.49
58	0.57	0.79	0.68
59	0.77	1.28	1.03
60	0.82	1.51	1.16
61	0.48	0.79	0.63
62	0.38	0.77	0.57
63	0.65	1.15	0.90

Basin	Kirpich (h)	Temez (h)	Average (h)
64	1.24	2.07	1.66
65	2.01	3.30	2.65
66	2.45	4.35	3.40
67	2.09	3.96	3.03
68	7.27	12.37	9.82
69	0.48	0.79	0.63
70	1.39	2.38	1.88
71	2.07	3.65	2.86
72	5.47	9.52	7.50
73	0.81	1.56	1.19
74	1.62	2.92	2.27
75	0.98	1.62	1.30
76	1.78	2.82	2.30
77	1.76	3.24	2.50
78	5.32	8.74	7.03
79	1.20	2.00	1.60

(Source: Preliminary Design Report, Mota-Engil Africa, 2021).

Hydrological Calculation

The hydrological data obtained are not sufficient for the development of any updated IDF curve. In fact, as referred in "Highway Manual Part 1: Design – Volume IV: Drainage Design – Federal Ministry of Works- Federal Republic of Nigeria", currently reliable data for the derivation of IDF curves across the whole of Nigeria is only available for the period prior to the early 1980. Thus, indirect pluviometric method will be used to calculate the discharge of the different rivers.

Rainfall-Durtation Curves

In order to cover the adequacy of meteorological data, a method that allows to compute the rainfall intensity at any place in Nigeria for certain durations and return periods, was used in the present study as support for computing the peak flows of the water courses that intercept the railway. The method divides Nigeria in ten rainfall zones as shown in Figure 4. 119, and assign coefficients based on the time of concentration and in the distance to some main cities given in the tables of the manual. The basins of the study area are located in the rainfall zones VIII and X as can be seen also in Figure 4. 119, and thus Table 4.26 presents the coefficients used for computing the intensity.

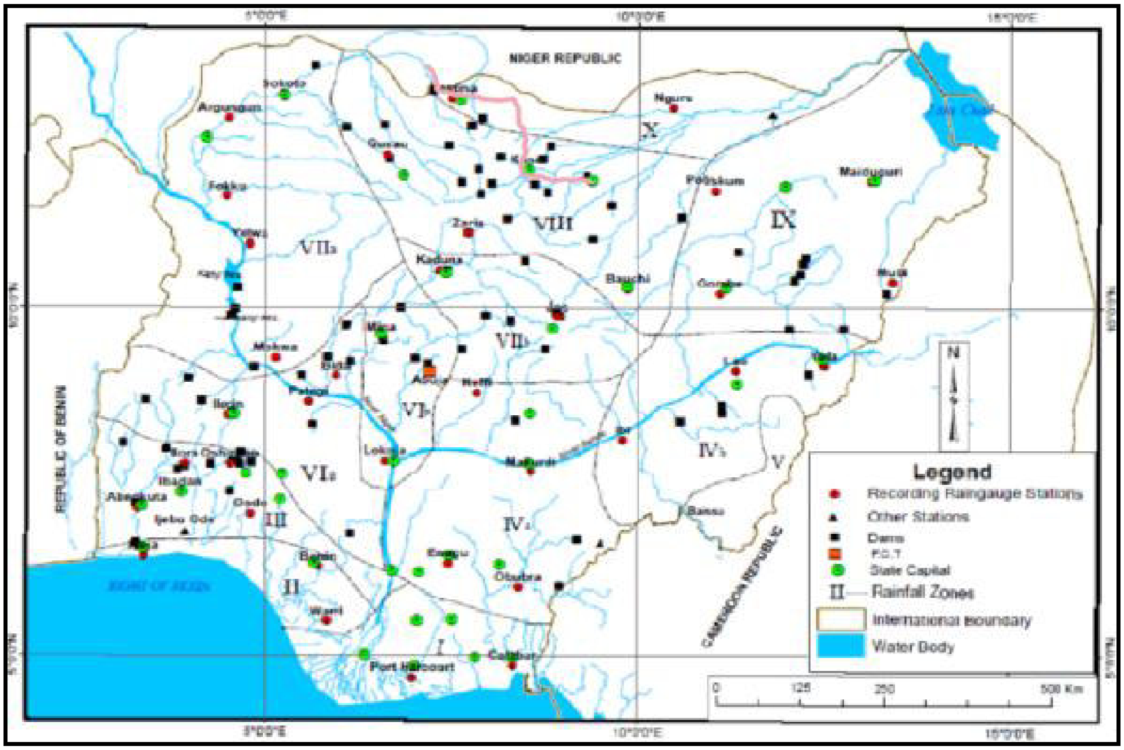


Figure 4. 119: Rainfall zones of Nigeria and location of the new railway in these areas
(Source: Preliminary Design Report, Mota-Engil Africa, 2021)

Table 4. 26: Coefficients 1/α and β for the rainfall zones where the railway will be located

Rainfall zone	Coefficient	Time of concentration (h)						
		0.2	0.4	1	3	6	12	24
VIII	**1/α**	18.04	14.64	10.87	4.76	2.7	1.53	0.78
VIII	**β**	95.65	69.79	40.67	15.92	8.46	4.47	2.28
X	**1/α**	21.53	17.65	9.35	3.86	2.09	1.08	0.57
X	**β**	103.66	69.82	35.75	12.78	6.73	3.43	1.76

(Source: Preliminary Design Report, Mota-Engil Africa, 2021).

After determining the coefficients, the following equation is applied in order to find the rainfall intensity:

$$I = \beta + y\left(\frac{1}{\alpha}\right)$$

Where,

$$y = ln(Tr) - \frac{1}{(2 * Tr)} - \frac{1}{(24 * Tr^2)} - \frac{1}{(8 * Tr^3)}$$

Finally, it is important to highlight that when the time of concentration didn't match that presented in the tables of the manual, interpolation was done to get the wanted value.

Methodology Description for Calculation of Peak Flow

For the calculation of peak flow, two different methodologies according to the hydrographic basin dimension were used:

- Rational Method for basin areas up to 12 km^2;
- Soil Conservation Service (SCS) for the remaining cases.

The division of the studied basins according to these criteria is presented in Figure 4. 120. As can be seen, the great majority of them were studied following the SCS method. Besides, given the influence of the mentioned climate change for the present study, it is considered an increase rate of 20% in the flood flow for the areas where the eventual flood could endanger human lives, the Urban Areas. For rural areas, an increase rate of 10% is assumed in counterpart.

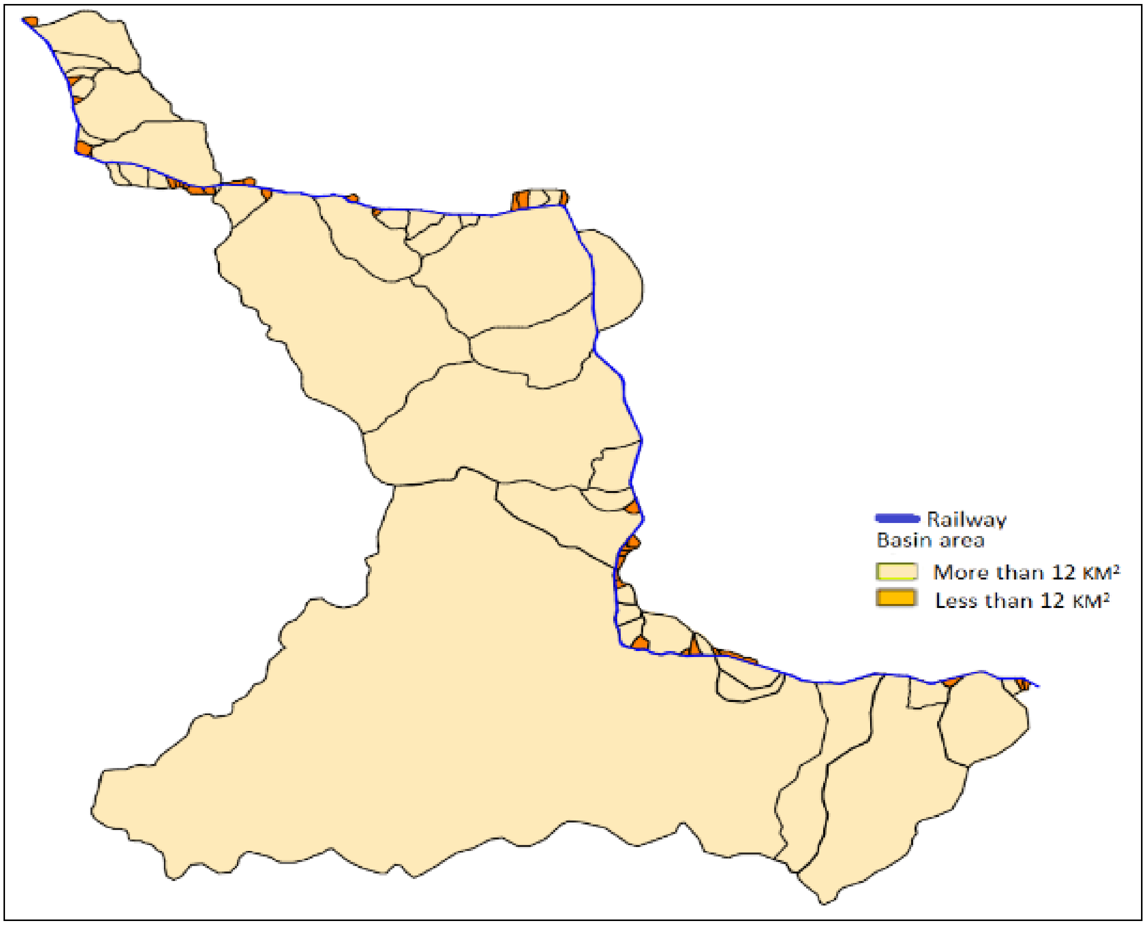


Figure 4. 120: Types of basins according to the area
Source: Preliminary Design Report, Mota-Engil Africa, 2021)

Rational Method

Rational method relates two independent variables (rainfall intensity and catchment area) with the dependent variable of precipitation in order to estimate the peak discharge, following the equation below. It is only applied in small catchments because when assuming uniform rainfall there is underestimation of peak flow, and opposite, neglecting storage effects leads to overestimation of peak discharge. In general, smaller basins have short storms, which are more uniform and thus, the method works better with these kinds of catchments.

$$Q = 0.00277CIA$$

Where:

Q- Flow (m^3/s);

C – dimensionless runoff coefficient;

I – Rainfall intensity (mm/hr);

A – drainage area (ha)

The runoff coefficient is a parameter which considers that from the rain that falls in one specific area, only one percentage contributes for the superficial runoff. This coefficient is strictly connected with the land use and its value increases with the occupation density. For the intervention area and taking in account the land occupation and the existing terrain slopes most of the hydrographic basin will have a runoff coefficient of around 0.50. In urban areas this value could be increased up to 0.85. Table 4. 27 presents these coefficients associated to each basin according to the use of soil.

Table 4. 27: Basin with area lower than 12 Km^2 and their runoff coefficient

Basin	C
0	0.5
1	0.5
2	0.5
5	0.5
6	0.5
7	0.5
10	0.5
17	0.5
19	0.5
21	0.5
22	0.5
24	0.85
28A	0.85
28B	0.85
29	0.5
30A	0.85
31	0.5
32	0.5
39	0.5
42	0.5
43	0.5
49	0.5
50	0.5
51	0.5

Basin	C
54	0.5
56	0.5
57	0.5
58	0.85
59	0.85
60	0.5
61	0.5
62	0.5
63	0.5
64	0.5
69	0.5
70	0.5
73	0.5
75	0.5
79	0.5

(Source: Preliminary Design Report, Mota-Engil Africa, 2021)

SCS Method

This method is the most used for the establishment of flood hydrographs and has the great advantage of considering the type of soils within the catchment area when calculating the concentration time. It is computed manually with the following equation:

$$Q = \frac{(P - \psi)^2}{(P - \psi) + S}$$

Where,

P – rainfall in mm (from hyetographs generated from IDF curves)

Ψ – initial precipitation losses (due to infiltration, evapotranspiration, etc.) are equal to 0.2xS

S – maximum detention capacity on catchment area and is equal to (25400/CN)-254 in metric system

CN – curve number

In this study for the peak flow calculation with SCS, the software HEC-HMS 3.4, from «Hydrological Engineering Center» of «U.S. Army Corps of Engineers», will be used, which requires the mentioned parameters as input.

Rainfall

In this case, for the rainfall it will be needed to define the intensity for other durations than the ones presented in the referred Nigerian standard. To obtain those hyetographs it is performed by drawing a trend line with the existing values for each return period.

According to Portela, (2008), the attribution of hyetographs with non-uniform precipitation intensity to the intense rainfall of a given duration leads to peak flows always higher than the flow resulting from the hypothesis of temporal uniformity of the intensity of the same amount of precipitation". The author also concludes that the "association of a non-uniform intensity hyetograph with triple-duration precipitation of concentration time leads to a higher peak flow rate than the duration equal to concentration time". Thus, the design precipitation will be defined with triple concentration time duration and in alternate blocks, resulting in hyetographs as the presented in Figure 4. 121, which is an example of the basin 9, located in the PK 92+206, which has a concentration time of 10.02 hours and thus as it can be seen that the hyetograph is divided in blocks of 3.34 hours.

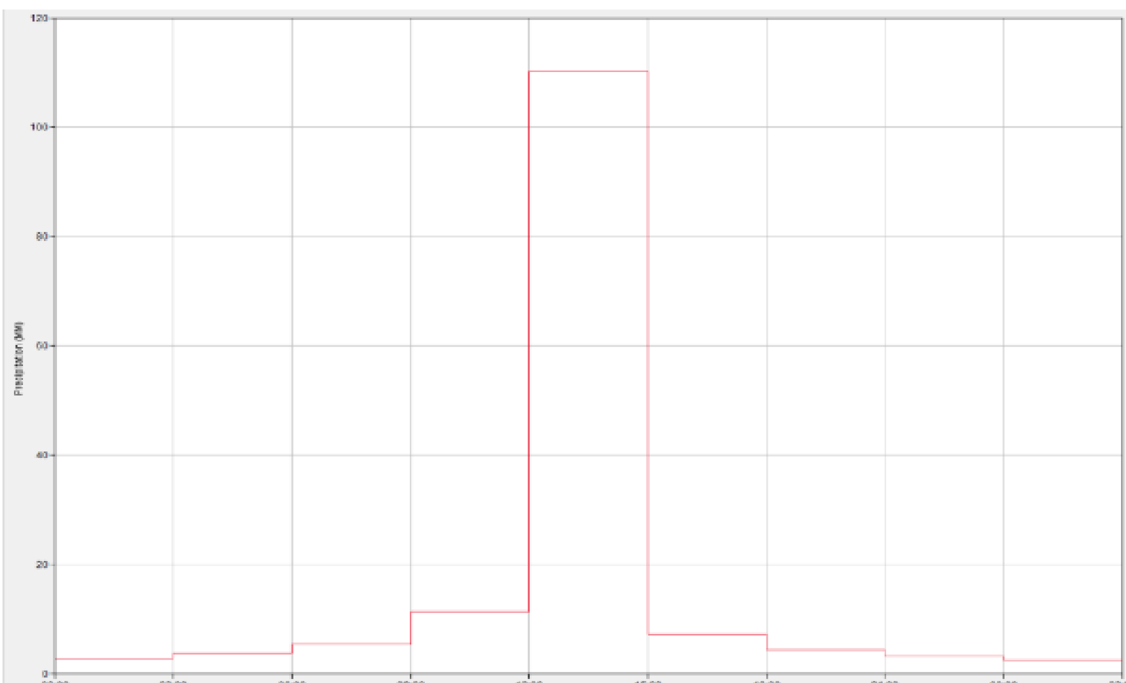


Figure 4. 121: Hyetograph of basin 9
(Source: Preliminary Design Report, Mota-Engil Africa, 2021)

Curve Number (CN)

It is a parameter which is estimated based on hydrological soil type (A, B, C or D), land use/cover and antecedent moisture condition of the basin. The CN to be used will follow two of the tables from the United States Department of Agriculture TR-55 (SCS -peak flow method), that provide estimates of the curve number (CN) as a function of hydrologic soil group (HSG), cover type, hydrologic condition, antecedent runoff condition (ARC), and impervious area in the catchment.

These tables include several options, however, in the studied area only three types of soil were clearly identified: pastures, cultivated plowed land and urban areas with low impermeabilization. Additionally, the study area is a soil types B and C, as it can be seen in Figure 4. 122, and it was considered normal antecedent moisture conditions (AMC II). Therefore, the CN selected along the railway range between 61 and 79, as presented in the Table 4. 28.

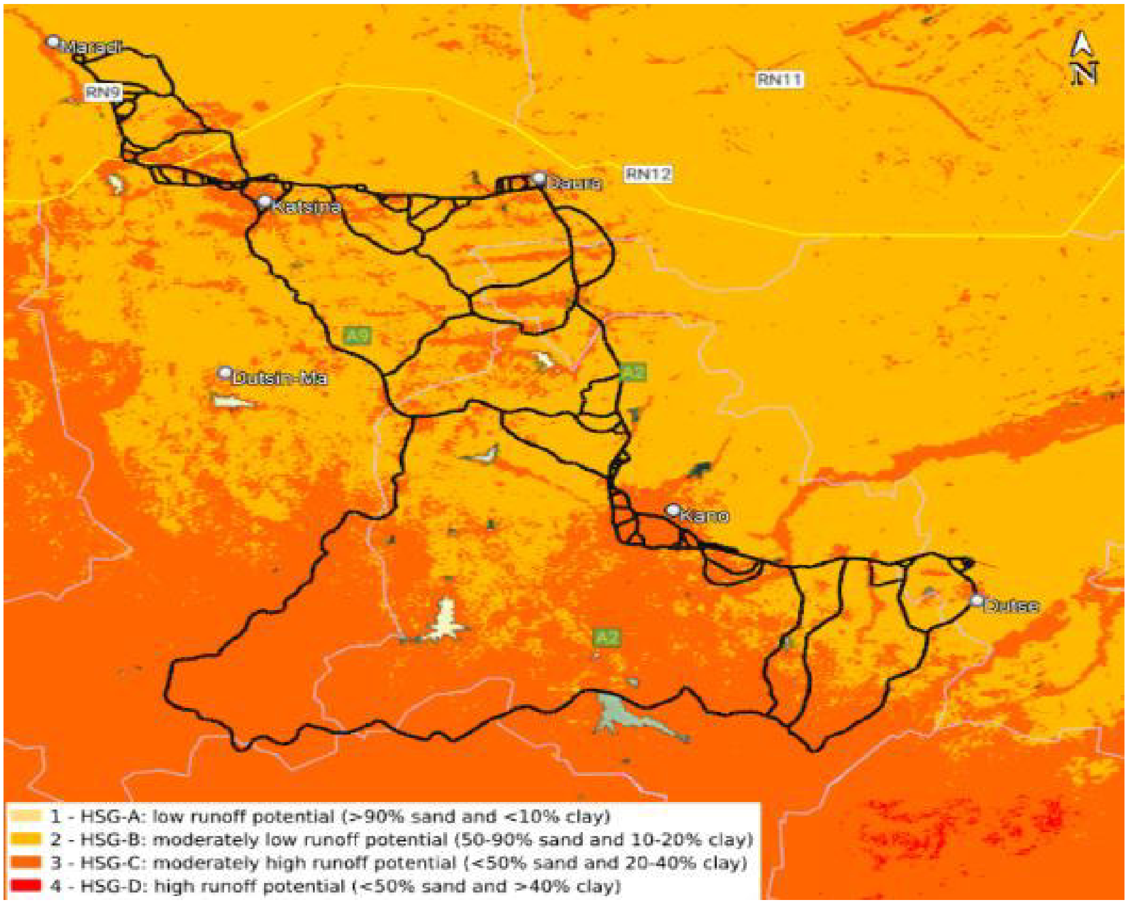


Figure 4. 122: Soil types in the study area

(Source: Preliminary Design Report, Mota-Engil Africa, 2021)

Table 4. 28: CN Values according to the US TR-55 for the use and type of soils in the study area

Use of soil	Hydrologic group of soil	
	B	C
Pastures	61	74
Cultivated plowed land	71	78
Urban areas with 20% of impermeabilization	68	79

Summing up each of the selected curve numbers for each of the basins that were studied under the SCS method, are presented in the Table 4. 29:

Table 4. 29: Basin with area higher than 12 KM2 and their Curve Numbers (CN)

Basin	CN
8	70
9	67
11	67
12	67
13	67
14	70
15	67
16	67
20	70
23	70
25	70
26	70
27	70
33	70
34	70
35	70
37	67
38	64
40	70
41	70
44	70
45	67
46	67
47	67
48	70
52	67
53	70
55	75
65	67
66	67
67	67
68	67
71	67
72	67
74	67
76	67
77	67
78	67

(Source: Preliminary Design Report, Mota-Engil Africa, 2021)

Results of HEC-HMS

After imputing the geometry and properties of the basins (such as area and CN), the correspondent hyetograph with the methodology explained, and selecting to compute the peak flow with the SCS method, the program will throw a result as the presented in Figure 4.123, which is the hydrogram of the basin 9 from the previous example. From this graph, the peak flow to be used for designing the necessary bridges or box culverts along the railway can be selected.

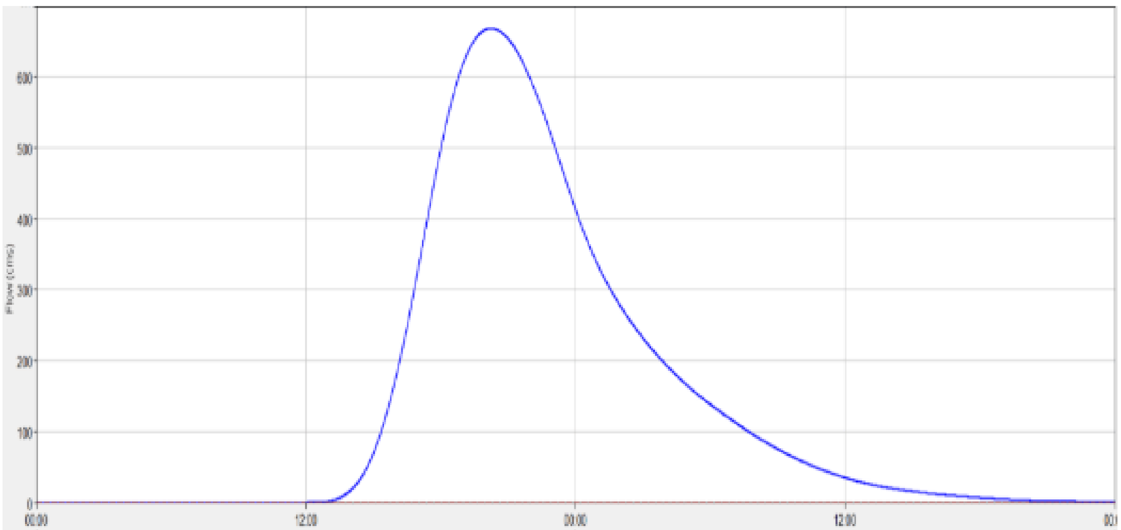


Figure 4.123: Hydrogram of basin 9
(Source: Preliminary Design Report, Mota-Engil Africa, 2021)

Results

The railway will cross 80 basins that are presented in Table 4. 30 and Table 4. 31. They show the location of the intersections between the rivers and the line of the railway, as well as the necessary parameters that were used for computing the discharge values such as length of the longest line of water in each basin, differences of elevation of this rivers, and area of each basin.

Table 4. 30: Geometry and hydrology of the basin in the Dutse to Kano Section of the railway

Basin	CH (km)	L (km)	ΔH (m)	A (km^2)	tc (h)	RP	Q(m^3/s)	Q considering climate change (m^3/s)
0	107+600	1.20	2	1.23	1.02	50	14.06	15.47
1	106+450	0.90	2	0.73	0.77	50	11.93	13.13
2	104+050	0.92	3	0.59	0.70	50	9.71	10.68
5	102+800	0.98	2	0.48	0.83	50	7.73	8.50
6	100+275	2.05	3	2.63	1.58	50	26.41	29.05
7	098+620	2.41	2	3.71	2.08	50	32.42	35.66
8	094+950	6.52	16	14.52	3.22	50	57.6	63.36
9	092+206	21.58	50	378.93	9.65	100	668.40	735.24
10	080+218	2.83	3	6.74	2.19	50	56.98	62.68
11	072+350	12.76	11	60.62	7.03	100	159.40	175.34
12	070+523	75.68	23	1294.42	2.06	100	1298.70	1428.57
13	049+231	62.82	192	504.37	20.28	100	596.70	656.37
14	048+050	213.26	260	10314.55	51.38	100	10782.30	11860.53
15	040+151	21.76	30	67.95	9.62	100	146.90	161.59
16	039+270	18.46	42	76.16	7.39	100	168.80	185.68
17	029+200	5.04	13	10.39	2.63	50	75.85	83.43
19	024+000	0.88	3	2.66	0.67	50	44.40	48.84
20	023+200	5.34	25	16.78	2.34	100	101.70	122.04
21	019+300	0.87	2	7.66	0.74	100	135.08	148.59
22	016+500	0.56	2	2.84	0.47	50	49.45	54.39
23	009+586	11.11	11	103.37	6.11	100	304.46	365.35
24	006+800	3.38	3	11.84	2.62	50	70.49	84.58
25	000+282	3.39	4	22.72	2.42	100	133.86	160.63

(Source: Preliminary Design Report, Mota-Engil Africa, 2021).

Table 4. 31: Geometry and hydrology of the basis in the section of the railway from Kano to Katsina

Basin	CH (km)	L (km)	ΔH (m)	A (km^2)	tc (h)	RP	Q (m^3/s)	Q considering climate change (m^3/s)
26	007+400	2.79	11	27.92	1.51	100	218.1	261.72
27	011+205	4.64	16	20.76	2.29	100	117	140.4
28A	015+420	1.28	9	4.49	0.73	100	134.91	161.90
28B	017+115	0.79	7	2.71	0.48	50	79.77	95.73
29	022+750	2.22	10	5.25	1.23	50	57.37	63.10
30A	024+020	0.74	2	3.16	0.63	50	90.3903	108.47
30B	026+885	1.12	14	3.66	0.57	50	62.37233	68.61
31	028+050	0.82	12	0.66	0.43	50	11.48	12.63
32	030+020	2.47	13	7.44	1.28	50	80.32	88.36
33	039+527	41.12	79	413.62	13.46	100	671.2	738.32
34	039+500	9.84	22	56.31	4.48	100	200	220
35	047+020	10.78	35	111.12	4.34	100	405.6	446.16
36	075+353	86.00	140	1713.20	24.0	100	1641.90	1806.09
37	086+762	35.00	70	435.20	11.81	100	683.10	751.41
38	105+942	21.00	8	241.00	12.74	100	173.50	190.85

(Source: Preliminary Design Report, Mota-Engil Africa, 2021).

4.3.12 Health Impact Assessment

4.3.12.1 Background

Health impact assessment is a means of evidence -based policy making for improvement in health. It is a combination of methods whose aim is to assess the health consequences to a population of a policy, project, or programme that does not necessarily have health as its primary objective. Nigerian policy on the environment and Decree 88 of 1992 requires the filing of an Environmental Impact Assessment (EIA) report before any major project with significant impact on the environment can be undertaken; and Health Impact Assessment (HIA) is now recognized as an important part of a comprehensive Environmental Impact Assessment study.

Health impact assessment is a multidisciplinary process within which a range of evidence about the health effects of a proposal is considered in a structured framework. It takes into account the opinions and expectations of those who may be affected by a proposed policy. Potential health impacts of a proposal are analyzed and used to influence the decision-making process.

HIA may be retrospective, concurrent, or prospective. Most HIAs are prospective and aim to predict the health consequences of a proposal before it has been implemented. Some HIA practitioners also describe two other types of HIA. A concurrent HIA involves monitoring an intervention during implementation, and is useful when health impacts are expected but their nature and severity are uncertain, so that the work can be influenced as it progresses. A retrospective HIA takes place after the proposal has occurred. It differs from evaluation as it considers all health outcomes, not only those intended. The role of which is to provide evidence for future similar interventions. However, it can also be used to address health impacts that have occurred because of proposal implementation in order to mitigate any that are negative and enhance any that are positive.

This HIA study conducted for the Kano-Maradi rail project is to satisfy the requirements of the Nigerian EIA legislation. The Kano-Maradi Railway Line Project (KMRLP) will pass through three states in Nigeria to Maradi in Niger Republic. It cuts across 15 Local Government Areas (LGAs) with the railway line route passing through 105 urban, peri urban and rural communities in these affected states. During the construction phase, it is expected that thousands of jobs will be created for both locals and expatriates (Chinese workers) to fill the labour needs. Whilst this can bring significant economic gain, there could potentially be health impacts and changes to vulnerability due to high mobility and interaction between migrants and host communities in these areas. Therefore, the aim of the assessment is to analyze the current health-related situations and assess the potential health impacts of the Kano-Maradi railway construction with a focus on both communicable and non-communicable diseases.

Objectives

1. To determine the baseline health status of the communities to be impacted by the project
2. To determine the prevalence of risk factors in communities to be impacted by the project
3. To appraise the quality of available health services in communities to be impacted by the project
4. To assess the health impact of the project in those communities where the project traverse
5. To Recommend mitigation measures in those communities to be impacted by the project

4.3.12.2Methodology

This Health Impact Assessment (HIA) was conducted in the proposed project area which included 15 Local Government Areas (LGAs) that cut across three states, namely; Katsina (6), Kano (6) and Jigawa (3). Prior to data collection, extensive literature review on the area and the project was conducted. Scoping workshops were carried out to establish baseline data, engage relevant stakeholders and sensitize the affected communities on subsequent field work activities. Thereafter, semi- structured questionnaires and Key

Informant Interview (KII) guides were developed targeting main project objectives and research assistants were trained on data collection.

A total of 105 communities were identified within the project area and 53 were selected, representing both urban and rural settlements. The data for the study was collected from host communities located in 15 LGAs of Kano, Katsina and Jigawa states. In each community, interviews were conducted with systematically selected adult members using household questionnaires. Key informant interviews were also conducted with each of the 15 Directors of Health. At the end of the exercise, a total of 374 household members were interviewed and 15 LGA Directors of health were interviewed. The data gathered was analyzed electronically to generate health-related numbers/figures, and proportions/percentages. Texts from the key informant interviews with Directors of Health were also critically analyzed to extract key messages, views and perceptions.

4.3.12.3 Summary of Results

Data was collected from different communities across 15 Local Government Areas (LGAs) of Kano (6), Katsina (6) and Jigawa State (3). The overall year 2021 estimated population of people in the study area was 5,875,414 people. A total of 374 respondents were interviewed, the questionnaires were then retrieved and analyzed using statistical package for social sciences (IBM SPSS version 25). The results showed that, 339 (92.4%) respondents were females and 28 (7.6%) were males. (This is because questions on health were asked primarily of female respondents). The mean age was 34.3 years with a standard deviation (SD) of 13.0 years (34.3±13.0). Figure 4. 124 below gives the age distribution of respondents:

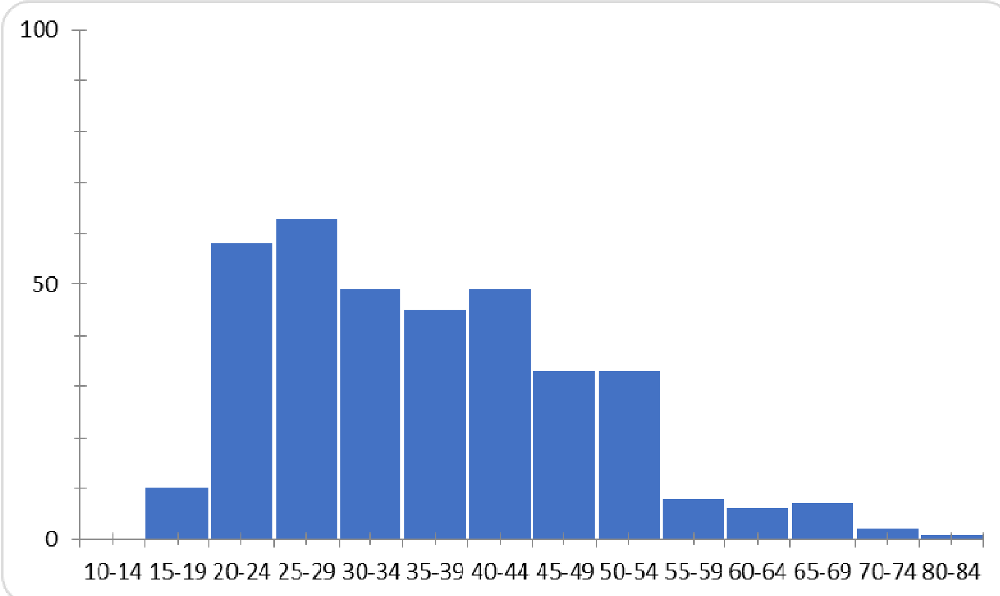


Figure 4. 124: Age groups of respondents

In terms of residency, 95.0% of the people interviewed were permanent residents in the study area compared to 5.0% that were temporary residents. Majority of the respondents belonged to either Hausa (68.9%) or Fulani (30.0%) ethnic groups, with only about 1.0% belonging to other ethnic groups. About four (4) of ten (10) respondents (39.6%) had Islamic education only, followed by primary (25.9%) and secondary (22.4%) education. Only 12.1% of the respondents had post-secondary education. Similarly, majority (88.8%) of the respondents were married compared to 11.2% that were not. The number of children per respondent ranged from 0 to 22 (median value was 6), whereas the number of dependents per respondent ranged from 0 to 24 (median value was 3). The respondents were mostly into food processing (32.4%), small-scale businesses (25.1%), artisanal works (23.5%) and livestock farming (12.6%) as shown in Figure 4. 125.

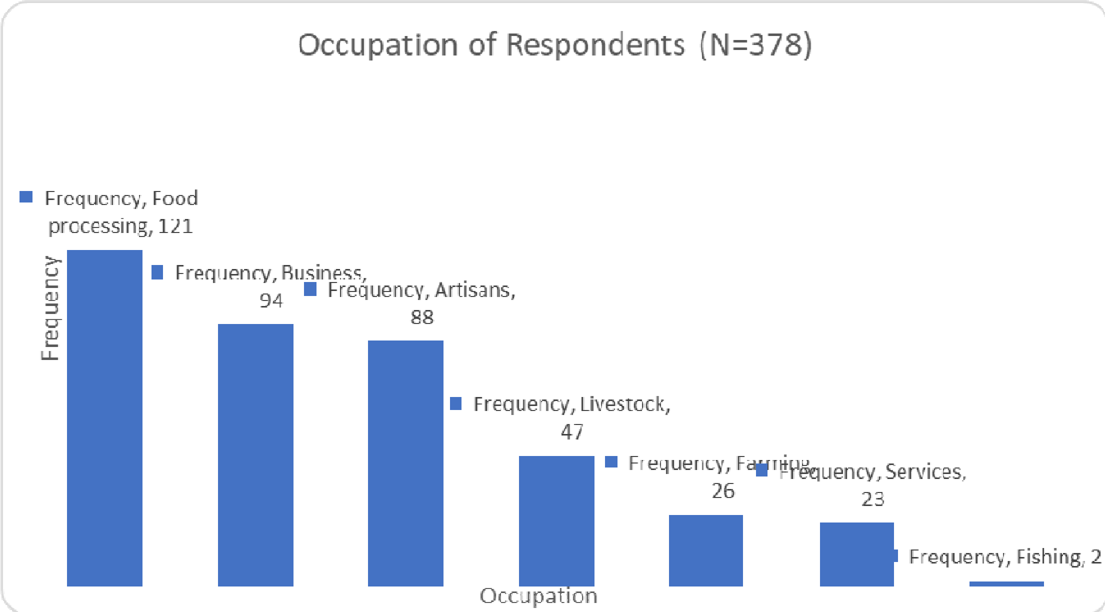


Figure 4. 125: Occupation of respondents

The monthly income of the respondents ranged from N100 to N300,000 depending on the season, even though the median income per month (N5,000) did not change with the seasons. In terms of expenditures, respondents spent between N100 to N15,000 (median = N2,000) monthly on transportation and between N2,000 to N30,000 (median = N2,000) monthly on health.

Access to potable water is one of the Sustainable Development Goals. Most members of the host communities of the KMRLP are able to meet the daily per capita water requirement of 20 – 40 liters, but mainly from a variety of sources such boreholes, wells, sachet water, rainwater and river. The main source of drinking water for several residents of the communities is public bore holes. According to the interviews carried out in the communities, this is mainly because of the good taste of the water, and the obvious contamination of surface water, streams and the rivers.

Plate 4. 23: Sources of potable water in the project area. (A. Water Cart Pushers at Gwarabjawa B. Water Supply Scheme, Nasarawa Community, Sandamu LG. C. Community Tap, Wailare Gari, Makoda D. Well at Ajumawa E. Communal well at Nahuce F. Solar Borehole at Dambat

When asked about antenatal care (ANC), less than half (44.0%) of the female respondents attended ANC during their last pregnancies. Majority of the women sought ANC care in public health facilities (84.7%) and only 22 (15.3%) went to private health facilities. Home delivery was also very common (61.8%) in the area and only few deliveries were supervised by doctors (9.2%) and midwives (28.8%). Figure 4.126 below shows the distribution of birth attendants during last child birth among female respondents in the study area:

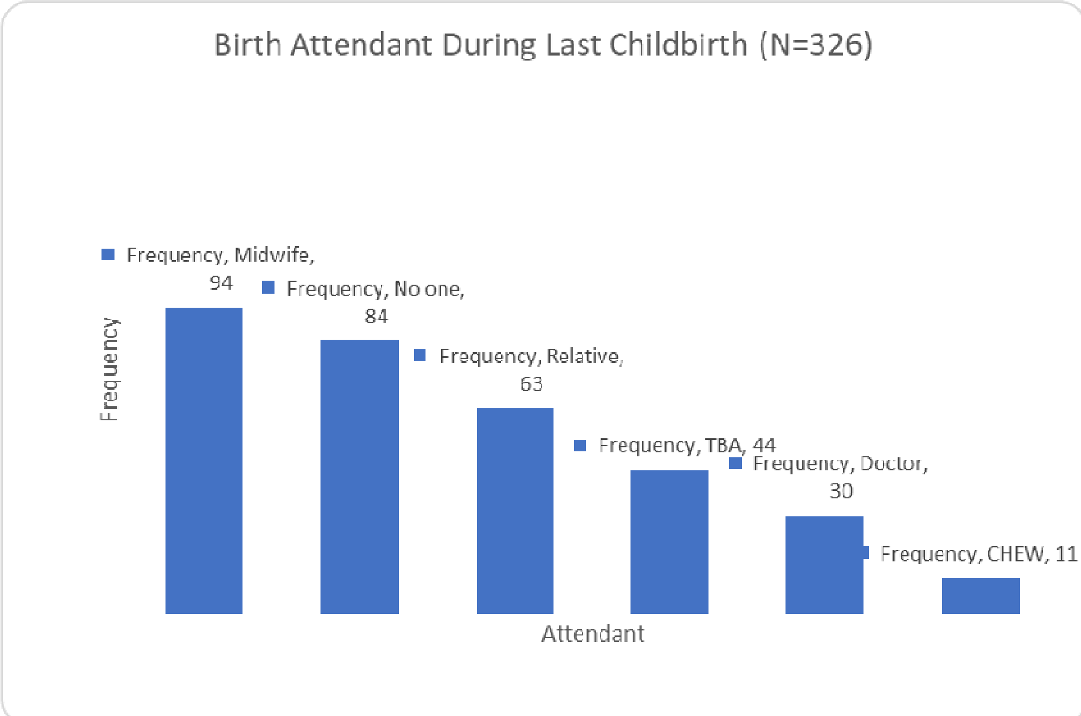


Figure 4.126: Birth attendant during last childbirth

In terms of healthcare-seeking behaviour, majority of the female respondents said they normally take their children to public health facility (76.3%) or private health facility (7.3%) when they are sick. Only few went to patent medicine vendors (8.5%) or did home/traditional care (7.9%). This is particularly significant given that up to 217 (60.3%) have to walk for more than 30 minutes before reaching the closest healthcare facility (Plate 4.20). Other factors identified as barriers to effective healthcare services utilization in the area included poor transportation (47.3%), lack of funds to pay for services (21.4%) and lack of trained staff and health equipment in the health facilities (23.8%).

Plate 4. 24: Healthcare Facilities in Project Area. (A. Public Health Care Centre, Tsallewa, Dambatta B. Local Medicine Store, Gangaren Dutse, Dawakin Tofa C. Private Clinic, Dawanau, Dawakin Tofa D. Primary Health Care Centre, Dan Dalama, Dawakin Tofa E. Patent Me

Regarding the proposed railway line project, majority of the respondents anticipated positive impact on their health (23.9%), family life (66.7%) and income (90.1%). however, adverse health concerns were also raised by the respondents including fear of accidents and injuries (31.9%), spread of communicable diseases (28.6%) as well as excessive noise and vibrations (15.7%).

Key informant interviews with health directors in the LGAs to be affected by the project noted reported health problems to be similar to those noted in the records of the health facilities that serve the communities; and consistent with the diseases reported in similar northern Nigerian communities (*NDHS, 2018*). The directors noted that most common causes of ill-health in the communities were malaria and typhoid fever (100.0%). Malaria was also the most common cause of death, followed by childhood illnesses, accidents and injuries. The records of the health facilities in the communities show that malaria is easily the most common cause of morbidity, accounting for over two-third of the cases seen in the health facilities. This is also similar to the situation in other parts of northern Nigeria. The State governments in the north have been proactive in malaria control, with the distribution of insecticide-treated bed nets, and free rapid malaria tests in health centres, as part of the Roll Back Malaria Initiative of the State governments.

The causes of death in the communities are also consistent with the findings in most other communities in northern Nigeria (*NDHS, 2018*). Adult members of the host communities according to the directors of health in the LGAs die mostly from the following communicable diseases: malaria, typhoid, diarrheal diseases and respiratory diseases such as pneumonia. Non-communicable diseases such as diabetes and hypertension were also said to be growing causes of death, especially amongst the elderly persons in the communities. Although about 97 health facilities were listed within the project area consisting of referral centre (15.5%), general hospitals (7.2%) and Primary Health Care (PHC) centres (72.3%). The communities are served by health centers, located such that most members of the communities are able to access primary health care within the prescribed 30-minutes travel time. Majority of the directors interviewed complained of inadequate number of health facilities. Only three (20.0%) directors reported having sufficient number of health facilities in their respective LGAs. Despite this, in terms of service provision at health facilities, all facilities in the area were said to offer immunization services. Other health services provided to various extents were malaria testing and treatment (86.6%), HIV testing (75.3%), antenatal care (90.7%), postnatal care (82.5%) and physiotherapy services (6.2%).

In terms of healthcare challenges faced by these LGAs, some of the most frequently cited were lack of qualified health personnel, lack of health equipment, inadequate financing for healthcare, inadequate supply of drugs and consumables. The health directors were also probed on the potential health impact of the proposed rail project and some of the most notable concerns were fear of spread of communicable diseases, environmental pollution as well as increase in accidents and injuries, whereas the potential benefits were said to be ease of transportation means and more economic opportunities in their domains. The communities have lots of land traffics, with accidents regularly reported from motorcycles and cars, which are the common means of transportation is said to be responsible for about 3% of the cases seen in the health facilities that serve the communities.

The incidence of traffic accidents is likely to increase during the rail line projects due to the expected increase in traffic, and the population explosion that is expected in the communities. This can be prevented with better education of not only the drivers, but also members of the communities, especially the children of the communities. There is no formal medical emergency evacuation system in all the host communities. Members of the communities make their own private arrangement in conveying their sick persons for appropriate treatment.

4.3.13 Stakeholder Engagement and Public Participation

4.3.13.1 Background

Engaging with stakeholders is important to the success and sustainability of the rail Project. The process is a systematic identification, analysis, planning and implementation of actions designed to influence stakeholders. Stakeholder engagement provides a mechanism for communication and feedback to assist in translating stakeholders needs into organisational goals and development of impact mitigation strategies. For this Project, a robust consultation is essential to provide insight into the project area environment, the people, their culture, their sensitive ecological and or social receptors, which may be threatened, damaged or destroyed by the project as well as their expectations and desired opportunities.

Principle 10 of the Declaration of the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro (Brazil, 1992) emphasizes that environmental issues are best handled with the participation of all concerned citizens, at the relevant levels. Agenda 21 adopted by United Nations Conference on Environment and Development (UNCED) recognized the important role of public participation in environmental impact assessment (EIA) in achieving sustainable development (item 23.2 of Agenda 21). Public participation in environmental decision-making and, in particular, in ESIA, may lead to some benefits in these processes. As a result of public participation, the process of decision-making, up to and including the final decision, becomes more transparent and legitimate. The methodology employed for the public consultation process considered the following aspects:

- The Nigerian legislative requirements;
- International stakeholder engagement practice guidelines;
- Local cultural requirements such as language proficiencies;
- Social sensitivities associated with the proposed project; and
- The geographical location of communities.

For the Kano-Maradi Rail project, a Stakeholder Engagement Plan (SEP) was developed as a key component of the ESIA process, which will serve as a guide in engaging with all the stakeholders; including PAPs and PACs. Mapping of the stakeholder groups in the project area is considered a fundamental step in developing an effective SEP. The stakeholder consultation exercise commenced at the very early stage of the environmental impact process and it is planned to continue throughout the project duration. The objective of the engagement plan is to identify stakeholders concerns and to ensure that issues raised during consultations are appropriately addressed in the ESIA. The Stakeholders Engagement process has been designed to comply with regulatory requirements set out in Nigerian environmental legislation and, where possible, implement international good practice guidelines. The process provides stakeholders with an opportunity to evaluate the proposed project and to submit comments for enhancing project benefits while minimizing the project's adverse effects. Further engagement processes and activities will build on the consultations already undertaken during scoping phase, and these will include periodic engagement and grievance resolution process.

4.3.13.2 National Requirements and International Standards

National Requirements

Stakeholder engagement is an important component of the ESIA process in Nigeria; and it is a key requirement for proposed development projects classified as Category I. In line with the ESIA Guidelines, engagement of PACs, PAPs, regulators and government ministries and parastatals at the three tiers of government is mandatory for development project of this magnitude. The FMEnv expects that persons, communities and government institutions who have an interest in the design, implementation and sustainability of the project, and who are likely to be positively or negatively impacted, must be carried along from the start.

International Finance Corporation Standards

The rail Project falls under Category A based on IFC classification. As a result, it must align with good international practice, including the IFC Performance Standards (PS) and Guidance Notes of 2013. One of the key requirements in the IFC "Good Practice

Handbook for Companies Doing Business in Emerging Markets" is stakeholders' engagement. In addition, the Scope of Application of the World Bank ESS10 requires Borrower to engage with stakeholders as an integral part of the project's environmental and social assessment and project design and implementation. This must be done throughout the project life cycle, commencing such engagement as early as possible in the project development process and in a time frame that enables meaningful consultations with stakeholders on project design.

4.3.13.3 Stakeholder Identification and Analysis

Stakeholder Identification

To achieve effective and appropriate engagement, the following stakeholder categories were identified during reconnaissance and scoping workshop:

Project-Affected Parties: These are individuals, groups and other entities along the project corridor and within the Project Area of Influence. The project-affected parties are potentially and directly affected by the proposed rail project. They are the most susceptible to possible changes associated with the project. They were well-engaged and continually for identification of likely project impacts and their significance as well as mitigation measures;

Other Interested Parties: Other interest parties are individuals, groups and entities that may not experience direct impacts from the Project but who consider or perceive their interests as being affected by the Project and/or who could influence the Project and the process of its implementation in some way; and

Vulnerable Groups: The vulnerable groups are persons who may be extremely impacted by the project and or who may be further disadvantaged by the Project in comparison with other groups by virtue of their vulnerable status. These groups may require special engagement efforts to guarantee their equal representation in the stakeholders' consultation engagement process as well as the decision-making process associated with the Project.

Scoping Methodology and Outcomes

Scoping workshops were organised and held at the state capitals of the three affected states in Nigeria; namely Dutse (Jigawa State), Kano (Kano State) and Katsina (Katsina State). In Jigawa, the scoping workshop was held at Dutse Royal Hotel, Dutse, Jigawa State on Monday, 20th September, 2021. The Scoping Workshop for stakeholders in Kano State was held at the Grand Central Hotel, Kano on Tuesday, 21st September, 2021 while the workshop was held in Katsina on Thursday, September 23rd, 2021 at Education Resource Centre, Opposite Katsina Museum, Katsina (Table 4. 32).

Table 4. 32: Summary of Scoping Workshops for the Kano-Maradi Rail Project

<table>
<tr><th>State</th><th>Date</th><th>Location</th><th>No. of Participants</th><th>Group of Participants / Stakeholders</th></tr>
<tr><td>Jigawa</td><td>Monday, 20th September, 2021</td><td>Dutse Royal Hotel, Dutse, Jigawa State</td><td>128</td><td rowspan="3">Listed under Section 6.3: Stakeholder Identification and Analysis (Subsection 6.3.3 to 6.3.11)

In attendance were: District Heads of Project Affected Communities, National Government: Regulatory and Executive Institutions, State Government Institutions, Local Government Authorities, Traditional Institutions and Emirates, Trade Unions, Non-Governmental Organisations (NGOs)/Community Based Organisations (CBOs), Media Organisations and Groups, International Organisations</td></tr>
<tr><td>Kano</td><td>Tuesday, 21st September, 2021</td><td>Grand Central Hotel, Kano</td><td>120</td></tr>
<tr><td>Katsina</td><td>Thursday, September 23, 2021</td><td>Education Resource Centre, Opposite Katsina Museum, Katsina</td><td>84</td></tr>
</table>

Prior to the workshops, invitation letters with the Project Background Information Document (PBID) were sent to all the key stakeholders in the three states. These include ministries and government agencies at the federal, state and local government levels. The traditional rulers including the Emirs, and District Heads were pre-informed and invited. In addition, Non-Government Organisations, Civil Society Organisations, trade unions, and other interest groups were invited to be a part of the scoping exercise.

At the scoping workshop in Jigawa, 128 participants were present; 120 people attended the workshop in Kano and 84 attendees came to the workshop held in Katsina (Table 4. 32). Majority of the stakeholders present at the workshops actively contributed to discussions. The scoping workshops were held in an open house format with adequate capacity for all attendees. Posters and banners about the Project were displayed at each of the venues while presentations were made in English and Hausa by Allott Team. At the end of presentation, participants were encouraged and given opportunities to express their views.

There is overwhelming support for the Project, due to the anticipated benefits, from all stakeholders at the workshop in Jigawa State (refer to minutes of the meeting in scoping report). Concerns were raised about economic and physical displacement. Also, of interest to some of the stakeholders are compensation for potential losses and displacement from farmlands and houses. The same concerns were expressed in Kano and Katsina States. Of particular interest to the Miyetti Allah Cattle Breeders Association of Nigeria in Kano and Katsina is the possible fragmentation of the international cattle routes, which link Kano and Katsina States with The Republic of Niger. Also, concerns about possible collision of train with herds of cattle while crossing the rail line at the operation phase of the project. The accident involving Abuja-Kaduna train and a herd of cattle, which occurred in September 2018 was cited as an instance.

Other key issues raised during the workshops are summarised as follow:

- The likely impact of the project on the Great Green Wall
- Adequate inclusion of women groups and the vulnerable individuals in the entire process.

Status of Stakeholders Engagement

Consultations have been held at different levels with all the major stakeholders. These include the Federal Ministry of Environment, the State Ministries of Environment in Jigawa, Kano and Katsina States as well as other government agencies and parastatals who are regulators on land and environmental matters. In addition, the Emirate Councils within which the proposed rail project falls have been engaged. Other stakeholders engaged and consulted are the heads of project affected communities, Non-Governmental Organisations (NGOs) and Community Based Organisations (CBOs). Primarily, consultations with the stakeholders were held to provide them with adequate information about the project and proposed project activities, its potential benefits and possible impacts. In addition, the engagement was intended to provide a platform for feedbacks, concerns and inputs that would guide in identifying key adverse impacts the project may have on the communities within the project's area of influence. Suggestions from the stakeholders on practicable mitigation measures for the identified potential impacts were also documented. The attendance registers and minutes of the workshops are provided in the Appendix and Scoping Report.

The following organisations, unions, government agencies, ministries and institutions have been engaged:

National Government: Regulatory and Executive Institutions

1. Department of State Security, Dutse
2. Federal Ministry of Environment
3. Federal Ministry of Water Resources, Federal Secretariat, Dutse
4. Federal Ministry of Works and Housing, Federal Secretariat, Dutse
5. Federal Road Safety Corp, Dutse
6. Hadejia Jama'are River Basin Development Authority, Dutse
7. National Environmental Standards and Regulations Enforcement Agency (NESREA)
8. Nigeria Erosion and Watershed Management Project
9. National Orientation Agency

10. Nigeria Police Force, Dutse
11. Nigerian Security and Civil Defense Corp

State Government Institutions

1. Jigawa State Agricultural and Rural Development Authority (JARDA), Dutse
2. Jigawa State Ministry of Agriculture, Dutse
3. Jigawa State Ministry of Environment, Dutse
4. Jigawa State Ministry of Information, Dutse
5. Jigawa State Ministry of Lands, Housing, Urban Development and Regional Planning,
6. Jigawa State Ministry of Local Government and Chieftaincy Affairs, Dutse
7. Jigawa State Ministry of Water Resources
8. Jigawa State Ministry of Works and Housing, Dutse
9. Kano State Agriculture and Rural Development Authority (KNARDA)
10. Kano State Agro Pastoral Development Project
11. Kano Chamber of Commerce Industry, Mines & Agriculture
12. Kano State Ministry of Agriculture and Natural Resources
13. Kano State Ministry of Environment
14. Kano State Ministry of information and internal affairs
15. Kano State Ministry of Local Government
16. Kano State Ministry of Water Resources
17. Kano State Ministry of Works and Housing
18. Katsina State Ministry of Agriculture
19. Katsina State Ministry of Environment
20. Katsina State Ministry of Information
21. Katsina State Ministry of Land and Survey
22. Katsina State Ministry of Local Government and Chieftaincy Affairs
23. Katsina State Ministry of Water Resources
24. Katsina State Ministry of Works and Housing

25. Livestock Development Project

Local Government Authorities

1. Daura Local Government Authority (Katsina)
2. Dambatta Local Government Authority
3. Dawakin Kudu Local Government Authority
4. Dawakin Tofa Local Government Authority
5. Dutse Local Government Authority (Jigawa)
6. Dutsi Local Government Authority (Katsina)
7. Gaya Local Government Authority
8. Gwale Local Government Authority
9. Gwiwa Local Government Authority
10. Jibiya Local Government Authority (Katsina)
11. Katsina Local Government Authority (Katsina)
12. Kazaure Local Government Authority (Jigawa)
13. Kumbotso Local Government Authority (Kano)
14. Mashi Local Government Authority (Katsina)
15. Minjibir Local Government Authority
16. Roni Local Government Authority
17. Sandamu Local Government Authority
18. Warawa Local Government Authority
19. Wudil Local Government Authority
20. Yankwashi Local Government Authority

Traditional Institutions and Emirates

1. Bichi Emirate Council
2. Daura Emirate Council
3. Dutse Emirate Council
4. Gaya Emirate Council
5. Kano Emirate Council
6. Katsina Emirate Council (Katsina)

7. Kazaure Emirate Council, Kazaure (Jigawa)

Trade Unions

1. All Farmers Association of Nigeria (AFAN)
2. Jigawa State Vigilante Group
3. Kano State Vigilante Group
4. Miyetti Allah Cattle Breeders Association (MACBAN)
5. National Association of Road Transport Owners (NARTO)
6. National Union of Road Transport Workers (NURTW)
7. Progressive Farmers Association, Zai Quarters, Dutse
8. Small Scale Women Farmers Association of Nigeria

Non-Governmental Organisations (NGOs)/Community Based Organisations (CBOs)

1. Africa Desertification Control Initiative
2. CAREFOR (NGO)
3. Center for Environment and Rural Development (CERD)
4. Civil Society Action Coalition on Education for All (CSACEFA)
5. Family Health and Youth Empowerment Organization (FAHYE)
6. Green Foundation Jigawa State, Dutse
7. Green Nigeria Foundation, Dutse
8. Global Environmental and Climate Conservation Initiative
9. Great Green Wall Programme, Dutse
10. Nigerian Environmental Society
11. Gender and Constitutional Reform Network (GECORN)
12. Stand up for Women Society
13. Fulbe Development Association of Nigeria (FULDAN)
14. Katsina Peace and Development Organization
15. Katsina Youth Support Against Deforestation
16. Kazaure Emirate Progressive Forum
17. Federation of Muslim Women's Associations of Nigeria (FOMWAN)

18. Connected Development Association (CODE)
19. Society for Women Development and Empowerment of Nigeria
20. Support for Women and Teenage
21. Support for Women and Teenage children (SWATCH)
22. Society for Women Development and Empowerment of Nigeria (SWODEN)
23. Strategic Women In Leadership Initiative (SWILI)
24. Rural Institution for Community Development (RICOD)
25. Youth and Environmental Development Association (YEDA)
26. WeGirls Foundation
27. Women Economic Empowerment Organization Katsina
28. Women Gender Developers

Media Organisations and Groups

1. Companion FM (Katsina)
2. Freedom Radio (Jigawa)
3. Nigerian Union of Journalist (NUJ)
4. Nigeria Association of Women Journalists (NAWOJ)
5. Nigerian Television Authority (NTA)
6. Radio Jigawa
7. Radio Kano
8. Vision FM, Katsina

International Organisations

1. World Health Organization (WHO)
2. United Nations Children's Fund (UNICEF)

4.3.13.4 *Key Issues and Concerns from Stakeholders*

The major issues that were raised during the Scoping Workshop (Photolog – Plate 4. 25) which are of concern to the stakeholders are possible displacement of farmers from farmlands and impacts on their livelihood. Also, the potential physical displacement and how to effectively mitigate the hardships that could result from that was a critical issue

(Table 4. 33). Others important matters arising are fragmentation of communities and grazing route, risk of train collision with cattle, train-related accident and other issues documented in the minutes of the workshop.

Table 4. 33: Summary of Comments and Key Issues Raised During Scoping Workshops

State	Summary of Comments and Key Issues Raised	Response
Jigawa	Representative of Jigawa State Commissioner of Police: Engagement of local youths in the project to reduce unemployment, which is a major cause of criminal activities. Women Leader (Hajiya Hadiza Abdulwahab): Women should be carried along throughout the project execution stages, especially concerning decisions and employment. A security operative (Musa Muhammed) raised concern about land take, displacement and grievances; suggesting that compensation and grievance resolution mechanisms should be put in place.	The RAP Team and the Environmental Consultant acknowledged the importance of engaging local youths to reduce unemployment and associated criminal activities. The participants were assured that the project will prioritize hiring local youths for various roles, including construction and support services, to foster local economic growth and stability. The Federal Ministry of Transport official assured that women will be actively included in key parts of the project during implementation. This will involve creating opportunities for women in decision-making processes and ensuring equitable employment practices. On the issue of land take and displacement, participants were informed by the FMT official that Compensation and grievance resolution mechanisms will be established to address issues of land take and displacement.
Kano	The Director of Kano State Stock Route (Dr. Saleh): Fragmentation of the international grazing routes by the rail line is a major concern. Mitigation measures to address this should be at the project design phase. MACBAN Representative: Potential impact on cattle, herdsmen should be well-addressed during planning and construction.	Mr. Attahiru Usman, the Environmental Consultant, assured the participants at the scoping workshop that the design team will ensure that international grazing routes are preserved or rerouted appropriately. This will include constructing underpasses or overpasses where necessary.

State	Summary of Comments and Key Issues Raised	Response
	Representative of Kano Emirate Council: Displacement of farmers and livestock owners from grazing field should be handled with caution. Grievances redress mechanism should be put in place.	It was also mentioned that the Federal Ministry of Transport will work closely with MACBAN to address potential impacts on cattle and herdsmen. This may involve creating alternative grazing routes and ensuring that herders are informed and involved in the planning process. Regarding the issues of displacement, a comprehensive grievance redress mechanism will be put in place to manage the displacement of farmers and livestock owners. Compensation plans will be developed in consultation with affected communities to ensure fairness and transparency.
Katsina	Sensitization campaigns for herders along the rail route should be embarked on so that there would not be cases of animal's crossing the rail line when it becomes operational. All Farmers Association of Nigeria (AFAN) Representative: Compensation for displacement The representation of Umaru Musa Yar'adua University Centre for Renewable Energy: Local content / engagement of local manpower at different phases of the project. The coordinator of Katsina Women Economic Empowerment Project: Women participation in the project Deputy Commandant of NSCDC: Security issues should be addressed by liaising with security operatives and investment in security outposts. The representatives of Katsina Livestock Development Project: Mitigation plan for livestock in the project area, which are likely to be impacted.	In response to some of the concerns, Mr. Attahiru told the people at the meeting that the FMT will collaborate with the state government and relevant associations to organize sensitization campaigns to educate herders about the operational rail line and measures to prevent animals from crossing it. He also mentioned that the federal government will ensure that adequate compensation is provided to landowners displaced by the project. This will be done in consultation with local communities and stakeholders to ensure fairness and transparency. Participants were also assured that the project will prioritize local content and the engagement of local manpower at different phases. Training programs will be implemented to build the capacity of local workers.

State	Summary of Comments and Key Issues Raised	Response
	The representative of Great Green Wall: Tree planting is an important mitigation measure to address land clearing for rail construction. Miyetti Allah Cattle Breeders Association of Nigeria Representative: Fragmentation of the local and international grazing routes, associated impacts and possible mitigation. The representative of CAREFOR (NGO) made case for likely impacts of the project on sensitive biological receptors.	For the women, they were given assurance that women will be encouraged to participate in the project through targeted employment opportunities and inclusion in decision-making processes. The project also will liaise with security operatives and invest in security outposts along the rail route to address potential security issues. In addition, a comprehensive mitigation plan will be developed to address the impact on livestock. This will include creating alternative grazing routes and providing necessary support to herders. Lastly, concerned individuals were told by Mr. Attahiru Usman that measures will be taken to minimize the fragmentation of local and international grazing routes. This may include constructing underpasses or overpasses.


A cross-section of the participants at the Kano Scoping Workshop


Another cross-section of the participants at the Kano Scoping Workshop


Some of the aides of traditional rulers present at the Scoping Workshop in Kano


Group photograph with Traditional rulers in Kano during the scoping exercise


A participant expressing his opinions at the Scoping Workshop in Jigawa

Another participant at the Katsina Scoping Workshop expressing his views about the project

Women at the Scoping Workshop in Katsina


Participants at the Scoping Workshop in Jigawa

Plate 4. 25: Photolog of Scoping Workshop

4.3.13.5 *Further Engagement of Stakeholders*

During the ESIA surveys, stakeholder mapping served as an important tool for identifying stakeholders in the Project Affected Communities (PACs), key informants, as well as, Project Affected Persons (PAPs). Using available data, a total of 105 named communities along the rail route within a 5 km radius of the line were identified. Out of which 50% was selected for interviews of the village head/leaders, administration of the household survey instruments, Key Informant Interviews and Focus Group Discussions. Baseline data on availability of infrastructures in the communities in terms of provision of potable water, electricity, functional orthodox health care facilities, renovation, and equipping schools, desertification control projects etc were also collated and presented in the socio-economic report. Find below some picture evidences of stakeholders' engagement during the field surveys (Plates 4.26 and 4.27). Field Note on Stakeholders engagement with pastoralist communities along the Project corridor are in Appendix II.

Plate 4. 26: Field Enumerator Administering Survey Instruments during the field surveys

Plate 4. 27: Focus Group Discussions and Key Informant Interviews during the Field Surveys

4.3.13.6 Indigenous Peoples in the Project Area

"Indigenous people" are usually conceptualised as a self-defined group with common cultural characteristics different from the dominant culture in an area. However, in the study area, these people are referred to as "Vulnerable Minorities".

In study area, there are communities along the rail route in Jigawa, Kano and Katsina States in the Northwest Zone of Nigeria, and two of such groups were originally identified. One is the pastoral Fulani, who although sharing the Muslim religion with the dominant Hausa culture, have a distinct language (Fulfulde) and a livelihood centered around the rearing of animals, particularly cattle, but also occasionally camels, and small ruminants like sheep and goats. Details about the livelihood of pastoral groups is documented in Allott Report on Pastoral issues.

The second group that was expected to be found in the project area are the Maguzawa. These are the original Hausa people, who continue to follow a pre-Islamic way of life and adhere to traditional religious practices centered around spirits, sacred animals and shrines. They share a common language (Hausa) with the dominant inhabitants, but differ with them in their cultural and religious beliefs. During the field study, while we found that several communities of Maguzawa still exist in the three affected states, these communities live in "deep rural" areas, far from centres of population and Muslim neighbours, and continue to separate themselves as much as possible from authority structures, whether traditional (the emirate structure) or modern (the Local Governments, State governments, etc.)

It was observed along the rail route in the 5km corridor that a few formerly Maguzawa communities who had converted to Islam and were indistinguishable from the wider Hausa Muslim society, as well as two of such communities who had converted to Christianity and continue to distinguish themselves from the Muslim Hausa although living amongst them.

Brief notes on these two communities who call themselves Hausa Christians are provided below:

1. **Mission community.** This community is located in Fago Ward of Sandamu Local Government in Katsina State, at lat. 12° 54' 01.8 N and long. 008° 22' 49.9E. It is located along the Daura-Kazaure Road, and the rail line will pass through the community. The community is said to have been established around 1947 by the Sudan Interior Mission. It is estimated to have about 100 members. The Mission established a clinic at the eastern part of Falgo village which attracted the attention of some Maguzawa and also some Muslim inhabitants who converted to Christianity. The community was named "Mission" after the missionary clinic. Aside from the clinic, the mission established a church and school for the members. The community was headed by a pastor who was posted from ECWA (A Mission organisation that succeeded the SIM) headquarters. He is assisted by a Council of Elders chosen by members of the church. The church is the center of activities, with youth clubs, choir, and womens' group. The community members had migrated to the area from various villages in the region. In their previous existence they were predominantly farmers, blacksmiths and animal herders. Farming is still the major occupation of the community members, but some are now artisans, traders and civil servants. The members say they have a good relationship with their Muslim neighbours. They invite each other for weddings, naming ceremonies and other occasions. They live interspersed with Muslims and are not segregated by religion. The members of the community are eager to embrace the railway project as they feel it will have a positive impact by way of providing jobs and better transportation facilities, but are also fearful as their farmlands may be affected.

2. **Katoge community**, located in Kazaure Local Government Area of Jigawa State. This community is located along the Daura-Kano Road, at lat. 12° 39' 10" N and lon. 008° 24' 43" E. The rail route passes through the community. The community is said to have been established by Maguzawa people around 1940. The population is estimated at between 250 and 300 people. They are said to have migrated from various villages near Kazaure such as Roni, Karare, Kagadama, Dangi, etc. They started converting to Christianity around 1940 when some missionaries from a

Canadian Christian Mission were posted to the area to establish a church by the Sudan Interior Mission. As in Mission Community, the community was headed by a Pastor posted to the area from ECWA Headquarters, assisted by a Council of Elders drawn from the community. At present there are many other churches that have been established in the area including Evangelical churches like Living Faith, Deeper Life, and others. They all have church-related institutions such as schools and clinics, choirs, youth groups, women's groups, etc. As is the case with Mission Community, the residents have good relations with their Muslim neighbours, with no history of friction between the religious groups. They are still predominantly farmers, as they had been before their conversion, but due to educational opportunities some have become artisans and civil servants. Like those in Mission Community, the residents are in support of the railroad for the opportunities it will provide but are worried that farmlands of affected individuals will be taken away.

4.3.13.7 Public Disclosure

Disclosure of information is equally as vital in the EIA process. In line with international best practice, consultation began by ensuring free, prior and informed engagement of the affected communities. In other words, effective consultation requires prior disclosure of important project information to enable stakeholders understand the Project risks, impacts, and opportunities. The Project's consultation program is to ensure that stakeholder concerns are considered, addressed and incorporated in the development process, especially during the EIA. As part of the formal regulatory and consultation process, when the draft ESIA report is submitted to Federal Ministry of Environment (FMEnv). FMEnv makes a public notice of the opportunity for information and comment on the draft ESIA report for the project. This notification is typically done through a newspaper and radio announcement.

The notification will provide:

- a brief description of the project;
- a list of venues where the ESIA report is on display and available for viewing;

- duration of the display period; and
- contact information for comments.

The FMEnv generally requires a twenty-one (21) working day display period. Display venues will be decided by FMEnv but could be expected to include:

- FMEnv offices in Abuja;
- Kano, Katsina and Jigawa State Ministries of Environment; and
- Project Affected Local Government headquarters.

Once the draft ESIA report has been submitted to the FMEnv, it will likely be subjected to a review by a panel of experts constituted by FMEnv. The panel would likely comprise experts from within FMEnv, as well as, external specialists included for their expertise on the specific environmental or social topic. Following the review period, the findings will be presented to the panel, likely to be in the form of a public hearing. The project will then need to take appropriate actions to address these findings and comments received from the panel members on the ESIA report. This may include additional studies; revision to the ESIA report text to correct or clarify content; or development of additional mitigation measures or management actions. Upon satisfactory completion of the actions required to address the findings, the draft ESIA report will be finalized and the FMEnv will issue an initial provisional EIA certification/authorization. After the issuance of the provisional ESIA permit, the Impact Mitigation Monitoring (IMM) process by the FMEnv will also be undertaken before final approval.

4.3.13.8 Grievance Redress Mechanisms

Grievances are real or perceived causes of concerns or distress felt by any project stakeholder, which is a reason for complaints or disputes. A grievance can be submitted by an individual or a group that has been affected by the project activity from the construction phase through the project operational and decommissioning phase. It is essential to have a grievance redress mechanism for every project that involves resettlement. Therefore, this grievance redress mechanism would be used through the scoping and resettlement phase of the project.

An effective and functional grievance redress mechanism would help in early indication of grievances, collection and prompt resolving of grievances from affected communities and other stakeholders related to the project. A functional grievance redress mechanism protects project owners from grievance related litigations, and it will prevent any grievance related conflict.

The purpose of the grievance redress mechanism is to address grievances or complaints resulting from land acquisition, resettlement, livelihood resettlement and other project activities the project affected parties may have concerning the project activities and find a resolution to the complaints. It is essential grievances are addressed timely as it is vital to the appropriate implementation of resettlement and timely completion of the project. The grievances raised would be addressed at no cost to the complainant.

Grievances and Resolution Process in the Project Area

The traditional leaders resolve all grievances in the community. Key issues that require settling or mediation include land issues between the community members, trespass issues by herders, or delay in payment of compensation from land acquisition for projects in the area. The communities historically have had few grievances, which are resolved by consultation with the traditional leader without the involvement of the court or police as the traditional leadership is highly respected.

Project Grievance Addressing Technique

In the course of the project, grievances will arise, which will have to be addressed accordingly. The project will adopt international best practices in collecting and resolving grievances as part of grievance management. In resolving grievances, the following measures will be put in place.

I. The Client will set up a Grievance Redress Committee (GRC) in each state to receive and address complaints from the resettlement planning, the committee will be responsible for collecting grievances at the local level. The members of the committee shall show excellent interpersonal and communication skills, be empathetic towards the local communities and have a good knowledge of the local language and the local context. The GRC committee will include both women and men to allow the easy access of men, women and vulnerable people to the GRM.

II. Grievances would be lodged both in written and verbal form. All grievances would be collected by grievance officers present in all project-affected communities in each state. These grievances would be collated and sent to the project headquarters for resolution.
III. Give deadlines for addressing complaints
IV. Ensure grievances can be submitted at no cost and the identity of complainants are kept confidential.
V. Verify eligibility of grievances before it is processed
VI. Allow complainants to seek alternative recourse such as the court or arbitration if they are not satisfied with the resolution of the GRC.
VII. Keep records of the complaints and resolutions for monitoring and evaluation.

4.3.13.9 Future Consultations

The proponent shall continue to consult with the regulatory agencies, the host communities, all stakeholders, and other relevant parties concerned with or are likely to be affected by the project at all stages of project development. On the approval of this ESIA to commence the construction activities, a detailed Memorandum of Understanding (MoU) shall be signed with the affected communities.

In conclusion, the community and stakeholder engagement undertaken by the project fulfils the requirements of the Terms of Reference and is undertaken according to the strategy prepared by the Project. A variety of communication activities and tools were used to seek broad and informed communities and stakeholders' responses, and the issues and opportunities identified through stakeholders' engagement informed the development of the ESIA. Specific communication activities undertaken to facilitate effective two-way communications included the Community Information Session, briefings of key stakeholders including government agencies and NGOs, and community-based groups. Throughout the project design and data gathering process, multiple avenues were provided for stakeholders to access information and provide comments and/or ask questions and receive answers. The engagement program engaged the community by:

- attracting approximately major community members to the Community Information Session
- providing briefings to government agencies and Community-Based Organisations (CBOs) and NGOs.
- generating feedback from community leaders and institutional stakeholders.

4.3.14 Resettlement Planning

The client has contracted the consultancy services of Translantic Development Limited (TDL), an international Environmental, Social and Governance service provider, to conduct the resettlement planning for the project. The scope of work for the resettlement planning includes:

1. Resettlement Scoping
2. Resettlement Policy Framework (RPF), and
3. Resettlement Action Plan (RAP) for the project.

4.3.14.1Resettlement Scoping

The resettlement scoping report outlines findings from the array of desk studies, field surveys, and multiple stakeholder engagement conducted to determine the nature and extent of physical and economic risks and impacts associated with land acquisition for the rail line and its ancillary facilities. The resettlement scoping report is formed of findings from the satellite imagery analyses (March 2021), reconnaissance studies (June 2021), site verification and screening exercise (August 2021), the resettlement scoping field study (September to October 2021), and other project background documents shared by MEA. The report also contains the Terms of Reference (ToR) for developing the RPF, which was conducted following the closure of the resettlement scoping report. This report has been prepared in line with requisite local and national laws, and importantly, necessary requirements in line with good international practices in resettlement planning.

Resettlement Scoping Objectives

The objectives of the resettlement scoping are to:

- To assess if the project would cause any displacement. The type of displacement it would cause will infer if a Resettlement Action Plan (RAP) or a Livelihood Resettlement Plan (LRP) is required.
- Develop a likely scope of displacement (both physical and economic).
- To assess whether any Project alternatives can avoid displacement, and where avoidance is not possible, minimize the extent of displacement.
- To prepare a clear ToR for the development of an RPF.

Scoping Workshop

The scoping workshop was held in Jigawa on 20th September 2021, Kano on 21st September 2021, and Katsina State on 23rd September 2021 as a 1-day strategic awareness creation, information dissemination and information gathering event for each State. Participants at the workshops included the relevant State Government Ministries Departments and Agencies (MDAs), project proponent, project consultants, NGOs, CBOs, Media Houses, and other interested parties (Plate 4. 28). The outcome of the RAP scoping workshop has been properly documented in the RAP scoping report.

Plate 4. 28: Presentation to Stakeholders at the Scoping Workshop
(Source: RAP Scoping Report, 2022)

4.3.14.2 *Resettlement Policy Framework*

The Resettlement Policy Framework (RPF) is a principle-based framework that guides potential land acquisition and potential resettlement for the construction of infrastructural projects in accordance with the requirements of the National and International laws and Standards. The RPF will govern and guide the development of a site-specific Resettlement Action Plan and Livelihood Restoration Plan and or any other social impact management plans.

Objectives of the RPF

The RPF will ensure that there is a systematic process for the distinct stages of the implementation of a framework that assures the participation of affected persons, involvement of relevant institutions and stakeholders, and adherence to local and best practice international laws such as the IFC Performance Standard. It will also serve as the framework within which the project resettlement action plan will be developed.

The specific objectives of the Resettlement Policy Framework are to:

I. Classify legal frameworks in all events of involuntary resettlement, relocation and loss of assets, including legal and administrative procedures and compensation for loss of assets
II. Identify key institutions involved in the project implementation, such as state institutions responsible for land management and implementation of procedures and safeguards of resettlement
III. Identify Project stakeholders and appropriate methods of engagement to be adopted throughout Project implementation
IV. Identify possible eligibility criteria for affected persons and proposed compensation entitlement matrix according to the type of loss assets, and define the process of identification and evaluation of affected assets (including the value of compensation to replace the loss)
V. Describe proposed mitigation measures for land acquisition associated with the Project, including procedures in order to minimize resettlement impacts on affected persons during Project implementation, including specific mitigation measures for vulnerable groups
VI. Define grievance and complaint rights and procedures that will be adopted for the duration of the Project implementation
VII. Describe processes and activities to prepare a full RAP and LRP, including their implementation process

VIII. Specify requirements for public disclosure, disclosure of documents, public and local community involvement in all phases of the project preparation, including the development of the RPF and RAP/LRP

IX. Establish a vulnerability framework (including gender) for resettlement in order to determine differential impacts since economic and social disruption may be experienced to differing degrees

X. Specify the approach (framework) to monitoring and evaluation (M&E), including both the resettlement process and management of resettlement impacts (both internal and external M&E).

4.3.14.3 Resettlement Action Plan (RAP)

According to the International Finance Corporation's (IFC) manual on resettlement planning, the first step in conducting a RAP is identifying project affected entities. Resettlement planning is much more than just undertaking land surveys or inventorying impacted assets. Generally, the RAP is more than just a tool for compensation, and it should be designed as a mechanism to improve the quality of life of project affected entities. In addition, a well-planned RAP should identify all project-affected entities and how land acquisition for the project will adversely impact their livelihoods, social infrastructure, access to social infrastructure and existing social networks.

Consultation with key stakeholders such as traditional leaders, government officials, community-based organisations, and non-governmental organisations is essential to understand the types and degrees of adverse project impacts.

<u>Principles</u>

For the Kano – Maradi Rail project, the approach to conducting the RAP study will follow the following principles;

- Accurately identify the project affected entities (person, households, communities, users/ owners, businesses, institutions) and ascertain the specific magnitude of physical/economic impacts within the Right of Way (RoW).

- Ascertain the market price and the replacement value of the affected assets by carrying out a detailed market survey.
- Collect relevant social data about impacted communities and align with the back-office quality control and existing project database.
- Ascertain the level of support required by Project Affected Persons and Households to cushion the effect of project impacts.
- Create seamless data management interphase from field to back end through TDL's Open Data Kit (ODK) platform for socioeconomic data, asset inventory data and geodatabase for the GIS data.
- Preparation of the valuation report for all assets along the RoW and;
- Preparation of asset identification maps and land use map;
- Create a suitable eligibility and entitlement matrix for the resettlement works.

RAP Study Stakeholder Engagement

Stakeholder engagement will guide the consultative process of the GIS land parcel survey, asset inventory and valuation, and socioeconomic census. Importantly, it will ensure that all stakeholders who are directly or indirectly involved are fully engaged about the RAP studies. Stakeholder engagement will include community entry meetings, key informant interviews, Focus Group Discussions, and town hall meetings, among others. GIS Land Parcel Survey.

Conducting the Survey

All impacted assets along the Right of Way will be systematically identified and documented by the valuation and GIS team. In this context, impacted assets refer to all unexhausted improvements at different levels of completion within the Right of Way. Each affected asset will be well documented alongside the name of its owner or claimant. As soon as all assets have been marked and documented, a detailed market survey of similar assets to the impacted will be conducted by a qualified Valuation expert(s). For the asset inventory survey, tablets will also be used to record details of affected persons and all assets identified. This data collection methodology uses TDL's ODK platform and would tie in seamlessly with the socioeconomic data.

- Impacted unexhausted improvements will be marked and documented by the enumerator or field valuation team.
- Details of all assets/asset owners will be documented on the tablet, and all relevant parties will be required to sign an inventory acknowledgement form electronically upon confirmation with the representatives from the traditional leadership. In addition, a hardcopy acknowledgement form/receipt duly signed will be completed on the field and shared with the asset owner.
- Affected crops will be inventoried and their land size recorded, while individual headcounts will be done for perennial and economic tree crops.
- As part of the survey, all uncultivated land parcels will also be considered and recorded to reflect their previous land use (if any) alongside their respective owners.
- Photographs of all affected assets and claimants, as well as the nature of impacts, will be documented on TDL's bespoke geodatabase.
- Account details of all claimants will be collected during the enumeration process.
- All acknowledgement forms will be completed on the field to be shared with the claimant, MEA representative and the survey team.
- A detailed market survey to understand the cultural/economic relevance of impacted land parcels, structures (completed & uncompleted), crops and economic trees within the Right of Way. This process entails the collection of relevant market information (current market rates of similar assets), which would inform the replacement costs for all impacted assets.

4.3.15 Socio-economic Studies

4.3.15.1 Introduction

The Federal Government of Nigeria (FGN) through the Federal Ministry of Transportation (FMT) proposes to construct a Standard Gauge Rail (SGR) line from Kano, north-western part of Nigeria to link Maradi Province in southern part of Niger Republic with a Branch Line connecting Kano with Dutse in Jigawa State. As part of the EIA studies, the human environment (comprising of the Social or Socioeconomic and Community Health aspects) were also required and undertaken. This document presents the baseline Socio-economic and health conditions prior to project development. The procedures and methodologies employed for data acquisition for the preparation of the Report are also outlined.

4.3.15.2 Scope of work for Social (Socio-economic) Impact Assessment Studies

Socio-economic (or social impact assessment) aspect is an integral part of environmental impact assessments (EIAs). The scope of work for the domain generally aligns with the overall objectives of well conducted EIA objectives but focus is on the human environment. The detailed scope of work for the social components of the study is essentially expected to include both a literature review and establishment of the baseline conditions or characteristics of the proposed project environment, achieved via fieldwork data acquisition.

Specifically, the variables needed to characterise a Project's Socio-economic environment include but not limited to the following:

- Identification of project stakeholders that are likely to be interested/affected by the project (project affected communities and population: PACs/PAPs).
- Demographic characteristics (current population and growth rate, household size, dependents education, male/female ratio, age distribution
- Community history, leadership structure and organization
- Culture and Religion
- Cultural festivals including dates
- Sites of cultural importance (coordinates and descriptions if within project site boundary) cemetery, shrines,

- Social practices (prostitution, drug use etc.)
- Markets types, uses, adequacy
- Education (primary, secondary and tertiary) and health services and infrastructure including adequacy of facilities and personnel
- School enrolment and educational attainment (male and female)
- Distance to school and medical facilities
- Means of livelihood (primary and secondary)
- Poverty and poverty indices in the area
- Income/economic structure (income from various livelihood means)
- Vulnerable people (physically and mentally challenged, elderly people etc.)
- Transportation methods and road network
- Availability, status and access to social amenities and infrastructures;
- Crime rate and History of conflict in the area
- Source of potable water and distance to potable water sources
- Sources of energy(wood/fuel/gas)
- Power (electricity)source and regularity
- Communication services/available networks
- Industrial activities and Infrastructure
- Housing types and quality
- Value and exploitation of renewable resources e.g. fisheries, agriculture, and other uses.
- Value and exploitation of non-renewable resources
- Tourism and recreational activities
- Developmental needs assessment
- Awareness and perception of the proposed Rail Line project.
- Role of women in political administration, economic activities etc.

4.3.15.3 Socio-economic and community health data acquisition methodology

Acquisition of baseline socioeconomic characteristics of a project area is an important phase of any integrated Impact Assessment (IA) process. Baseline data provides vital information on the existing human environmental quality in which a development is planned. It is also useful for delineating sensitive socioeconomic areas for avoidance and/or preparing of mitigation measures for potential adverse impacts. The task of obtaining the social data for the KM-SGR Project ESIA followed a series of overarching and overlapping activities including but not limited to the following concurrently:

- Extensive Literature Survey
- Field Data Gathering – one-off for socio-economic and Health Assessment
- Analysis of results and identification of pertinent socio-environmental and health issues
- Recommendations on Findings
- Reporting.

The Methodology utilized included extracting data from the GIS team, whereby some 105 named communities located along the rail route within a 5 km radius of the line were identified. Then 53 of the project-affected communities (PACs) (i.e., 50%) were selected for interviews of the village heads/leaders and administration of the household survey instruments (questionnaires). Six (6) of the stakeholder communities were designated as urban communities:

1) Takur (Dutse town) Jigawa State
2) Kazaure (Jigawa State)
3) Dambatta Town (Kano)
4) Dawanau (Kano)
5) Zawaciki (Kano)
6) Wakilin Yamma (Katsina Metropolis)

The data collection involved a combination of methods in order to achieve optimum results. The methods included the following:

- Administration of Structured Questionnaires

Designed copies of the questionnaires (including those of village heads, household heads, other individuals in household, livelihoods, managers of educational and health institutions) (Appendix I) were administered to the respondents across communities to selected sample sizes, which was determined by a number of factors including population size, heterogeneity of population, etc. In order to facilitate and ease communications with respondents, field assistants with knowledge of the prevailing language and environment were employed and used for questionnaire administration and enumeration activities.

- Focus Group Discussions

Discussions were also held with specific focus groups. This included Farmers and Herdsmen's Associations, Traders Associations, youths, women organizations, industrialists, etc. The purpose of this was to obtain and document the views of each of these stakeholders.

<u>Pre-field Activities: Consultations/Scoping Meetings/Standardization of Survey Instruments</u>

Prior to actual fieldwork and data collection, the Project's ESIA Consultant and study team members organised three (3) Scoping Meetings/Workshops in each of the Project affected 3 States' Capitals: Dutse in Jigawa, Kano in Kano and Katsina in Katsina respectively. These meetings were part of the consultation and Scoping exercise for the Project in compliance with subsisting national and international requirements. The Scoping Workshops were well-attended by various concerned stakeholders and public. The Project and its sub-activities, potential impacts, positive and negative were presented and the need to undertake the ESIA to have a better picture of the project environment and then present mitigations and enhancements where identified were discussed and participants appreciated the exercise. The Federal Ministry of Environment and Zonal Office representatives as well as the Federal Ministry of Transportation, representing the FGN as proponent were in attendance. Also, very important personalities (VIPs) graced the meetings. In all, persons and stakeholder groups present at the meeting included:

- Representative of the Hon. Minister of Environment from Abuja,
- Representatives of the Governors of the affected States (Kano, Katsina, Jigawa),
- Members of the States Ministries of Environment, Chairmen of LG Councils affected, and others as members,
- Representatives of FMT (Project Proponents),
- Representatives of Stakeholder communities and of course,
- Members of the Study Team with Engr. Usman of ALLOTT Nigeria Limited as team lead among others.

Another preliminary activity embarked upon prior to mobilization to the field for the data collection exercise was the preparation of the various study instruments for collection of socioeconomic and community data. The survey instruments (questionnaires) were reviewed and confirmed satisfactory and thus approved for use in the field for socio-economic data collection.

Delineation of Study Area- Spatial Coverage

The proposed project is essentially a linear project traversing three States and several communities. The 378 km Kano-Maradi railway line is designed to traverse 3 North-western states of Jigawa, Kano and Katsina in Nigeria (Figure 4. 127) and terminates in Maradi, Niger Republic. A total of 105 communities were identified situated within a 5 km radius of the project area, out of which 53 were selected, representing both urban and rural settlements. The data for the study was collected from host communities located in 15 LGAs of Kano, Katsina and Jigawa states.

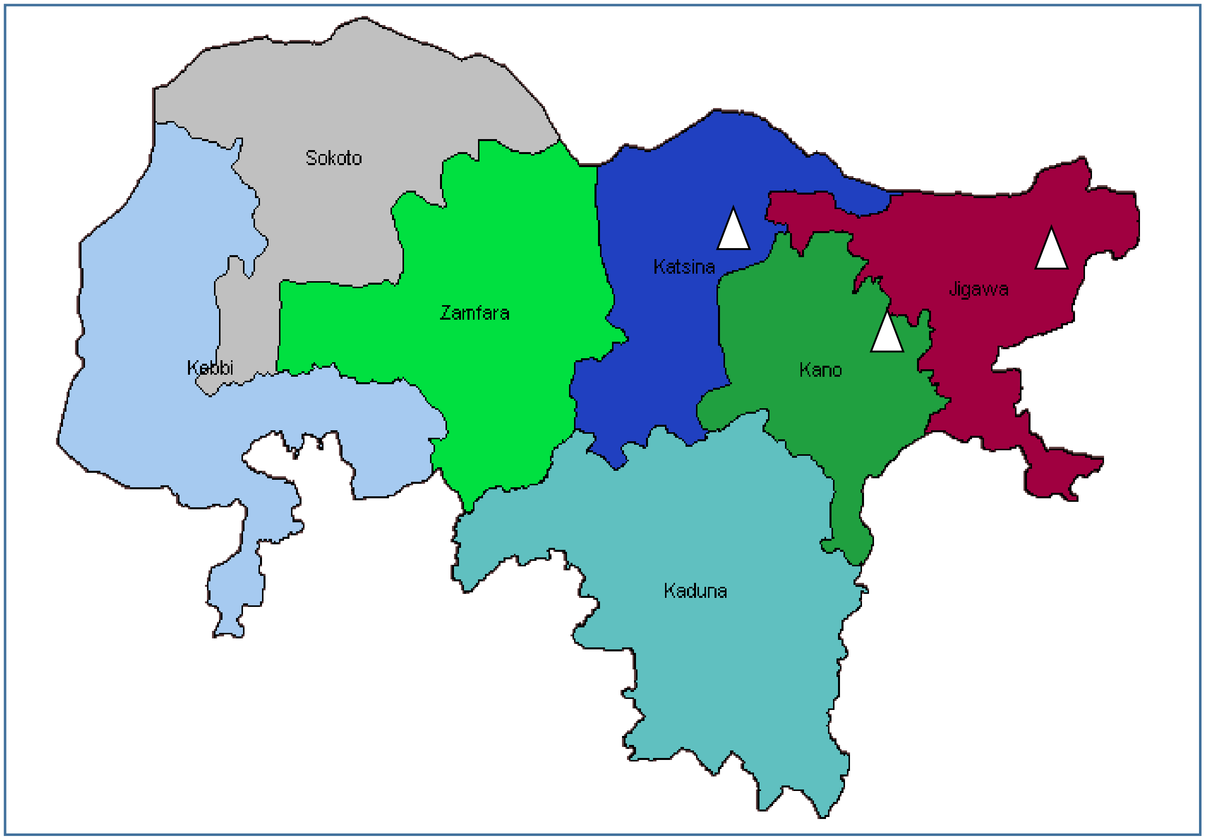


Figure 4. 127: The Regional setting/States in North West Zone

Community Interactions/Focus Group Discussions & Questionnaire Administration

Effective socio-economic baseline data collection involves the deployment of several techniques and methods, including using interview schedules, questionnaire administration, Focus Group Discussions (FGDs) and key informant interviews (KIIs). These techniques are within the basket of participatory rural appraisal and participatory learning appraisal techniques (PRA/PLA) which overtime have been found to yield better results when appropriately utilised (Ojile, et. al., 2016; Akpofure and Ojile 1999).

The months of November and December 2021 were spent in the field for data collection and input from the 53 affected communities. The socioeconomic study was based on a participative approach, involving the affected stakeholders as much and effectively as possible in the course of data collection. Both the qualitative and quantitative methods were employed for effective socioeconomic and community health data collection. Qualitative methods have to do with people's perceptions, how they view themselves and the world around them. Focus group meetings/discussions (FGMs/FGDs) and key informant interviews (KIIs) were utilized to solicit necessary information, including opinions and perceptions about the activities of the proposed KM-SGR.

Quantitative methods were also used to generate data, mostly at household level, using the structured copies of the questionnaire and the survey method. The administration of a set of structured questionnaires is a conventional method of data collection in the social sciences. As a survey instrument and primary data collection method, the questionnaire is structured to incorporate socioeconomic and environmental issues and included binary, optional and open-ended questions that solicited relevant information from the householder. A total of 105 communities were identified within the project area and 53 were selected, representing both urban and rural settlements. The data for the study was collected from host communities located in 15 LGAs of Kano, Katsina and Jigawa states. In each community, interviews were conducted first with the village head, and subsequently with systematically selected adult members using household questionnaires. Key informant interviews were also conducted with all the Heads of

Departments of Health, Education, Agriculture and Social Welfare in the affected Local Government Areas. A household survey was conducted on 374 households with three members interviewed from each household, giving a total of 1,122 interviews. In each household the household head was interviewed, another individual preferably a female, and a third interview was conducted on the dominant livelihood. The data collected was analyzed using SPSS software to generate numbers/figures, and proportions/percentages. Narratives from the key informant interviews were also thematically examined to extract key messages, views and perceptions.

To complement the fieldwork, the secondary source of data collection was also utilized, to fill the gaps that may arise from the field data collection. These involve statistical (census data/community profile), models (population projections), (Dale & Davis, 1995, SIEP, 1996, 2001), and reports of other socioeconomic/environmental assessment studies carried out in the area in the recent past as well as the consultant's knowledge of the area and literature searches.

In addition to the field study, a desktop review was conducted reviewing the following documentations to aid the report preparation:

- NPC 2006 Population and Housing Census, Priority Tables, III, 2010
- NPC 2006 Population and Housing Census, Priority Tables II, 2010
- NPC 2006 Population and Housing Census, Priority Tables I, 2009
- Kano State Development Plan, 2016-2025
- Federal Republic of Nigeria Country Strategy Paper, 2012-2016
- Other Social Impact Assessment Reports (SEIA/SIA) for related projects
- Maps and available satellite imagery of the Northwest geopolitical zone and proximate environment


Plate 4. 29: Interview in Takur Adu'a Dutse LGA, Jigawa State


Plate 4. 30: Interviewers in Achilafiya Yankwashi LGA, Jigawa State


Plate 4. 31: Village Head of Kwarare Yankwashi LGA, Jigawa State

Plate 4. 32: Village Head of Sada Yankwashi LGA, Jigawa State

Plate 4. 33: Village Head of Firji Yankwashi LGA, Jigawa State

4.3.15.4 *Socioeconomic Data Analysis and presentation*

To analyze both primary and secondary data, simple descriptive methods and summary statistics like mean, range, mode and percentages were used. Most of the data are presented in tables and graphs. Six major levels of aggregation and analysis are employed. These were the national, regional, state, LGA, community, household and individual respondent. The populations of the stakeholder communities were projected using results from 1991 (projected to 1996) and 2006 national population and housing censuses released by the National Population Commission (NPC, 2009, 2010). Two population projection methods (the linear extrapolation and exponential growth models) are often used in estimating the population. The linear extrapolation model assumes that population growth occurs in constant increments over time; while the exponential model assumes that the rate of growth is never constant but rather changes with time, growing faster as the population size increases. In other words, population often tends to grow exponentially rather than linearly. The exponential growth model was used in estimating the population of the communities. The formula is:

- Exponential Growth Model: $P_n = P_o (1+r)^n$

  Where:

  P_o = population in the base year (in this case 2006)

  r = annual growth rate of the population (as obtained from NPC and Rivers State)

  n = time lapse, in years

4.3.15.5 Socio-Economic Baseline Conditions

Project Location and stakeholder communities

The Kano-Maradi railway line is designed to traverse three northwestern states of Jigawa, Kano and Katsina in Nigeria and terminate in Maradi, Niger Republic. Jigawa state has a projected population of 7,499,059 which stands at 2.96 % of the nation's population. Kano on the other hand, has a population of 15,462,177 which is equivalent to 6.80% of the nation's population. Katsina has a projected population of 10,368,483 which stands at 4.00% of the nations' total population. The projected population for the three states in the year 2022 stand at 33,329,719.00 which is equivalent to 13.76% of Nigeria's total population.

The three states of Jigawa, Kano and Katsina cover a landmass of 67,477 km^2 which stands at 7.3 % of the 923,768 km^2 Nigeria's total landmass. Agriculture is the largest employer of labour in Nigeria. Arable land in Northern Nigeria as at 2013 is reported to represent 41.50% of the nation's rainfed agricultural land of 380,000 sq km.

The project corridor cuts across Jigawa, Kano and Katsina States and twenty local government areas earlier mentioned. These are areas affected either directly or indirectly by the project and its activities. The areas with direct interaction with the project activities are areas directly impacted in the project area. Beyond the communities adjacent the route, other areas and places will be indirectly impacted by the project. Table 4. 34 below shows the local government areas and some communities affected by the proposed SGR.

Table 4. 34: States Local Governments & Towns of Rail Routes

S/N	State	Local Government	Towns	Emirate
1	Kano	Kumbotso	Zawaciki	Kano
		Minjibir	Kunya	Kano
		Dawakin Tofa	Dawanau	Bichi
		Danbatta	Babbar Riga Ajumawa Danbatta Town	Bichi
		Gaya	Gaya Town	Gaya
		Dawakin Kudu	Gano Yargaya Makole	Gaya
		Wudil	Kausani	Gaya
		Warawa	Warawa	Kano
		Ungoggo	Bachirawa Rimin Gata	Kano
		Gwale	Rumfar Shehu Kuntau	Kano
2	Jigawa	Dutse	Bakin Ruwa Duru Dundubus Gamoji	Dutse
		Kazaure	Yanzaki Kazaure Town Achi Lafiya Maradawa	Kazaure
		Roni	Roni	Kazaure
3	Katsina	Sandamu	Fago Durbe Tambo	
		Daura	Daura Town	
		Rimi	Kayawa	
		Mashi	Dokawa Maduri Daga Bawa Makurda	
		Katsina LG	Daddara Tsanga	
		Jibiya	Zaure Magama	

4.3.15.5.1 *Historical and Regional Overview*

When the Kano to Maradi Rail line with a branch to Dutse is completed, it will connect, with modern infrastructure, communities that have shared close social, economic, cultural and political relations for well over five hundred years. The three states through which the rail route traverses, Jigawa, Kano, and Katsina in Nigeria, as well as Maradi Department in the Niger Republic, are home to populations that have a long history of relationship based on trade and exchange, diplomacy and warfare, and migration of people, which over the past centuries have created a mosaic of linkages that define the cultural pattern of Hausa land that has evolved since about the 15th century.

An examination of the history of the area will help us to understand the present characteristics of the communities impacted by the rail line in terms of their social and political structure, the patterns of authority and decision making, the economy including land holding and ownership, and the existence of potentially vulnerable groups in the area of the route.

The Precolonial Period

Kano: Kano has long been known for its role as a pre-eminent centre of trade in the region, a reputation which it still holds today, despite the many changes brought about through the years by colonialism and independence.

It is claimed that Kano was founded by Bagauda in 999 A.D. However, there is ample evidence of settlement before that time by hunters who were living around Dala hill. In addition, there were numerous settlements of farmers, miners and blacksmiths in the area, including places like Ringim, Kazaure, Gaya and others which likely pre-dated the establishment of Kano. With migration and increase in economic activities, these settlements became towns and eventually came to be under the authority of Kano (see *Cities of the Savannah*, p. 28). Migration from many places played a major role in the growth of the town. The *Wakar Bagauda* (Song of Bagauda) relates:

East, West including the North have all converged on Kano

From the South comes the animist.
Folks from Borno, Katsina and Daura
Including descents of Habe from Zamfara and Gobir
Behold Kabawa, Kambarawa and Adarawa
All in beseeching abodes in Kano.
When hunger envelopes Azbin
To Kano they grovel in search of reprieve.

The centralisation of authority in the form of a *sarki* seems to have been established by the successors of Bagauda, who made alliances with many nearby communities such as Santolo and Karaye. This period marked the coming into existence of *Kasar Kano* (The land of Kano) as opposed to *Birnin Kano* (Kano City). The height of Kano's expansion and consolidation occurred under the reign of Mohammed Rumfa (d. 1503) who was a contemporary of Muhammadu Korau of Katsina, who was also the leader who brought much development to Katsina during the same period. It was during Rumfa's time that Islam established itself in Kano among certain classes of the town and he promoted Islamic learning, leading to the influx of Musim scholars into the city. Trade with nearby and distant regions was prevalent, including states in North Africa, Egypt, the Western Sudan and elsewhere. It is Rumfa who is credited with the construction of the market at Jakara, now known as Kasuwan Kurmi. In fact, many of the present traders conducting business in Kasuwan Kurmi can trace their origins back many years to when their ancestors carried out such trade over long distances and can give detailed accounts of these transactions. (See *Kurmi Market Report,* Metropolitan Kano Planning and Development Board, Kano, 1972).

The Jihad of 1904 saw the overthrow of the Hausa *sarauta* system in Kano and the establishment of the Emirate. The Jihad had the support of the people in part due to the excesses of the Sarki, who imposed prohibitive taxes on all types of manufacture and commerce and nearly killed the Kasuwan Kurmi. In addition, his authority had been undermined by the growing power of slave officials in the military which grew as a result of wars with the Kwararafa and the eventual civil war in Kano. In Kano, the scholarly class was dominated by three Fulani clans, the Mundubawa, Danbazawa and the Sullubawa, who were the leaders of the Jihad. The existing Sarki, Alwali, was defeated in battle in 1806-07, and was subsequently killed. His death marked the end of the dynasty of Bagauda and the emergence of the Sullubawa dynasty and the beginnings of the Sokoto Caliphate.

Social Structure

The Caliphate system of Katsina and Kano was essentially a feudal society, which was hierarchal in nature. Officials exercised authority over territorial units. The majority of offices were hereditary, from father to son. Officials at all levels had a number of advisors and courtiers with whom they discussed issues and policies, but the ultimate decision remained with the monarch. This obtained at all levels of the society. The Emir was the head of the Emirate. Under him were District Heads (who were the major authorities in towns and settlements), then village heads, who presided over village communities, and then ward heads, who occupied the same position in the constituent wards of a village area. In addition to heads of territorial units, there were heads of craft and occupational guilds (such as chief of hunters, blacksmiths, silversmiths, goldsmiths, dyers, weavers, musicians, etc.) who exercised authority over their members and had specified roles to play in the system.

Katsina: Before the 15th century, the land occupied by present day Katsina was populated by village level settlements whose inhabitants were mainly farmers, but hunting, crafts, trading and pastoralism were also important occupations. "The exchange of basic commodities such as iron ore, indigo, cotton, natron, salt, food grains and livestock and manufactured goods such as textiles, farming and household implements, seems to have already developed." (Usman, 1972, P. 176). The basic social unit was the household, or *gida* under the authority of the senior male member. As the state structure began to emerge, the family units came to be grouped into larger settlement units known as *unguwa*, *kauye*, gari, or *birni*, depending on degree of permanence, size, heterogeneity of population and economic and political importance.

The kingdom of Katsina under a centralised ruler was established in the middle of the 15^{th} century. Muhammadu Korau is credited with the consolidation of this system. This system established with a Sarki and title holders is referred to as the Sarauta system, with the authority of a king, or *sarki*, wielding authority over groups of villages, and their leaders, including the village leaders and heads of craft guilds and occupational groups. Around the sarki was a retinue of officials in charge of such issues as finance and taxation, the military, religious affairs, supervision of royal lands and slave settlements, and supervision of the component village level settlements. The income of this ruling class was derived from the produce of their large farms, *gandaye*, worked by slaves and peasantry; the *kudin kasa,* a tax levied on each household, as well as taxes levied on occupational groups like craft producers, agriculture, and tolls on certain traded commodities like natron, and booty from war. (Usman, *op. cit*. p. 171).

The introduction of Islam into the area led to the foundation of a class of Islamic clerics and scholars who came to play an important role in the society and Katsina became known as a centre of Islamic learning. During the Sarauta period, migration into Katsina from many regions, including Borno, Nupeland, Gobir and Zamfara area, and areas to the north in present-day Niger Republic led to the growth of the town which extended its authority to surrounding areas. Many of the settlements through which the Kano to Maradi rail route passes like Dutsi, Shinkafe and others were established during this period, and thus they have a long history.

The Sarauta system continued until 1804 when the Jihad of Usman dan Fodio, an Islamic reform movement, established the Caliphate under the Sultan of Sokoto, and incorporated Katsina into the extensive Caliphate system, promoting even more interaction among the constituent polities. During the Caliphate era, conversion to Islam became widespread in the population, but there remained many communities that continued with their traditional religious and cultural practices, and lived in communities often separated from their Muslim neighbours. These were called Maguzawa, and in fact there are some communities of these Maguzawa still living in present day Kano and

Katsina States, although in recent times most of them have converted to either Islam or Christianity. Those converted to Christianity call themselves "Hausa Christians." In terms of the ESIA, we have referred to them as "vulnerable minorities", and we have identified a few of them who live along the rail route.

Maradi: At the time of the Jihad in the early 19th century, the Hausa dynasty of Katsina was overthrown by the jihadists, as happened in the other Hausa states. In the case of the Katsina dynasty, they fled north to find refuge in Zinder (Damagaram), which was a state under the influence of the Borno empire. Sometime after that, they left and established themselves in Maradi. So Maradi had its origin in the pre-jihad dynasty of Katsina, and the two states maintained a close but difficult relationship throughout the 19th century, until they respectively became absorbed into the British colony of Nigeria in the case of Katsina, and the French colony of Niger with the imposition of colonial domination in the early 20th century (see M. G. Smith, *The Affairs of Daura*).

Daura: Daura's history is somewhat different from that of Kano and Katsina. The somewhat apocryphal legend of the Hausa Bakwai refers to Daura as the spiritual home of the Hausa people because it is said to be the place where Bayajidda arrived and killed the snake that was preventing people from drawing water from the well (Kasugu). The local queen, Magariya, then married him and they gave birth to those who founded the seven Hausa states, of which Daura was one. Whatever the veracity of the story, it emphasises the close relationship among the so-called Hausa bakwai. At the time of the Jihad, the Hausa sarki, Sarki Gwari Abdu, fled and established successor states in Zango, Magaria and Baure (in present day Niger Republic). Under his successor, Sarki Lukudi, the dynasty split into three sections. However, the three states were overrun by Zinder (Damaragam), which was itself under the empire of Borno. When the British conquered the area and divided the territory with the French, they expelled the Fulani Emir and reinstated the Hausa dynasty at Daura in 1906. The three Hausa states had been under the rule of Borno for some time, and continued to maintain close relations with Borno, rather than Katsina and Kano. Aside from its close ties to Borno, Daura was overshadowed by the more commercially developed states of Kano and Katsina on its borders. (M. G. Smith, *The Affairs of Daura*).

Colonial Rule

Despite changes in the system once the area was conquered by the British and colonial rule established around 1900, the basic elements of the structure remained essentially unaltered, although of course the Sultan and the Emirs were subordinated to the colonial authority, who, after the conquest, deposed all Emirs who they found to be uncooperative and imposed more malleable ones who would carry out their policies. (see M. M. Tukur, *The Imposition of British Colonial Domination on the Sokoto Caliphate, Borno and Neighbouring States, 1897-1914).* In practice, the colonial system of "indirect rule" was even more authoritarian than the pre-colonial system, because the power of local authorities was backed up by the absolute power of the colonial government and the few checks to the power of rulers that had previously existed were therefore eliminated.

Among the most important changes brought about by colonialism was the re-orientation of the productive system (agriculture and manufacturing) away from fulfilling the needs of the population to focusing it on the production and expropriation, as well as export, of goods to fill the needs of the colonial power for raw materials for industries in Britain. Although in the pre-colonial era there existed widespread trade in foodstuffs and raw materials for industries (cotton, indigo, metals, etc), now through the imposition of taxation payable in hard currency, farmers and other producers were forced to produce items that they could sell for cash (shillings and pence) that they needed to pay their taxes; defaulting on such payments would lead to jail terms or punishment of forced labour. In virtually all areas conquered by the British, the first structure constructed in every location at the beginning of colonialism was the prison.

The economy became monetised based on the introduced currency. This led to the production of 'cash crops' like cotton, tobacco, and groundnuts in the northern part of the country, and cocoa, palm oil, rubber and other crops in the southern areas. In regions which were not suited for cash crop production, inhabitants were forced to migrate to sell their labour in order to earn money to pay their taxes. Such individuals often joined the army, or migrated (on a seasonal or permanent basis) to the tin mines on the Jos Plateau, to the army, to the areas of railway construction, and also to areas where they became labourers on farms producing cash crops like the groundnut or cotton growing areas, or to the cocoa growing areas of the western part of the country.

The reorientation of production in the region led to the increasing commercialisation of land and labour. The buying and selling of land became a general practice. Even though in most rural communities, land was acquired largely through inheritance, from father to male children, according to the Islamic inheritance practices, selling of land in areas where it was in demand for cash crop production, along with other capitalist practices like mortgaging land, lending, or even outright expropriation by local functionaries became a usual practice. Local officials like district and village heads retained enormous powers over the acquisition of land. (See *Report of the Land Investigation Commission, Kaduna State*) And despite the Land Use Act of 1978 specifying that all land is vested in the State Governors for urban lands and in local governments for rural land, the system at the local level has in practice continued to operate much as it has done in the past. (see T. Ladan, B.L. Aliyu *et. al.* *"Human Rights Impact Assessment on the Kano-Maradi Railway Project"*).

Independent Nigeria (1960- Present)

At independence in 1960, the area under review constituted part of the Northern Region of the Federal Republic of Nigeria. Since then, a number of boundary adjustments have occurred. Twelve states were created out of the former four regions under the regime of Yakubu Gowon in 1967. Kano State was created, incorporating the present area of Jigawa. The North Central State comprised Katsina and Kaduna State. In 1976, Murtala Muhammed created more states, making 19 states in the country. Under Babangida, Katsina State was created out of the former Kaduna State. In 1991, more states were created making the total number of states to be 30. At that time, Jigawa State was created out of Kano State. Sani Abacha created six more states in 1996, making the total number of states in Nigeria to be 36.

With independence, the economy underwent major changes. In the early years after independence, the country adopted an import substitution policy, and many new industries grew up. Kano in particular became a major centre of industrial production, with numerous industrial establishments springing up in Bompai and other parts of the town, mainly for the production of consumer goods such as cooking oil, textiles, sweets, enamelware and others. A large number of workers, both from Kano and elsewhere, formed a significant working class, mainly concentrated in Tudun Wada and Gwagwarwa areas of Kano City. (Ref. Paul Lubeck, *Islam and Urban Labor in Northern Nigeria: The Making of a Musim Working Class*,) Farmers in rural areas began to alter their production away from colonial export crops to growing raw materials to feed the new industries, as well as growing food for the burgeoning urban working class.

In the early 1980s, under pressure from the World Bank and the IMF, the government began to implement a Structural Adjustment Programme, designed to promote exports at the expense of production for the local market. (see Y. B. Usman, *Nigeria Against the IMF*). With the devaluation of the currency, the retrenchment of many civil servants, the privatisation of government-owned industries, the reduction of social services like free education and subsidised health care, most of the existing industries collapsed, leaving many workers unemployed and greatly increasing the levels of poverty in both rural and urban areas.

While farmers in Kano, Katsina and Jigawa presently focus on growing food for themselves and for urban markets, many are now producing for the world market as well. Of particular importance are crops such as roselle (hibiscus) and sesame, which are now the two major export crops from Kano State. The well-known groundnut pyramids are now gone. No doubt additional products will also be added to the agricultural repertoire, with the world market in mind. Hence the importance of the proposed railway, to provide a cheap and reliable means of transporting these products to Lagos and international markets as well as accessing markets to the north and other parts of Africa.

Whether under democratic rule or that of the military, which governed at the national level from 1966 to 1999, (with a brief period of the Second Republic from 1979-1983) social relations at the local level remained substantially unchanged, although reforms were made to the state and local government system under several regimes. Whether under military rule or a democratic constitution, (with elected president, state governors and elected local government councils), the remnants of the feudal system continue to function in the form of the emirate structure. Although constitutionally subordinate to the Federal and State governments, traditional rulers like the emirs, district heads, village and ward heads, continued to fulfil many of the roles they have been playing over the years. Their positions, from emirs down to village and ward heads, continue to be hereditary, and the authoritarian nature of decision making at the village level continues in practice.

The above overview of the history of the region through which the proposed new rail line passes illustrate the reasons why it is so important for the inhabitants of the area. The close relationships that have existed among the communities for hundreds of years means that the connection among them, which the railway will cement, is not just a neutral one of connection to places unknown, but a real, meaningful connection among communities and peoples that have a long, common history and culture.

In addition, through a perusal of the history of the area, we can better understand the nature of social relations among the inhabitants of the communities, and between them and the structure of authority. This knowledge should help us to develop strategies to enhance the positive impact of the project.

The coming of the railway to these communities will no doubt bring about important changes, both social and economic, which are likely to fundamentally change, hopefully for the better, the lives of all of those impacted by the Kano to Maradi Railroad.

4.3.15.5.2 *Population and Socio-demographic Characteristics*

The population of a geographical area is the cornerstone of the development process, as it affects the economic growth through provision of labour and entrepreneurial skills, and forms the demand for the production output. Thus, the analysis of its dynamics, including size and growth pattern, is imperative for understanding the future population growth trends.

Population size, growth and distribution

According to the national census of 2006, the total population of the project affected states was 19,563,874; and constituted over one half (54.47%) of the total population of the North-West geopolitical zone (NBS, 2018). This represents an annual growth rate of 2.68 percent between 2006 and 2016. With a land size of 223,150 sqkm, the population density in the region came down to 161 per sqkm.

Table 4. 35: Projected Population of Three Affected States

States	2006	2016	2021
Jigawa	4,361,002	5,828,163	6,737,587
Kano	9,401,288	13,076,892	15,422,796
Katsina	5,801,584	7,831,319	9,098,695
TOTAL	19,563,874	26,736,374	31,259,078

(Source: National Population Commission and National Bureau of Statistics Estimates 2022)

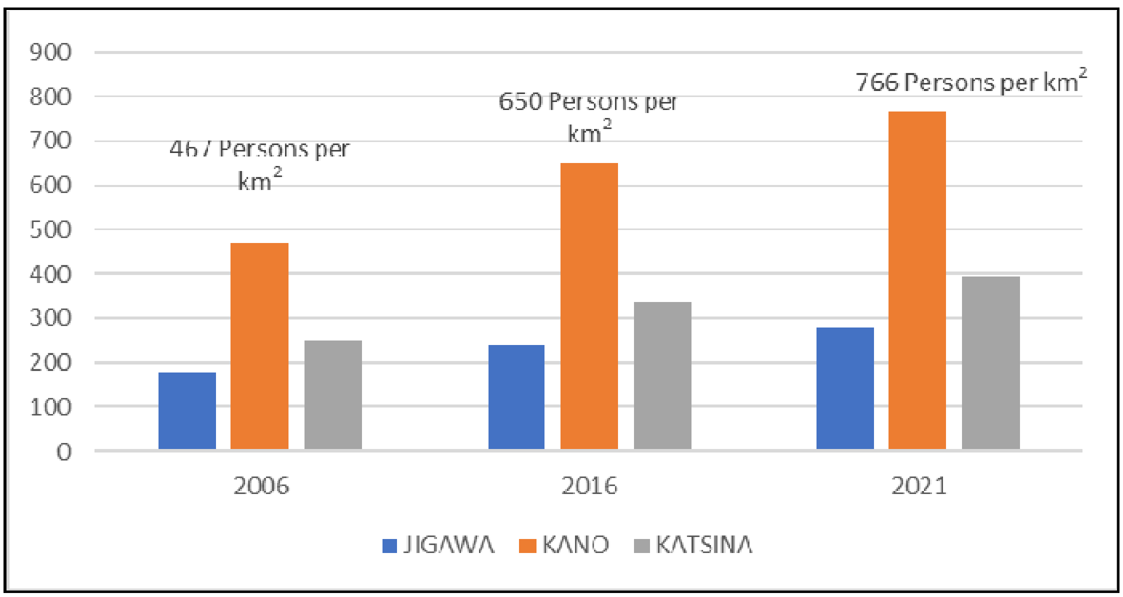


Figure 4. 128: Population density in person per square kilometre
Source: National Population Commission and National Bureau of Statistics Estimates 2021

Kano State is the most populous of Nigeria's 36 States. The 2016 population was estimated at approximately 13,076,892, up from 9,401,288 in 2006. Growth in population has been rather rapid: 3.6million (62%) more people in 2006 than in 1991 and 5.2million (90%) more in 2010 compared to 1991. Annual rate of growth averaged 3% (1991-2006) and 4% (2006-2010). If projected to the present, (it has a total land mass of 20,280 sqkm) the state will have a population density of 747.5 persons per km^2, a frightening figure suggesting congestion. As at 2006, the population density was 442, more than 2 and $^1/_5$ times above the average population density of 161 persons per sq.km in the Northwest geo-political zone (NPC, 2010).

Jigawa States is relatively less populous. From a population of 4,361,002 in 2006, the state is projected to record a growth in her population to 5,828,163 in 2016 and 6,737,587 in 2021. Similarly, the population density of the state rose from 180 persons per sq.km in 2006. The population density has been projected to increase, to 241 persons per sq.km in 2016 and 279 persons per sq.km in 2021 (Table 4. 36).

Katsina State was also estimated to have a population of 7,831,319 in 2016, which is also projected to rise to 9,098,695 in 2021. On the other hand, Jigawa State, from its modest population of 4,361,002 in 2006 and density of 178 persons per sq.km, has been projected to have a population of 5,828,16 and a density of 338 persons per sq.km in 2016 and a population of 9,098,695 and a density of 393 persons per sq.km in 2021 (Table 4. 36).

The populations of the project affected states are as shown in the Table 4. 36 and Table 4. 36 depict dynamism in the population. The dynamics have indicated a rise in population with a corresponding high number of persons per square kilometre, leading to a scramble for the little available resources. Obviously, lack of opportunities will continue to be the pull factor causing rural-urban drifts amongst the population. State capitals and other more commercial-oriented towns and cities continue to expand, causing strain on public infrastructure and residences. Ungogo and, Kumbotso, two well-known commercial LGAs in Kano have the highest and second highest population concentrations and densities as well; 1710 and 1787 persons per sqkm respectively.

Dambatta, also an industrial hub within the Kano socioeconomic terrain, also densely populated, however has lower density (274). The population growth potential and its accompanying challenges have been well-acknowledged by the state government. According to the Kano State last Development Plan, urban population has been growing rapidly since the creation of the state in 1967. The 8 metropolitan local governments, Kano Municipal, Gwale, Tarauni, Fagge, Ungogo, Kumbotso, Dala and Nassarawa, accommodate approximately 3.6million people or 30% of the Kano population. Approximately 5.3million people or 44% of the population is accommodated within the Kano Central Senatorial district which consists of 15 local government areas (KSDP, 2015).

Katsina with over 370,000 (2011, NPC, 2012) as the capital of the state also has over 2,000 persons per sqkm as population density suggesting land availability has become a serious problem. Of the four project-affected LGAs in Jigawa, Dutse, the state capital has the highest concentration of the population while Roni is the least inhabited. Table 4. 37 shows the population characteristics of the area.

Table 4. 36: Gender distribution across the three affected states

	2007			2017			2021		
State	Male	Female	Total	Male	Female	Total	Male	Female	Total
Jigawa	2,289,555	2,199,768	4,489,323	3,059,824	2,939,831	5,999,654	3,436,169	3,301,418	6,737,587
Kano	4,955,520	4,761,186	9,716,706	6,892,971	6,622,658	13,515,629	7,865,626	7,557,170	15,422,796
Katsina	3,048,917	2,929,352	5,978,269	4,115,607	3,954,211	8,069,818	4,640,334	4,458,360	9,098,695

(Source: National Population Commission and National Bureau of Statistics Estimates 2022)

Table 4. 37: Population Characteristics of affected LGAs and States

LGA/State	1991*			Area (km²)	Pop. Density	2006			2011
	Male	Female	Total			Total	Male	Female	
Makoda[a]				462.918	475.5	220094	110014	110080	259577
Minjibir	69126	70624	139750	435.582	504.2	219611	108218	111393	259008
Danbatta	105174	109048	214222	767.455	274.3	210474	105538	104936	248232
Dawakin Tofa	77611	78832	156443	501.377	491	246197	126390	119807	290363
Kumbotso	85978	80580	166558	164.704	1787.4	294391	166171	128220	347203
Ungoggo	86579	81794	168373	213.831	1710.4	365737	192372	173365	431348
Kano	**2958736**	**2851734**	**5810470**	**20,280**	**442**	**9401288**	**4947952**	**4453336**	**11087817**
Jibiya	60450	64281	124731	1091.871	153.4	167435	85149	82286	194532
Batagarawa	41599	43265	84864	455.203	456.7	207874	104279	103595	219655
Mani	59215	62674	121889	825.642	213.5	176301	88007	88294	204833
Sandamu[c]				1487.539	92.1	136944	68512	68432	159106
Rimi	94868	97968	192836	475.638	324	154092	77059	77033	179029
Mashi	96269	99780	196049	954.08	178.6	171070	84105	86965	198755
Katsina	116704	106940	223644	149.633	2126.1	318132	168906	149226	369617
Dutsi[b]	57785	58005	115790	297.875	405.9	120902	61430	59472	197313
Daura	77898	78974	156872	332.931	675.5	224884	115576	109308	261278
Kaita	48985	52893	101878	975.584	187	182405	93190	89215	211924
Katsina	**1860658**	**1892475**	**3753133**	**23561**	**232**	**5801584**	**2948279**	**2853305**	**7831319**
Yankwashi[d]				390.324	245	95643	48062	47581	110567

LGA/State	1991*			Area (km²)	Pop. Density	2006			2011
	Male	Female	Total			Total	Male	Female	
Roni	27552	27702	55254	338.524	228.7	77414	39618	37796	89494
Kazaure	64794	63942	128736	387.026	416.4	161161	82513	78648	186308
Dutse	68975	69476	138451	1147.246	218.9	251135	125773	125362	290322
Jigawa	**1453376**	**1419745**	**2873121**	**23287**	**178**	**4361002**	**2198076**	**2162926**	**5828163**

(Sources: 2006 National Population and Housing Census (NPC, 2010, 2009); NBS, 2012; 2018
** Source: NBS, 2018: Demographic Statistics Bulletin; Nigeria Population Projection by State (2012-2016)
[A, b, c] and [d] were not created and/or were part of an older LGA as at 1991 Population Census.

The results of the 2006 Population and Housing Census up till this date have not been broken down into the various constituent enumeration areas or, localities/settlements and communities. This circumstances notwithstanding, the number of persons living in project affected communities and settlements are estimated based on available 1991 populations projected to 1996 (the base year for projections). The populations of the Kano-Maradi SGR stakeholder communities are yet to be accessed. However, some insights into how many actually live within the affected communities were offered from the Jigawa State axis as presented in Table 4. 38. Suffice to say here for now that a very high number of the affected communities/settlements are rural settlements while few can be regarded as 'urban' using population, occupational heterogeneity and available infrastructural facilities as qualifiers. Hence only six (6) of the surveyed were recognised as such, namely:

1) Takur (Dutse town) Jigawa State
2) Kazaure (Jigawa State)
3) Dambatta Town (Kano)
4) Dawanau (Kano)
5) Zawaciki (Kano)
6) Wakilin Yamma (Katsina Metropolis)

Table 4. 38: Population estimates of some surveyed communities in Jigawa State

S/N	Community	Population	No of HH in Community	Household Size
1	Firji	10,000	800	12.5
2	Kwarare	6,000	400	15
3	Achilafiya	12,010	1996	6.0
4	Sada	8,000	3,500	2.3
5	Ban-dutse	6,000	580	10.3
6	Kazaure town	250,000	80,020	3.1
7	Takur (dutse)	350,000	66,350	5.3
	Average			7.8

Household Composition, Marital status and household size

Information on household composition is critical for understanding family size, household headship, and for implementing meaningful population-based policies and programmes. Household composition is also a determinant of health status and well-being (NPC and ICF Macro, 2014). These characteristics are important because they are associated with household welfare. Female-headed households are, for example, are typically poorer than male-headed households. Economic resources are often more limited in larger households. Moreover, where the size of the household is large, crowding also can lead to health problems (NPC and ICF Macro, 2009).

The NDHS 2013 survey found average household size in Nigeria to be 4.6 persons, as compared with 4.4 in 2008; household sizes are larger in rural (4.9) than urban (4.2) areas. The proportion of households with nine or more members is reported to be higher in rural areas (12 percent) than in urban areas (7 percent) (NPC and ICF Macro, 2014). Population reference Bureau (PRB, 2013), had earlier reported about the demographics revealing that the total fertility rate is as high as 6 for Nigeria, an indication of large household size still very prevalent. 12% of households have over 10 members. Mean size of household in affected communities is 5.48 members (Figure 4. 129). Over 71% of members are under 30 years old, emphasizing the youthfulness of the population structure (Figure 4. 130). Also, 20% of household heads are monogamous, while 14% are polygamous.

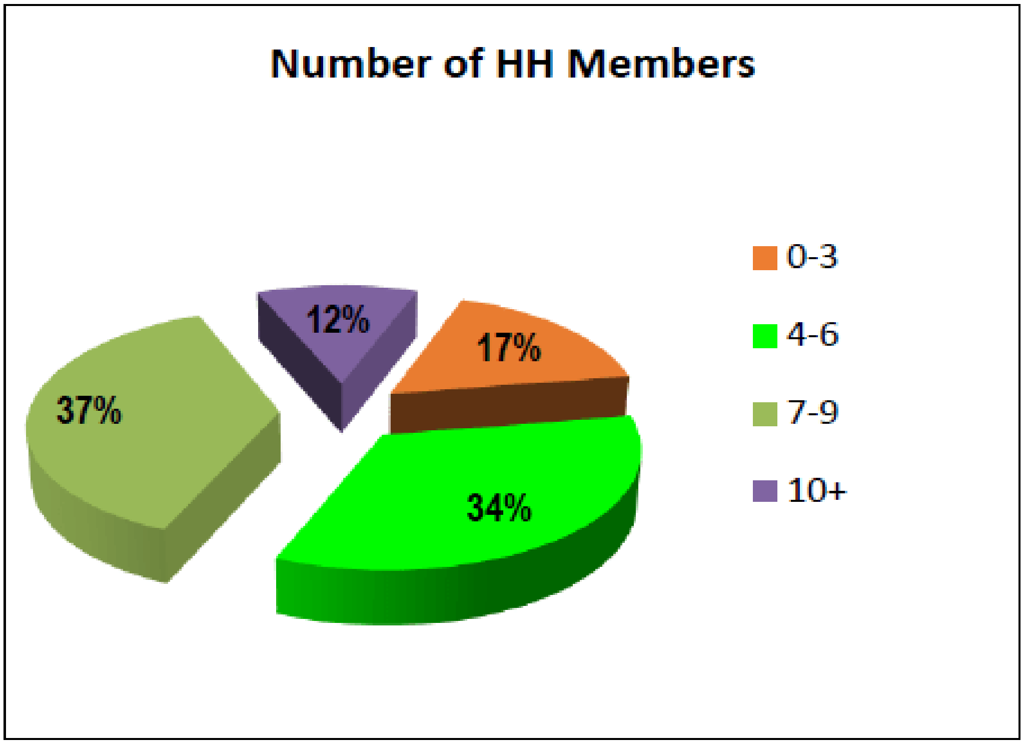


Figure 4. 129: Number of household members

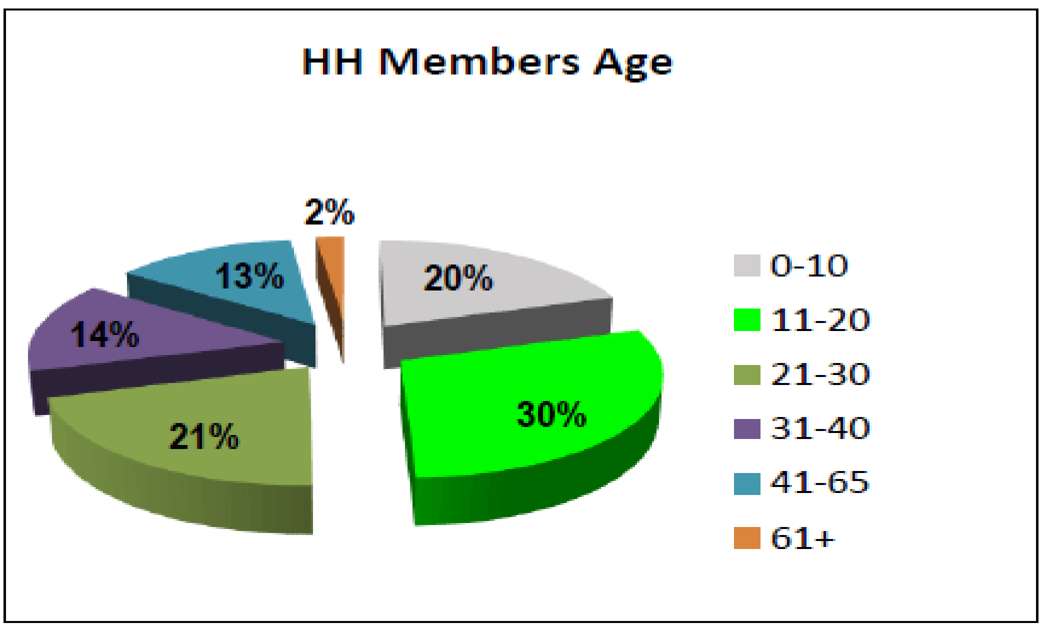


Figure 4. 130: Age of Household members

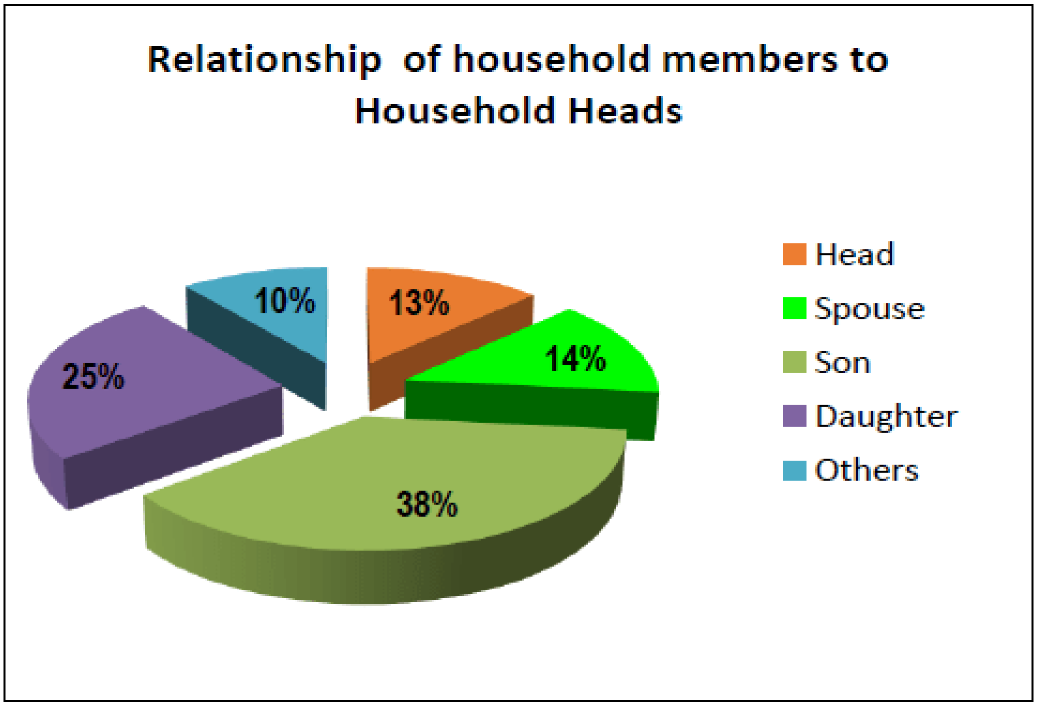


Figure 4. 131: Relationship of household members to household heads

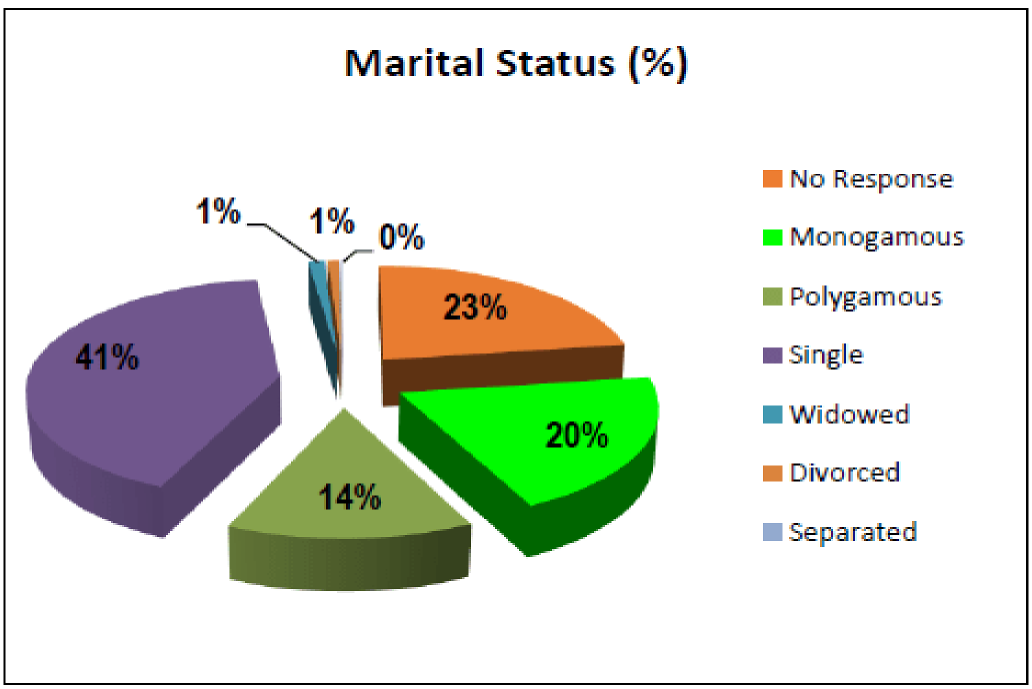


Figure 4. 132: Marital status of household heads

Returned responses from the administered household questionnaires revealed that majority (88.8%) of the respondents were married compared to 11.2% that were not. Influenced more by culture and religious orientation (Islamic), early marriages are the norm in the part of the country where the project is proposed. In the survey, it was determined that 41.7% of household heads were monogamous, 48.4% were polygamous, 7.5% were single, 1.1% widowed and 0.5% divorced.

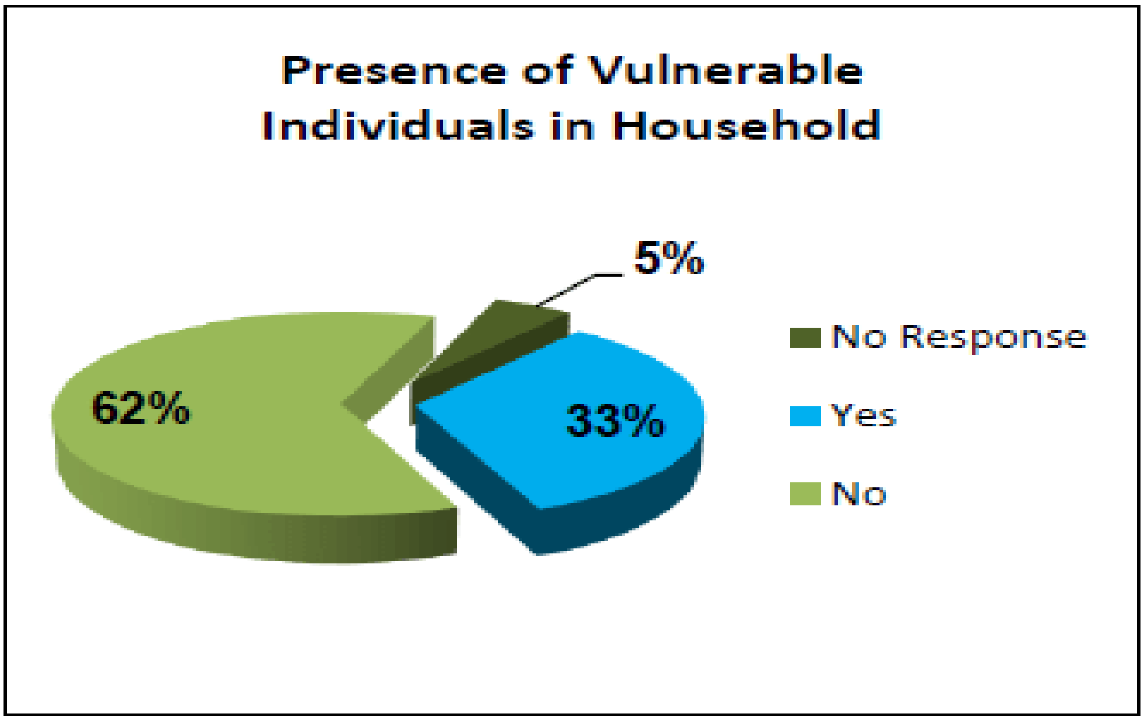


Figure 4. 133: Vulnerable individuals in household as reported by household head

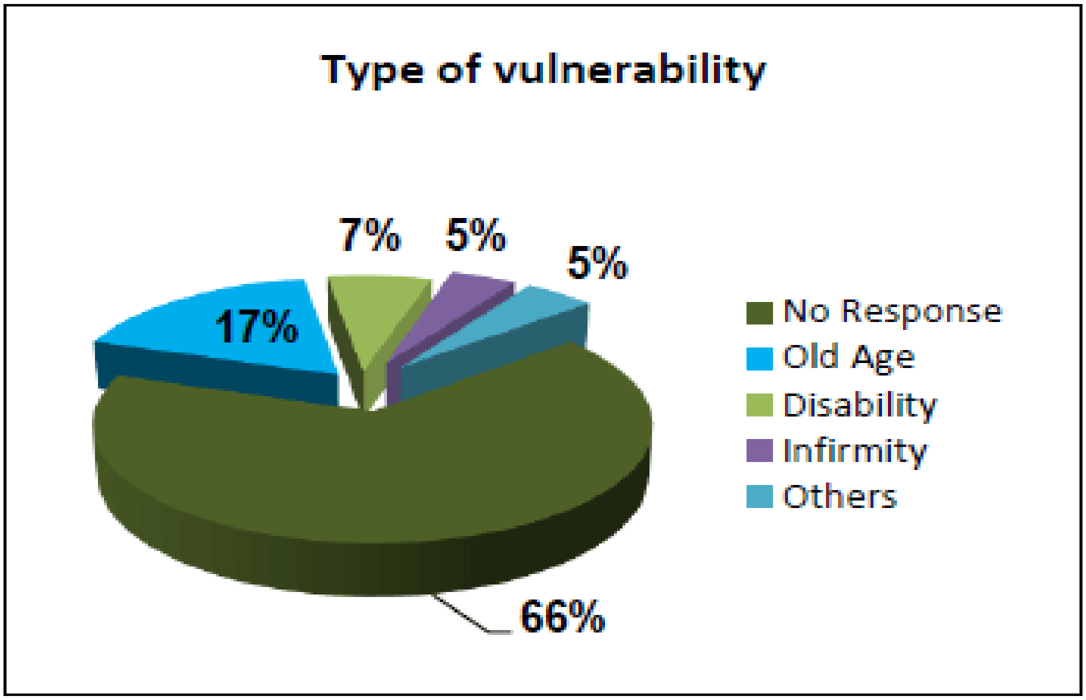


Figure 4. 134: Types of vulnerability

The proportion of married persons in the project area also tallied with the age of the respondents; over 90 percent of the respondents were aged 30 years and above. The mean age of respondents was 34.3 years with a standard deviation (SD) of 13.0 years (34.3±13.0). Figure 4. 135 below gives the age distribution of respondents:

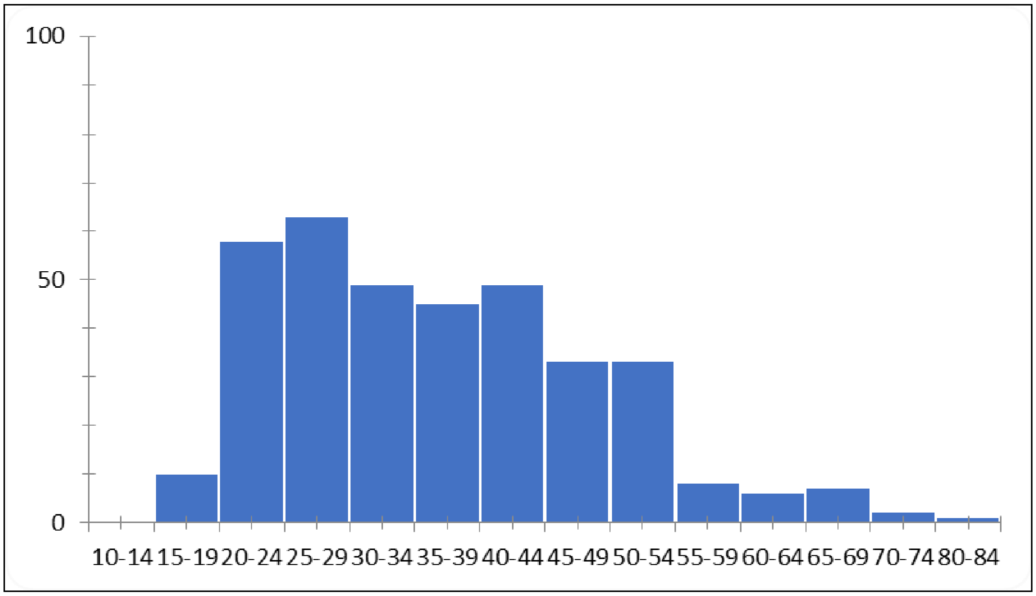


Figure 4. 135: Age distribution of respondents

<u>Population Structure: Age and sex distribution</u>

The population structure reflects the age and sex composition of a population. Information on age and sex composition is very important especially for the evaluation of the quality of the enumeration, and for the description and analysis of several types of socioeconomic and demographic data. The population structure is usually characterized with reference to (a) the age-sex distribution and (b) two other key demographic ratios: the sex ratio and the dependency ratio.

Age and Sex Structure of Population

Age and sex are important demographic variables and are the primary basis of demographic classification. They are also important variables in the study of mortality, fertility, and nuptiality. In general, a cross-classification by age and sex is useful for the effective analysis of all forms of data obtained in surveys. The household age structure and population distribution in the Kano-Maradi SGR stakeholder communities conforms to the overall regional and Nigeria's pyramidal structure. It is broad-based with the younger cohorts predominant and the aged fewest in proportion. In fact, an overwhelming percentage of the population is made up of persons below 19 years old, effectively classified as children (NPC, 2002, 2010). The Kano State population typically representative is almost equally divided between males (51%) and females (49%) and is predominantly youthful. 50% of the population is economically active within the 15-64 year-age bracket, while 47% are below the age of 15 and only 3% are above the retirement age of 65 years. Thus 50% of the population [made up of the young and the old] is made to depend on the other 50% of the population which constitutes the labour force. This implies a dependency ratio of 1:1. In other words, there is only one adult of working age available to take care of each dependent in the population.

The active youth within the 15-39 years age bracket constitute 38% of the State population, while 47% is within the 5-24 year-age bracket. There are nearly 2million women in the critical child bearing age [20-44year] bracket. Such a structure has obvious implications for State resources and future growth: the State needs to devote a disproportionate share of its resources to education at all levels, to maternal and child care and to programmes that create jobs and ensure the active youths are kept off the streets and are in productive ventures.

The age distribution of Nigeria as a whole has always been found to be younger, with 52% of the population younger than age 20. Nigeria still maintains its broad-based pyramidal structure. According to NPC and ICF Macro (2014), the broad base of the pyramid indicates that Nigeria's population is young, a scenario typical of countries with high fertility rates. The proportion of children under age 15 is around 46 percent, while the proportion of individuals age 65 and older is 4 percent. This imply that half of the population belongs to the working age (15-64 years). The communities have a high dependency ratio. The overall implications of the age profile are that the population is young and growing and places a heavy burden on the adult population. More importantly, the provision of educational facilities and health care services are paramount in order to accommodate this young population.

The sex ratio, a useful demographic descriptor is the ratio of males to females in a given population, usually expressed as the number of males for every 100 females (Haupt and Kane, 2004). Gender distribution of the population in the project area reveals a gender balance at the household level. For example, the Kano State population typically representative is almost equally divided between males (51%) and females (49%).

During the field data gathering exercise, the females were found to be generally very well represented in the survey particularly in the health studies. The results showed that 339 (92.4%) respondents to the individual survey were females and 28 (7.6%) were males. (This is because questions on health were asked primarily of female respondents).

Educational characteristics

Education is a key determinant of the lifestyle and societal status an individual enjoys. Studies have consistently shown that educational attainment has a strong effect on health behaviours and attitudes. As a result, there have been increases in the enrolment of children and in the number of educational institutions both in the public and private sectors.

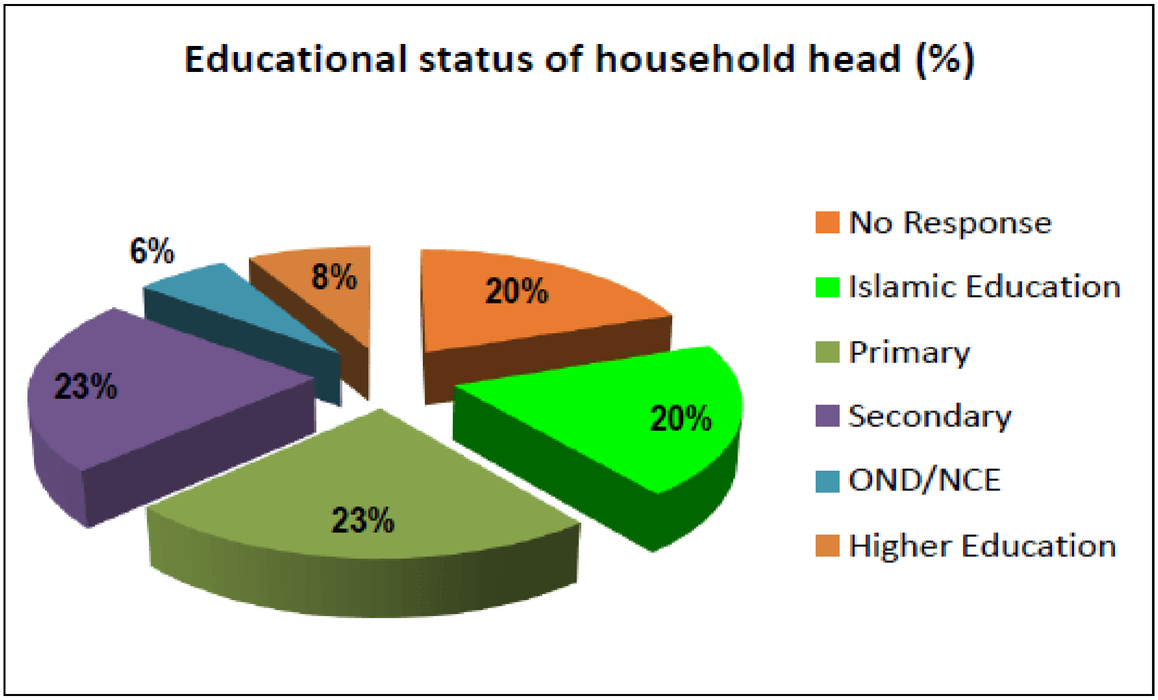


Figure 4. 136: Educational status of household head

The socioeconomic survey analysis revealed that four (4) of ten (10) respondents (39.6%) had Islamic education only, followed by primary (25.9%) and secondary (22.4%) education. Only 12.1% of the respondents had post-secondary education. In the study area the percentage of students enrolled in primary schools were found to be below the national rate 63.8%. In all three States, female enrolments are well below the national average equal to 45.17%. Just as what is obtainable at the national level, the gender gap remains wide. The number of schools, facilities and teachers available for basic education remain inadequate for the eligible number of children and youths. Below are state-specific data on education.

Kano State

Education is delivered at three levels: basic, post basic and tertiary. Basic education comprises of pre-primary, primary, junior secondary and non-formal education and is usually achieved in 9 years with a defined curriculum at each of the three stages. The post basic level is a three year [senior secondary or technical & vocational] education which mainly prepares students for admission into tertiary institution. There are approximately 3 million primary school pupils enrolled in more than 6,000 schools. There are 724,978 secondary school students, 44% of which are female, and a total enrolment of nearly 100,000 students at the tertiary level. Science and technical education occupy a unique position in the state's education system. The Science and Technical Schools Board manage a total of 48 science and technical colleges. A number of religious schools such as the Tsangaya/Quranic, Islamiyya and Ilmi schools compliment the conventional government schools. There are approximately 3,000 Islamiyya Integrated with 800,000 pupils.

There are 33 Junior and an equal number of senior secondary IQTE schools in the State. The tertiary level consists of 9 state owned institutions and 6 Federal Government owned institutions as at December 2014including two state universities, namely Kano State University of Science and Technology (KUT) Wudil and North West University (NWU). Others are: Kano State Polytechnic (KSP), Sa'adatu Rimi College of Education (SR-COE), Aminu Kano College of Islamic and Legal Studies (AK-CILS), Kano State College of Arts, Science and Remedial Studies (KS-CARS), Rabiu Musa Kwankwaso School of Basic and Remedial Studies Tudun Wada, Amana College of Education Kunchi, Audu Bako College of Agriculture (AB-COA) as well as Kano State Scholarship Board and three Federal Institutions – Bayero University, Kano (BUK), Federal College of Education (FCE) Kano and Federal College of Education (FCE) Bichi, Federal College of Agriculture Hotoro Kano, and Digital Bridge Institute Pilgrims Camp, Kano.

Table 4. 39: Educational statistics for Kano State – 2013-2018

Primary statistics and indicators		2013	2014	2015	2016	2017	2018
System description							
Number of primary schools		6,328	6,478	6,648	6,888	6,992	7,079
Number of primary pupils		2,441,332	3,000,725	3,054,446	3,184,362	3,275,660	3,324,208
Percentage of female primary pupils		49	48	49	50	50	50
Number of primary teachers		68,839	66,874	54,929	64,113	65,970	66,851
	Percentage of female primary teachers	35%	26%	28%	29%	29%	30%
Percentage of qualified public primary teachers		76	49	51	62	70	75
	Percentage of qualified female public primary teachers	17	20	22	24	27	30
Primary education student flows							
GER in Primary		117	139	141	145	147	148
	Girls' GER in Primary	112	144	148	152	154	157
Public Primary Completion rate		69	72	76	78	80	85
	Girls' Public Primary Completion rate	65	70	72	77	79	81
Public Primary-Junior secondary transition rate		48	45	52	65	70	72
	Girls' public transition rate	43	40	47	55	65	70
Service delivery							

indicators for public schools							
Pupil-teacher ratio		35	45	56	50	50	50
	Lowest LGA ratio						
	Highest LGA ratio						
Pupil-classroom ratio		82	91	94	91	90	89
Number of classrooms		27,408	30,126	30,761	32,938	33,914	34,991
	Percentage of classrooms in good condition	26,766	29,531	26,299	31,405	31,905	31,605

Current statistics show that the percentage of students enrolled in primary schools is 49.6%, 14.2% below the national rate in Kano State. Gender gap is 43.80% which corresponds to 559,721 girls enrolled in the state. The largest number of primary schools amongst the three affected states is reported in Kano State, where there are 3,875 schools of the 67,362 in Nigeria equal to 5.75% of the total (NBS, 2019). The number of primary school enrolment in Kano State in presented in Table 4. 40.

Table 4. 40: Primary School Enrolment in Kano State

State	Enrolment %Average
Kano	49.6%
National	63.8%

Source: National Bureau of Statistics 2019

Katsina State

Currently, the State has 2,771 primary schools with pupils' enrolment of 1,963,468 (1,004,698 males and 958,770 females), 251 Junior Secondary Schools and 245 Senior Secondary Schools with an enrolment of 300,125 (166,270 males and 133,855 females) and 198,773 (119,037 males and 79,736 females) respectively (Table 4. 41). Four-year trends in school enrolments are provided in Figures 4.137 – 139.

Table 4. 41: Enrolment in Public Pre-primary and Primary Schools in Katsina

Sector	No. of Schools	Male	Female	Total
Pre-primary	1,716	**103,175**	**106,447**	**209,622**
Primary	2,771	1,004,698	958,770	**1,963,468**
Junior Secondary	251	**166,270**	**133,855**	**300,125**
Senior Secondary	245	**119,037**	**79,736**	**198,773**
Tech. & Voc, FGC	6	5698	988	**6689**

(Source: Katsina State: Annual School Census, 2018/2019 Report. Ministry of Education)

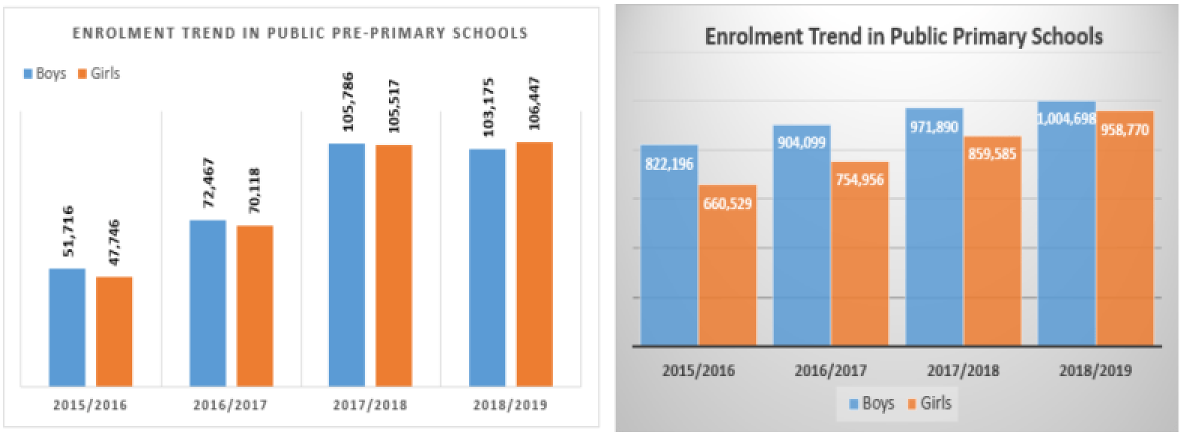


Figure 4. 137: 4-years enrolment trends in Pre-primary and Primary Schools in Katsina
(Source: Katsina State: Annual School Census, 2018/2019 Report. Ministry of Education)

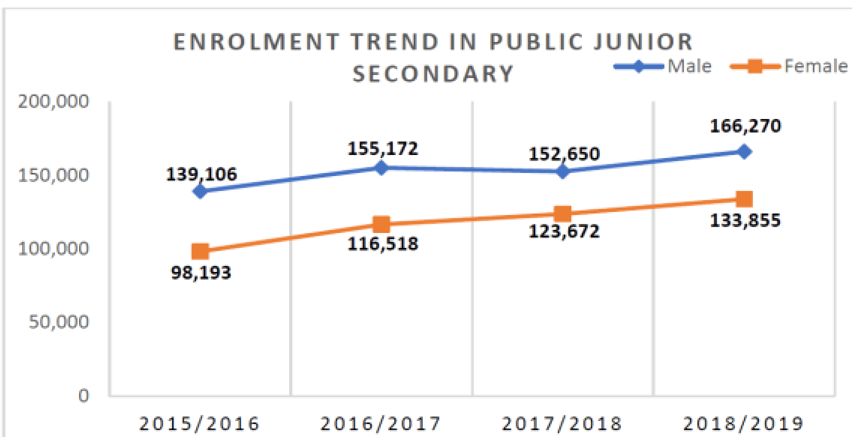


Figure 4. 138: 4 years trend in Public Junior Secondary School Enrolment in Katsina State
(Source: Katsina State: Annual School Census, 2018/2019 Report. Ministry of Education)

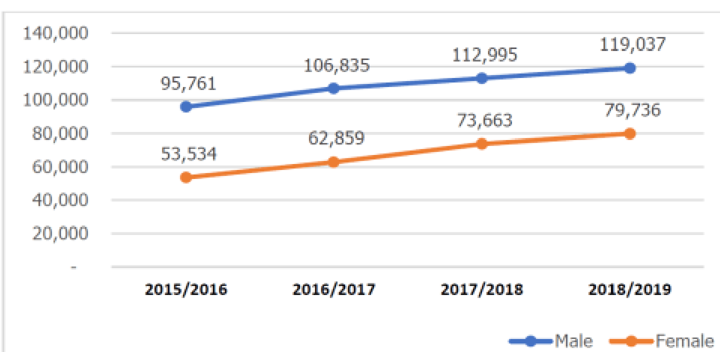


Figure 4. 139: 4 years trend in Public Senior Secondary School Enrolment
(Source: Katsina State: Annual School Census, 2018/2019 Report. Ministry of Education)

The number of pupils enrolled in primary schools is however, 44.0%, 19.8% percentage points below the national average of 63.8%, as presented in Table 4. 42, while the gender gap is 35.92%, which is equal to 155,267 female pupils in the state. The number of primary schools is equal to 2,275 (NBS, 2019).

Table 4. 42: Primary School Enrolment in Katsina State

State	Enrolment %Average
Katsina	44.0%
National	63.8%

(Source: National Bureau of Statistics 2019)

Katsina State is a centre of both formal and informal education. The following are list of tertiary institutions in the state: Umaru Musa Yar'adua University is a public university owned by the state government. Al-Qalam University, the first Islamic university in Nigeria is privately owned. Federal University, Dutsin-Ma is owned by the federal government as well as Federal College of Education, Katsina (affiliated to Bayero University Kano). National Open University of Nigeria, Isa Kaita College of Education Dutsinma (affiliated to Ahmadu Bello University, Zaria), a state-owned college of education. Cherish Institute Batsari, a privately-owned university awarding degree in health course (Katsina State Government, 2016).

On the whole, students' enrolments in college are less than 1% of the population of the respective states. The proposed rail project would likely impact on the education in the states affected by the project. Ease of transportation would attract more student enrolment at primary, secondary and tertiary levels.

Jigawa State

In Jigawa State, the percentage of students enrolled in primary schools 35.92%., 19.8% below the national rate, while the gender gap remains at 40.43%, which equals to 155,267 female pupils in the state (NBS, 2019). Primary school enrolment in Jigawa State is presented in Table 4. 43 (NBS, 2019).

Table 4. 43: Primary School Enrolment in Jigawa State

State	Enrolment %Average
Jigawa	44.0%
National	63.8%

(Source: National Bureau of Statistics 2019)

Currently Jigawa State has a Federal University which is situated in the state capital, Dutse and a state-owned University situated at Kafin Hausa Local Government Area of the state. There is also Federal Polytechnic in Kazaure, Hussaini Adamu Federal Polytechnic, and two state owned polytechnics: Binyaminu Usman Polytechnic, Jigawa State Polytechnic situated at Hadejia and Dutse respectively and a number of Monotechnics across the state (Jigawa State Government, n.d.).

4.3.15.5.2 *Economic Setting: Occupation and Employment (Macro and Micro-Levels)*

Economic conditions have a vital role to play in people's experience and perceptions of place. A person or a household's socioeconomic status influences the range of opportunities and constraints that people face. In fact, socioeconomic status affects almost all aspects of life. It affects nutrition levels and health, geographic mobility, educational attainment, and overall quality of life.

Most of the affected population are involved in farming and animal husbandry. However, as is traditional in the culture, individuals also have secondary occupations such as trading which they may pursue all year around together with agricultural activities or in the dry season when they are not farming like house building and other crafts. Moreover, most women are involved in economic activities, which they usually pursue from within the household. These may be food processing like making oil from groundnuts, cooking food for sale, making of snacks, or craft activities like making of baskets, mats, sewing of caps, hair plaiting. For the items produced that need to be sold outside the house, usually children of the house are sent out with these items to hawk them in the area. Often this means that children are denied the opportunity to attend school because they need to help their mothers earn some income. Womens' income is often the daily support of the family, as farmers' income is seasonal, depending on harvesting of crops, and does not provide daily income for family needs.

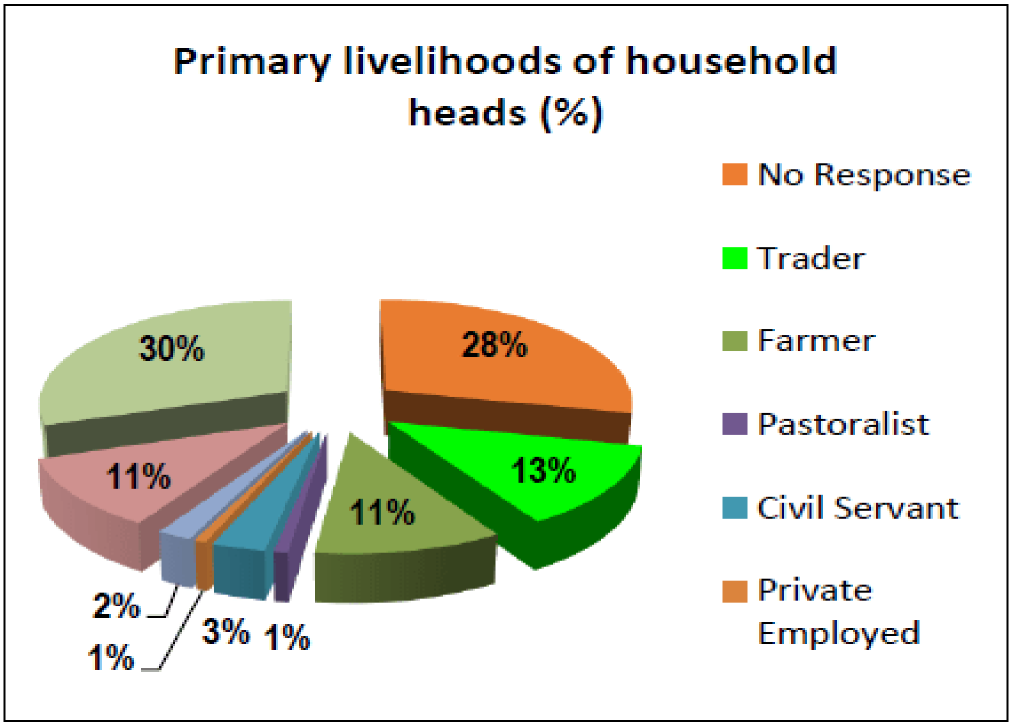


Figure 4. 140: primary means of livelihood of household heads

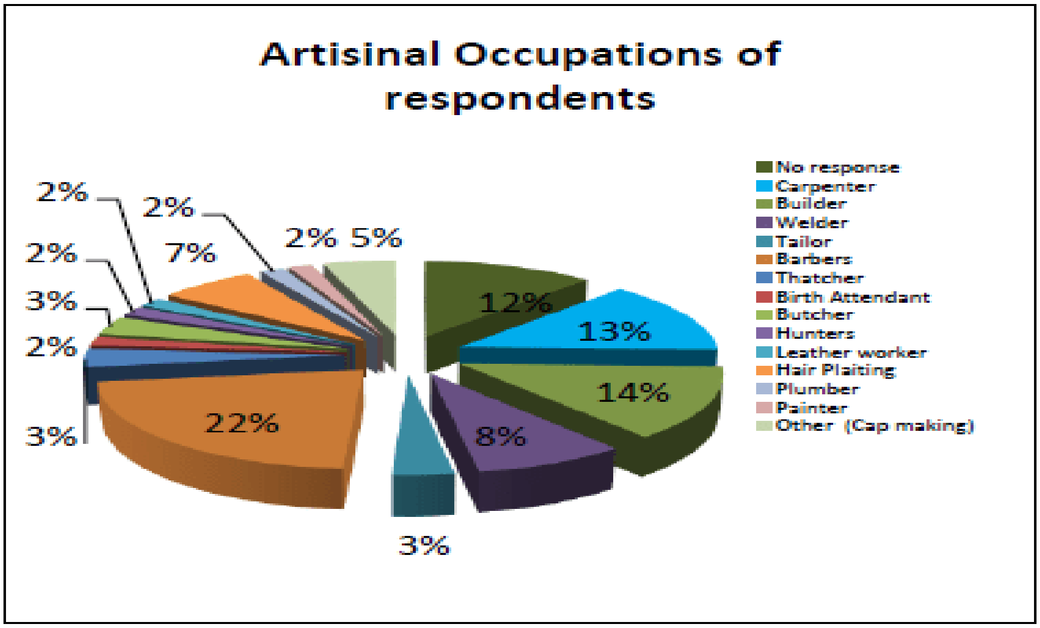


Figure 4. 141: Artisanal occupations of respondents both primary and secondary

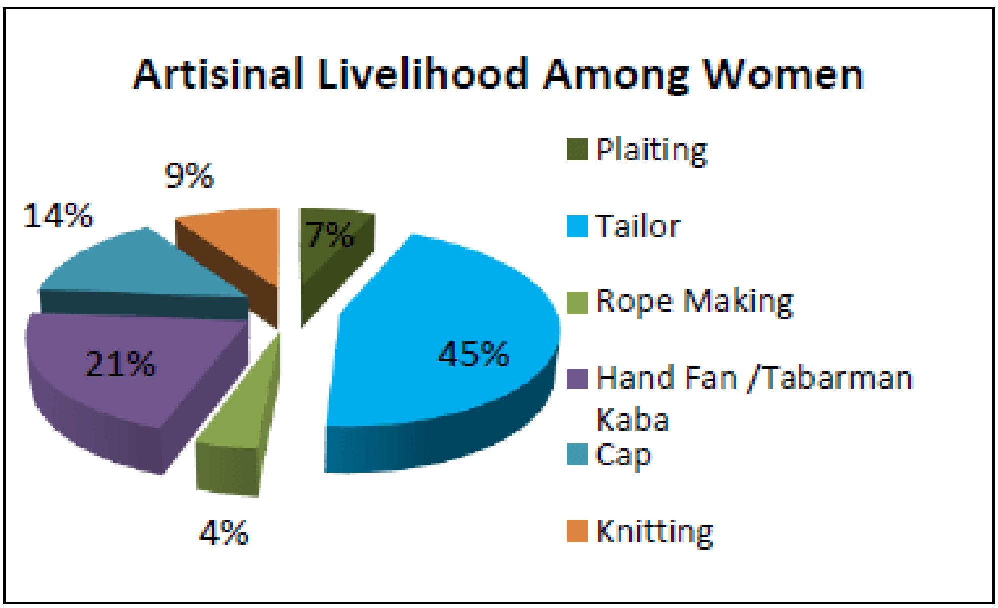


Figure 4. 142: Women artisanal means of livelihood

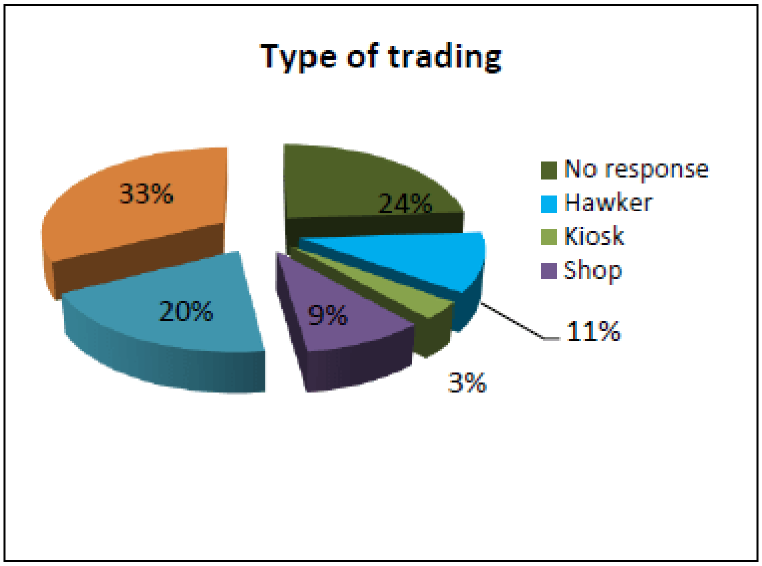


Figure 4. 143: Type of trading activities by traders

Seasonality of livelihoods: 50.8% of household heads said they are involved in dry season occupations, while 41.2% said they are not. For rainy season occupations, 86.9% said they are engaged in occupational activities. This emphasises the importance of rain-fed agricultural activities as a primary income-generating activity in the communities along the rail route. It also indirectly points to the importance of women's occupations being able to fill the gap in income during times of the year when household heads have no income due to the seasonality of their livelihood.

The Economy: KANO

Kano is the commercial and investment hub of Northern Nigeria and third largest non- oil & gas economy in Nigeria, with a GDP of approximately US$12 billion. The Kano economy is driven largely by commerce, manufacturing and subsistence agriculture-the dominant activity, with up to 70% of the population engaged directly or indirectly. Informal sector is strong and diverse, with numerous MSMEs across all economic activities, and contributing approximately 60-70% of output and employment.

Kano has historically been a major commercial and manufacturing centre in the West African sub-region even before the incorporation of Nigeria into the European system of global commerce. In the pre-colonial period, it served as a major entry port and the southern hub of the trans-Saharan trade route for centuries. In the 1950's and 1960's, Kano provided the bulk of Northern Nigeria's export products of groundnuts, cotton, hides and skins. The famous groundnut pyramids were a national emblem portraying wealth and self-reliance. Throughout the 1970's and 1980's, Kano grew to become Nigeria's 2nd largest industrial and commercial centre with over 450 medium-large scale industries. Almost all branches of manufacturing activities were registered: textiles and apparels, plastic and rubber, paper and paper products, leather, food and beverages, chemicals, metals and basic industrial products etc.

Since the mid 1990's however, the economy has suffered steady decline with loss of competitiveness within the national economy. Industrial production and sustained private sector growth have been severely constrained by an unfavourable investment climate, characterized by high production costs, cumbersome regulatory environment, general insecurity and occasional communal strife. The manufacturing sector has been badly hit also by external forces. Nigeria's pursuit of IMF-inspired structural adjustment policies in the late 1980's and other poorly designed macro-economic reforms in subsequent years, have adversely affected many enterprises as they faced intense competition from imported goods.

Today, approximately 70% of the State's medium and large-scale manufacturing establishments are non-operational, while the rest have shrunk considerably, operating at less than 40% capacity. Hardest hit are the textiles, leather, chemicals, plastics, food & beverages and pharmaceutical sub-sectors. Nearly 40% of closed textile firms in Nigeria are in Kano. Kano once dubbed: Nigeria's most celebrated textile exporter is now more appropriately Nigeria's-and perhaps Africa's-most celebrated textile importer. This has resulted in high rates of unemployment, depressed incomes and low rates of economic growth.

The Economy of Katsina State

Due to its vast arable land, the State is playing a leading role in commodity and food production, as crops are grown during both dry and rainy seasons. Major crops include cotton, groundnut, millet, guinea-corn, maize, beans and rice. Successive governments have been encouraging farmers through the provision of farm implements, pesticides and fertilizer to boost food production in the country. New ventures include fish and bee farming, sesame and cassava production. It is also pioneering in tapping the potentials of neem.

In complementing agricultural development, the State Government has made it possible for the establishment of viable industrial ventures in the State. They include Cotton Ginneries, Oil and Flour Mills, Kaolin Processing Factories and Fertilizer Blending Plants in Funtua, Safana, Sandamu and Batsari. The Funtua Burnt Bricks Factory was completed and privatized by the government. Similarly, wealthy individuals have, in response to Government's call, established viable industrial ventures such as the Plastic and Rubber Processing Companies, Northern Diaries and Hamada Carpets. They also participate in oil extraction companies in Malumfashi, Industrial Mineral Ltd in Katsina and Kankia Metal Works as core investors. The Neem (azaderacta indica.) Processing Plant in Katsina is expected to produce 1,000 metric tons of organic fertilizer and 400 metric tons of pesticide. The state has large deposits of untapped kaolin and asbestos as well as other needed materials for good industrial take-off.

The Economy of Jigawa State

The State covers over 23,000 sqkm (some literature claimed 24,516km^2, 22,410 sq km, etc.), of largely undulating lands of loamy soil referred to by the local population as 'Jigawa'. Traditionally, food crops such as groundnut, millet, guinea corn and cassava have been the dominant crops produced in the state. It is estimated that "70 per cent of the total land area is cultivable with 10 percent constituting grazing reserve, 5 percent forest reserve and the remaining 15 percent are settlements and uncultivable areas" (Essiet & Yusuf, 2000). Fishing, fadama farming of vegetables, livestock rearing and sugar cane production are the major economic activities in the state. Trading is also a significant economic activity especially in peri-urban communities or in the dry season in the rural areas. A total of 88% of the population in the state is engaged in agriculture (FOS, 1997:101).

The Economy of Jigawa State is largely characterized by informal sector activities with agriculture as the major economic activity. Over 80% of the population is engaged in subsistence farming and animal husbandry. Trade and commerce are undertaken on small and medium scale, especially in agricultural goods, livestock and other consumer goods. Other informal sector activities include blacksmithing, leather-works, tailoring services, auto repairs, metal works, carpentry, tanning, dyeing, food processing, masonry etc. Even though modern industrial sector is yet to gain a solid footing, the seed for their development was planted through establishment of small-scale industries particularly in areas of food processing and other agro-allied activities.

There are industrial enterprises in the state and these industries operate mostly with raw materials produced locally. These are in form of agriculture and livestock. With an international border to the north, the opportunity for cross-border trading activities was taken advantage of by the government by initiating and establishing a Free-Trade Zone at the Border town of Maigatari.

3.3.15.5.3 Income Distribution, Consumption and Expenditure Profile

Income distribution is one of the most important indicators of the regional welfare. Income level determines the ability to meet basic needs and provide information on the poverty rates in the area. It is also an important variable that influences socio-economic status of individuals and its distribution pattern has the potential of influencing other demographic variables. However, personal income levels of self-employed rural households are always difficult to assess because many local people do not keep records and are therefore uncertain of the gross or net amount actually earned from self-endeavours. Household members are engaged in several income-generating activities and their respective contributions to the overall household income most times are difficult to calculate. Some who may have information about their earnings are also not willing to divulge such sensitive data, considering the effects of taxation. The consequence is that incomes of rural (and urban too) households are often less reliable.

According to those surveyed, the monthly income of the respondents ranged from N100 to N300,000 depending on the season, even though the median income per month (N5,000) did not change with the seasons. In terms of expenditures, respondents said they spent between N100 to N15,000 (median = N2,000) monthly on transportation and between N2,000 to N30,000 (median = N2,000) monthly on health. The "2019 Poverty and Inequality in Nigeria" report released by the National Bureau of Statistics (NBS) highlighted that 40 percent of the total population in Nigeria, or almost 83 million people, live below the country's poverty line of 137,430 naira ($381.75) per year.

<u>Household consumption and expenditure pattern</u>

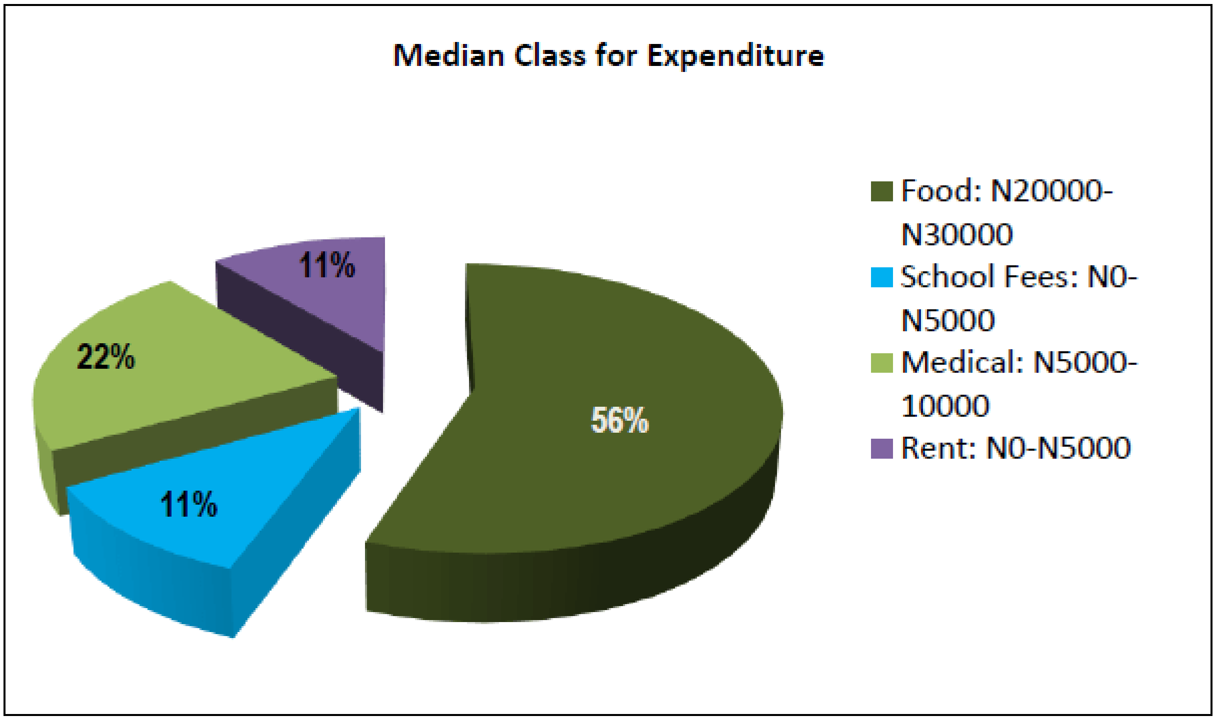


Figure 4. 144: Percentage of expenditure spent on food, school fees, medical bills and rent

Even if the absolute figures for expenditure are likely exaggerated, the percentage of income spent on the items such as food, school fees, medical bills, rent and others is likely reflective of the true situation.

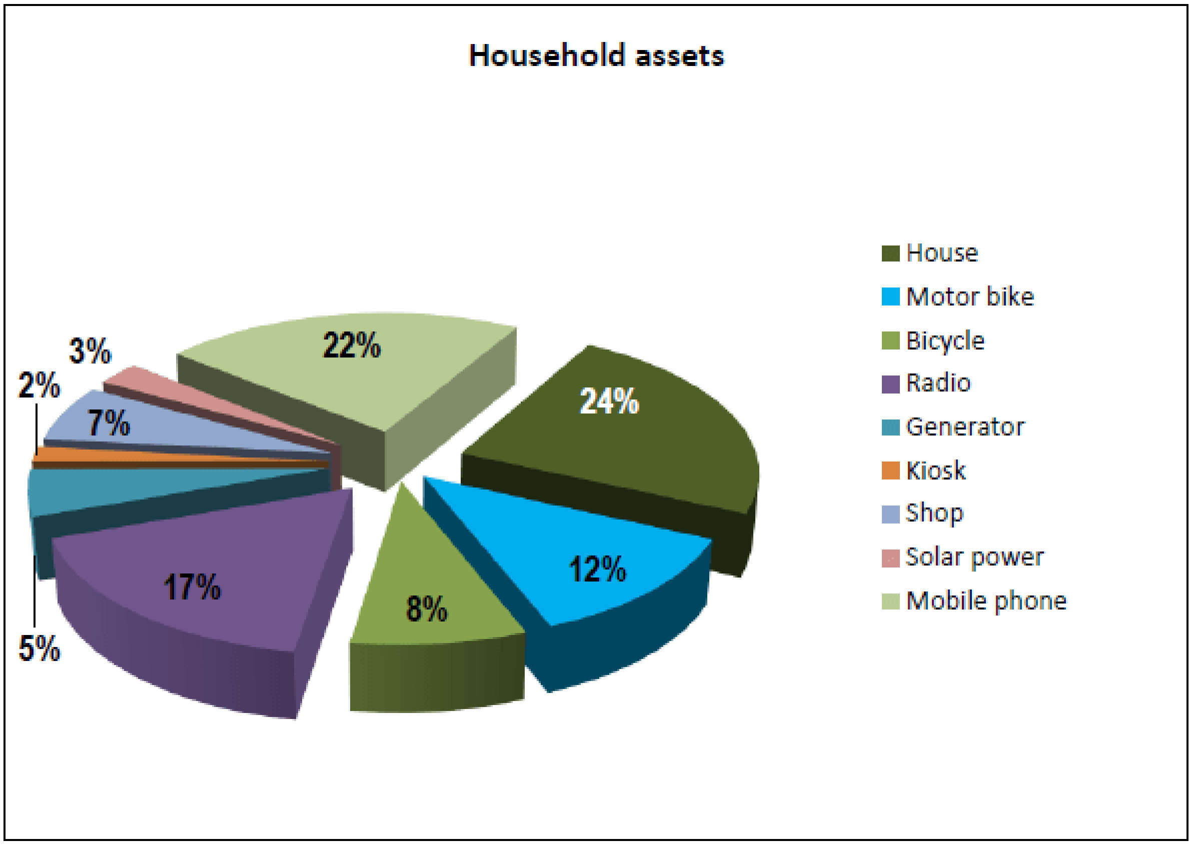


Figure 4. 145: Percentage of households owning assets, as reported by household heads

Considerable proportion of incomes of most rural households is spent on feeding the large family reared, on education and medical needs, as well as other sundry expenses.

4.3.15.5.3 Land Use and Management: Landownership System and Tenure

Land Ownership System/Access and Tenure System

Land Tenure System in Nigeria

Nigeria operates a complex tenure system for land use and acquisition. The system involves the rights of occupancy system under the Land Use Act and indigenous tenure system under customary law, which has been in practice before the advent of the uniform statutory rights of occupancy.

The indigenous land tenure system practiced in the Northern States has been influenced by Islamic land tenure principles following the Fulani conquest on the early 1800s. The Fulani jihadists introduced a kind of feudal tenure under which they claimed overlordship of the land. The British established Lands Committee documented that traditional tenure was communal, in that the emir owned land and assigned use rights to others with an obligation to pay taxes.

In 1978, the federal government promulgated the Land Use Act (LUA) as the supervening legislation on land. The Act vests land in the territory of each state in the Governor to be held in trust and administered for the use and common benefits of all Nigerians. Management and control of land in urban areas is vested in the Governor, while the local governments assume this responsibility over land in non-urban areas. The Supreme Court in Abioye v. Yakubu affirms that provisions of the LUA do not invalidate customary rights of occupancy. The fact that it can now be granted by the local government does not take it out of the realm of customary law.

Apart from obtaining the right of occupancy from government, succession is a major process through which land interests are transferred in Nigeria. Sura (Chapter 4) Verses 11,12 and 176 of the Holy Quran, complemented by the Hadith (Sunnah) and Ijma, providing inheritance indicate the absence of discrimination between male and females. Daughters and wives of a deceased are entitled as sharers under Islamic law.

The governor has the power to revoke any right of occupancy for overriding public interest. Overriding public interest includes the requirement of the land by the Government of the State or by a Local Government in the State, in either case for public purposes within the State, or the requirement of the land by the Government of the Federation for public purposes of the Federation. Payment of compensation for the revocation shall be paid to the individual or, where rights revoked belongs to a community, compensation will be paid to the chief or leader of the community for the benefit of the community in accordance with the applicable customary law. (Human Rights Impact Assessment, Baba Lawal et al.)

The population across the project area area are predominantly farmers, combining animal husbandry with agricultural activities. Land is acquired either by inheritance, purchase, gift, loan, or mortgage (*Jingina*). Village heads interviewed said that 24.5% of land transactions occurred through inheritance and 75.5% were through purchase, which indicates the very high level of commercialisation of land. Rules of inheritance follow Muslim legal practice. As is traditional in the culture, most men also have an additional craft or artisanal occupation that they may pursue in the dry season when they are not occupied with rainy season farming activities. Agricultural production is generally for subsistence and also partially for the market.

It is common in rural communities for households to own the land on which they construct their houses. In the affected communities, 88% of household heads said they owned residential land while 30% of household heads indicated that they owned the land for their livelihood. Other required land could be accessed through renting, loans, or other means.

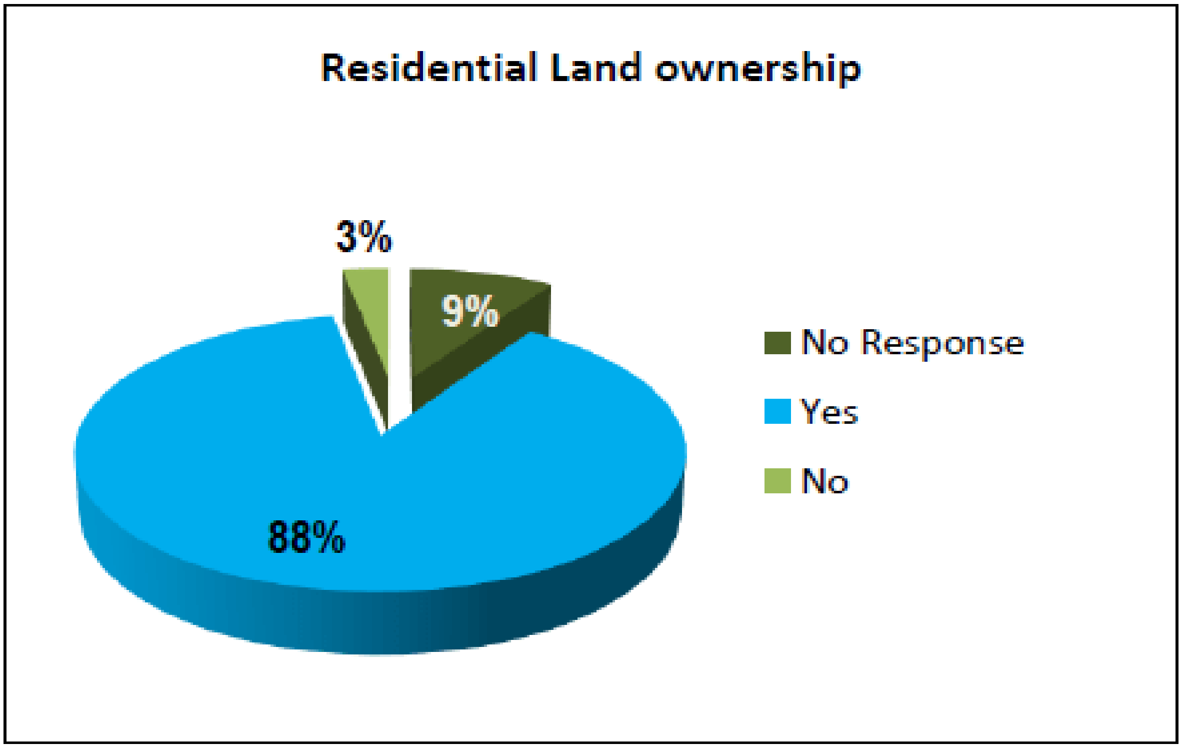


Figure 4. 146: Percentage of land ownership for residential purpose

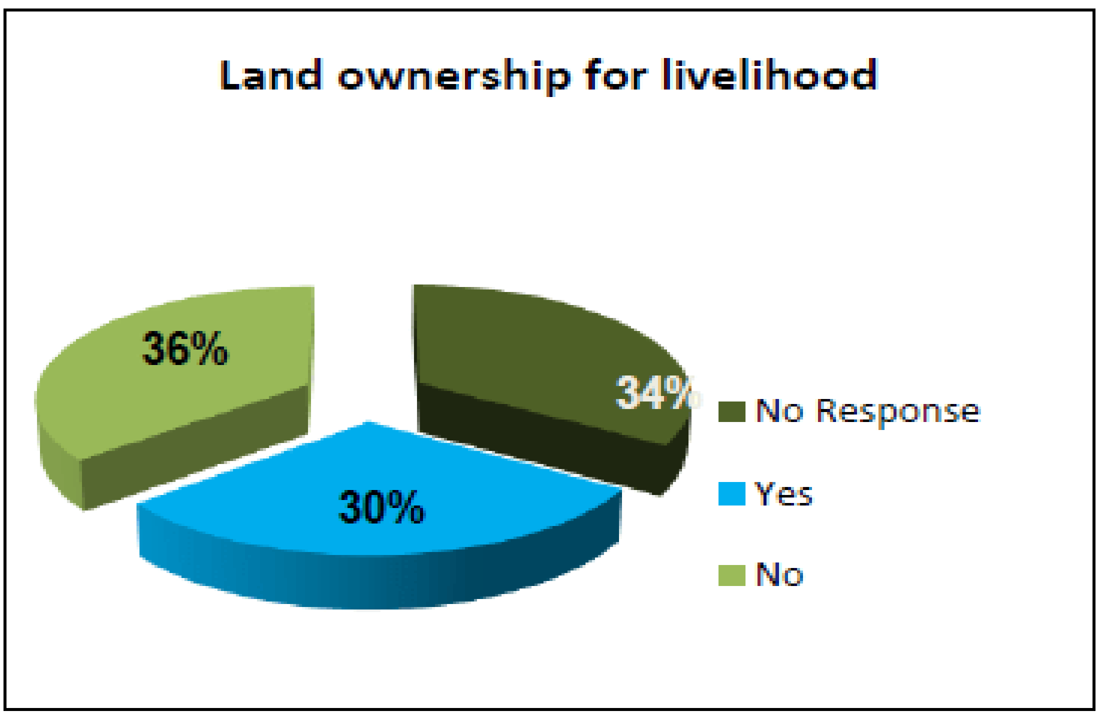


Figure 4. 147: Percentage of land ownership for livelihood

5.3.15.5.4 *Socio-cultural setting and Characteristics*

Religion, customs, beliefs systems and cultural heritage

As we can see from the historical overview, the communities along the Kano to Maradi Rail Line share a common history and a common culture. Most of them were founded many years ago, and have a very long history. With a few exceptions, they are overwhelmingly Muslim by religion, Hausa or Fulani by culture, speak Hausa as a first language, and are largely rural dwellers. 96.2% of community leaders reported that Hausa was the primary language spoken in their area, while in 3.8%, Fulfulde (the language of the Fulani) was dominant.

They are predominantly farmers, combining animal husbandry with agricultural activities. Land is acquired either by inheritance, purchase, gift, loan, or mortgage (*Jingina*). Village heads interviewed said that 24.5% of land transactions occurred through inheritance and 75.5% were through purchase, which indicates the very high level of commercialisation of land. Rules of inheritance follow Muslim legal practice. As is traditional in the culture, most men also have an additional craft or artisanal occupation that they may pursue in the dry season when they are not occupied with rainy season farming activities. Agricultural production is generally for subsistence and also partially for the market.

Minority groups

The prevalence of the Hausa-Fulani culture is ubiquitous throughout the route, with the exception of a few communities that were previously Maguzawa (Original Hausa people who still follow traditional religious practices). Within the 5 km band along the route, we identified three of these. They no longer adhere to traditional (animist) religion, but have been converted to either Islam (in one case), or to Christianity, in the case of the other two. The latter refer to themselves as Hausa Christians. [More information on these communities will be found in the Report on "Vulnerable Minorities", attached to the ESIA draft.] There are certainly a number of other Maguzawa communities following their traditional culture in the three states under consideration, but they live in areas remote from urban populations and are not to be found in our study area.

Nearly all the communities along the route are rural. The only truly urban communities are in Kano metropolitan, exhibiting the classic characteristics of urbanism, i.e. a large population, high population density, a high degree of division of labour (a wide variety of economic activities), and ethnic and religious heterogeneity. Other towns like Katsina, Daura, Dutse, Kazaure and Dambatta have fewer of urban characteristics and maintain a partially rural profile.

Women

As noted above, rules of inheritance, including those over land, follow Islamic practice. Both men and women inherit from their fathers and other male relatives, but women inherit only half of what their male siblings inherit. In practice, women normally inherit movable property while the sons inherit the land. When women do inherit land, they often sell it because they cannot farm it themselves (due to their seclusion) and usually do not have the capital to operate it as a farming enterprise. However, nearly all adult women are engaged in some form of economic activities which they pursue from the house, (such as food preparation, making of snacks, selling of agricultural produce, operating machines for grinding of soup ingredients, weaving mats and baskets, sewing or other craft activities,) often using children or other intermediaries to market their products. In many cases, it is the economic activities of the women who provide for the daily needs of the household, as many of the men's livelihood activities are seasonal or do not provide daily income. As wife seclusion (*kulle*) is widely practiced, women are normally left out of the process of decision making in the community, and usually get the information about significant events either through their male relatives or over the radio or other media. (In the course of interviews, it was striking that in many communities' women had never heard anything about the proposed railway line, although the men in the community were well aware of it.)

4.3.15.5.5 Institutional arrangements, governance system and structures

The three states of Kano, Jigawa and Katsina have similar modern and traditional administrative structures. The modern administrative structures are made up of elected governors, executive local government chairmen and ward councillors. The State Government administrative apparatus is organized into ministries, extra-ministerial departments and parastatals. The traditional administrative structure in these states is made up of Emirs, district heads, village heads and ward heads, who administer traditional institutions at various levels across the three states. Headship of traditional structures is inherited by eligible males from royal houses. Occupants hold office for life except where they are deposed by the community or the government. The village heads report to district heads who are appointed by the emirs. The Mai Angwas (ward heads) as they are referred to, oversee the affairs of the community and represent them in community matters. They also play the role of adviser to District heads. The Emirs and District Heads, unlike other public functionaries, do not exercise political power but serve as custodians of culture and advisers to the Government on traditional and religious affairs.

Kano

Kano State lies between latitude 13°N in the North and 11°N in the South and longitude 8°W in the West and 10°E in the East and covers approximately 20,760 sq km or 2.2% of Nigeria's land mass. It is bordered by four States: Jigawa, Kaduna, Bauchi and Katsina, within the NW geo-political zone.

Kano State is one of Nigeria's 36 states and was created on May 27 1967 by virtue of Decree No. 14 of 1967. It formally came into being on April 1, 1968. Prior to that Kano was administered as a province by the Northern Nigeria Regional Government. Today, the State comprises of 44 local councils which are divided into 40 State constituencies, grouped into 24 federal constituencies and three senatorial districts.

In accordance with the 1999 constitution of the Federal Republic of Nigeria, the State government consists of three arms: the executive, the legislature and the judiciary. The executive powers are vested on and exercised by an elected governor, who is assisted by deputy governor-similarly elected- through an appointed executive council chaired by the Governor. Other members of the Council are the Deputy Governor, the Secretary to the State Government, the Head of the State Civil Service, and Commissioners.

Currently the State Civil Service is made up of 13 ministries and a range of extra-ministerial departments, agencies and parastatals. The State House of Assembly consists of 40 elected members constituting the legislative arm. The Assembly is headed by a Speaker elected from among the 40 members. Other principal officers of the Assembly include the Deputy Speaker, Majority Leader, Minority Leader, the Chief Whip and the Committee Leaders.

The judiciary is responsible for interpreting laws and administration of justice. It is headed by the Chief Judge who is also the Chairman of the Judicial Service Commission (JSC), which is responsible for the appointment, promotion and discipline of judicial officers in the state.

The state known as the *Centre of Commerce,* historically, was the site of numerous kingdoms and empires, including the Kingdom of Kano, which was centred in Dalla Hill. The Kurmi Market helped Kano become a centre of commercial activity in Hausaland. Kano has a total of 44 local governments.

Katsina

Katsina State was created on 23$^{rd.}$ September 1987 out of the defunct Kaduna State, with the capital at Katsina. It is made up of Daura and Katsina Emirates which featured prominently in the establishment of the historical Seven Hausa Kingdoms (*Hausa Bakwai*). The State lies between latitudes 11°08'N and 13°22'N and longitudes 6°52'E and 9°20'E and occupies an area of about 24,194 square kilometers. It has a population of 5,801,584 comprising 2,948,279 males and 2,853,305 females, based on 2006 census final results. It shares boundaries with

Kano and Jigawa States in the East, Kaduna State in the South, Sokoto and Zamfara States to the West, as well as international border with Niger Republic to the North. The major ethnic groups are Hausa and Fulani. Islam is the predominant religion, while the main occupations of the people are farming, cattle rearing and crafts.

The administrative and political structure of Katsina State is not different from what is obtainable in other States of Nigeria. The State Governor is the Chief Executive and Chairman of the State Executive Council. The Executive Council is made up of Deputy Governor, Commissioners, and Secretary to the State Government and other key Government functionaries. The Commissioners are in charge of the day-to-day running of the Ministries. There are 13 Ministries, and 46 Extra-Ministerial Departments/ Parastatals in the State. Administratively, the State is divided into thirty - four (34) Local Government Areas (LGAs), mapped into three Senatorial Districts, namely: Daura, Funtua, and Katsina. The state is referred to as the "Home of Hospitality", while the state capital and the town of Daura have been described as "ancient seats of Islamic culture and learning" in Nigeria.

Jigawa State

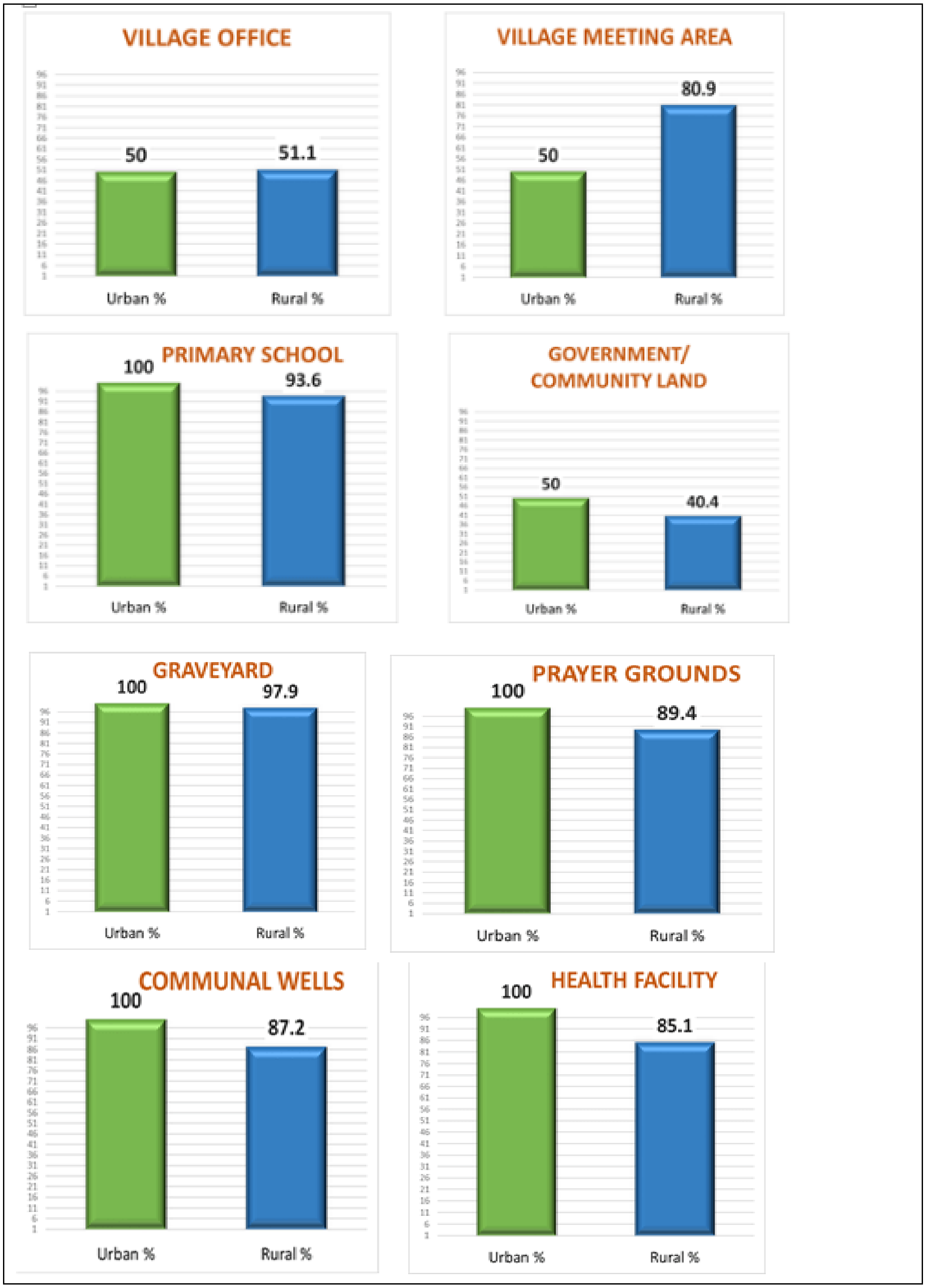
Jigawa State, located in the northern region of the country, was created in 1991 from Kano state. It covers a total land area of about 22,410sq Km. It is bordered on the West by Kano State, on the East by Bauchi and Yobe States and on the North by Katsina and Yobe States and the Republic of Niger. Jigawa state has 27 local governments areas (LGAs) as listed below:

1. Auyo
2. Babura
3. Biriniwa
4. Birnin Kudu
5. Buji
6. Dutse

7. Gagarawa
8. Garki
9. Gumel
10. Guri
11. Gwaram
12. Gwiwa
13. Hadejia
14. Jahun
15. Kafin Hausa
16. Kaugama
17. Kazaure
18. Kiri Kasama
19. Kiyawa
20. Maigatari
21. Malam Madori
22. Miga
23. Ringim
24. Roni
25. Sule Tankarkar
26. Taura
27. Yankwashi

4.3.15.5.6 *Community and Public Infrastructures and Amenities*

Information about social services and infrastructure available to affected communities was obtained from interviews with village heads and also from KIIs with the heads of departments of Health, Education, Agriculture and Social Welfare in all of the affected Local Governments. The following charts (presented as Figure 4. 148) show the presence of different facilities in between rural and urban communities in the study area.


VILLAGE OFFICE
50
51.1
Urban %
Rural %
VILLAGE MEETING AREA
50
80.9
Urban %
Rural %
PRIMARY SCHOOL
100
93.6
Urban %
Rural %
GOVERNMENT/
COMMUNITY LAND
50
40.4
Urban %
Rural %
GRAVEYARD
100
97.9
Urban %
Rural %
PRAYER GROUNDS
100
89.4
Urban %
Rural %
COMMUNAL WELLS
100
87.2
Urban %
Rural %
HEALTH FACILITY
100
85.1
Urban %
Rural %

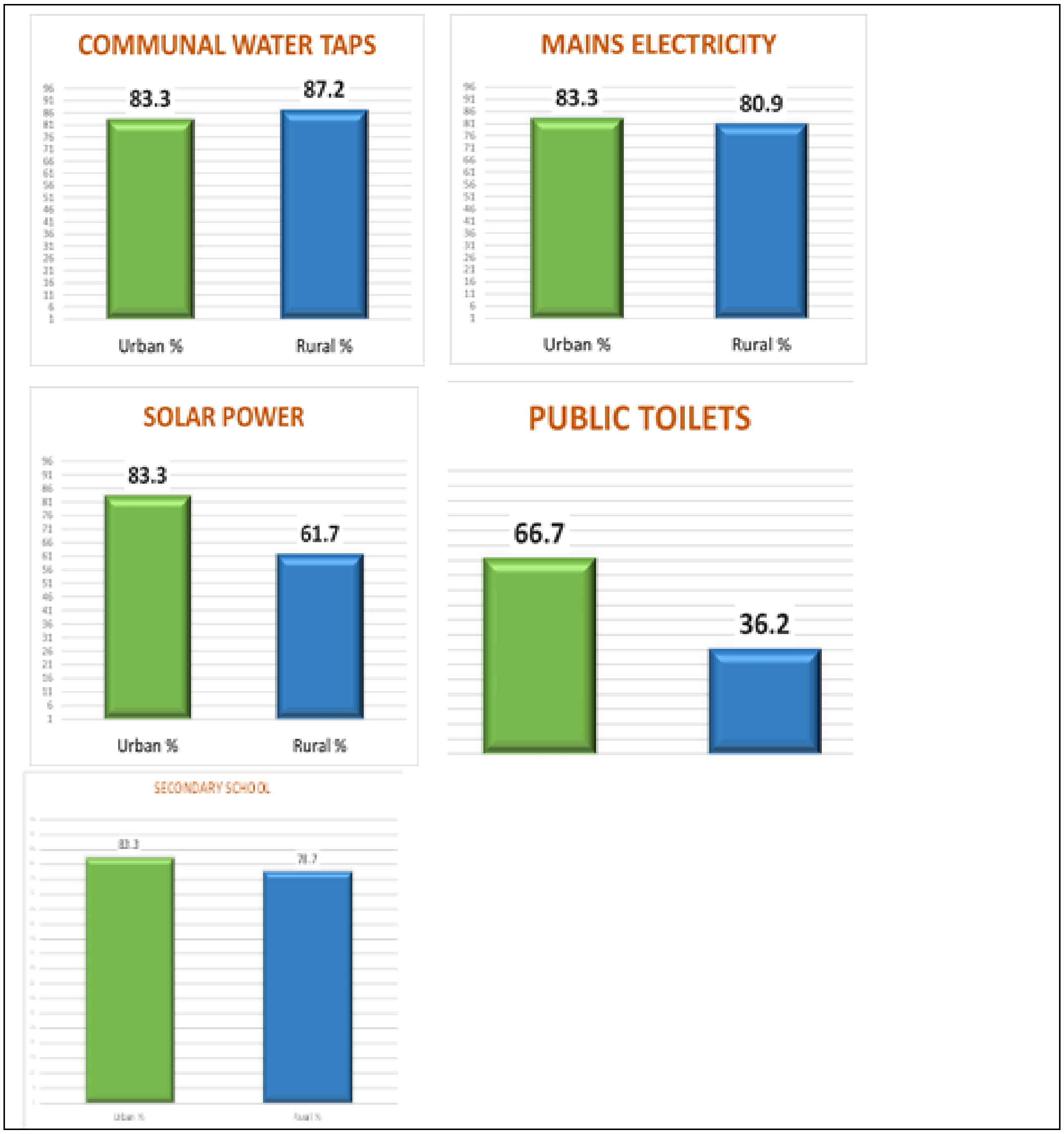


Figure 4. 148: Different facilities in rural and urban communities in the study area

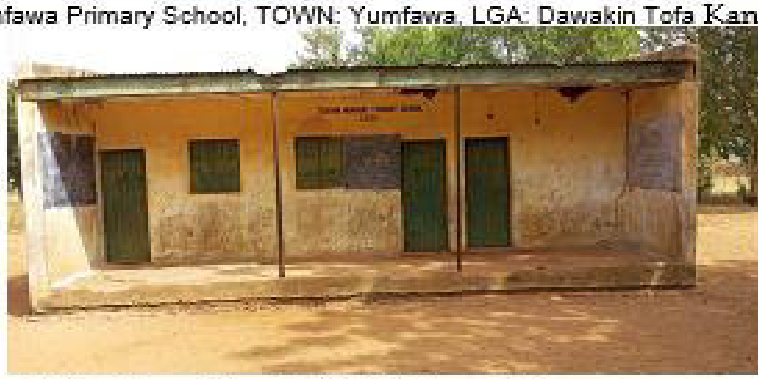
Education

There are public primary and secondary schools across the project affected communities together with some private schools, with different capacities and functional statuses (Plate 4.31). Quranic schools are also found in many rural and urban settings (Plate 4. 34 and Plate 4. 35).

Private School, TOWN: Dambatta Town, LGA: Dambatta-Kano State

Islamiyya School, TOWN: Ajumawa, LGA: Dambatta-Kano State

Yumfawa Primary School, TOWN: Yumfawa, LGA: Dawakin Tofa Kano



Public Primary School, TOWN: Tsallewa, LGA: Dambatta-Kano State

Plate 4. 34: Some Educational Facilities in the Project Area

Plate 4. 35: Qur'anic School, TOWN: Wailare Gari, LGA: Makoda Kano State

Electricity and Energy Use

There was some evidence that the Project affected communities in the Kano-Maradi SGR study environment are connected to the public mains supply system of the national electricity grid operated by the DISCOs. Transformers of various sizes and capacities were seen located at strategic points in some of the communities (Plate 4. 36).

Plate 4. 36: Electricity transformer at Zangon Kaya Ungogo LGA (left) and electric poles and strung lines for electricity supply at Gwarabjawa, Danbatta LGA (right)

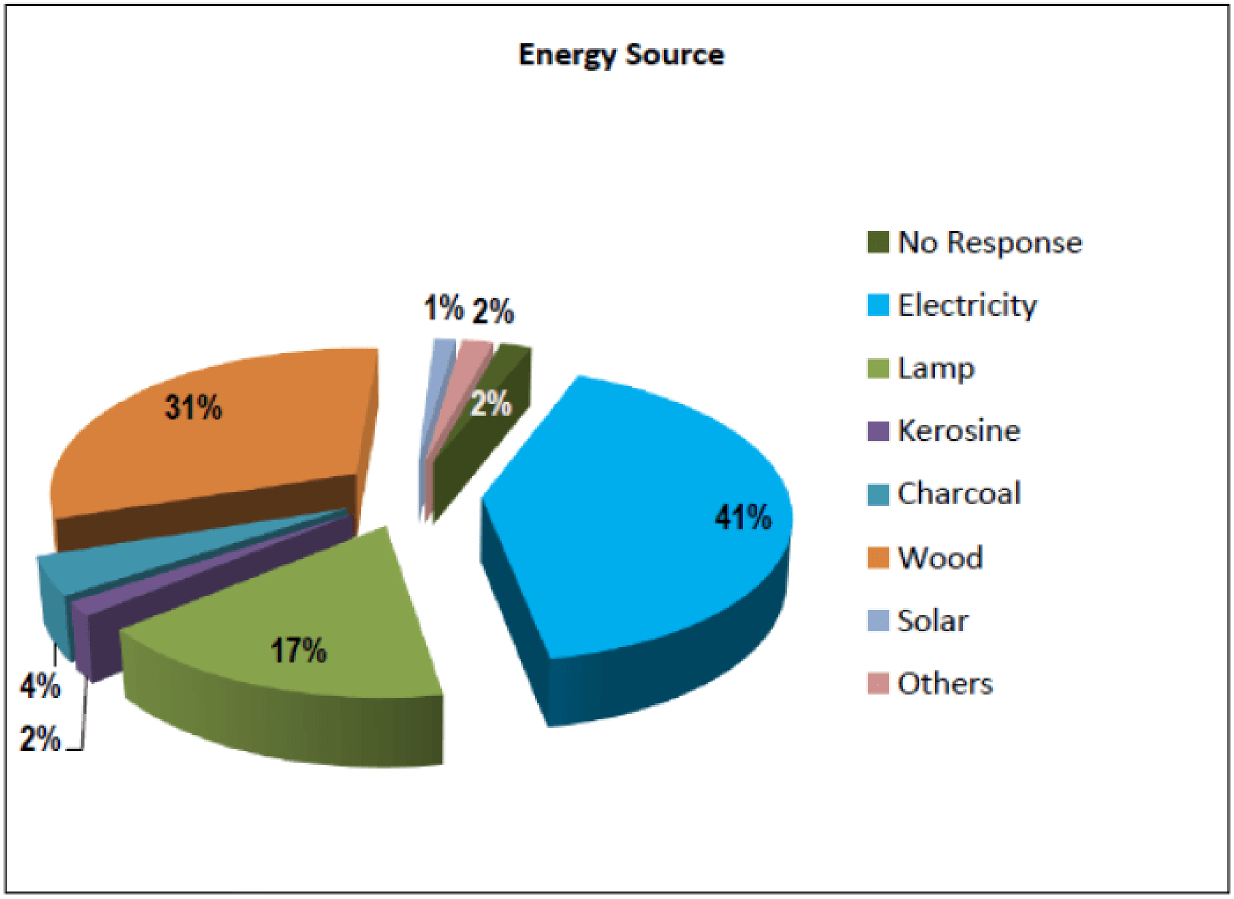


Figure 4. 149: Energy sources for households in the project area

As reported by village heads, for urban communities, 83.3% have access to solar power. In rural communities this is 61.7%

Transportation and Communication facilities

Accessibility to the stakeholder communities although made easy through the presence of primary and secondary roads has become problematic and risky in recent times because of the spate of kidnapping and banditry activities in the area that is not matched with security infrastructure. The study area and communities are accessed via roads that run through from Kano down to Katsina and Maradi and Dutse at the other axis. The population is served by a mix of transportation modes – from cars and trucks to buses, motor bicycles, bicycles and foot. These are used either by the individual or groups to carry out personal business and to transport the variety of agricultural produce especially to the markets on market days. In many rural communities, ox-driven carts are used for movement of farm produce.

Access to modern communication facilities like the telephone services in the project area communities was found to be greatly enhanced. The new mode of telephony, the GSM which has made telecommunications much easier across most communities in Nigeria is generally available in the study area.

Plate 4. 37: Telecommunication mast at Duwama Minjibir stakeholder LGA

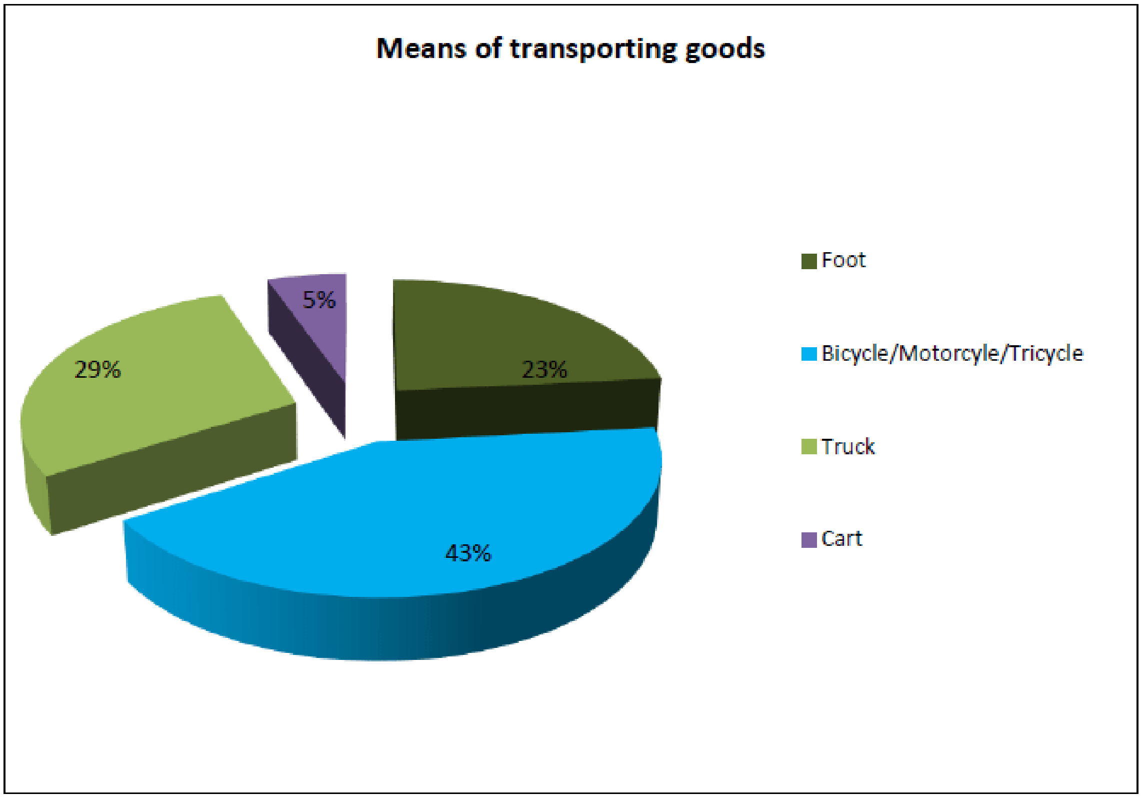


Figure 4. 150: Means of transporting goods as reported by traders

Plate 4. 38: Ox-drawn cart used to transport agricultural produce

4.3.15.5.7 Community and Environmental Health Related Issues

Water supply Facilities

Increasing access to improved drinking water was part of Millennium Development Goal (MDG) 7 (ensuring environmental sustainability), adopted by Nigeria and other nations worldwide (United Nations General Assembly, 2002). The goal in Nigeria was for 77 percent of the country's residents to have access to an improved drinking water source by 2015 (Federal Republic of Nigeria, 2010a). Nigeria met the MDG target; the proportion of the 2015 population that gained access to water since 1990 amounted to 48% (UNICEF and WHO, 2015). The statistics however, showed that while some 69% had access to improved sources of water, only 2% had piped water on premises, some 21% depended on 'other' improved sources while 10% sourced water from ''surface water'' susceptible to contamination.

A number of indicators are useful in monitoring household access to improved drinking water. The source of drinking water is an indicator of whether it is suitable for drinking. Sources that are likely to provide water suitable for drinking are identified as improved sources. These include a piped source within the dwelling, yard, or plot; a public tap/stand pipe or a borehole; a protected well or spring; and rainwater (WHO and UNICEF, 2010).

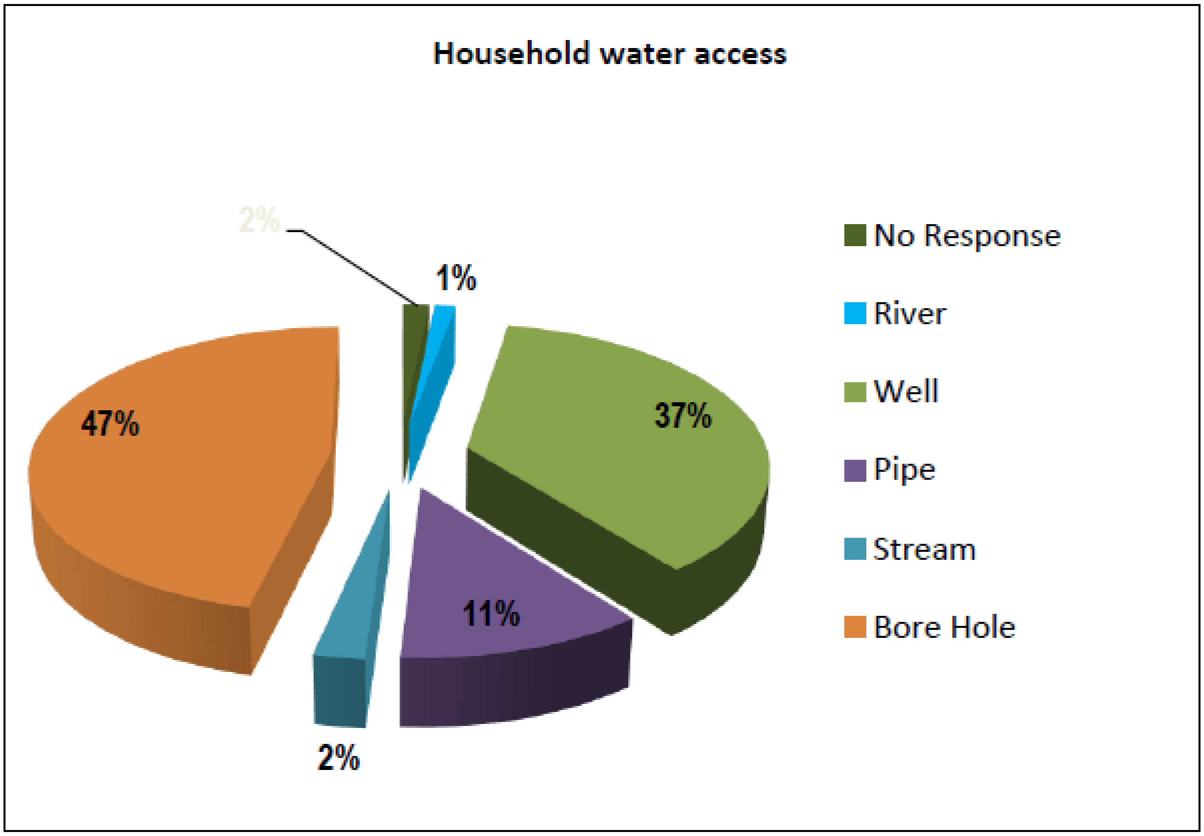


Figure 4. 151: Access to water sources by households

As important as potable drinking water is to good quality of life, not all of the resident population of the K-M-SGR Project has access to modern potable water facilities. Most members of the host communities of the KMRLP are able to meet the daily per capita water requirement of 20 – 40 liters, but mainly from a variety of sources such boreholes, wells, sachet water, rainwater and river. The main source of drinking water for many residents of the communities is public wells and bore holes. According to the interviews carried out in the communities, this is mainly because of the good taste of the water, and the obvious contamination of surface water, streams and the rivers. Communal wells are reported in all urban communities, and in 87.2% or rural areas. According to village heads. Communal water taps were present in 87.2% of rural communities, and 83.3% in urban areas.

Plate 4. 39: A communal borehole (mono-pump) at Sabuwar Kaduna village of D. Tofa LGA (left), well water at Ajumawa (centre) and a cart pusher with loaded jerrycans of water for sale in Gwarabjawa (right)

Plate 4. 40: Water sources across the study communities: Dumawa Minijibir, Gwarabjawar, Danbatta and Nahuce

Plate 4. 41: Solar-powered Water facilities at Danbatta and Gwarabjawar

4.3.15.5.8 Basic Sanitation/Waste Management

Access to basic sanitation is conceptualized on the proportion of the total population with access to sanitary facility for human waste disposal in the dwelling or immediate vicinity. Virtually no households in rural communities use modern toilets (WC) for disposal of human waste. Most compounds made use of pit latrines.

Proper sanitation and hygiene with respect to solid waste was observed to be good within the project environment; no solid waste was seen strewn along the streets/roads in the communities. Attempts at waste conversion through recycling was also observed across some communities in the study environment; turning wastes into fertilizers is a welcome development and should be encouraged.

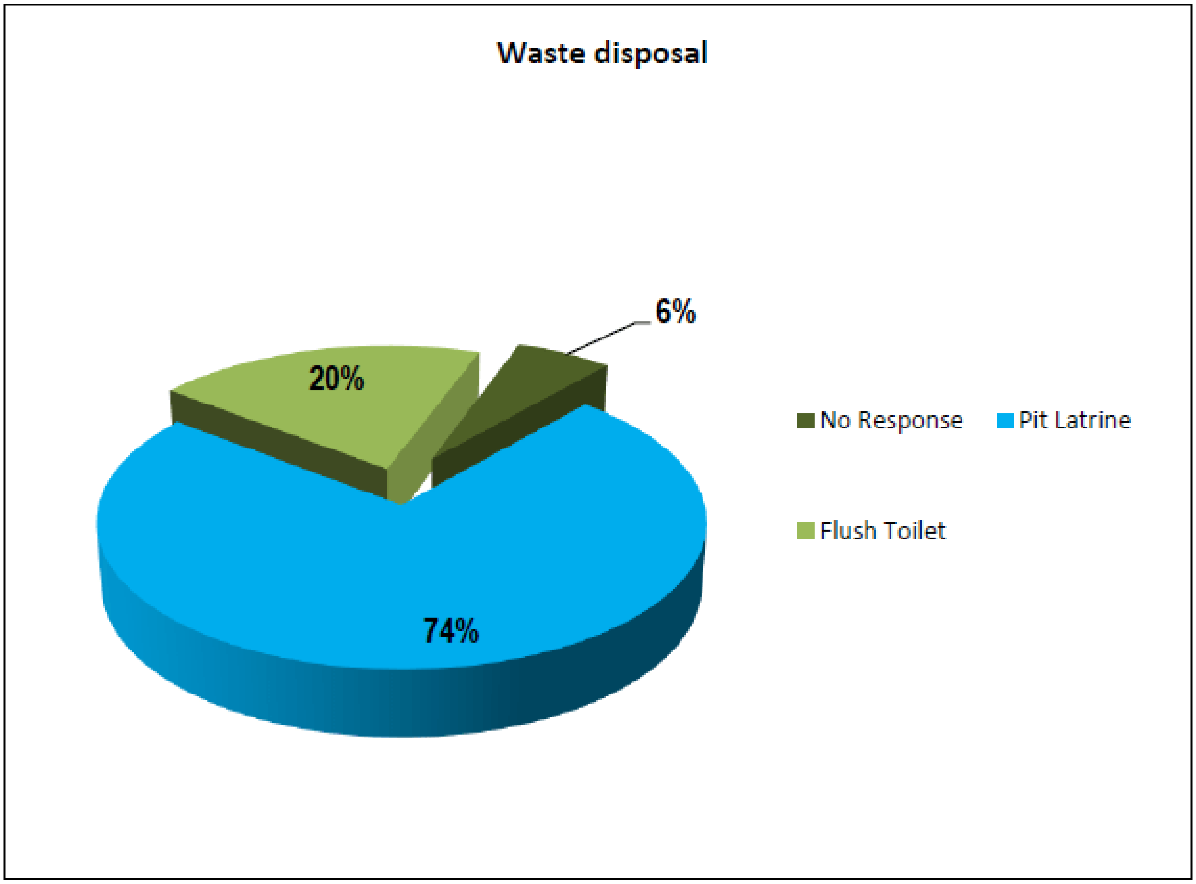


Figure 4. 152: Percentage of households utilising toilets and pit latrines for waste disposal

Plate 4. 42: Solid waste and sewerage recycling for farm use as fertilizers at Sabuwar Kaduan village in D. Tofa LGA

Plate 4. 43: Public Toilet: Tsallewa, Dawakin Tofe LGA, Kano State

Plate 4. 44: Public toilet in Yumfuwa, Dawakin Tofa LGA, Kano State

4.3.15.5.9 Housing Types/Quality and Ownership

The provision of good housing is an important aspect of environmental health. It represents a significant part of man's environment; shelter from the elements; and home (the residence of the family, where this social institution carries out some of its major functions. Consequently, good housing should minimize physical and biological hazards in the environment, provide a good social environment and promote the health of the inhabitants. The housing type, pattern and structure in the study environment are reflections of the environmental and socio-cultural settings (Plates 4.45 – 4.47). The housing stock ranges from the very modern and sophisticated stock to those constructed of ephemeral materials that need regular maintenance.

In the project area, the majority of houses are individually owned, and the only places where rented accommodation is common is in some urban communities. In our survey of household heads, 93.3% indicated that they owned their own houses. In rural areas, the vast majority of houses are constructed by householders and local builders using mud blocks, which are suited to the environment as they maintain a cool interior during hot weather, although they need constant maintenance to keep them in good repair. This provides regular work for local builders. Traditional urban architecture in Hausa towns was one or two storey mud buildings with domed roofs supported by wooden beams and covered with mud plaster. In rural areas the mud houses were traditionally roofed with thatching, although now the use of tin roofs is becoming more common, along with cement block construction.

Plate 4. 45: Mud Sand Excavation area for mud building blocks, at Kwidawa, LGA: Dawakin Tofa, Kano State

Plate 4. 46: Traditional Hausa Urban Architecture

Plate 4. 47: A typical Fulani Settlement

Recreation, Tourism, Security and Public Safety Facilities and Services

The three stakeholder States of Kano, Katsina and Jigawa and constituent communities have own share of touristic and recreational attractions. Security and public safety issues are critical issues in any project development. It is the duty of governmental authorities at all tiers, national/federal, state/provincial and regional/local to provide a safe and secure working environment for the population. The clamour for employment and other benefits associated with any major development as well as the emergence of cult groups which has assumed frightening dimension in some parts of the country could result to youth restiveness if not arrested or attended to in time.

Insecurity remains a major issue of concern along the proposed Kano-Maradi railway route. According to the Nigeria Security Tracker (NST) project of the United States Council on Foreign Relations' Africa program, violence in Nigeria is motivated by political, economic, or social grievances. Different groups in Nigeria resort to violence. Northern

Nigeria has emerged as a hotspot of violence leading to number of deaths including in the states affected by the project. The work of de Bruijn, van Oostrum, Obono, Oumarou, Boureima (2011) stated that new forms of insecurities related to pastoral cross border mobility are emerging in the Kano-Maradi axis. As noted earlier in this report, livestock farming is the second largest economic activity for the population of the area, after agriculture. However, in recent years, this activity has faced various difficulties: series of droughts, scarcity of water resources and vegetation, growing insecurity in the pastoral areas, deterioration of moral standards. The common conflict arising from the movement of the fulbe and clashes with farmers is the farmer-herder conflict which is common in both Nigeria and Niger republic. Insecurity due to robberies and armed raids is a major concern among livestock farmers. They complain about this situation because they are victims of it all the time, even when they return to their home areas. This form of insecurity happens in both directions of the transhumance, with robbers mostly armed with rifles. Below is the breakdown of deaths arising from the activities of bandits and non-state actors (NSA) from 2011-2021. The number of deaths by state is found in the Table 4. 44.

Table 4. 44: Number of Deaths by State

Country	State	Reasons For Deaths	Total Deaths
Nigeria	Katsina	Banditry/NSA	1,783
Nigeria	Kano	Banditry/NSA	1,084
Nigeria	Jigawa	Banditry/NSA	56
	Total		**2,923**

(Source: Nigeria Security Tracker, Council on Foreign Relations' Africa program) (**https://www.cfr.org/nigeria/nigeria-security-tracker/p29483)**

Establishing the Kano-Maradi railway could plug some insecurity holes, while creating new ones. Some hotspots of insecurity along the route include among others are Batsari, Falgore forest, Magama, Jibiya among others. Data from the Armed Conflict Location & Event Data Project, shows that in the last two-decades, not less than 868 civilians who followed these routes met unfortunate situations with assailants. Thus, seeing that most users of these routes are traders, establishing a railway route devoid of breakdowns or limitations of the automobile, in reality, solves this challenge. Consequently, merchants and traders alike would be able to transport their goods without fear of attacks

4.3.15.6 Focus Groups Discussions

Jigawa State FGDs Report

This activity started with questions to ascertain the level of awareness of the Kano-Maradi rail line project by respondents. The FGD respondents overwhelmingly noted that they are aware of the railway project and they heard about the ground breaking project in both electronic and print media. Many of the respondents said that they saw the project map and they are well informed about the project and where train stations would be sited (FGD with Community Based Organization (CBO) held in Dutse Local Government, (2021). In an FGD with Farmers held in Yankwashi Local Government Area (2021) all the participants stated that they are fully aware that the government has approved the contract for the construction of railway line from Kano-Maradi and Kano-Dutse. Toeing the line of other groups and associations, the traditional leaders of Kazaure stated that they are aware of the railway track from Kano-Maradi and Kano-Dutse. They said that they have severally sighted workers embarking on survey while some of the participant said that they even interacted with the surveyors/consultants and the contractors (FGD with traditional leaders held in Kazaure Local Government Area, 2021).

In an attempt to ascertain the level of awareness of the Kano-Maradi Rail project, the members of the National Union of Road Transport Workers (NURTW) claimed that they were very much aware of the project. Most of the respondents noted that they are aware of the railway. Some of the participants observed that they heard about the award of the contract on media outlets like radio and TV while a respondent said that he heard of the award of contract through an informal discussion with a staff of Federal University Dutse who told him about the award of contract for rail project from Kano-Maradi and Kano-Dutse (FGD with NURTW, 2021).

Whether or not the rail project will be of benefit and in what ways was a major focus of the discussion. All the participants concur that the railway project is of immense importance to the state and the country at large. A vast majority of the respondents agreed that the train services will create job opportunities for the teeming youths in the state. They argued that most of the youths in the area are engaged in rainy season farm work and move outside the state during dry season in order to seek for their livelihood, so the introduction of the train services will to a large extent reduce seasonal migration because of the multiplier effect associated with the project. Many of the respondents observed that the train project will be about a drop in the prices of goods. They argued that the goods will be cheap because it will be cheaper to transport goods using train than by road transportation (FGD with Community Base Organization (CBO) held in Dutse Local, 2021).

The FGD with Community Base Organization further noted that:

> The rail project will open up the economies of Jigawa and Katsina States as well as promote socio-economic activities between Nigeria and Niger Republic. Many tourists are going to patronize tourist sites during festive periods like Sallah Dubar (Hawan Sallah) and Sallar Gani in Dutse and Gumel respectively and many of them are going to seek for accommodation and also spend money. Some of them will also take advantage of going to Birnin Kudu in order to visit the local government area for tourism in order to see the tallest flag in the country which is a stone's throw away from Dutse (FGD with Community Base Organization (CBO) Held in Dutse Local, 2021).

In an FGD with Farmers Held in Yankwashi Local Government Area (2021) virtually all the participants agreed that the train services will be of immense importance to them and it will ease transporting their farm implements and produce. They further noted that it has the potential of reducing the high cost of fertilizer because transportation from the manufacturer to the users will be done speedily.

FGD with Farmers held in Yankwashi Local Government Area (2021) further claimed that:

> The rail project will also lead to the opening of new markets and businesses that will eventually bring about an increase in the influx of people in the state leading to high demand for our farm produce. Some of the sales can even be made amongst different nationals from Nigeria and Niger. Employment amongst our youths will increase, youths will be less idle and the transportation of goods and services will be easy. We urge the government to ensure that the project is executed and we thank the government for the good intention towards the development of our state.

In a FGD with pastoralists, the respondents were unanimous that the railway services will bring about ease in transportation as it will further enhance trans-border movement of goods and services. They noted that it will lead to economic prosperity as greater number of cows is likely to be slaughtered on a daily basis as compared to before hence, translating into more income. Some of the participants stressed that the train services will enhance the transportation of cows and animal products from one market to the other market and between states will be easier as compared to transporting them in long vehicles and that the animals will be devoid of fatigue (FGD with Pastoralists held in Dutse Local Government Area, 2021).

Sharing similar thoughts on the rail project were traditional rulers at an FGD Held in Kazaure Local Government Area of Jigawa state. Majority of the participants stated that the project will enhance security as train services are more secured and that it will reduce the spate of kidnapping and banditry that the region is confronted with as many people will prefer utilizing the train than road due to insecurity. While some of the participants noted that the train services will ease transporting goods and services across borders and a reduction in the transportation cost by almost 50% from what it used to be by road. Few participants states that it will also bring about tourist attraction to the state. Some of the respondents agreed that it will promote economic empowerment as businesses will expand and farm produce will be easily transported at a cheaper cost. Some of the participants noted that the rate of occurrence of accidents will be drastically reduced (FGD with traditional leaders held in Kazaure Local Government Area, (2021).

Most of the respondents noted that the decision to embark on such a gigantic project is the right step in the right direction because it will boost socio-economic activities which will in the long run bring about the much-needed development aimed at improving their livelihood as it will enhance their daily income and bring about efficient transportation of goods and services. Some of the participants noted that it will boost commercial activities between Kazaure and the state capital as passengers will require shuttle services to Dutse and even beyond (FGD with NURTW, 2021).

The members of the NURTW further elucidated on the importance of the rail project when they said:

> The high traffic associated with lorries will be reduced drastically, hence reducing the level of damages to the road thereby translating into durable road network in the state. It will give us the opportunity to experience what it means to board a train, because some of us only hear about train but have never seen or boarded it. The train services will bring a rise in employment as motor parks will be established at each train station and some people may hawk drinks and other forms of consumables and can serve as park assistants among others. Transportation business will boom when the train services commence and it will eliminate the current insecurity issues around the Northern part of the country (FGD with NURTW, 2021).

In a FGD with Youths held in Dutse Local Government Area, **t**he participants collectively agreed that it will bring about massive development in their town/villages as train stations and motor parks amongst other infrastructure will be built and several economic activities will take place. Some of them noted that many of the youths will be gainfully employed as there are several multiplier effects associated with the project such as the provision of Okada riding from the train station to villages and towns and many will also operate mini-supermarkets (FGD with Youth, 2021). The rail project will give room for faster and more efficient means of transportation vaccines and drugs during outbreak of diseases (KII with President of Professional Association of Environmental Health Officers, 2021).

A sizable number of the business women and men alluded to the fact that the Kano-Maradi rail project is a huge developmental stride to the people of Jigawa State. They said that:

> We are all happy and it will improve upon our daily sales, ease transportation of goods from South East, South West to our state. The introduction of train services will also ensure timely delivery of our ordered goods and will also bring development to the entire country not only Jigawa State alone. Government should please ensure that the project is executed soonest as it will enhance trans-border trade between Nigeria and Niger and hence, more revenue and socio-economic prosperity (FGD with business man and women, 2021).

Despite the participants' agreement that the train services are going to be associated with several opportunities for economic prosperity, they all agreed that there are challenges to be encountered if not properly managed. They noted the possibility of the influx of criminal elements in the state which will affect peaceful nature of the state as the most peaceful in the region. Many of the communities are isolated and could harbour criminals thereby affecting security negatively (FGD with Community Based Organization (CBO) Held in Dutse Local Government, 2021).

They further said:

> The project will result in many farmers forfeiting their farmland in the overriding public interest. This development means economic disempowerment to many and may lead to worsening poverty and unemployment. We cannot also rule out the possibility of compensation not reaching the target beneficiaries due to corruption that may affect the payment of compensation and resettlement of displaced people in new locations in order to give way for the project (FGD with Community Base Organization (CBO) Held in Dutse Local, 2021).

Many of the respondents embraced the fear that the train services may also increase the cost of living in the state as there is likelihood of increase in prices of goods and services and accommodation may be out reach due to high demand and competition. Whereas some of the respondents noted that it may also lead to trans-border crimes and the rise in drug smuggling and abuse of substances by the youths. Many of the participants observed that the project may lead to high level of moral decadence in the state. As there is the possibility of infiltration and the introduction of alien cultural practices. There is the tendency of many young girls engaging in prostitution and the males mingling with other people which may result into anti-social activities and the spread of sexually transmitted diseases (FGD with Community Based Organization (CBO) Held in Dutse Local Governmenty, 2021).

A substantial number of the participants observed that the railway line will pass through several local government areas in the state and it will encourage entrepreneurship amongst the inhabitants of these local government areas and also boost farming activities. Even some of our youths that were not fully engaged in farming will embrace it, because of the boom that the agricultural sector in the state may record. However, some of the respondents revealed that the railway line will lead to many families losing their farms, houses, cattle routes amongst others (FGD with Farmers, 2021).

The FGD with farmers also maintained that:

> The railway track may lead to the displacement of many locals that may be affected by the project. Adequate compensation to people that may be directly affected like people that may lose their houses, date palms and other economic trees, and farmlands could be an issue. A participant noted that if compensation is not paid, the project may start on a bad note. Imagine it passing through my rice farm that is my only source of survival and I am not reimbursed I will see the project as an avenue for losing my only means of livelihood. A great number of the participants decried that their concern is that there is the likelihood of recording casualties of both human and animal lives as one of the major challenges they may encounter. Cattle breeders may be careless when crossing the rail lines with their cows and in the process the train may run over them (FGD with Farmers, 2021).

Regarding our children too, we need to be vigilant. In as much as trains have an indication of their presence by hooting, there is the possibility of accidents since trains are not like vehicles that can halt easily. Once it's on momentum, whatever is on the rail track will be crushed. However, overall, the participants despite the fears highlighted, noted that the project will be well embraced by their communities as they are positive that it will promote development in their locality but they urged the government to pay adequate compensation and make sure that the compensation is paid directly to the beneficiaries (FGD with Farmers, 2021).

Many of the participants observed that if the contract is executed, there may be intrusion of their animals on rail lines and the train is difficult to halt when it is on speed, while some of them noted that their children and themselves may also be vulnerable to accidents most especially that they are not used to the train and how it operates. Some of them equally noted that it may affect their grazing lands and their cattle routes. However, few of the respondent are of the opinion that it won't affect their businesses in any way. But other respondents stressed that if perimeter fences are not built along the rail lines there may be several incidences of train running over their animals and even their children most especially at the initial stage of the take-off of the train services. They however, recommended the provision of barriers and alternative routes for grazing (FGD with Pastoralist, 2021).

Sharing their perspectives on the possible negative effect of the rail project, the traditional leaders noted that farming may be affected negatively and that people's houses may also may be affected as lands may be taken over since the rail path is likely to pass through it. But it is important that provision for compensation should be made (FGD with traditional leaders, 2021).

The traditional leaders further posit that:

> We are concerned about the displacement that has to do with the possible arrival of the train services to our community although the displacement does not supersede the development that will come with commencement of train services but the issue of compensation should be utmost. I do agree with the above assertion. People's farm will be collected and most of us are farmers, it will be important if our compensations will be paid (FGD with traditional leaders, 2021).

Another dimension of the discussion with traditional leaders was to identify and examine the impact of the rail project within the context of its effect on sacred or other important cultural sites in or near their community. The discussants were of the opinion that:

> The effect of the rail project on that cattle route could be a major problem, it will affect most of us as we recently spoke to our Emir about it. There are Islamiyya Schools that have been marked for demolition because they are along the proposed rail line path and most of these Islamiyya Schools were built by locals. However, participants from Dutse observed that the railway

station which they said will be in Duru village will affect their security wall (Ganuwa). They further stated that their tanneries and the old grave yards of their ancestors may be affected by the project (FGD with traditional leaders, 2021).

The FGD with members of the NURTW indicated that the train services will not affect their business because it will bring about high influx of passengers that will require road transport services and that unlike cars the train cannot have access to everywhere cars can access, as such it will have no negative effect on their businesses. However, few participants noted that the emergence of train services will to a large extent reduce their passengers, for example if Kano-Kazaure is 2 hours by road, it will take the train maybe less than an hour, so people will prefer train to vehicle even because of the comfort associated with the train. (FGD with NURTW, 2021).

In an FGD with farmers held in Yankwashi Local Government Area (2021) they identified series of challenges that they grapple with on daily basis. They were of the opinion that:

> It is very difficult for us to get fertilizer now, but if government can provide us with it, it can transform our lives because fertilizer today is not for ordinary farmers like us. We can't afford it. Rice is now expensive, it would have helped us to make a lot of money, but the problem now is that we are unable to farm it because we are unable to afford bags of fertilizer which is very important for the farming of rice. A participant said that our major problem is capital and farming in most instances requires capital. The bill starts from the purchase of fertilizer, water generating set, payment of ad-hoc staff, petrol amongst others. If all these things are not put in place, to venture into farming is a major problem.

The farmers emphasized on the need to have access to fertilizer at affordable prices since they cannot venture into mechanized farming. What is utmost is fertilizer and to encourage government to donate fertilizers to farmers. When they decide to do so, they should not give it to politicians because they will misuse it or use it for political campaign when they distribute it, it will be based on sentiments. They emphatically stated that if fertilizers would be provided, they prefer it is channelled through their traditional leaders (FGD with Farmers Held in Yankwashi Local Government Area, 2021).

All the participants agreed that:

> There are numerous challenges associated with our businesses. We are incurring huge losses as a result of buying unhealthy animals or livestock. At times it is very difficult to determine if the animal is unhealthy, upon taking possession of it one may discover it has an ailment. Therefore, selling it even at the cost price becomes a problem. We're at times forced to sell it below the cost price. Sometime we buy stolen animal without realizing it thereby having to grappling with litigations. The problem is that how do we differentiate between a stolen animal and a legitimate one? This is always a problem for us especially with the level of cattle rustling in our state. It is for this reason that the presence of security is very important, and at times it is often very difficult to agree or settle on a price between the buyer and the seller (FGD with Farmers Held in Yankwashi Local Government Area, 2021).

Apart from the possible problems that the traditional leaders envisaged that the rail project may cause, they also claimed that there are inherent challenges within their community that they are grappling with. Most of the traditional leaders observed that:

> One of the major challenges that we are facing is the issue of drug abuse largely due to joblessness because the youths are idle and could not think in a positive way. This led to serious social problems such as broken home, moral decadence among the children as marriages crumbled and leading to insecurity. Even feeding among most house-holds was a problem. There is

> there a need to address the youth's unemployment (FGD with traditional leaders, 2021).

In the same vein the NURTW also pointed out several other challenges they are grappling with. They unanimously decried the cost of maintenance of their vehicles due to high cost of spare parts and food commodities. They noted that in the past, daily proceeds could buy a tyre but now the price of tyre is very high. Tyre for Golf car now goes for about N17, 000 before it used to be N8, 000. The cost of servicing and engine oil is now also very expensive. Before it uses to be less than N5,000 but now it goes to about N8,000-N11,000 depending on the type of engine oil. Government should find a way of helping us (FGD with NURTW, 2021).

At the FGD with youth of Dutse most of the participants noted that they are in most cases bread winners of their family and they are overwhelmed with catering for their families' immediate needs and as such they are unable to sponsor their young ones to school, and because of the polygamous nature of their societies they cannot be able to sponsor anyone from their family so that they would not be accused of being biased. Some of them identified the problem of laziness and lack of motivation within themselves as one of the major problems confronting them (FGD, with Youth, 2021).

The Youth of Dutse further stated that:

> About 50%-80% of the youths are unemployed. 85% have no government job. Laziness, lack of sponsorship, illiteracy and lack of capital are the major factors why the youths have no job. The politics of God-fatherism and exclusion is partly responsible for our inability to gain jobs. Some other socio-cultural factors such as early marriage is a barrier because of the burden of keeping a family (FGD with youth, 2021).

A further discussion on the challenges of farmers particularly in relations to COVID 19 also exposed further the challenge that farmers encountered. Virtually all the participants revealed that Covid-19 affected them negatively and they are yet to fully recover from it. They noted that they are still going through a lot of difficulties because of the aftermath of the lock-down (FGD with Farmers held in Yankwashi Local Government Area, 2021)

The Farmers also said that:

> We were unable to travel in order to purchase our farm implements and other consumables for our farming activities and our farm implements that needed repairs were not fixed because of lack of supply of spare parts as a result of the closure of markets across the state and most specifically Kano State that is their major source of supplies. Most of the participants noted that the government intervened by giving out loans to people, but because they did not benefit from such interventions (FGD with Farmers Held in Yankwashi Local Government Area, 2021).

Most of the participants noted that the pandemic affected their wealth and income as inter and intra state boarders were shut. Even international boarders were shut as well. Some of us had planted our crops and some crops need fertilizer after certain weeks or days, but because of the lock down, they couldn't buy and our crops were affected thereby resulting in low yield and many of them incurred high debts. Some of the respondents revealed that they had to buy fertilizer at very exorbitant rates due to scarcity thereby resulting in their inability to adequately apply fertilizer on their farms and that affected their yield and the small money we are making now, we are using to pay debts incurred from Covid-19 lock down (FGD with Farmers Held in Yankwashi Local Government Area, 2021).

In a similar light, the pastoralists also concur that the lock-down decision by the government as a result of the Covid-19 pandemic affected them negatively as they were deprived of access to market. They noted that they usually patronize markets in Kano and Shuwarin market in Dutse but they were all closed and as such they had nowhere to sell their animals or even buy drugs for their animal. They noted that the lock down was a global affair but they are now gradually regaining their stability in the market (FGD with pastoralist, 2021).

Of all the FGDs, the members of the NURTW seem to be more affected by COVID 19 from the arguments that they put forward. The participants totally agreed that the government decision to shut down the country negatively affected their business. They further noted that their daily income is from passengers and that they don't earn monthly allowances or salaries (FGD with NURTW, 2021)

The NURTW also claimed that:

> It was indeed difficult for us to survive as we struggled in order to cater for our families' basic needs. It wasn't funny at all. We have 37 branches of NURTW offices, but all of them were shut down. Imagine how many families were affected... government did not help us any way as no palliatives was given to us. We really suffered with no compensation of any form. We pray it never happens again... up till now they are yet to recover from the impact of the Covid-19. The lock down resulted in the shutting down of markets and motor parks, people were equally restrained at home and with that we would not get passengers (FGD with NURTW, 2021).

A further discussion on the role, functions and activities of CBOs indicates that CBOs are instrumental to local communities in different ways. The FGD with CBOs in Jigawa were of the opinion that:

> CBOs they are non-profit and apolitical organizations. We are largely concerned about solving societal problems through advocacy and sensitization programmes aimed at educating the populace. We partner with government in the areas of campaign against Covid-19, cattle/farmers feud and other self-help issues related to our communities (FGD with CBOs, 2021).

In terms of accessibility to and ownership of landed properties, the CBOs were of the view that:

> Land or property ownership is a matter of choice and the capacity to afford. CBOs that are financially buoyant are occupying their permanent structures across the country but most CBOs in Jigawa State are occupying rented offices and accommodation for their operations. Since there is no law that prohibits us from acquiring any property, we're entitle to own a land or property of our choice in anywhere in the country (FGD with CBOs, 2021).

This research also attempts to examine the life-chances of the members of CBOs particularly within the context of their membership. How easy has life been and what advantages do the CBOs create for its members. The CBOs were of the view that:

> We concur that life is far easier under an organization rather than working separately or at cross purpose with one another. Working collectively increases bonds and cohesion and promotes group interest among them, and their ability to collectively address issues brings about the concentration of effort, hence a reduction in the magnitude of the problem on time, and collectively we have a voice and can influence public policy or government decisions across all levels of government. Several bills such as the paedophile bill that was recently signed into law by the Governor were a product of our collective resolve to end sexual abuse of minors in the state (FGD with CBOs, 2021).

In term of how community-based organizations receive information about local issues and development news, all the respondents affirmed that they do receive official invitations from different stakeholders and government mostly through written invitation. Some of the participants state that apart from written invitation, they are invited using the social media handle or print and electronic media and other jingles or fliers (FGD with CBOs, 2021).

On the education of CBO members and encumbrances to the establishment of CBOs, a vast majority of the participants have obtained their degrees in different fields of their chosen endeavour while some of them are NCE and diploma holders, with a few of them having Senior Secondary Certificate Examination (SSCE). The participants collectively noted that there are no encumbrances in forming Community-Based Organizations in the state. Some of respondents noted that the only challenge is lack of interest from many people to join or form a CBO. People are more interested in making quick money and as such they are not willing to make sacrifices (FGD with CBOs, 2021).

In an FGD with youths of Dutse LGA they stressed that most of them conclude their primary school between the ages of 12-14 years and they further noted that most of them finish secondary school at 18-20 years and that the highest qualification most of the youths attain is NCE or Diploma. They noted that majority of them only poses senior secondary school certificate (FGD with Youths, 2021).

According to the CBOs the basic needs and priorities that will improve their activities are:

> The key areas that we need improvement are an increase in the level of conscientizing and educating the populace on burning community issues that are confronting them as a people collectively united together. Secondly, is to ensure that the government increase the level of partnership in the areas of robust constructive engagement and funding in order to penetrate further at the grass-roots level, and lastly, to create awareness by ensuring that the rich and educated members of the society are actively involved in community services by contributing through their wealth and expertise towards community development (FGD with CBOs, 2021).

Most the participants stress the importance of advocacy and the need for it to be aired frequently through both print and electronic media and social media handles. They further stressed the low level of literacy in the state and the need for all stakeholders to put their hands on together and address the challenge. Some of them noted that many of the locals that are going to be affected by the railroad project needs to be carried along and their role in that regard cannot be overemphasized as organizations that are very close to the people at the grass-roots (FGD with CBOs, 2021).

Whether or not businesses find it hard to recruit people with appropriate skills was a major subject of discussion with farmers, and the measures employed to curb this challenge. Most of the participants emphasized the need for the government to recruit extension workers and send them across all the local government areas in the state so that they can train farmers on new farming procedures. They argued that the recruitment of extension workers will go a long way in improving their knowledge on rice farming. The knowledge we have today on rice farming may be out-dated (FGD with Farmers Held in Yankwashi Local Government Area, 2021).

Many of the respondents noted that they inherited the business from their parents and that they are going to pass it on to their children too, but at times recruitment into the business is a result of self-interest. A respondent noted that the business was introduced to him through a friend that he followed to the market in Wudil to purchase animals and from there he developed interest and joined the business (FGD with Farmers Held in Yankwashi Local Government Area, 2021).

While discussing the nature of and recruitment processes of drivers, the discussants maintained that the recruitment process for drivers has been bastardized over time. They observed that people no longer follow the acceptable procedure for recruitment of drivers. In those days one will starts from a car boy (Karan Mota) then subsequently learns how to drive from his master before he is registered as a driver. The process was there, but now, you will see a retiree joining us as a driver without knowing about his ability to drive safely. Most of the respondents noted that the process is bad, people now drive without knowing road signs, without going to driving schools and certificates are just issued to them without proper training. Driving schools are now market places, just a place for business, people now pay for driving certificates (FGD with NURTW, 2021).

Kano State FGDs Report

An important component of every field research is the awareness of the subject matter of the research by respondents. This survey on environmental and social impact assessment of the Kano-Maradi Rail line took this into cognizance. In a Focus Group Discussion with Members of Youth Organizations in Kano State, most of the discussants say they are aware of the project and that they got to know about the Kano-Maradi rail line project through print and electronic media, when the project was launched (FGD with Youth Organizations in Kano, 2021).

The Nigerian Association of Road Transport Owners (NARTO) also claimed that they are aware of the Kano-Maradi railway line project of the Federal Government. A large number of the discussants said they came to know of the project via radio claiming that it is a national issue and it has been in the public domain of the print and electronic media (FGD with NARTO, 2021). The Focus Group Discussion with Pastoralists in Kano State also indicates that they are aware of the rail project.

Discussing the Kano-Maradi railway line and its prospects vis-à-vis the opportunities it will have for youth engagements, the discussants opine that, the rail line project if properly implemented will surely boost the economy of the people, and it will provide employment opportunities for the people, especially the youths (FGD with Youth Organizations in Kano, 2021).

The youth organizations in Kano (2021) also claimed that:

> It will also lead to the establishment of more settlements. Likewise, the project will curb the issue of insecurity as it will engage the youths directly or indirectly, and this will prevent the youths from getting attracted or lured by insurgents who offer the youths “monetary enticements” to help them carryout their nefarious acts. The rail line project will boost transportation activities in the host communities and Kano

> state at large. The rail transport will also help in reducing accidents to the minimum level when compared to road accidents and other means of transportations (FGD with Youth Organizations in Kano, 2021).

While assessing the likely positive impacts and benefits of the Kano-Maradi Rail line project with the members of Nigerian Association of Road Transport Owners (NARTO), they were of the opinion that:

> As transporters we have been following the trend of the project and we believe the benefits are mutual because there are areas the train cannot get to and there are sections of the road that are bad, the quantity of goods to be delivered to the hinter by the train will increase, so also the quantity of goods to be distributed from the train station. From the outside it will seem as though the coming of the train will take away our business which is not so. It would rather further promote our business as the train station will now be a location for our members to pick up passengers (FGD with NARTO, 2021).

A discussion with pastoralists in Kano on the benefits of the Kano-Maradi rail project indicatede some form of consensus amongst members of the FGD as they all agreed that it will be beneficial to the community. It can ease transporting the cattle. The train station can bring up mini-markets, instead of conveying cattle long distance to the southern part of the country. Likewise, the farmer can take their farm produce to the nearest train station where business transactions can take place (FGD with pastoralist, 2021).

Interrogating the subject further, the discussants also maintained that:

> We believe that the train service will serve as an additional means of transporting animal feed for our livestock from Niger Republic to Nigeria. Transporting cattle feed by rail is cheaper than road transport. It can also enhance business activities, like, transporting sheep from Maradi to Kano. The train can ease the tension involved in transportation; boarding the train from the nearest point, and departing for the

desired destination. In addition, train stations can provide avenues for more business that can be explored. We have products (like milk, yoghurt and butter) that are in high demand in some other places; likewise, there is abundance of animal feeds in other places that we may need to purchase. All these business opportunities can be achieved by the pastoralists through the railway network (FGD with Pastoralist, 2021).

A large section of the discussants believe that the railway project is very important for women, especially the businesswomen, most of whom were discouraged by the amount of transportation fare charged to deliver their goods. The railway will help in beating down the cost of transportation. The issue of insecurity adversely affects women. They believe that when the railway project is completed, youths will be gainfully employed, which will engage their attention away from crimes. There are sections that women can work in, therefore, increasing their input to the community. They also express joy over the possibility that, at various train stations, women can have some shops, kiosks and canteen that they will be selling goods, provisions, foods and so on (FGD with Women Associations, 2021).

Most public policies are intended for the general wellbeing of citizens or to promote economic growth and development as it is the basic responsibility of the state/government to guarantee good life for citizens. However good the intensions of government are, there are some unforeseen consequences of public policies. Whether or not the Kano-Maradi Rail line project has such unintended consequences was part of what this research attempts to expose.

The survey outcome indicates that there are fears among members of the communities and such fears are predicated upon some envisaged challenges that the rail project may come with. The first palpable fear of the farmers is the loss of farmland without commensurate compensation or under payment for them. Discussants were made to understand that engagement with different stakeholders at different levels was conducted so that all fears are allayed; all channels are followed toward getting to know who is affected, who gets what, how and when and how; there is Resettlement Action Plan which will handle compensations, and owners of land are established even before going to any traditional authority or any intermediary (FGD with Youth Organizations in Kano, 2021).

The youth organizations in Kano (2021) also discussed about the issue of cultural diffusion which could eventually instigate some forms of anomie, since the advent of train service will bring about influx of people from several parts of Nigeria and Niger into Kano state. They further concluded that:

> Kano will be affected as the rail line will lead to the emergence of new cultures. Youths will imbibe these new cultures, most especially those that are negative and not in conformity with local cultures. People with questionable characters will migrate to Kano. People migrate from one country to another and as they migrate, they come along with their own kind of issues. It is possible somebody who runs away from prosecution from Niger to use the train to cross into Nigeria which would be easier for him, and settle in Kano and vice-versa. Places where rail stations are sited have prevalence of criminal activities and such communities are vulnerable in terms of security issue which mostly affects youths. In other words, the construction of the rail line project will increase the rate of crime and juvenile delinquency, especially if it is not properly managed (FGD with Youth Organizations in Kano, 2021).

The FGD with Youth Organizations in Kano, (2021) also remarked on the possibility of conflict between youth in host communities and construction companies in the event where youth from Kano state and host communities are not incorporated into the construction project. It is pertinent to note that most government project don't carry out conflict sensitivity analysis of assessments both at the state of planning and implementation.

Shedding more light on the above, the FGD posited further:

> Unless consideration is given to the youth from the affected communities in terms of employment by the construction company, it will create another problem. For instance, there was a protest by the youths of Kiru-Bebeji against Julius Berger Company, during the ongoing construction of Kano-Abuja Road because youths from the affected communities were not engaged as manual laborers in the workforce of the company, rather laborers from Enugu and Edo state were employed during the construction of the Kano-Abuja Road (FGD with Youth Organizations in Kano, 2021).

The members of NARTO further posited that:

> There is no doubt that the advent of the rail system will create employment opportunities for a lot of people but it will affect our members negatively. We own a large percentage of trucks in Nigeria and the tendency is that if the train becomes more efficient and effective in delivering goods and service from the North to the South, our source of business and livelihood becomes threatened (FGD with NARTO, 2021).

The scope of our activities will be reduced in the initial state of the project but in the long run the scope of our work will be expanded because of the quantity of imported goods the train will be delivering into the hinter land as well as what it is going to be carrying to the coastal areas for export will be enormous and capable of stretching their capacity (FGD with NARTO, 2021). On the effect and possible implications of the rail project on pastoralist and their cattle, they had this to say:

> One of the possible problems we the pastoralist will encounter is the railway crossing coupled with the loss of routes (*burtali*). We suggest that there should be safety crossing overhead or subway that can allow free passage of cattle. Then we expect a clear rail sign indicating cows crossing point, especially in areas where pastoralist communities are. A rail traffic staff should be stationed in all the cattle crossing points to pass signal to the driver. Proximity between the rail or train station and the

> herd should also be taken into consideration during construction. Another problem, is when cattle are crushed by the train, no compensation, no payment, no apology in any form is forwarded to the owner. The incidence may be ignored completely (FGD with pastoralist, 2021).

Discussants allude to the issue of trans-border insecurity. Some other said the activities of Nigerian Customs Services are capable of being an impediment to the activities of women traders. They also raised the issue of their fears regarding the failure to pay compensation to those whose livelihood, houses and farmland will be affected by the rail line project. The issue of the activities surrounding the rail line during and after its construction as capable of being a distraction to the education of their children. Exposure to rape was also raised by some of the respondents (FGD with Women Association, 2021).

Majority of the discussants are either educated to university level, self-employed, married with children of school going age children and living in rented houses. They do not have satisfactory health service. Their children are well fed and also attend school. Few are above global level poverty threshold. Majority want to have stable source of income, own personal homes. Reduce the rate of poverty and illiteracy amongst youth (FGD with Youth Organizations in Kano, 2021).

A gender analysis of the quality of life to ascertain the standard of living of women in relation to men was discussed, and the women were asked if life is easier for men or for women in the community and their response was that men seems to enjoy better life than women. They were of the opinion that:

> Life is much easier for men as many men shy away from their responsibilities. You will see a man with thirty children who doesn't care about his responsibilities of taking care of them. They send most of these children to the city as beggars. A lot of these men are just interested in marrying more wives than they can take care of and in most cases the wives are also busy competing with one another in terms of child

> bearing. We are in a patriarchal society with cultures that place men in dominant position hence it is difficult to address these issues (FGD with Women Association, 2021).

When the wife reports men to their parents, they will not listen to them. They will tell their daughter how their mothers also endured. The woman is suppressed to the extent she cannot express her feelings to anyone. They will end up driving her away. Frustration and depression have led some women into committing murder. Men are trained to exercise supremacy over women. That was why all the preaching about marriage is directed to the females, to serve their husbands. But the males which are the husbands are not conscientized about their responsibilities to the family. Men are hardly taught how to take care of the wife and her children (FGD with Women Association, 2021).

They stated further that:

> As we know, women are the backbone of the society. In this era, women are really suffering in keeping the household alive. They have become the bread winners. Men are no longer the bread winners as it used to be. Women are the providers of soap, food, shelter, pocket money, school fees, books, uniform even PTA is only attended by the women. The interest of men is only to marry more wives by any means. This is the order of the day. Even the least salary earner is struggling to marry more wives. The matter of women is not considered; in fact they do everything for the family. This is the truth. Women participate in farming, business, domestic business, and food services of local dishes of different varieties (FGD with Women Association, 2021).

In an FGD with women organization on the nature of their programs and activities, they said they are engaged in series of activities ranging from advocacy and other forms of community services.

We do all these through training, community organization and empowerment, stakeholders mapping, we develop and distribute high quality materials, we build capacity on polling; we sensitize the community members and stakeholders, we discuss the issue of gender related violence among both men and women, because currently we have gender-based quarrelling (FGD with women, 2021).

They further claimed that:

> We do a lot of counseling events where we invite the relevant stakeholders together so that we can discuss issues on the table. We work on the area of WASH (Water Sanitation and Hygiene). Women were educated on how to take maintain hygienic environment and healthy food at home and elsewhere. We treated the area of nutrition, health education, we counsel, we empower both adults and adolescents in the area of tailoring, photography, soap making, beads making, leather works, how to sew bags. We collaborate with other Womens Rights activists in case of abuses, even yesterday we had a meeting where we invited a Human Rights activist called Mr. Peter. We also have inspectors from the state criminal intelligence division (CID), they delivered some lectures on gender-based violence (FGD with Women Association, 2021)

The youth are not just the leaders of tomorrow but are critical stakeholders in every political system even though in most cases they are relegated to the background. The nature of leadership and governance in Nigeria is such that the youth are used by the political class to achieve the political ambitions but when it comes to assigning responsibilities, the youth are exempted. Bearing this in mind, this research attempts to examine the level and degree of youth participation/representation in community affairs.

The FGD with youth organizations in Kano (2021) reveals that the youth are represented in the daily running of the affairs in their locality, most especially that which pertains to them but as far as leadership is concerned, they are nowhere to be found…In the village leadership, the youths are not directly represented but through an intermediary representative called the "*Wakilin matasa*" in that community. At the community level and at the village level a lot of youth interact on several issues, and pushed a lot of issues from the Districts Head to the village Head and Ward Head. A lot of resolutions that resulted to a lot of development issues were achieved through the youths. Even youth targeted programs initiated by government are poorly implemented or short-lived without any projection into the future. For instance, the ultra-modern vocational centres established by Dangote, which is one of the best in the country, but it is still not yet functional due to some political issues in the state (FGD with youth organizations in Kano, 2021).

In terms of women representation in the communities the women association claimed it is very poor. Women are hardly represented and even when such opportunities are created, there are only limited slots for women therefor further widening the gap between man and women. A gathering where women need representation becomes very difficult for the women to attend. Especially when it is for the community, except in an organization like ours. A community representation lacks women cooperation because most of the women delegate their sons for such meetings (FGD with women Associations, 2021).

The youth were unanimous on the issue of accessibility to education, that the highest level of education majority of men in the rural area attain is senior secondary education, while females attain first school leaving certificate or primary school. In the urban centres youth pursue their education up to university, or Postgraduate level, depending on the wealth and social status of the family (FGD with youth organizations in Kano, 2021).

They also identified some socio-economic reasons as part of the factors limiting school enrolment and education of young people. Their claim was that:

> The nature of education in terms of its quality constitute a challenge apart from the fact that the economic condition of most parents is a limiting factor. Parents in some instance would rather send their kids to go hawking goods or go farming rather than

> sending them to school. However, it is important to note that the level of orientation on the side of parents on the importance of education is very germane. The place of proper mentoring for youth cannot also be ruled out if the level of school enrolment and access to education must be improved (FGD with youth organizations in Kano, 2021).

In an attempt to examine the challenges that members of NARTO are grappling with, they identified bad roads as a major challenge even though they also indicted themselves when they said bad roads are a product of over loaded trucks and the inability of government to determine and regulate what should be the maximum weight for vehicles to carry and also guarantee standards in the construction of roads (FGD with NARTO, 2021).

They also argued further by stating that:

> Our problem is exacerbated by poor construction and supervision. For instance, the ongoing Lagos-Ibadan expressway reconstruction which is 165km is being handed by three construction companies, but the Abuja-Kaduna express way with a distance of 400km is being handed by one company which is giving room for loss of lives, delay due to traffic hold up which makes transportation very expensive. The Kano-Maiduguri Road construction it is also being handed by three construction companies (FGD with NARTO, 2021).

In addition to these problems, the member of NARTO also listed the following as specific challenges that they are grappling with:

i. The issue of multiple taxation by states and local governments that travers their journey.
ii. There is also issue of security check points manned by different agencies; at each check point they have to pay some amount of money else they would be delayed. For example, on a journey from Kano to Gombe they encounter almost 20 check points and they have to pay money at each of these check points.

iii. There is exorbitant cost of spare parts, which makes maintaining trucks very expensive.

iv. They also contend with the issue of counterfeit or substandard spare parts which do not last long.

v. There is issue of high exchange rate to buy genuine spare parts, transporters cannot afford the cost of these spare parts taking into consideration, the exchange rate of Dollar & Euro and pounds to Naira.

vi. Dumping of used vehicles and spare parts from Europe Asia and America has contributed to the difficulty of maintaining trucks.

Like every other group and association, the General Manager Manufacturers Association, in a KII (2021) outlined the following as the problems that their association is grappling with:

i. Market challenges
ii. Insecurity
iii. Lack of activities in CCIMA
iv. Problem with Nigerian Custom Services
v. High cost of power
vi. Low patronage by government agencies
vii. Low purchasing power/ capital holdings
viii. Scarcity of foreign exchange
ix. Lack of awareness on modern business and sources of financing

A further discussion on the challenges faced by member of NARTO with specific emphasis on the impact of COVID 19 on their business indicated that COVID affected their business negatively. They discussants maintained that:

> COVID-19 has affected our activities severally, because we have employees who were paid salaries while doing nothing. During the COVID 19 lockdown. our vehicles were

kept idle for a very long time, when the lockdown was lifted, many of our trucks already developed faults…The Federal Government gave palliative assistance to so many categories of Nigerians such as the Aviation sector, but NARTO members were not included despites our compliance to government policies. The only beneficiaries to the government palliative were drivers of buses, who were paid Federal Government palliatives of ₦30,000 each (FGD with NARTO, 2021).

The pastoralist account of the impact of COVID 19 indicates that during the pandemic, business was paralyzed with commodities up for sale, but no one to buy them. Activities of the pastoralist declined drastically. The suspension of dry season farming this year due to dredging of the Hadeja Jama'are River Basin water channels is another challenge for both food production and pastoral activities. The dredging project is taking place in Garun Malam and Kura dams. They therefore appeal to government to give them access to one alternative water channels, while the others undergo reconstruction (FGD with pastoralist, 2021).

Attempt was made at discussing the challenges that pastoralists are grappling with and the outcome of the discussion showed that there are many challenges bedeviling pastoralists. Among the major challenges we face are youth idleness and cattle infections. This is a serious challenge knowing that we depend solely on the cattle. The modern livelihood will not support this obsolete lifestyle. Hence our youth need to acquire some skills and a lucrative business in order to be self-reliant (FGD with Pastoralist, 2021).

The FGD with the pastoralist further identified some thematic challenge such as:

a) Ignorance; lack of modern livestock farming or ranching.
b) Abandonment by government in its activities and planning.
c) The government is not supporting the herders financially.
d) The taking over of grazing reserve land by the politicians for other purposes, by chairmen and governors.

e) Lack of introducing improved varieties of cows and bulls; new varieties of grasses and others.

f) Lack of dams for the cattle to have drinking water.

g) No grass reserves, no water reserve for ranching.

h) No training given to Fulani youths on how to improve the pastoralism.

i) All the agricultural budgets were spent on crop farming not livestock farming. Crop farmers were given fertilizers, seeds, and training accordingly.

A further interrogation and holistic assessment of the challenges of pastoralist shows that pastoralism is deteriorating because the profit has become so slim and the attendant difficulties have become more strenuous. With regards to security, we are well secured in Kano, as we don't have insecurity problems. The pastoralist further claimed that:

> All the eight states around Kano have their herds of cattle reared here in Kano. The insecurity situation affecting Zamfara, Katsina and Kaduna state has made a large number of herdsmen move their cattle to Kano state. This increased the population of cattle resulted in high production of milk and scarcity of fodder. The high number of cattle translates to abundance of milk. In some areas, the milk is wasted because it is under-utilized since we lack storage facilitie. While some vendors train Fulani pastoralist on how to collect the milk for the companies to process and package for sale, the major problem with that arrangement is that companies cannot exhaust 10% of the milk produced in the Falgore axis alone (FGD with pastoralist, 2021).

Whether or not there are support services that are available in the local communities to assist the pastoralist was an issue of interest to this research. Here is what the pastoralist had to say:

> The Fulani through Miyetti Allah, FULDA and Kautal Hore, reported to have requested the Central Bank of Nigeria (CBN) for an intervention in the area of provision of fodder and water for their cattle. The request was granted, as a result, we were given

> loans to purchase stalk milling machines. Initially, we fed our cattle with leaves leaving the stalk as a waste. Because of the machine that grinds the stalk, we are no more wasting it. At the beginning of dry season, we buy heaps of stalks from farmers, and grind it for our cattle. The machine can generate income too. It can be hired for some hours with conforming charges. During Covid-19, assistance to the Fulanis from the government came in the name of Hausa-Fulani, that means the assistance was meant for Hausa and Fulani simultaneously. There wasn't any preferential consideration given to any Fulani specifically (FGD with pastoralist, 2021).

In a bid to ascertain how pastoralist normally educate their children and recruit cattle herders, they maintain that:

> In Kano State, no Fulani can give any excuse for not sending his child to school. In any five kilometers distance there is a school in this state. Schools are available for Fulani children, except if the parents are not willing to enroll their children. There has been a mass campaign for the Fulanis to enroll their children in schools. Illiteracy was what made some Fulani youths to become what they are now. We frown at under aged children rearing cattle. we also made a call on Federal Government to enact a law that will prohibit cattle rearing for any child below 18 years (FGD with pastoralist, 2021).

We enjoin our fellow Fulanis to build houses, remain in one place, so that their children can have the opportunity of attending school. About 95% of Fulanis in Kano State attend school. We need to make a shift from traditional herding to modern livestock ranching. Marauding Fulani nomads that intrude into people's farms have deviated from our customs, our cattle are not grazing in the night, because we don't rear cattle at night. Some of the pastoralist can't even speak the Fulfulde. But they move their cattle in the night, thereby damaging crops while the farmer will blame their Fulani neighbor (FGD with pastoralist, 2021).

Some of the drivers recruited are said to be products of apprenticeship with older drivers. They also do routine test for their drivers in order to ensure safety of lives and properties. There is also issue of guarantor for recruited drivers by association of drivers. There is also an issue of background check on the prospective driver, to know where he previously drove, why did he leave his previous employer. The fact that they are going to entrust the driver with their valuable property, they need to ascertain the trustworthiness of the person in question (FGD with NARTO, 2021).

Katsina State FGDs Report

This analysis of the environmental and social impact assessment of the Kano-Maradi Railway line is a product of qualitative data sourced from the field through the instrumentality of KII and FGDs to elicit the opinion of respondents on the subject matter. The key informant and Focus Group Discussants cut across several categories of samples ranging from stakeholders such as community leaders/heads, youth leaders, women leaders, traditional political institutions, Community Based Organizations (CBOs), NGOs, business leaders amongst others.

An analysis of such requires that the respondents are acquainted with the rail project and the proposed benefits or otherwise of the project. Hence questions were designed in such a way as to ascertain whether or not respondents are aware of the project before other follow-up questions. In a focussed Group Discussion with Community Based Organizations (CBOS) From Jibiya Local Government, held on the 23rd December 2021, the participants demonstrated a high level of awareness about the project. The discussants were of the opinion that:

> All of us are aware of the rail project and we got to know about this project through several media platforms such as radio, television, Social Media, and Newspaper reports among others. We are also aware of the locations and communities where the railway line will traverse through as there are established beacons by government in some of areas and locations like Magamarv, Jibiya town. Community

Based Organizations are also invited to discuss community affairs through formal invitations from the government, NGOs, development partners through different media platforms (FGD with CBOs from Jibiya LGA, 2021).

On the other hand, the FGD with the Pastoralist groups in Shargalle, Dutsi Local Government Area shows that they were not aware of the rail project. Some claimed that they were informed by their elders that railway is a dangerous thing which if any living organism goes close to or touches, it will suck their blood instantly. Most of the participants confessed that they are not aware of Kano-Maradi Railway Project and they don't know what the train or rail tracks looks like. However, few of them who have once travelled out of their localities claimed that they know what a railway line looks like (FGD with the Pastoralist groups in Shargalle, Dutsi, 2021).

There seems to be a high degree of awareness of the Kano-Maradi Railway Line among citizens in Katsina state. The FGD with Youth Based Organizations in Katsina Local Government reveals that the level of awareness is high. These youths ware not only aware but also made allusions to knowing the proposed budget for the project. They claimed that:

We are not only aware of the Kano-Maradi Railway project but we also know the communities that the rail line will pass through and we got to know from the newspapers, social media, radio and through numerous television channels in Nigeria. We also understand that the project is a Federal Government of Nigeria project through the Federal Ministry of Transportation. We are happy with this Kano-Maradi project as we anticipate massive development in our communities and Nigeria at large (FGD with Youth Based Organizations in Katsina Local Government, 2021).

In a similar vein, the Focus Group Discussion (FGD) With Women Groups in Katsina Local Government indicates that they are also aware of the Kano-Maradi rail project even though most of them claimed they got to know about it through their husbands. On their opinion on the benefit of the project to women in their community and the community at large, the respondents claimed that the project has immense impact not only to the women within the community but the entire community looking at it from holistic perspectives. The participants outlined several benefits that they think the project will bring to their communities on social and economic impact. Socially, they revealed that the project would curtail the menace of smuggling which their town is well known for. Jibiya is among the Nigeria's border Local Governments with the Republic of Niger. Hundreds of its youth earn their living from smuggling activities (FGD with CBOs from Jibiya, 2021).

The focus Group Discussants from Jibiya Local Government further posit thus:

> The railway would help in checkmating drug trafficking along the border routes. This is possible especially if the management could deploy modern gadgets such as scanners and surveillance cameras in the stations as well as inside the train. Motor parks lack facilities and men to assist in curtailing drug trafficking. Apart from drug trafficking; the railway line would help in reducing the rate of crimes in their communities. Crimes such as robbery, kidnappings and banditry. Usually, cars are ambushed by these criminals but it will be impossible for kidnappers or armed robbers to stop a moving train the way they do to motors and other vehicles. Economically, there are many benefits of the project to our communities. These include indirectly linking Jibiya to the Atlantic Ocean because some of the commodities the train would be transporting would come from the Southern part of Nigeria. Jibiya is a commercial centre, therefore, it would derive greater benefits by linking it to Lekki Port in Lagos (FGD with CBOs from Jibiya LGA, 2021).

Since the railway would link Kano to Maradi in Niger Republic, Jibiya will be connected to more international business opportunities. Hence, Jibiya traders would have more access to the large ECOWAS markets. The rail project will bring about job creation for youths in communities in Jibiya Local Government and this will have direct impact on crime reduction. The Railway line would also stimulate the economy, including trade and manufacturing industries, which means more job opportunities to the teeming youth (FGD with CBOs from Jibiya, 2021).

The foregoing view was corroborated by FGD with the Pastoralist groups in Shargalle, Dutsi (Miyetti Cattle Breeders Association, Miyetti Allah Kautal Hore) when they agreed that Kano-Maradi Railway line is a welcome development. They also claimed that:

> It will have positive social and economic impact on our life. The social impact includes safe transportation of our animals to the south. Nowadays transporting cattle from the North to South is nearly impossible because of many obstacles we encounter on the way. But we hope the railway project would make things easier. Therefore, the Kano-Maradi Railway project would provide us with better alternative of cheaper and safer means of transporting our animals not only from the North to the South but also from different markets (FGD with the Pastoralist groups in Shargalle, Dutsi, 2021).

Shedding light on the envisaged benefits of the Kano-Maradi railway line project, some of the participants suggested that the railway line would help in educational awareness of youth in the area because it will provide easier and cheaper means of transportation of people from different parts of Nigeria to Katsina. According to them, most times many youths especially those who are not working, who belong to some national associations, find it difficult to attend national gatherings such as conventions in Abuja, Port Harcourt or Lagos due to expensive transport fees. Now, the railway line if completed will reduce the charges. Kano-Maradi railway line project could improve accessibility to healthcare services delivery (FGD with Youth Based Organizations in Katsina Local Government, 2021).

The Youth Based Organizations in Katsina Local Government (2021) further posited thus:

> Transportation is very key in every commercial activity especially trade which involves the movement of goods and services. Hence interconnectivity between the rail line and raw material producing areas is an important gain that this project would bring.

> Scrap metals are raw materials for us in Kano state and a lot of youths are into this business even though we lack the industries in Kano to process them. The Kano-Maradi Railway could help in movement of this scrap metals to other states where these industries are located or even encourage entrepreneurs to localise such industry in Kano thereby giving room for many youths to engage in some forms of skilled and unskilled jobs… we also believe that as a result of this rail line project, insecurity would be drastically reduced especially, high way kidnapping and armed robbery. It would also reduce smuggling and international border crimes. The Kano-Maradi Railway Line would foster the competition among the local traders because of the incoming of variety of goods and merchants from other parts of Nigeria (FGD with Youth Based Organizations in Katsina Local Government, 2021).

On the potential gains of the project, the participants agreed that the Kano-Maradi Railway project has potential social and economic benefits. Economically, the project could stimulate agricultural development through reduction in the cost of transportation and market connectivity. Women participate in these activities; hence, the railway line will benefit them. Women empowerment is another potential benefit of the Kano-Maradi Railway. In Northern Nigeria, poverty has a women face. Due to socio-cultural factor and structural constraints, women in Northern Nigeria are more affected by poverty than their male counterparts. This imbalance is exacerbating inequality and gap (FGD with women groups in Katsina Local Government, 2021).

These women groups in Katsina Local Government further maintained that:

> Since women are into several trades mostly micro and small enterprises, the Railway would increase their access to goods. They could also transport their wares to places at cheaper rate. Their businesses would boom so also their income. In the area of social benefits, the rail project will increase access to education. The lack of efficient means of transportation has been hindering girl child from access to schools. We

> believe that the train services could address this challenge. Access to healthcare service delivery is another impact that we hope would be achieved and we also anticipate that the project would attract other social amenities to our communities (FGD with women groups in Katsina Local Government, 2021).

According to business leaders within Jibiya LGA, the benefit of the Kano-Maradi Railway Line Project to business owners is enormous. It would reduce the cost of transporting goods from one location to another. Currently we are spending huge amount of money in transporting our goods from Kano to Jibiya. Apart from legitimate but exorbitant transportation cost, we also face extortion from different security agents whenever we are bringing our goods to home. It is our hope that the Railway Project would be a panacea to our suffering (FDG with Business Leaders of Jibiya Local Government, 2021).

These business leaders further maintained that:

> The ease of transporting cattle to other parts of the country is another area of benefit that we anticipate. It is hellish to transport cattle to Lagos because of high cost and extortion by security personnel and armed robbers on the road. But with train, this unwholesome practice would be a thing of the past. The project would give room for efficiency as it will reduce the traffic burden on road and would cut down the cost of road maintenance… because of the high concentration of vehicles on the road; the government has been spending its scarce resources in reconstruction and maintenance of roads. But if there is railway alternative, the narrative would have been different. The Kano-Maradi Railway Line Project therefore, if successfully completed, would definitely reduce the humongous amount government utilizes in road maintenance (FDG with Business Leader of Jibiya Local Government, 2021).

Transportation of farm produce either to silos/stores or market is another noted benefit identified by the traders. They also believe that the Railway Project would result in reducing insecurity. Nowadays many traders are afraid to travel to market because of kidnappers and bandits. But if there is a Railway line; the situation could have been different. Another benefit of the project as pinpointed by the traders is that it could lead to the emergence of new cities and towns. They cited examples like the emergence of Funtua, Gusau, Kafanchan, etc. (FDG with Business Leader of Jibiya Local Government, 2021).

Like every other group and association who envisage positive impact of the rail project, the Manufacturers Association also share similar faith. Taking into cognizance the activities of the association which includes: protecting the interest of industrialist and manufacturers in Nigeria, manufacturing of goods, profit making and business development, business linkages, organizing seminars, workshop, training for members and public amongst others. In a KII (2021) with the Katsina state chairman of Manufacturers Association, he identified several ways through which the Kano-Maradi Railway Line Project will promote the interest of manufacturers. Some of these ways are:

i. Through easier and faster means of transportation of raw materials, natural resources, materials to the factories and finished products to targeted markets.
ii. Boost quantity of trade between Nigeria and Niger
iii. Increase profit margin of manufacturers due to cheaper and more effective means of transport provided by the railway line.

The Katsina state chairman of Manufacturers Association also used the opportunity to identify the challenges that the manufacturers are grappling with. Some of these challenges are; (a) Power shortage (b) Market challenges (c) Insecurity (d) Lack of activities in CCIMA (e) Problem with Nigerian Custom Services (f) High cost of power (g) Low patronage by government agencies (h) Low purchasing power/ capital holding (i) Scarcity of foreign exchange (j) Lack of awareness on modern business and sources of financing (KII with the chairmen of Katsina state manufacturers Association, 2021)

In most cases developmental projects are initiated by states as a way to promote social-economic prosperity within communities and the state at large. However, such projects may come with some unintentional consequences. This research also took cognizance of this hence attempt was made to ascertain the opinion of respondents on these issues. In an attempt to examine the projected or envisaged negative/adverse effects of the rail line project on the community, the FGD with CBOs from Jibiya, (2021) were optimistic that the benefits of the Kano-Maradi Railway Project notwithstanding, they envisaged the following problems which the project could cause to the communities. These include:

1. Intrusion of immigrants which might bring about strange cultural practices.
2. Loss of farmlands due to the construction.
3. Possibility of inadequate compensation and confiscation of people's land.
4. The Environmental and Social Impact Assessment might not be implemented.
5. The project could cause all forms of pollution including land, air, noise, mechanical, etc.
6. It could cause vibration which might lead to collapse of buildings and adverse implication on sense of hearing.
7. It could also cause radiation.
8. Armed robbery could happen inside a train.

Sharing their views on the perceived negative impact of the rail project on the activities of pastoralist, the discussant maintained that:

> We are sceptical and scared that the Kano-Maradi Railway project may adversely affect our grazing reserves. Another challenge which the project could pose to us is accident related which could lead to the killing our animals on passage since it is alleged that the train has no control. It is unlike motor-vehicle which can stop at any point. It that massive sensitization of pastoralists should be undertaken with a view to educate and enlighten us on the projects as well as how to ensure safety for ourselves and our animals and there is the need to put in place safety measures so as to minimize accidents (FGD with the Pastoralist groups in Shargalle, Dutsi, 2021).

While identifying other challenges that the pastoralist are grappling with, they were of the opinion that land grabbing, climate change and farmers-herders conflict are major challenges that they are facing. They also claimed that:

> The major problems associated with our rearing profession in this part of Katsina state is shortage of pastoral land. Apart from the climate change that is affecting adversely us, some local government officials also sell pastoral land meant for rearing to wealthy individuals who eventually fence the land with blocks to prevent our animals from rearing. This has spill-over effect as it makes of cattle to encroach into farmlands which lead to clashes between us and farmers… COVID 19 has also directly and indirectly affected has indirectly affected our rearing profession. Indirectly in the sense that we usually sell our cattle and use the money for food from other farmers but when the lockdown was imposed, there were no markets in operations; hence, we could not sell our animals at the nearby local markets to buy food. This created lot of difficulties for our member especially those who didn't farm at all (FGD with the Pastoralist groups in Shargalle, Dutsi, 2021).

Unlike the pastoralist who claimed that COVID 19 affected their business, the FDG with business leaders from Jibiya were not unanimous on this. To some of them COVID 19 was a blessing in disguise but to others it affected their business negatively. Like every other FGDs, the Youth Based Organizations in Katsina Local Government, (2021) were of the opinion that despite their optimism and the envisaged positive impact the rail line will bring to them, they identified certain unintentional consequences that will accompany the project. Some of these include the following:

1. Increase in rate of accidents where human beings and animals could be the victims. Also, there might be case of rail derailment.
2. Increase in social crimes like burglary and robbery.

3. Uncontrolled movement of people along the border which would bring about another security challenge.
4. It might worsen drug trafficking.
5. Vandalization of Railway Tracks.

The women groups in Katsina Local Government, (2021) were of the opinion that activities around the train station could generate some of challenges for women especially knowing how vulnerable women can be. They fear that cases of sexual harassment may occur at construction sites and that if Environmental and Social Impact Assessment Report is not well implemented, the rail system may come up with other unintended consequences.

In a KII WITH State Coordinator, Care Foundation for the Reforestation of Katsina on the impact of the Kano-Maradi rail project he says the project will affect their activities several ways. It is important to note that the foundation activity is basically on the protection of the ecosystem by mobilization on tree planting activities, sensitization on the importance of trees to the environment, mobilization on preservation of indigenous tree species, bio-diversity control, prevention of erosion pollution and desertification, health awareness on disease outbreak and pest control.

The Kano-Maradi rail project will affect their activities in the following ways:

- Construction of rail line will lead to cutting down of trees, which has negative impact on the environment (ecosystem).
- Ease transportation thereby creating increase collaboration with sister organization, donor agencies and philanthropist,
- Smoke from the train can lead to environmental pollution.

Attempt was made to elicit the opinion of the discussants on the quality of life vis-à-vis the challenges that youth in Katsina state are grappling with. They were of the view that the quality of life of the youth is relative as they come from different family backgrounds. But most of them are educated or enlightened without jobs to cater for their social well beings (FGDs, with Youth Based Organizations in Katsina Local Government, 2021).

The Youth Based Organizations in Katsina Local Government (2021) for claimed that:

> The inadequacies of industries which assist governments all over the world in taming unemployment, there is large scale unemployment… Okada/motorcycle or tricycle transports are the major jobs of the youth in this area as most youth finish their secondary education in Katsina within 23-25 years. Apart from illiteracy and poverty, youth involvement in crimes especially armed banditry, thuggery and youth restiveness during elections are major issues facing the youth (FGDs, with Youth Based Organizations in Katsina Local Government, 2021).

In relations to above issue is the response and efforts of government in addressing the challenges that youth in Katsina state are grappling with. The discussants agreed that there are several efforts, programmes and policies that both federal and state government have initiated. They claimed that:

> The government has over time come up with certain programs which are geared to addressing unemployment through establishing schools and skill acquisition and training centres for teaching the youth various skills acquisition. These include; Katsina Youth Craft Village, Schools for Reformation among others. However, the major challenge is that these schools are inadequate even though many youth have benefitted immensely and some are currently benefitting (FGDs, with Youth Based Organizations in Katsina Local Government, 2021).

While describing the roles and contributions of CBOs, the participants stated that as community-based organizations, they play role in the development of their communities in different ways and areas of human endeavours. Firstly, they serve as agents of mobilization to enlighten local populace about certain government policies like vaccines for immunization, sensitization for voters registration, elections activities and other newly introduced economic matters such as use of ATM cards, POS and so on (FGD with CBOs from Jibiya, 2021).

In the same vein, the women groups in Katsina Local Government, (2021), claimed that women in Katsina communities play important roles in the development of their various communities in matters of economic, political and social issues. They explained that women that are allowed by their husbands to engage in communal activities like them (the participants) always champion the course of the rest of their community's members.

As members of community-based organizations in Jibiya, the participants believed that life is easier under a collective sense of direction. This is because of the unity an association provides to people. According to one of them, if there is unity of purpose, life will be generally simple because individual problems are collectively approached to the end by registered members especially through the use of the limited resources being gathered by the members of that particular organization (FGD with CBOs from Jibiya, 2021). They further maintained that:

If people are organized in a community-based organization that are more recognized and respected by the government, politicians and development partners, the benefits are immense. For instance, it was through Jibiya Babba Development Association (JBDA) that they were able to provide scholarship to some native students by prominent people of the area. This is a success which could not be achieved through individual effort. Similarly, the Zandam Area Development Association (ZADA) was able to repair roads leading to their town and engage in other social mobilization campaigns (FGD with CBOs from Jibiya, 2021).
While interrogating the life-chances of women in relations to men the women groups in Katsina Local Government, (2021) had this to say:

> Life is easier to men because they do not have some societal restrictions or any form of impediments hindering them from struggling for survival compared to women, bearing in mind the socio-cultural limitation that women are grappling with particularly in northern Nigeria. However, in few cases, there are situations whereby you find life being easier for women than men especially when such women are married to wealthy individual or in instances where the women are successful in business or they are occupying top positions in the civil service (FDG with women groups in Katsina Local Government, 2021).

They also claimed that:

> Women are represented in many issues in the community unlike before when voices of women are not listened to. There are some successful women who distinguished themselves in their chosen careers as school teachers, business women, politicians among others and this has helped to an extent to change the narrative about women (FDG with women groups in Katsina Local Government, 2021).

In terms of representation in community organizations and vis-à-vis the aggregation and articulation of their interest, the discussants indicated that interests of the people are well represented in the activities of the community-based organizations. However, there were situations in which some leader of the community-based organizations betrayed the communities and siphoned the wealth in the treasury for their personal usage. If not in this kind of cases, the community based-organizations do well to the society. They also claimed that all the community-based organization are well represented in the community meetings (FGD with CBOs from Jibiya LGA, 2021).

The FGDs also gave an opportunity to interact and interrogate the CSOs on the purpose and objectives of CSOs in relations to the nature of their activities. The discussants were of the view that:

> Despite the fact that all the community-based organizations that make up the FGD e are from different towns and villages under Jibiya local government, we are unanimous in our aims and objectives which is for the general development of our respective communities, more importantly education and poverty alleviation… there are no restrictions in the formation of the community-based organizations from either traditional institutions or government. In fact, the head of Zandam town is the head of the community-based organization in the town. With regards to the educational status of the members of the community based-organizations, few of our members are university graduates, others and Diploma or National Certificate Examination (NCE) and the vast majority secondary school leavers (FGD with CBOs from Jibiya, 2021).

In an interaction on the existence of women associations the women groups in Katsina Local Government says:

> There are many womens' associations in the Katsina communities. We who are here for this FGD are just one example of women association and mandates differ from one association to another. For instance, FOMWAN's major activities are Islamic educational awareness of women in the rural areas. NCWSKTC's main activities are women empowerment especially through trade and skills acquisitions and QDFPCD's main objectives is to fight against molestation of women like rape, marital injustices, and educational campaigns and so on (FGD with women groups in Katsina Local Government, 2021).

In a discussion on the factors that prevent women and girls from either going to school or continuing their education the women identified several factors. They were of the view that:

> Most girls don't go to school as there are thousands of girls roaming on the streets hawking instead of schooling. In most cases where the girls attend schools, they stop at secondary school level and are giving out in marriage instead of furthering

their education. Poverty, lack of parental awareness of the importance of female child education, cultural barriers that tend to give out teenage daughters in marriage immediately the pass 17 years amongst several others accounts for the low rate of girl child education (FGD with women group in Katsina LGA, 2021).

The CBOs from Jibiya, (2021) also suggested some priority areas that needs improvement as far as the establishment of community-based organizations is concerned. The participants suggested the following:

1. More educational awareness from the more enlightened community to less enlightened one.
2. Indigenous educated elites should be sparing time to enter remote areas and educate them on the importance of community-based organizations.
3. Wealthy people in the State should finance the establishment of community-based organizations in the rural areas for rural developments.

4.3.15.7 Stock Routes Within the Project Corridor

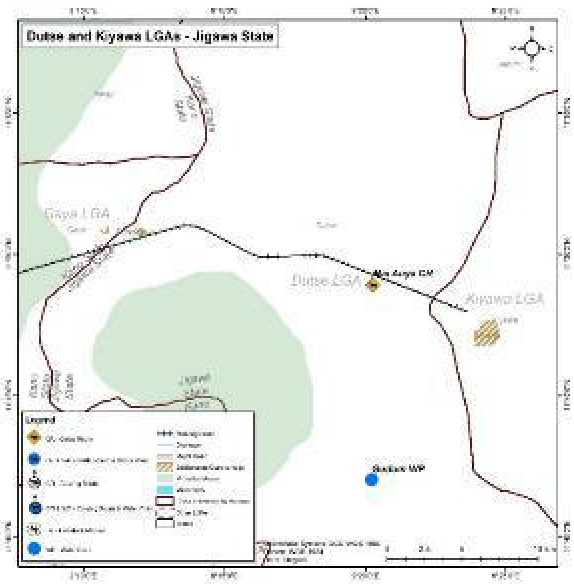
There are many stock routes within the project area. Issues concerning the likely fragmentation and general impact on the stock routes were raised during stakeholder engagement activities. Stock routes were identified across the three states in the following local government areas:

1. Jigawa State: Dutse, Kiyawa, Roni, Gwiwa, and Kazaure LGAs
2. Kano State: Dawakin Tofa, Dawakin Kudu, Warawa, Gaya, Kumbotso, Ungongo, Wudil, Dambatta and Makoda LGAs
3. Katsina State: Sandamu, Rimi, Batagarawa, Kaita, Mashi, Mani, Daura, Katsina and Jibiya LGAs.

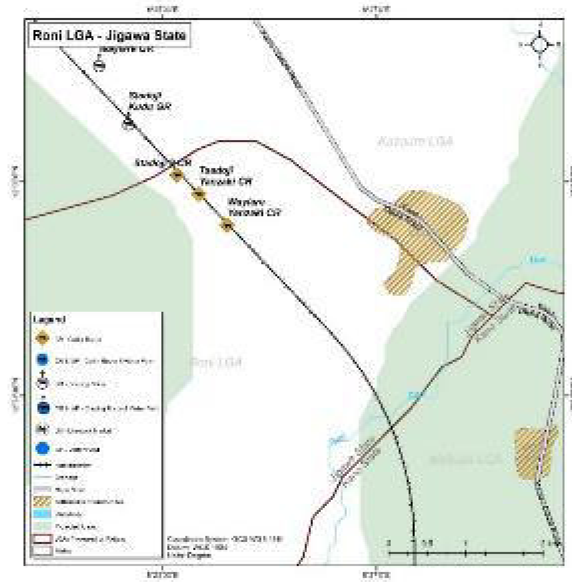
There is a cattle route at Mai close to the rail alignment in Dutse LGA. In addition, the rail alignment crosses cattle routes at Bangel, Musa Intu, Kora Kauye and an international cattle route at Tabkin Yari in Gwiwa LGA of Jigawa State. Also, in Gwiwa LGA and within the RoW are grazing routes at Tokosa Pangani, Tafasa Mera and Danmaimaji. In Kazaure LGA of Jigawa State, the rail line passes through stock routes at Dinkura while grazing routes at Bayan Dutse, Tsadoji Waylare, and Tsadoji Kudu.

In Roni LGA, Tsadoji Yanzaki and Waylare Yanzaki cattle routes are within the alignments while another cattle route and a water point at Zubuwa Dawaki is close to the RoW in Dawakin Kudu LGA of Kano State. Also, there is an international route at Fara Mokole in Dawakin Kudu LGA. In Dawakin Tofa LGA of Kano State, there are cattle routes at Jemoni, Janli, Madaci Janli and Dirkiji, which will be crossed by the rail line.

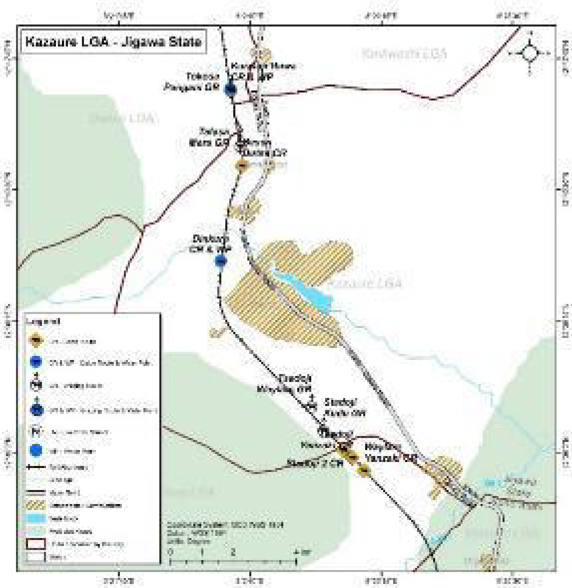
Other cattle routes within the rail alignments are at Mahaka Camp in Gaya LGA; Jugel and Lamya cattle in Wudil LGAs; Zago, Lirigo, Rijiyar Danya and Wanzame with an international route at Jedawa all in Dambatta LGA of Kano State. At Makoda LGA of Kano State, there is an international stock route at Angwar Adamu and a grazing route at Durma. In Katsina State, there are stock routes within the rail alignment at Agagara, Anguwar Gamji and Bojo in Sandamu LGA; Waylaare Sharganle, Malkere, Samawa and Gudawa in Dutsi LGA; Muduru Kiringa and Shirinya in Mani LGA; Sabon Gari, Korin Tanra, and Yendadi in Katsina LGA. Also, in Katsina State there are cattle routes within the rail alignments at Tsintsiya and an international cattle route at Kurori as well as a grazing route at Karahun in Mashi LGA. Bakura and Kogoi cattle routes are within the aligment in Kaita LGA while Riminguza cattle route is within the rail alignment in Rimi LGA (Figure 4. 153).



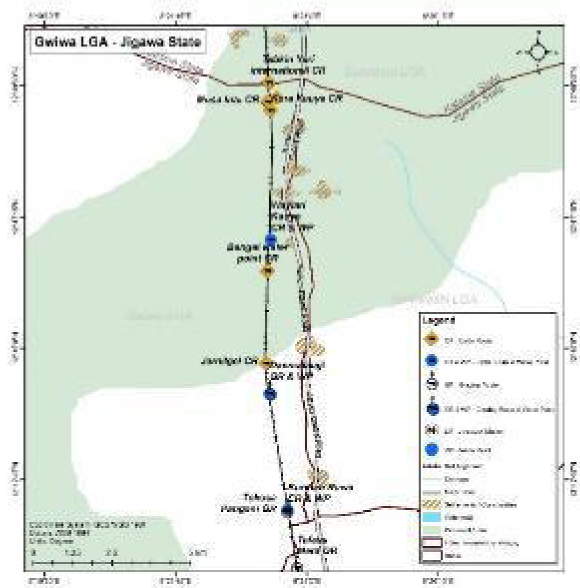
Map showing stock and grazing routes in Dutse and Kiyawa LGAs of Jigawa State



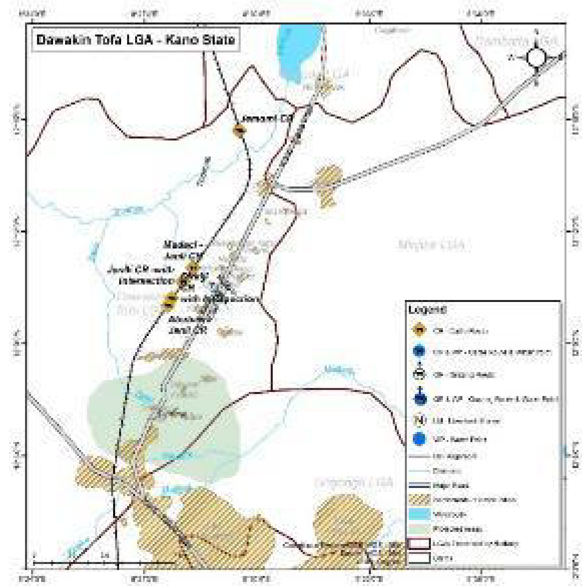
Map showing stock and grazing routes in Roni LGA of Jigawa State



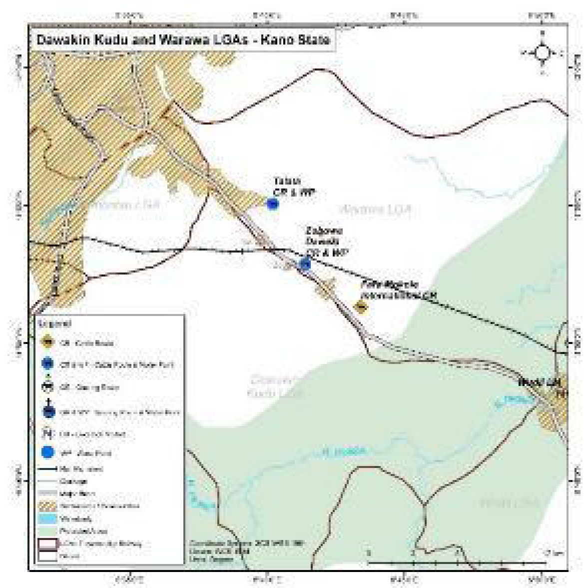
Map showing stock and grazing routes in Kazaure LGA of Jigawa State



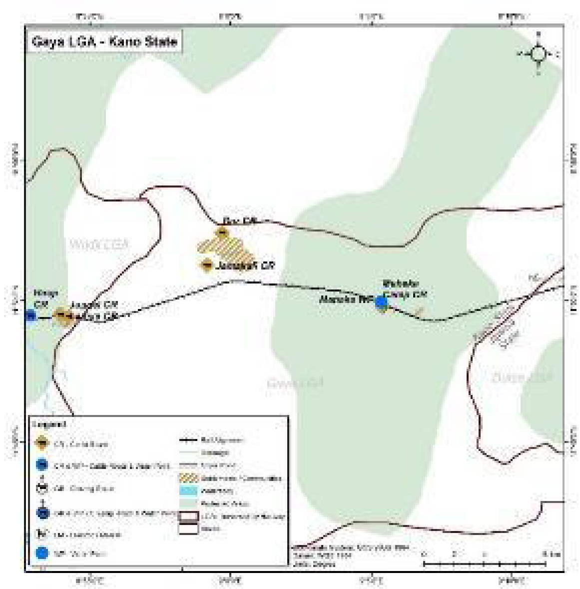
Map showing stock and grazing routes in Gwiwa LGA of Jigawa State



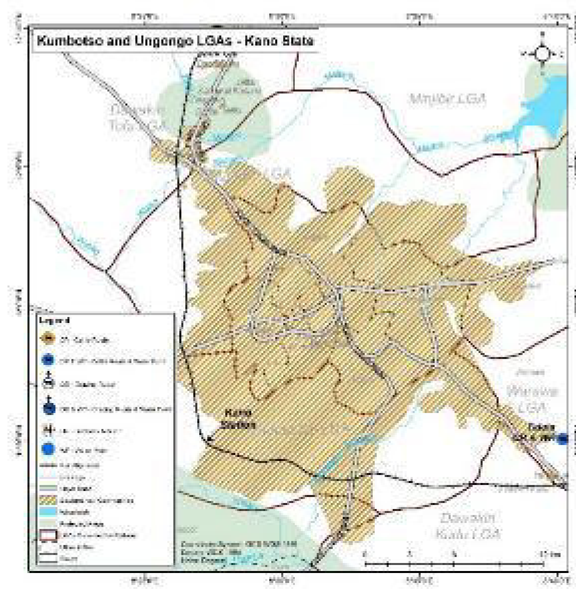
Map showing stock and grazing routes in Dawakin Tofa LGA of Kano State



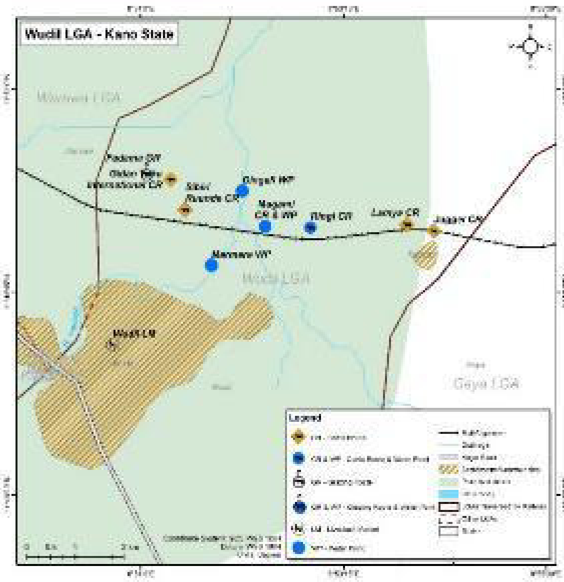
Map showing stock and grazing routes in Dawakin Kudu and Warawa LGAs of Kano State



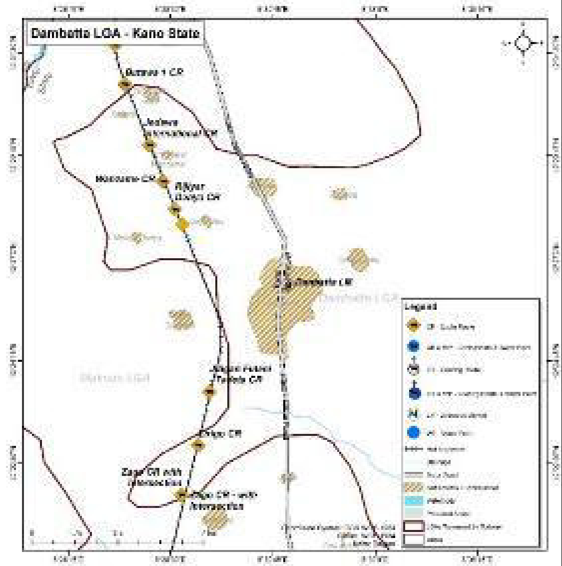
Map showing stock and grazing routes in Gaya LGA of Kano State



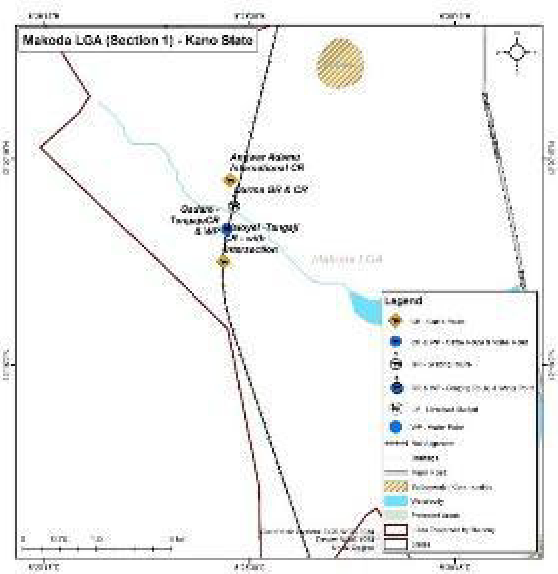
Map showing stock and grazing routes in Kumbotso and Ungongo LGAs of Kano State



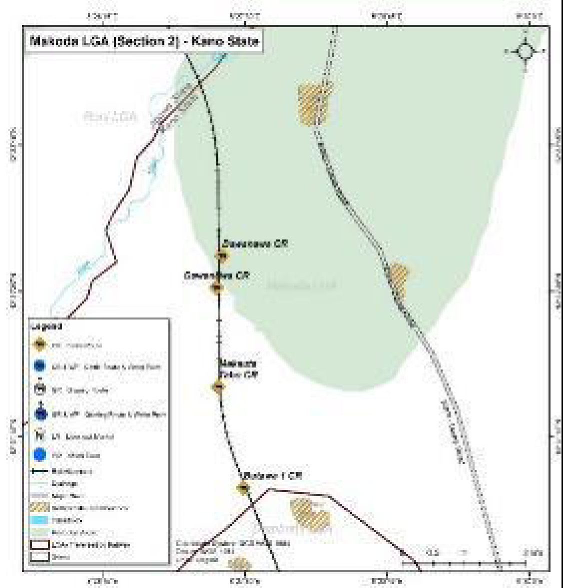
Map showing stock and grazing routes in Wudil LGA of Kano State



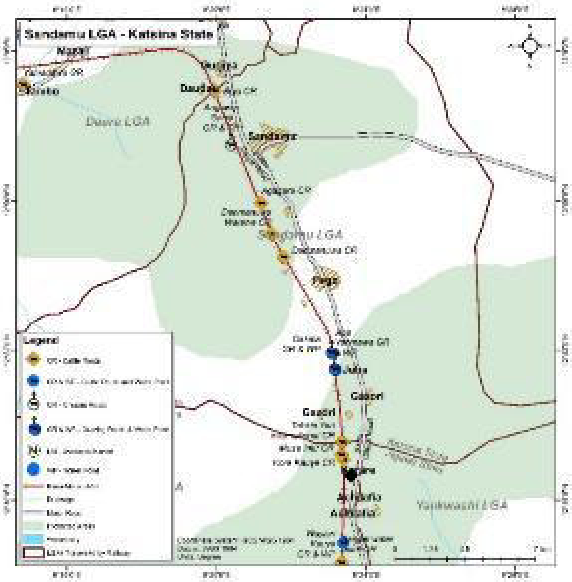
Map showing stock and grazing routes in Dambatta LGA of Kano State



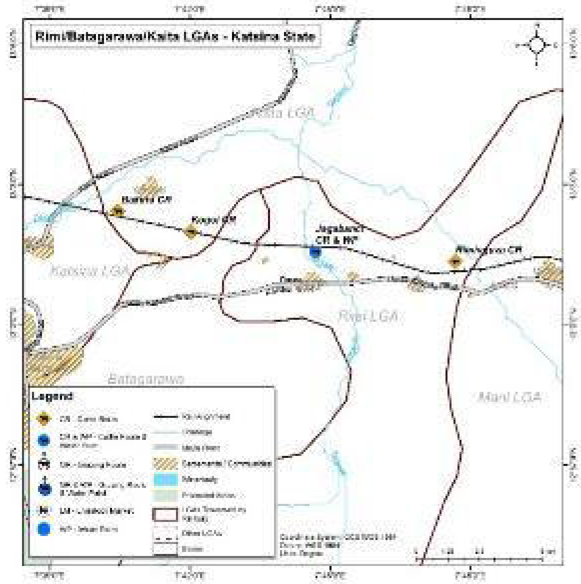
Map showing stock and grazing routes in Makoda LGA (Section 1) of Kano State



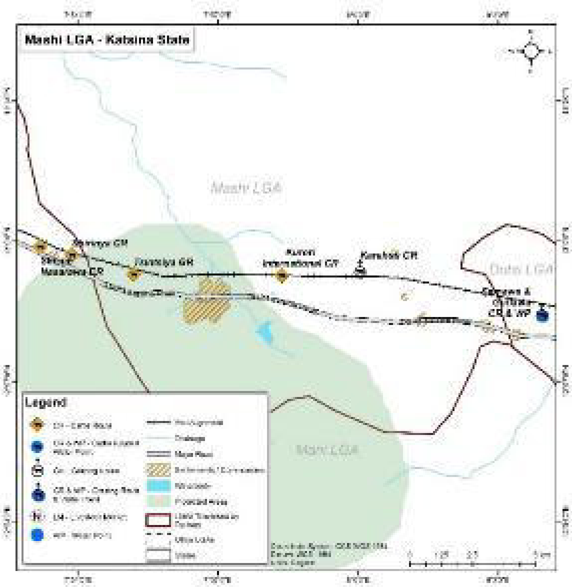
Map showing stock and grazing routes in Makoda LGA (Section 2) of Kano State



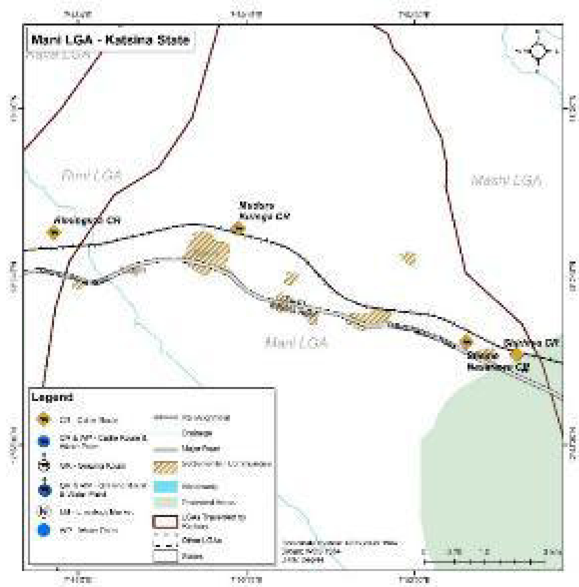
Map showing stock and grazing routes in Sandamu LGA of Katsina State



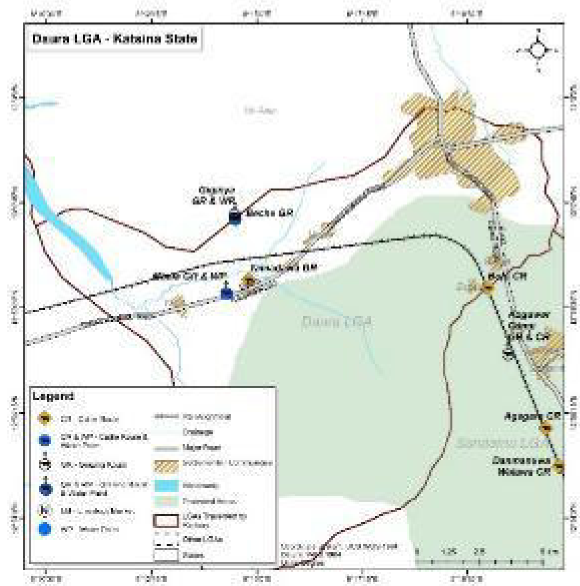
Map showing stock and grazing routes in Rimi/Batagarawa Kaita LGAs of Katsina State



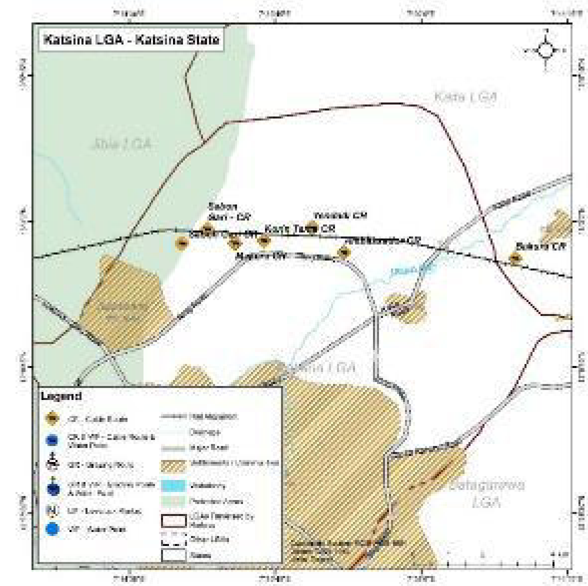
Map showing stock and grazing routes in Mashi LGA of Katsina State



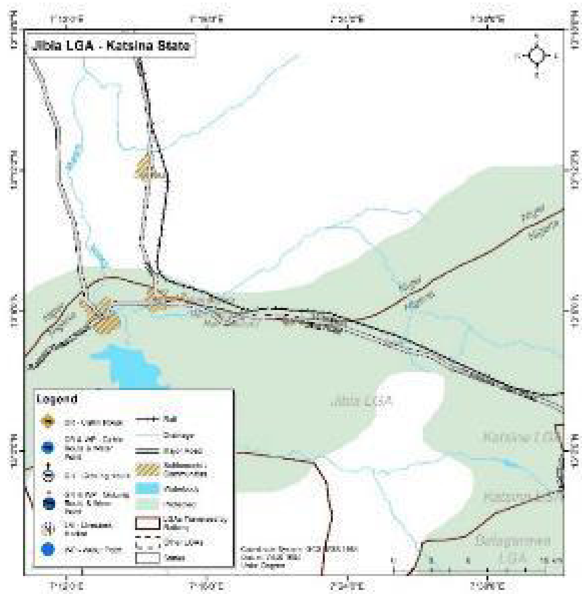
Map showing stock and grazing routes in Mani LGA of Katsina State



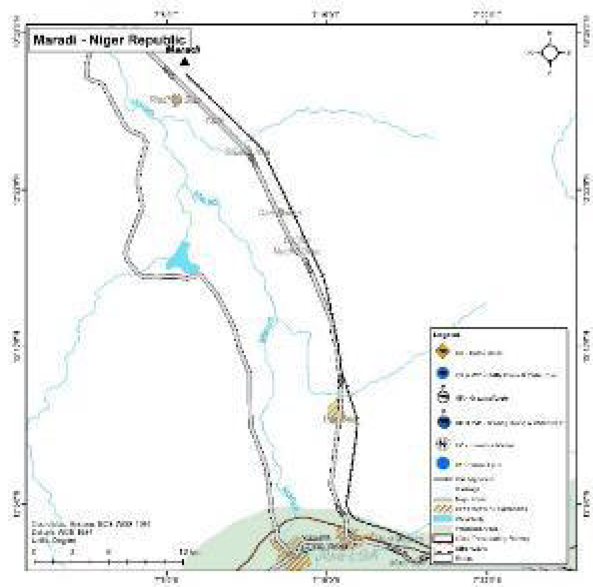
Map showing stock and grazing routes in Daura LGA of Katsina State



Map showing stock and grazing routes in Katsina LGA of Katsina State



Map showing stock and grazing routes in Jibiya LGA of Katsina State



Map showing transnational grazing routes in the Katsina Border Community

Figure 4. 153: Maps showing cattle routes within the rail alignments from Dutse to Maradi

4.3.15.8 Batakaba: A Place of Cultural Importance

In the course of the social survey, a place of cultural significance within the project corridor at Jalli Village in Dawakin Tofa LGA of Kano State was encountered. Known as Batakaba, the village head describe the place as a spooky and mysterious place that dates back to ages. No one is allowed to farm or build house in the area, and there were reports of deaths, insanity and hallucinations among many people who dared to desecrate or tamper with the area. Batakaba, covering a land area of 1.68 ha and located within Latitude 12.179402773, Longitude 8.4652176126, is considered by the people of Jalli as a special historical place and a symbol of their identity. The rail alignment does not pass through Batakaba, which is about 550 metres from the RoW.

Plate 4.48: A cross-section of the Batakaba mysterious place at Jalli Village

5.0 CHAPTER FIVE: ASSOCIATED AND POTENTIAL IMPACTS

5.1 PROJECT IMPACT ASSESSMENT AND OBJECTIVES

Impact assessment is an important and early step in managing and improving environmental and social performance, as it helps to screen and assess all significant potential impacts and risks associated with the development project and identify any mitigation or corrective measures that should enable the project to meet the requirements of applicable national and international laws and regulations. In recognition of this, an assessment of the associated and potential environmental and social risks and impacts of the proposed rail line project was carried out. The main objectives of the impact assessment are to:

- Identify and evaluate associated and potential environmental and social risks and impacts of the project and determine their significance.
- Isolate significant associated and potential risks and impacts requiring further management actions.
- Enable an adoption of a mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimise, compensate/offset for potential impacts to workers, project affected communities, and the environment.

This chapter presents the potential impacts associated with the proposed project and project activities (documented in Chapter 3) on the biophysical and socioeconomic environment of the project area (documented in Chapter Four). Although, the planned project has some potential benefits, the adverse economic, environmental and social effects of the project require thorough consideration. Associated and likely environmental and social impacts of the proposed project vary by development phases, and the associated impacts of the proposed project are direct, indirect, and cumulative. The impacts are determined by factors such as the scale of the planned construction activities, the land acquired and which would be disturbed by construction activities, and the location of the train stations with respect to other adjacent facilities and the sensitive environmental resources available in the project area and along the project corridor. In many instances, however, project impacts may be attributed to the lack of an adequate environmental management system of the Project proponent (Christini *et al*., 2004).

5.2 IMPACT ASSESSMENT APPROACH AND METHODOLOGY

There are different methodologies and tools recommended by United Nations Environment Programme (UNEP) for environmental and social impact assessment. These recommended methodologies, some of which were used for this study, include but not limited to the following:

Analytical Methods

Analytical method of impact analysis entails stakeholder analysis, which addresses strategic questions, attempts to identify major stakeholders and their interests in the project or policy and their level of influence on the project operation. In addition, analytical method of impact analysis focuses on understanding and documenting the differences in gender roles, activities, needs and opportunities in a given context. It highlights the different roles and behaviour of men and women in the project area. However, this approach, known as 'gender analysis' does not treat women as homogenous group by virtue of variation in the attributes across diverse ethnic groups, cultures, income level, and educational status, among others. To complement this, review of secondary data and information on similar project was undertaken. Some of the existing rail projects (especially the Abuja-Kaduna and Lagos-Ibadan rail projects), observed and documented project impacts were reviewed and considered for the potential impact assessment of this project.

Beneficiary Assessment (BA)

This is a consultation method of social impact assessment. It is a systematic investigation of the perceptions of a sample of beneficiaries and other stakeholders to ensure that concerns of Project Affected Persons (PAPs) and Project Affected Communities (PACs) are considered and incorporated into project design and implementation. The purposes are to:

- Undertake systematic listening, which "gives voice" to poor and other hard-to-reach beneficiaries, highlighting constraints to beneficiary participation; and
- Obtain feedback on interventions.

Community-based methods

Community-based methods are mostly Participatory Rural Appraisal (PRA), which covers a group of participatory approaches and methods; and emphasises local knowledge and action. Originally developed for use in rural areas, which will be most appropriate in some rural settlements along the project corridor, PRA has been employed successfully in a variety of settings to enable local people to work together to plan community-appropriate developments.

Therefore, the impact assessment approach and methodology employed for the study is consistent with the United Nations Environment Programme assessment methodologies, the International Organization for Standardization (ISO) 14001 requirements for risk and impact assessment and the World Bank Environmental and Social Standards.

The process of identification and assessment of potential environmental and social risks and impacts was based on recent, up-to-date primary information involving the use of empirical data obtained from field studies and detailed description of the project area in its geographic, ecological, social, health and temporal context (the environmental and social baseline). This was used alongside a combination of other methods including checklists, matrix and professional experience and judgement. It also took into account findings and conclusions of EIA of similar rail development projects in Nigeria as well as guides from the FMT, FMEnv, other regulators and project consultants. The outcome of the engagement processes with stakeholders in the affected communities, precisely those within and near to the proposed route equally assisted in identifying the potential impacts.

The assessment methodology comprised a number of steps to assess the manner in which the project will likely interact with the elements of the biophysical and social environment to impact on the resources/receptors identified in Chapter 4 of the Report.

The steps involved were as follows:

- Identification of potential interactions between the project activities and the biophysical and social resources/receptors.
- Prediction of potential risks and impacts – to determine what could potentially happen because of the interaction of the project with the biophysical and social resources/receptors.
- Characterisation of risks and impacts – to determine/predict the type, nature, duration and reversibility of each risk and impact.
- Evaluation of risks and impacts – to evaluate potential risks and impacts based on clearly defined criteria.
- Determination of significance of risks and impacts – to determine the significance of all identified environmental and social risks and impacts, taking account of the evaluation of the legal/regulatory requirement; risk posed by impact; frequency of occurrence of risk/impact; importance of target environmental and social components as well as public interest/concern and perception of such risks and impacts.

The pathway and approach used for the assessment of the associated and potential environmental and social risks and impacts of the project and project activities is shown in Figure 5.1

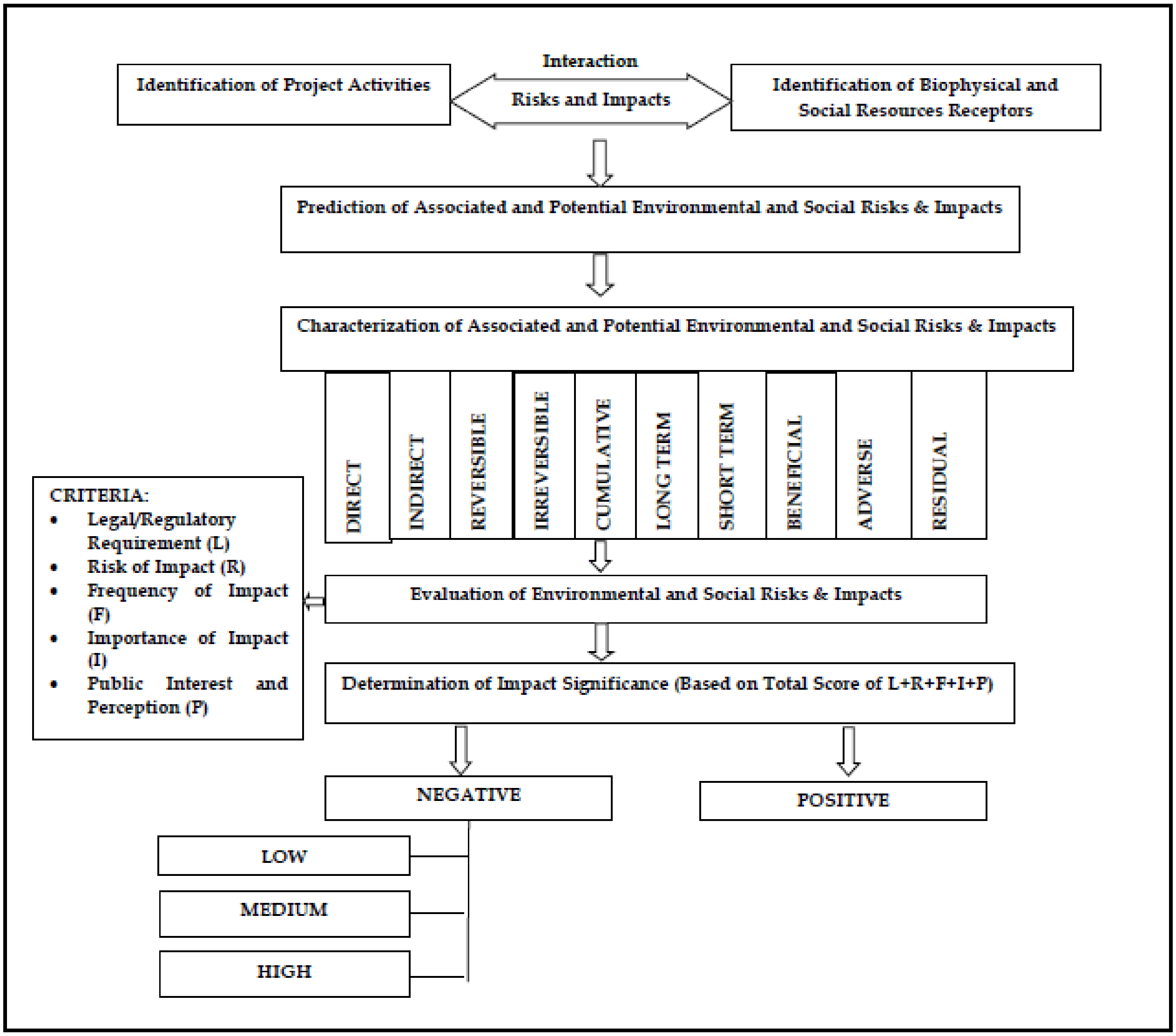


Figure 5. 1: Overview of Risk and Impact Assessment Methodology

5.2.1 Identification of Project – Environment Interactions

Generally, construction activities consume half of all the natural resources, and account for one-sixth of global freshwater consumption, one-quarter of wood consumption, and one-quarter of global waste, according to research by Bimhow (GoContractor, 2017). https://gocontractor.com/blog/how-does-construction-impact-the-environment/

The potential interactions between the planned project activities and the biophysical and social resources/receptors were identified based on vital information gathered on the project and project activities (Chapter 3), project alternatives (Chapter 2) and existing environmental and social baseline conditions of the project area (Chapter 4). The outcome of the scoping exercise also helped to identify the resources/receptors likely to be significantly impacted by the project.

The most likely interactions of the project with the biophysical and human environment and the significance of potential impacts associated with the project activities formed the basis for the matrix presented in Table 5.1. The interaction matrix was used as the tool to identify possible connections between project activities and resources/receptors. The matrix helped to methodologically identify the potential interactions each project activity may have with the range of potential resources/receptors within the project area. The matrix consists of a list of resources/receptors (on the horizontal axis) that could be affected by the project activities set against a list of project activities (on the vertical axis). The interactions coloured white indicates an interaction is not reasonably expected, yellow indicates that an interaction is reasonably possible but none of the resulting impacts are likely to lead to significant effects while red indicates that the interaction is reasonably possible and at least one of the resulting impacts is likely to lead to an effect that is significant. The interactions coloured white was “scoped out” of further consideration in the EIA process. In addition, the interaction coloured yellow (or considered minor) was also “scoped out”, as they are not likely to have significant impact on these resources and receptors.

Table 5. 1: Impact matrix for the Kano-Maradi Rail Project

	Physical													Biological				Social										
Project Items and Activities	Surface Water	Groundwater	Flooding	Noise and Vibration	Air Quality / Dust	Climate Change	GHG emissions	Soils	Geology	Topography	Seismic	Landscape	Waste Management	Flora	Fauna	Protected Areas	Ecosystem Services	Traffic and Transport	Employment	Livelihoods	Cultural Heritage	Resettlement	Community H&S	Security	Worker Safety	Public Infrastructure	Migration / demographics	Human Rights
Design and Preconstruction																												
Land acquisition for project																												
Demolition of old buildings and infrastructure																												
Site clearance																												
Construction																												
Transport of materials to site																												
Earthworks																												
Access Roads																												
Installation of fencing																												

	Physical													Biological				Social										
Project Items and Activities	Surface Water	Groundwater	Flooding	Noise and Vibration	Air Quality / Dust	Climate Change	GHG emissions	Soils	Geology	Topography	Seismic	Landscape	Waste Management	Flora	Fauna	Protected Areas	Ecosystem Services	Traffic and Transport	Employment	Livelihoods	Cultural Heritage	Resettlement	Community H&S	Security	Worker Safety	Public Infrastructure	Migration / demographics	Human Rights
Construction of Tracks																												
Construction of Stations etc.																												
Logistics Routes																												
Borrow Pits																												
Presence of worker camp (inc. wastewater treatment)																												
Disposal of construction waste																												
Loss of jobs at end of the construction phase																												
Operations																												

	Physical													Biological				Social										
Project Items and Activities	Surface Water	Groundwater	Flooding	Noise and Vibration	Air Quality / Dust	Climate Change	GHG emissions	Soils	Geology	Topography	Seismic	Landscape	Waste Management	Flora	Fauna	Protected Areas	Ecosystem Services	Traffic and Transport	Employment	Livelihoods	Cultural Heritage	Resettlement	Community H&S	Security	Worker Safety	Public Infrastructure	Migration / demographics	Human Rights
Rail Operation (Trains)																												
Rail operations (Stations)																												
Rail Operations (Maintenance Facilities)																												
Track Maintenance																												
Abstractions/ Water Supply																												
Discharge of treated wastewater and stormwater																												
Fuel storage																												
Solid waste disposal																												

	Physical													Biological				Social										
Project Items and Activities	Surface Water	Groundwater	Flooding	Noise and Vibration	Air Quality / Dust	Climate Change	GHG emissions	Soils	Geology	Topography	Seismic	Landscape	Waste Management	Flora	Fauna	Protected Areas	Ecosystem Services	Traffic and Transport	Employment	Livelihoods	Cultural Heritage	Resettlement	Community H&S	Security	Worker Safety	Public Infrastructure	Migration / demographics	Human Rights
Cumulative impacts																												
Transboundary impacts																												
Closure / Decommissioning	Decommissioning of the Project will be subject to a full decommissioning plan in line with national requirements and international best practice in place at the appropriate time.																											

Significance of Effect

Adverse Effects			Beneficial Effects
Low	Medium	High	Positive

5.2.2 Prediction of Potential Risks and Impacts

In order to predict the potential environmental and social risks and impacts of the project, the environmental aspects of project activities for the different phases of the project cycle will be identified. The project activities include planned routine activities, planned but non-routine activities and unplanned or accidental events such as oil spills and accidents at construction site.

Environmental risks and impacts that will be considered include (i) those defined by the World Bank IFC General and Industry Specific Environmental Health and Safety Guidelines; (ii) those related to community safety and public health; (iii) those impacts and risks related to climate change; (iv) any material threat to the protection, conservation, maintenance and restoration of natural habitats and biodiversity; and (v) impacts related to ecosystem services and the use of living natural resources, such as fisheries and forests.

Social risks and impacts will include: (i) threats to human security through the escalation of communal conflict; (ii) risks that project impacts fall disproportionately on individuals and groups who, because of their particular circumstances, may be disadvantaged or vulnerable; (iii) any prejudice or discrimination toward individuals or groups in providing access to development resources and project benefits, particularly in the case of those who may be disadvantaged or vulnerable; (iv) negative economic and social impacts relating to the involuntary taking of land or restrictions on land use; (v) risks or impacts associated with land and natural resource tenure and use, including any corresponding risks related to conflict or contestation over land and natural resources; (vi) impacts on the health, safety and well-being of workers and project-affected communities; and (vii) risks to cultural heritage.

5.2.3 Characterisation of Potential Risks and Impacts

In order to further qualify the risks and impacts of the proposed project activities on the environment and the people, all identified risks and impacts will be characterised based on their type, nature, duration and reversibility. The characteristics will be defined as follows:

Positive or Beneficial Impact: An impact that is considered to represent an improvement to the baseline condition or introduces new desirable factor.

Negative or Adverse Impact**:** An impact that is considered to represent an untoward change from the baseline condition or introduces a new undesirable factor.

Direct Impact: An impact which is caused by the project, and occurs contemporaneously (the same time) in the location of the project.

Indirect Impact: An impact which is caused by the project and is later in time or farther removed in distance than a direct impact, but is still reasonably foreseeable, and will not include induced impacts.

Cumulative Impact: The incremental impact of the project when added to impacts from other related past, present and reasonably foreseeable development as well as unplanned but predictable activities enabled by the project that may occur later or at a different location. Cumulative impact can result from individually minor but collectively significant activities taking place over a period.

Short Term Impact: An impact that is predicted to last only for a limited period, but will cease on completion of a specific project activity or because of mitigation measures and natural recovery.

Long Term Impact: An impact that will continue for the life span of the project, but cease when the project stops operating. It is also an impact that may be intermittent or repeated rather than continuous if it occurs over an extended period.

Reversible Impact: An impact, which effects are such that the affected environmental or social resource/receptor can be returned to its original state by natural processes or through mitigation measures.

Irreversible Impact: This is an impact, which effects are such that the affected environmental or social resource/receptor cannot be returned to its original state even after adequate mitigation measures are applied.

Residual Impact: An impact that its effect remains after mitigation measures would have been applied.

5.2.4 Evaluation of Potential Risks and Impacts

Impact evaluation to determine its level of significance will be based on the methodological framework set by (ISO) 14001 – Environmental Management System (EMS). The evaluation will be based on the following clearly defined criteria:

- Legal/Regulatory requirement (L)
- Risk posed by impact (R)
- Frequency of occurrence of environmental impact (F)
- Importance of affected environmental component and impact (I)
- Public interest/concern & perception (P)

The above criteria and the rating adopted for the evaluation are described below:

5.2.4.1 *Legal/Regulatory Requirement (L)*

In the evaluation process, project activities that could result in impacts were weighed against existing legal/regulatory requirements to determine if the issue is affected by legislation or whether permits are required prior to the execution of such activities. Such legal/regulatory requirements were identified from the laws/guidelines, which have been reviewed in Chapter 1 as well as those guidelines in the source references relating to the proposed project activities. The rating used for this criterion is as shown in Table 5.2.

Table 5. 2: Legal/Regulatory Requirement Criteria

Legal/Regulatory Requirement	Rating	Condition
Low	0	No legal/regulatory requirement for carrying out project activity
Medium	3	Legal/regulatory requirement exist for carrying out project activity
High	5	A permit is required prior to carrying out project activity

5.2.4.2 *Risk Posed by Impact (R)*

What is the risk/hazard associated with the project activity?

Risk is a measure of the likelihood and magnitude of an adverse effect. Associated risks with aspects of project activities were evaluated in terms of:

- Risk to human health;
- Risk to asset (commercial and economic risk);
- Risk to the biophysical environment; and
- Risk to the client's reputation.

Risks posed by potential impacts were evaluated based on the Risk Assessment Matrix (RAM) shown in Figure 5.2. Two main criteria, namely: Severity (S) and Probability of occurrence (P) were used as basis for ranking the risk.

- ***Severity (S):*** The severity of an impact is the degree or scale of change from an existing condition as a result of an impact. The severity factor is quantified as whole numbers between 1 and 5, where 1 indicates slight effect and 5 indicates multiple fatalities, extensive damage, massive or international effect as it relates to people, assets, environment and reputation.

- ***Probability (P):*** Probability is the measure of the likeliness that an event will occur. The probability factor is quantified as whole numbers between 1 and 5 (where 1 indicates impossibility and 5 indicate absolute certainty). The higher the probability of an event within the scale, the more certain that the event will occur as described in Table 5.3.

Table 5. 3: Description of Probability

S/No.	Occurrence	Description
1	Seemingly impossible	An event which has never occurred or is unheard of in the industry or related projects.
2	Not likely to occur in the project	An event which rarely occurs in the industry, although it may have occurred before but it is uncommon.
3	Possibility of occurring in the project	An event which is likely going to occur.
4	Possibility of occurring more than once in the project	An event which the industry is familiar with and may occur more than once within a project.
5	Possibility of repeated occurrence	An event which occurs frequently in the industry and may likely occur almost every day during the project.

- ***Risk (R):*** The level of risk was determined by the sum of the severity and probability of occurrence. Using the RAM in Figure 5.2, risk posed by potential impacts were assessed and ranked as presented in Table 5.4.

Table 5. 4: Risk Criteria

Risk	S + P	Rating	Attribute – Environmental, Human Health, Safety and Reputation
Low	2 ≤ 5	1	This means that no further mitigation action may be required
Medium	6 ≤ 7	3	The impact can be mitigated with additional controls and modifications
High	8 ≤ 10	5	This means that the impact requires avoidance or major control/mitigation

	CONSEQUENCE				INCREASING PROBABILITY				
					1	2	3	4	5
SEVERITY	People	Asset Damage	Environmental Effect	Reputation	Seemingly Impossible	Not Likely to Occur	Possibility of Occurring in the Project	Possibility of Occurring more than Once	Possibility of Repeated Incidents
1	**Slight injury:** Superficial, does not require First-Aid treatment	**Slight:** Superficial equipment damage. Does not require any repairs	**Slight:** Insignificant effect that can immediately be corrected	**Slight:** No complaint or media attention	Low Risk				
2	**Minor injury:** Requires First-Aid treatment	**Minor:** Requires little repairs but can be used without repairs	**Minor:** Short term effects but not affecting ecosystem	**Limited:** Possible complaint, low media attention					
3	**Major injury:** Requires medical treatment.	**Localized:** Damage done to a specific part of the equipment which makes it un-useable without	**Localized:** Serious medium-term effects to a specific part of the environment	**Considerable:** Public complaint, moderate media attention, possible legal action			Medium Risk		

		repairs							
4	**Serious injury:** Partial disablement or severe injury	**Major:** Irreparable equipment damage, needs replacement	**Major:** Very serious, long term impairment of the environment	**National:** Several public complaints, damage to reputation within the country, public embarrassment, high media attention, legal action					
5	**Multiple fatalities:** Death or permanent disablement	**Extensive:** Irreparable multiple equipment damage	**Massive:** Irreversible harm on the environment	**International:** Irreversible damage to reputation both within and outside the country, very high level of public embarrassment, very high media attention					**High Risk**

Figure 5. 2: Risk Assessment Matrix

5.2.4.3 *Frequency of Impact (F)*

What is the frequency rating of impact?

Evaluation of the frequency of occurrence was carried out and rated as "low", "medium" or "high" based on the outcome of the RAM, consultation with project proponent, experts and professional judgment. The weighing scale used for this criterion is presented in Table 5.5.

Table 5. 5: Frequency Criteria

Importance	Rating	Attribute – Environmental, Human Health and Safety
Low	1	• Minor degradation in quality in terms of scale (<0.1% of study area), appearance and duration (e.g. only a few days). • Rapid reversibility (change lasting only a few weeks before recovery, no lasting residual impact of significance) • No potential for cumulative impact • Very localized geographic extent of impact (e.g. not more than a few meters from impact source point) • Low frequency of impact (occur in just about one occasion during the project execution period) • Immeasurable change in social, cultural, economic activity of affected communities (e.g. a few jobs lost, etc.)
Medium	3	• Degradation in quality in terms of scale (>0.1% of study area), appearance and duration (e.g. a few months). • Slow reversibility (change lasting only a few months before recovery, lasting residual impact of significance) • Potential for cumulative impact • Limited geographic extent of impact • Intermittent frequency of impact (occur in only a few 'occasions during the project execution period) • Measurable change in social, cultural, economic activity of affected communities (e.g. percent of jobs losses, etc.)
High	5	• Major degradation in quality in terms of scale (>1% of study area), appearance and duration (beyond duration of project). • Irreversible or only slowly recoverable (change lasting more than one year, degradation of environmental ecosystem level (population, abundance, diversity, productivity) • Existing cumulative impact • Geographic extent of impact (Encompassing areas up to half the area of project coverage) • High frequency of impact (occur continuously and almost and almost throughout the project execution period (about 12 months) • Major change in social, cultural, economic activity of affected communities (e.g. percent of jobs losses, etc.)

5.2.4.4 Importance of Impact (I)

What is the rating of importance based on consensus of opinions concerning the proposed project? The importance of target environmental component in respect of identified potential impact was determined and rated as "low", "medium" or "high". The ratings were based on consensus of opinions among consulted experts and stakeholders. The rating used for the criterion is outlined in Table 5.6.

Table 5. 6: Importance Criteria

Importance	Rating	Attribute – Environmental, Human Health and Safety
Low	1	• Low Imperceptible outcome • Insignificant alteration in value, function or service of impacted resource • Within the compliance of regulations, no controls required
Medium	3	• Negative outcome • Measurable reduction or disruption in value, function or service of impacted resource • Potential for noncompliance with regulations
High	5	• Highly undesirable outcome (e.g., impairment of endangered, protected habitat, species) • Detrimental and extended flora and fauna behavioural change (breeding, spawning, molting) • Major reduction or disruption in value, function or service of impacted resource • Impact during environmentally sensitive period • Continuous noncompliance with regulations

5.2.4.5 Public Interest / Concern and Perception

What is the rating of public perception and interest regarding the project and impacts? The opinions, views and concerns of interested parties including members of the project communities interviewed were solicited through questionnaire administration. The ratings were assigned as follows:

1 = Low perception and interest;

3 = Medium perception and interest;

5 = High perception and interest. The criteria used to assign the ratings are outlined in Table 5.7.

Table 5. 7: Public Interest/Concern and Perception Criteria

Public Interest/Concern & Perception	Rating	Attribute – Environmental, Human Health & Safety
Low	1	• No risk of accident and/or death • No risk to human health, acute and/or chronic • No negative effect on means of livelihood • No possibility of life endangered for on-site personnel • Minor reduction in social, cultural, economic value
Medium	3	• Limited incremental risk of accidents and death • Minimal report on risk to human health, acute or chronic • Unlikely life endangered for on-site personnel • Some reduction in social, cultural, economic value • Possibility of adverse perception among population in the study area • Potential for non-compliance
High	5	• Elevated incremental risk to accidents and death • Increased risk to human health, acute and / or chronic • Possibility of life endangered for on-site personnel • Possibility of fuelling conflict • Major reduction in social, cultural, economic value • Major public concern among population in the study area • Continuance non-compliance with statutes

5.2.4.6 *Determination of Risk and Impact Significance*

The key element of impact assessment is to determine the significance of impacts on environmental and social resources/receptors. The significance of each risk and impact was determined based on the evaluation of their legal requirement (L), risk factor (R), frequency of occurrence of impact (F), importance (I) & public perception (P). The significance was rated as "Low", "Medium" or "High" using the following criteria.

Low / Negligible:

(L+R+F+I+P) = 0 - 8: *That is the sum of weight of Legal Requirement, Risk Factor, Frequency of Occurrence of Impact, Importance & Public Perception ranges between 0 and 8.*

Medium / Moderate:

(L+R+F+I+P) = 9 - 14: *That is the sum of weight of Legal Requirement, Risk Factor, Frequency of Occurrence of Impact, Importance & Public Perception ranges between 9 and 14.*

High / Major:

(L+R+F+I+P) ≥15: *That is the sum of weight of Legal Requirement, Risk Factor, Frequency of Occurrence of Impact, Importance & Public Perception is greater or equal to 15.*

OR

(F+I) > 6: *That is sum of weight of Frequency of Occurrence of Environmental Impact and Importance of affected Environmental Component is greater than the benchmark of 6.*

OR

P = 5: *That is the weight of public interest and perception of the potential impact is the benchmark of 5.*

The impact values and significance is presented in Table 5.8

Table 5. 8: Impact Values and Rating Colour Code

Impact Value	Cut off values	Impact Rating
L+R+F+I+P	<8	Low
L+R+F+I+P	≥8≤14 (8-14)	Medium
L+R+F+I+P	≥15	High
F+I	> 6	
P	= 5	
Positive		Positive

5.2.5 Significance of Potential Impacts

The determination of impact significance is critical to appropriate mitigation measures, sound environmental management and performance as well as sustainability of the proposed rail project. Therefore, the significance of potential impacts associated with the project prior to implementation of appropriate and practicable mitigation measures was evaluated. In addition, the residual impact significance after mitigation measures would have been implemented was also assessed. It is expected that residual impacts will be insignificant or low.

The impact significance is summed up in the magnitude of potential impact and the importance or sensitivity of the environmental and socioeconomic components that are likely to be impacted. The consequences of the project activities on the natural and socioeconomic environment; and the possibility that such activities may or have occurred are very important in determining the significance of potential impacts. Thus, the levels of impacts that may result from the proposed project activities and their significance were assessed based on the understanding of its entire environmental aspects. The impact significance assessment matrix is provided in Table 5.9.

Table 5. 9: Impact Significance Criteria for Environmental and Social Components

Impact Rating (-ve)	*Impact Rating (+ve)*	*Impact Duration*	*Impact Severity*	*Probability of Occurrence*	*Reversibility of Impact*
Insignificant		*Short term, medium term*	*Negligible*	*Less likely, likely or definite*	*Reversible*
Minor	*Minor*	*Short term, medium term or long term*	*Low*	*Likely or definite*	*Reversible*
Moderate	*Moderate*	*Medium or long term*	*Medium*	*Likely or definite*	*Reversible*
Major / High	*Major*	*Long term / permanent*	*High*	*Likely or definite*	*Irreversible or partly reversible*

The identified receptors of potential adverse impacts of the project are ambient air quality, noise level, land, soil and the biological resources of the project area. In addition, there are potential social receptors, road traffic, among others, which are likely to be negatively impacted, particularly at the pre-construction, construction and operation phases of the project.

5.3 ASSOCIATED AND POTENTIAL IMPACTS OF RAIL PROJECT

5.3.1 Potential Impacts during Pre-Construction Phase

5.3.1.1 Impacts of Land Acquisition

Impact on Protected and Designated Areas: The proposed rail line will pass through some forest reserves across the three states in Nigeria. These are Damangu Forest Reserve, Daura Forest Reserve, Dutsin Kuba Forest Reserve, Gasartani Forest Reserve, Gwiwa Forest Reserve, Nasarawa Forest Reserve and Shakwadina Forest Reserve. The Gasartani, Gwiwa Korel and Daura Forest Reserves are classified as IUCN Category IV, Dutsin Kuba is IUCN category III while Shakwadina, Damangu and Nasarawa Forest Reserves are not classified. The RoW of the rail track across these protected areas is approximately 50 metres, which is likely to impact on some important plant species and habitats. The impact significance of the project on protected area is considered moderate.

Impacts on Livelihood: There are several farmlands and grazing area within the RoW and at the proposed site of the train stations; and acquisition of these agricultural lands will eventually lead to economic displacement. The places where farmlands and grazing sites will be mostly impacted include Ajumawa. Babbar Riga, Danbatta, Gaya, Makole, Kausani, Warawa, Bachirawa, Rimin Gata, Bakin Ruwa, Dundubus, Yanzaki, and Achi Lafiya. In addition, some of the properties within the rail alignment have shops where the potentially affected persons source their livelihood. Economic displacement may result in long-term privation, impoverishment and suffering for the economically displaced persons. In turn, this may affect other aspects of their socio-economic life such as ability to provide food, clothing, shelter, education and other basic needs for dependents. The impact significance of land acquisition is major considering thousands of potentially affected individuals within the project corridor. The representative of the Kano Emirate Council expressed concerns about this potential impact and underscored the importance of handling the displacement of farmers with caution. It is a major impact considering the high sensitivity of the receptors.

Physical Displacement: Residential and commercial properties within the rail alignment will lead to physical displacement; affecting hundreds of people and families who may be forced or obliged to leave their places of habitual residence and homes. The potentially affected persons may lose their properties and assets. When displaced, proximity to their place of work, employment, farmland may be affected. The project impacts on livelihood and homes are often interrelated and the significance of this effect is a major one.

Human Rights Infringement Acquisition of land for project under the Land Use Act, which often leads to involuntary displacement and inadequate compensation may infringe on the rights of the affected persons. Many of the potentially-affected persons may not have the capacity to enforce their right or seek redress, which may affect their emotional well-being. Others who may wish to seek redress may choose non-legal means, fostering unrest, instability, which can threaten the sustainability of the project. This is a potential impact of major significance.

5.3.1.2 *Impacts of Building and Structure Demolition*

Impacts on groundwater: Demolition buildings and structures within the RoW may impact on groundwater as a result of spills of fuel, lube oil and other hydrocarbon materials from demolition equipment and vehicles. Demolition wastes are likely to contain hazardous materials, which may seep into groundwater at dumpsite if improperly managed or disposed. For example, Arsenic, Boron and Manganese are identified as contaminants of concern (COCs) from demolition debris, which can leach into subsurface water (Chiles et al., 2019). Other hazardous materials of concern in demolition debris are asbestos and polychlorinated biphenyl (PCB) with potential health risk if consumed in contaminated water. The impact significance is moderate.

Increased Noise and vibration: Demolition of buildings may lead to noise and significant vibration caused by equipment, explosives and or falling structures. Several communities along the project corridor may be impacted due to noise and vibration during the period of demolition. This can cause disturbance, stress or sleep disturbance to people in the nearby buildings, and may equally lead to structural damage of buildings in the vicinity of demolition activities in places like Kazaure, Gagarawa, Juba, among others. The impact significance is moderate.

Impact on air quality: Release of fugitive dust, which is windblown and into nearby properties, homes, vegetation, etc. is a common occurrence at demolition site. Machinery such as breakers, bulldozers, dumpers, excavators as well as haulage vehicles used for movement of demolition waste operate on diesel engines. Inadvertently, priority air pollutants such as diesel particulate matter (containing sulphate and silicates), other suspended particulates, carbon monoxide, carbon dioxide and hydrocarbons are released to the ambient air. Residents of communities along the rail project corridor are at risk of exposure to dust and other air pollutants. The impact significance is moderate.

Greenhouse gas emission: Emission of CO_2 and N_2O from demolition equipment, which are powered by fossil fuel is inevitable. In some cases, materials from demolition wastes such as household items containing fluorinated gases with high global warming potentials and methane from organic wastes are likely sources of emission. Over the long stretch of the RoW, the level of greenhouse gas emission is of moderate significance.

Impact on soil: Demolition of buildings may lead to soil degradation, soil compaction and soil contamination resulting from hydrocarbon accidentally released from machinery and equipment. The impact is moderate.

Impact on topography: Removal of physical structures, which possibly have been built and existing for decades, would significantly altered the forms and features of the area. A significantly altered topography could mislead natives or visitors who have long been absent from that locality prior to demolition of landmark structures. The impact is of moderate significance.

Impact on waste management. The volume of wastes that are likely to be generated from demolition are enormous, consisting of concrete rubble and earth materials, plastics, glass, metals, fabrics, wooden and plant materials. Due to their heterogeneity, demolition wastes can be complicated to manage. The impact of demolition on waste management is considered to be of moderate significance.

Potential employment opportunities: Demolition experts and skilled workers such as operators of breakers, excavators and other demolition equipment would have opportunities to be employed and earn income. This phase will also provide opportunities for scraps buyers and recyclers. The potential effect on employment and income opportunities is positive.

Impact on cultural heritage: Demolition of people's places of residence is beyond physical displacement and the need for proper resettlement. "When a house is demolished, more than a home is lost"- Murphy (2015). There is a strong sentiment attached to places that used to be homes for generations. The possibility of gathering under a perennial at twilight or nights cannot be ruled out. There would likely be a sense of loss of historic piece when their houses are demolished; leading to eviction of families from a community they grew up in. In the process, affected persons lose crucial footprints of their past. Growing children and geriatrics also lose their social networks when displaced from a community. The impact significance is a major one.

Impact on community health and safety: Demolition of structures may lead to unintended collapse of building in an unintended direction. Also, equipment and haulage vehicles for the exercise may accidentally hit members of the community. These may lead to fatal or life-threatening injury, permanent incapacitation or other forms of injuries. In addition, noise, vibration and air pollution arising from demolition activities may affect health and well-being of residents close to the demolition site. The impact significance is considered to be major.

Security: The security risks associated with demolition are high. Workers are at risk of being attacked by aggrieved residents whose properties are affected. In addition, the risk of being kidnapped for ransom as a construction worker is high particularly around Katsina - Jibiya – Maradi axis. The potential impact is of major significance.

5.3.1.3 Associated and Potential Impacts of Site Clearance

Noise impact and vibration: Site clearance for construction will be a medium-term activities that may may lead to noise and significant vibration caused by equipment, explosives and or falling structures. Concrete demolition generally produces continuous impulsive loading with moderate vibration intensity. However, this can cause disturbance, stress or sleep disturbance to people in the nearby buildings, and may equally lead to structural damage of buildings in the vicinity of demolition activities. In Dumawa, for example, the use of heavy machinery and equipment can generate substantial noise levels, leading to sleep disturbances, increased stress levels, and potential hearing damage among residents. Similarly, in the Gagarawa community, construction noise could disrupt daily life, particularly affecting school activities and reducing the overall quality of life. In the quiet environments of Dawan Kaya and Zuru Felele in Makoda LGA), construction activities might significantly disrupt students' concentration in schools and residents' comfort. The situation is likely to be the same In Banbara, Tsallewa, and Gwarabjawa (Danbatta LGA), both residential and agricultural areas could experience significant noise disruptions.

Further, Kazaure and Bayan Dutse (Kazaure LGA) and Sada (Yankwashi LGA) could face substantial noise pollution affecting school and religious activities, business operations, and residential comfort. Elevated noise levels in Achilafia, Korare, and Bandawa are likely and this might disrupt activities at local mosques and schools, impacting religious and educational activities. In Juba, Fego, and Sandamu (Sandamu LGA), noise from construction could disrupt local life, affecting both residential comfort and potentially local businesses. In Gurjiya, Daudau, and Mazaji (Daura LGA), significant noise pollution could affect daily activities, health services at the Nigerian Airforce Reference Hospital, and residential life.

Finally, in Mashi and Muduru (Mashi LGA), the proximity of the community to the rail track might result in high noise levels affecting residents and businesses, particularly disrupting activities at Muduru Model Primary School. Katsina Township may experience elevated noise levels from construction, impacting urban life, including schools, businesses, and homes. In Jibia, noise pollution might affect local life, including schools and businesses. Continuous community consultation and the implementation of effective noise control measures will be critical in minimizing impacts. The overall impact significance is moderate.

Impact on Air Quality: Release of fugitive dust, which is windblown and into nearby properties, homes, vegetation, etc. is a common occurrence at construction sites. Inadvertently, priority air pollutants such as diesel particulate matter (containing sulphate and silicates), other suspended particulates, carbon monoxide, carbon dioxide and hydrocarbons are released to the ambient air. Of particular concern is the dust, which could carry other toxic pollutants. Due to its proximity to the proposed rail track, residents of Gagarawa are potentially exposed to air emissions including dust that may cause respiratory issues and reduce visibility, affecting residents' health and comfort. Dawan Kaya and Zuru Felele (Makoda LGA) might experience similar impacts, with dust affecting both the health of residents and agricultural productivity. Communities like Banbara, Tsallewa, and Gwarabjawa (Danbatta LGA) face potential health issues and agricultural impacts from air pollution, especially TSP. Kazaure and Bayan Dutse (Kazaure LGA) and Sada (Yankwashi LGA) might experience degraded air quality, leading to respiratory problems.

In addition, Achilafia, Korare, and Bandawa could see air pollution including dust emissions impacting schools, mosques, and homes, leading to health and comfort issues. Juba, Fego, and Sandamu (Sandamu LGA) might also suffer reduced air quality, affecting daily residential and business activities. In Gurjiya, Daudau, and Mazaji (Daura LGA), dust could impact hospital environments, residential comfort, and local businesses. Shargalle (Dutsi LGA) could face health and comfort issues from dust. Mashi and Muduru (Mashi LGA) might experience poor air quality affecting residents, businesses, and schools. Katsina Township could see widespread health issues due to construction dust affecting schools, businesses, and homes. In addition, Kusa and Tsamga could be impacted by dust affecting residential areas and forest/grazing reserves. Jibia might face air quality issues affecting schools and businesses, leading to health problems and economic impacts. In summary, these communities are likely to face significant challenges due to dust emissions, impacting air quality, health, and daily life. The overall impact significance in every community is moderate.

GHG emissions: Also, fossil fuel-powered machines and vehicles are major sources of greenhouse gases. Land clearing is one of the project activities with potential for release of greenhouse gases, and by extension contributing to global warming. While greenhouse gases are being released from construction equipment, some parts of the vegetation which serves as carbon sink are being removed. As a result, the net carbon emission for site clearing is high. The potential for emission of GHGs and its adverse effects are of moderate significance.

Impact on soils: Plants naturally provide cover for soil against erosion apart from their roots, which keep soil in place and help retain moisture. Topsoil in particular is characterised by high biological activity, organic matter, and plant nutrients. When this upper layer of soil is removed during site clearance for construction, the soil's natural ability to provide nutrients, regulate water flow, and fight off disease and pests are eliminated. Removal of organic matter which is normally found at the topsoil increases soil density and enhances compaction; which in turn lowers infiltration rate of water and reduces the available water holding capacity. Clearing also exposes the subsoil; increasing the susceptibility of the largely loose sandy soil in the project area to erosion during rainfall. The effects include soil degradation and inability of adjacent land to effectively support crop growth. The significance of impact is moderate.

Waste impacts: Wastes generated during site clearing are enormous, and they include cleared vegetation and plant materials, earth materials, domestic wastes (plastic bottle, food wraps, styrofoam, cans, etc.) from construction workers, spent batteries and waste oil from the equipment deployed for clearing and haulage. The impact significance is moderate.

Impact on Biodiversity: Along the project corridor is a diverse array of plant species of economic and/or ecological importance, many of which are at risk of being cleared for the rail project. Among these, *Acacia nilotica* and *Adenium obesum* are locally assessed as near threatened and endangered respectively, although they have not been evaluated globally.

Similarly, *Annona senegalensis* and *Cissus populnea* hold an endangered status at the local level. Notably, *Vitellaria paradoxa* and *Pavonia senegalensis* are critically endangered locally, with the former also recognized as vulnerable globally. These species are predominantly found in locations such as Daura, Dutsin Kuba, Gasartani, and Gwiwa Korel.

The fauna within the project's area of influence, which might be displaced due to habitat destruction or fragmentation, also includes animal species of ecological importance identified in the baseline study. The Slender-snouted Crocodile and the Black Rhino are critically endangered, with the former reported in parts of Katsina. Various species of vultures, such as the Hooded, White-backed, Ruppell's, White-headed, and Lappet-faced Vultures, face critical endangerment or endangerment, Additionally, the African Spurred Tortoise, Egyptian Vulture, Bateleur, Martial Eagle, and Secretarybird are found in varying statuses from vulnerable to near threatened within the project locale, especially near the Jibiya dam area. The removal of vegetation may further impact these fauna species. Considering the landtake and size of the project, the impact of this project activity on flora species is long-term, irreversible and by extension on the animal species.

The impact of this project on biodiversity extends to impacts on grazing areas. The disruption to forest and grazing reserves across various communities could have significant environmental impacts. Additionally, areas like Banbara, Tsallewa, and Gwarabjawa in Danbatta LGA, along with grasslands in Roni LGA, may see their grasslands, woodlands, and shrublands, impacted by the project. The same could happen in locales such as Banbara, Tsallewa, and Gwarabjawa. Construction activities could also impact the grasslands in Makurda (Batagarawa LGA) and Roni LGA, including a few areas of woodlands and shrublands. Moreover, in Kazaure LGA, grasslands in Kazaure and Bayan Dutse might face disruptions due to construction, posing further challenges to maintaining ecological balance and preserving wildlife habitats. The overall impacts of the project activity during site clearing is of major significance.

Impact on protected areas and areas of conservation importance: Clearing the RoW across the forest reserves is a permanent, irreversible potential impact, which will be detrimental to biodiversity found in the protected area. A sacred forest in Niger Republic (Rinian Forest Reserve) has also been identified as a protected area under the likely influence of the project. Although no fauna species of conservation importance was encountered or previously documented, there are plant species of conservation concerns locally, which may be impacted during clearing. Also of importance is the Great Green Wall, and clearing rail route, which passes through the Great Green Wall corridor in the Jibia – Maradi axis can potentially impact on this ecological initiative. On one hand, the construction and operation of the railway could lead to habitat disruption, increased pollution, and potential interference with local wildlife, which might undermine the ecological goals of the Great Green Wall. The project activity has a major impact on the protected area.

Impact on ecosystem services: A large expanse of farmlands and vegetation across the project area, which serve as source of food, traditional medicine, forage and fuel (firewood) will be destroyed during clearing. The Rinian Forest Reserve, which is a sacred reserve providing ecosystem cultural services may be impacted as well. It is an impact of major significance.

Potential employment opportunities: Construction workers, principally operators of land clearing equipment and machinery will be engaged for the task, thereby providing people in the project area with job opportunity and positive impact on their livelihood.

Impact on community health and safety: As mentioned under demolition activities, equipment and haulage vehicles for site clearing may accidentally hit members of the community. Children are the most vulnerable due to the attraction construction site has on them. Collision with the equipment and trucks may cause death or life-threatening injury and permanent incapacitation. The potential impact is of major significance.

Impact on Grazing Route and Cultural Heritage: Grazing routes, specifically the international livestock routes connecting Nigeria and Niger Republic, may be considered cultural heritage for pastoralists in the project area. Several cattle and grazing routes will potentially be impacted by the construction activities. In Angwar Adamu and Durma, grazing routes will be affected, disrupting the movement of cattle. Similarly, cattle routes at Jugel and Lamya will face interruptions, impacting livestock herding practices. Further, cattle routes at Bangel, Musa Intu, and Kora Kauye, along with an international cattle route at Tabkin Yari, are likely to experience disturbances. Grazing routes at Tokosa Pangani, Tafasa Mera, and Danmaimaji may also be affected, potentially hindering cattle grazing activities. Stock routes at Dinkura and grazing routes at Bayan Dutse, Tsadoji Waylare, and Tsadoji Kudu are likely to face disruptions. Additionally, cattle routes at Tsintsiya and an international cattle route at Kurori, as well as the grazing route at Karahun, will be impacted, affecting the traditional cattle movement and grazing patterns in these areas. Other cattle routes in the project area such as the ones in Gwiwa and Gwiwa Korel as well as international grazing route at Fara Mokole and are close to the rail alignment. Cattle routes at Jemoni, Janli, Madaci Janli, and Dirkiji will likely be crossed by the rail line. Grazing routes will be fragmented, affecting pastoralist activities. Dr. Saleh, the Director of Kano State Stock Route, expressed regarding this during stakeholders' engagement and MACBAN highlighted the potential impacts of the project on cattle and herdsmen, emphasizing the need for careful planning and construction to minimize disruptions. Although this may impact on the livelihood of the herders, the effect is also disruption in their cultural practices. It is a major impact.

5.3.2 Potential Impacts of Construction Phase

5.3.2.1 Impacts of Materials Transport

Impact on air quality and dust: Uncovered construction materials such as sand in transit are likely to generate fugitive dust. Moreover, diesel-powered haulage vehicles generate emissions that are equally capable of polluting the ambient air. The impact significance is moderate.

Increased noise and vibration: Construction materials will be moved to site using heavy-duty vehicles and trucks, which are capable of generating noise and vibration impact on the neighbouring communities. The potential impact is moderate.

GHG emissions: Emission of greenhouse gases from haulage vehicles is a medium-term potential impact, which will last throughout the construction phase. It is of moderate significance.

Impact on traffic and transportation: A key component of construction activities, which has significant effect on the operational performance of roads, is movement of materials to construction sites. The major traffic problems will arise from additional number of vehicles accessing the site from the public road network during the project's construction phase. The traffic surge will be necessitated by the delivery of equipment, materials and construction work force travelling on a daily basis to and from the project site. The volume and frequency of traffic will fluctuate from time to time over the construction period depending on the construction activities taking place at the time. Deliveries of materials may involve hundreds of large-sized vehicles per week. Some delays may be experienced by local residents in particular road users (drivers of smaller vehicles and motorcyclists) due to slow movement of oversized delivery trucks plying the connecting roads. The likely increase in the number of heavy-duty vehicles using the road has the potential to aggravate any deteriorating portion of the roads. The anticipated temporary increase in construction traffic and possible closure or diversion may cause delays and congestion for road users and has a severe effect for other road users. The traffic impact due to additional vehicular activities will be moderate relative to the low daily traffic volumes in the area, particularly in places like Kazaure, Daura, Juba, etc. The potential impact is of major significance.

Potential employment opportunities: Truck drivers, procurement specialists, merchants of construction materials and others associated with this phase will have opportunity for employment. Its impact is positive.

Community Health & Safety: The risk of accident, involving trucks and members of the communities are high. Road accident may lead to death or serious injury. It is a potential impact of major significance.

5.3.2.2 Impacts of Earthworks

The potential impacts of earthworks on topography, biodiversity, ecosystem services and protected area are of minor significance. As a result, the following potential impacts, which are of moderate and major significance, are considered.

Impact on surface water: Earthwork activities often expose land surfaces and increase the possibility of sediment loads, which are discharged to water bodies beyond normal levels. This can result in significant adverse effects on receiving aquatic environments, especially at the points where rail track will cross water bodies. An increased sediment load discharged to watercourses can adversely affect surface water quality and the aquatic ecosystem. Although the activity is temporary, it may have a prolonged or lasting effect on the aquatic ecosystem. The impact significance is considered moderate.

Flooding: Earthworks are likely to create land instability and flooding. Filling some sections of an overland flow path is likely to obstruct runoff and worsen flooding upstream, potentially enlarging the area affected by inundation. The impact significance is moderate.

Noise and vibration effects: Noise and vibration usually accompany earthworks and the effects would be more in built-up areas and rural communities close to the worksite. Elevated noise level and vibration can lead to stress and sleeplessness for human receptors. The impact is short-term but of moderate significance.

Impacts on air quality and dust: Dust from earthwork activities can have a potential effect on adjacent private or public. The level of dust generated by earthworks is dependent on soil characteristics, excavation method and prevailing weather condition. Also, movement of excess earth materials off-site may lead to emission of air pollutants such as CO, CO_2, NOx, etc. as well as fugitive dust if the haulage trucks are uncovered in transit. All the vulnerable nearby communities that are potentially exposed to the impacts of demolition and site clearance are exposed to similar impacts of dust emission and air pollution resulting from earthworks. The impact significance is moderate.

GHG emissions: Emission of greenhouse gases is a possibility during the operation of construction machinery used for earthworks and trucks that will handle the movement of excess earth materials off the construction site. The impact is of moderate significance.

Impact on soils: Excavation and removal of soil from one area to another have the potential to change the underlying landform of the project area. Erodibility of the impacted soil is increased, and soil at and or around the construction site can become polluted due to accidental spill of hydrocarbons used as fuel and lubricants used in machinery. The impact significance is moderate.

Seismic impact: Seismic effects are caused by extensive earthworks, which may affect nearby buildings. The potential impact is of moderate significance.

Waste management: Earth materials are the most voluminous waste from earthworks, which can be challenging to properly manage. Other waste materials include spent batteries, and domestic waste (food packs, cans, plastic bottles) generated by workers on site. The overall impact of wastes from earthworks on waste management is of moderate significance.

Employment: Skilled, semi-skilled, and unskilled workers have temporary job opportunities to carry out the task. Operators of excavators and other construction equipment will have opportunities to earn considerable income to enhance their livelihood.

5.3.2.3 Impacts of Access Road Construction

Impact on surface water: Road construction comes with attendant spills of hydrocarbon materials, which are likely to be carried by run-off to waterbodies down the slope. Siltation of water bodies may result from suspended earth materials (from impacted soil) in run-off. Water from ponds will be exploited during road construction, and the possibility of pollution or over-exploitation is present. The impact significance is moderate.

Impact on groundwater: The potential impact of road construction on groundwater is moderate. Seepage of hydrocarbon from the construction area to nearby underground water source is a major source of project impact on groundwater.

Flooding: Construction of access road may result in obstruction of run-off due to likely filling of some sections of an overland flow path is likely to obstruct runoff and lead to flooding of adjacent land. The impact significance is moderate.

Noise and vibration: Construction equipment generate noise and vibration that could reach a disturbing level for residents and people near along the proposed access roads to the train stations. The overall impact significance is moderate.

Impact on air quality: Emission of air pollutants and dust are associated effects of road construction. The impact significance is moderate.

GHG Emissions: Release of greenhouse gases such as methane, CO_2 and N_2O is an associated impacts of access road construction, which of moderate significance.

Impacts on soils: The likelihood of adverse effects of road construction includes erosion, compaction and contamination due to accidental spill of hazardous substances used in construction. The impact is of moderate significance.

5.3.2.4 *Impacts of Rail Tracks Construction*

Rail track is one of the most critical components of rail infrastructure, and this entails production of precast reinforced concrete slabs, installation and fastening of steel rails. These are preceded by grading of the rail route and construction of drainage system to prevent waterlogging. Activities relating to rail tracks construction have some potential impacts on surface water, groundwater, air quality, soil, geology, water resources, security (moderate); Community safety and security (major); employment (positive)

Impact on surface water: There are surface water bodies over which the rail tracks will cross. Construction activities near and at these locations are likely to lead to unintentional release or accidental spill of hazardous construction materials capable of polluting or contaminating surface water. Furthermore, siltation of the water bodies is a likely occurrence during rainy season as construction materials (such as sand and cement) may be carried by runoff during rainfall. Moreover, surface water bodies along the route have been identified as a major source of water for the project at the construction phase. Exploitation of the surface water may lead to impacts such as accidental contamination, depletion (during dry season); and these effects can further adversely affect aquatic organisms. Surface water along the project corridor serves as source of domestic water for the people and livestock. The impact significance is moderate.

Impact on groundwater: Construction during dry season may lead to sourcing of water from underground for production precast concrete slabs. The volume of water for this activity may significantly affect the aquifer considering the vulnerability of the project area to drought, water scarcity and prolonged dry season. The significance of potential impact is considered moderate.

Impact on air quality: Emission of air pollutants and dust occurs at the concrete slab production yard affecting the ambient air. Fugitive dust from production materials and emissions from fuel-powered machines used for the production and conveyance of the slabs to the point of use are possible sources of impacts on air quality. The potential impact is of moderate significance.

Impact on soil: Grading of the planned rail route prior to installation of pre-cast slabs and steel tracks can affect the soil adversely. Possible sources of impacts include pollution resulting from accidental spill of hazardous materials and soil compaction or exposure to agents of erosion. The impact significance on soil is deemed moderate.

Impact on community safety and security: The risk of accidents involving members of a local community during construction has been acknowledged as an issue of concern that cannot be downplayed. Performance Standard 4 seeks to protect the public in the project host communities from the potential threat to their health, safety and security. Construction activities at a site are characterised by increased vehicular movement in and out of the site, which have inherent risks to the people. Machineries and equipment generally attract children, and they are prone to stand close to the site and observe with excitement. Vehicles and construction equipment may be reversing or manoeuvring and children are the most vulnerable to construction site hazards. In addition, the likely increase in traffic situation in the area may result in accident involving members of the public, which may lead to fatal injury, or permanent incapacitation. Grading and construction of drainage system during tracks construction are likely sources of impacts. This is a potential impact of major significance.

Potential employment opportunities: Construction of rail tracks provides enormous job opportunities for a wide range of skilled and unskilled workers; and these include civil engineers, electrical engineers, railway engineers, operators of construction equipment, truck drivers, etc.

Occupational hazards and safety: The IFC Performance Standard 2, among other issues on the protection of workers' fundamental rights, underscores the possibility of this risk and the need to protect workers from them. Apart from fatigue and other minor work-related risks, there are major occupational hazards during construction. Construction sites are associated with diverse job hazards with high level of risk to workers. The probability of being hit by project vehicle or mobile construction equipment is real. Hazards involving vehicles and heavy-duty equipment may occur during arrival or departure of vehicles, loading and unloading, mounting and dismounting from vehicles, and when operators are attempting to reverse or manoeuvre the equipment. Other hazards include fall from height (particularly during construction of overhead bridges across waterbodies or roads), being hit by hard or falling object, etc., all of which may result in minor or major injury, permanent incapacitation or death of the worker(s). Permanent incapacitation or death has an extended impact on the family of the affected workers, such as prolonged period of grief and economic hardship for dependents. The impact severity is high and of major significance.

Security risk: Construction workers, particularly expatriates, are key targets of kidnapping. Construction rail tracks which will pass through some isolated areas such as forest reserves and other isolated areas can predispose the workers to the risk of being kidnapped for ransom. The Katsina – Jibiya axis of the proposed route has been identified as a place of high security risk due to its proximity to Zamfara State where bandits (recently classified as terrorists) have been operating. The risk is high and the potential impact is of major significance.

Labour and Working Condition: In a bid to get cheap labour, contractors may circumvent best practices on Labour and Working Condition by engaging minors (children less than 18 years old). There are also a risk of forced labour or poor working conditions and people working with no personal protective equipment (PPE) or with substandard ones.

5.3.2.5 Impacts Associated with Construction of Train Stations

The potential impacts associated with construction of the proposed train stations are mostly similar to likely environmental impacts and inherent risks of construction activities previously highlighted under the potential impacts of rail tracks construction. In addition to the impacts and risks earlier mentioned, the risk of electrical hazards such as electrical shock and electrocution is worthy of note. Welding and related activities involving use of electricity and electrical equipment during construction of the train stations are sources of occupational hazards or safety risks to the public. The risk of a fall from height is also high during construction of the train stations. The significance of all impacts on the environmental and social receptors in the project area are similar to the impacts already discussed.

5.3.2.6 Impacts Associated with Use of Borrow Pits

Impact on groundwater*:* Borrow pits are likely to be contaminated by hydrocarbon materials from equipment accidentally spilled or deliberately discarded at the borrow sites by workers. Some workers urinate and openly defaecate on borrow site, and when the site is eventually abandoned, it becomes an illegal dumping site for all kinds of waste materials. Rainfall accelerates seepage of pollutants in borrow pit into the groundwater thereby adversely affecting its quality. The impact severity is medium and of moderate significance.

Impact on air quality and dust: Excavation at the borrow site generates significant level of suspended particulates while excavator and haulage vehicles emit air pollutants. The impact severity is medium and of moderate significance.

Impact on *flora* and *fauna:* Opening new borrow pits may likely impact on vegetation at the site, and by extension impact on habitats. Animals are also likely to fall into borrow pits if unprotected. The impact significance is moderate.

Potential employment opportunities: Operating borrow pits provides job opportunities to operators of bulldozers, excavators, payloaders, and truck drivers who will be engaged for sourcing earth materials for the rail project. This is a positive potential impact.

Impact on community health and safety: Movement of vehicles to and from the borrow sites poses risks of accident to members of the nearby communities. The possibility of accidental fall into borrow pit (especially if sliding occurs) or drowning in a water-filled pit during wet season is a high risk to people nearby. Stagnant water in borrow pits often turn foul and inadvertently become breeding ground for debilitating disease vectors. Another community safety concern is the likelihood of turning borrow pits as hideouts for criminal gangs, who may unleash terror on the communities unaware. The impact severity is high and of major significance.

Geological impacts: Landslide, which has been previously reported in some parts of Katsina, is a geological event, that results from groundwater movement, and this is common in abandoned and active borrow pits. This is often triggered by prolonged rainfall, poor design of mine pits and negative slope. The impact of borrow pits on the geology of the proposed borrow sites is of moderate significance.

5.3.2.7 Impact of Quarry Operations

Impact on Air Quality and Dust**:** In quarry locations such as Dawan-kaya, Tsadoji, Kunchi, Katsina, Gano, Kayauki, and others where the quarry is identified as a source of ballast for the project is located, excavation and quarry activities generate significant levels of suspended particulates, impacting air quality. The operation of excavators and haulage vehicles emits air pollutants, further degrading local air quality. These activities pose moderate health risks to nearby communities due to the inhalation of dust and pollutants. The severity of this impact is medium, with moderate significance.

Noise and Vibration: Quarry operations will generate significant noise from blasting, crushing, and transporting materials, affecting nearby settlements in Dawan-kaya, Tsadoji, Kunchi, Katsina, Gano, Kayauki and adjoining communities. Regular blasting operations can create significant noise, disturbing residents' peace and well-being and disrupting local wildlife. The vibrations from blasting can also damage nearby structures, including homes and schools, posing safety risks. The impact severity is medium, and the significance is moderate.

Impact on Groundwater**:** Quarry operations may lead to the contamination of groundwater. Hydrocarbon materials from equipment can accidentally spill or be deliberately discarded by workers at the quarry sites. Additionally, workers' urination and open defecation at these sites can further degrade groundwater quality. Abandoned quarry pits often become illegal dumping sites for various waste materials, and rainfall can accelerate the seepage of pollutants into the groundwater, adversely affecting its quality. The severity of this impact in these communities is medium, and its significance is moderate.

Impact on Flora and Fauna: In regions such as Dawan Kaya and Tsadoji, the opening of new quarry pits can significantly impact local vegetation, disrupting habitats and ecosystems. Vegetation at quarry sites is often cleared, leading to habitat loss for various species. Additionally, animals are at risk of falling into unprotected quarry pits, which can result in injury or death. The impact on flora and fauna in these areas is of moderate significance.

Potential Employment Opportunities: Operating quarry pits in communities like Dan Issa and Maradi presents positive potential impacts by providing job opportunities. Operators of bulldozers, excavators, payloaders, and truck drivers will be engaged in sourcing granite ballast for the rail project. These employment opportunities can stimulate local economic activity and improve livelihoods in these areas.

Impact on Community Health and Safety: The movement of heavy vehicles to and from quarry sites poses significant risks to community health and safety. The increased traffic raises the likelihood of accidents involving local residents. There is also a high risk of accidental falls into quarry pits, especially during the wet season when pits may fill with water, posing a drowning hazard. Stagnant water in these pits can become breeding grounds for disease vectors, contributing to public health issues. Additionally, abandoned quarry pits may become hideouts for criminal gangs, posing a security threat to nearby communities. The severity of these impacts is high, and their significance is major.

Geological Impacts: Quarry operations in areas like Dawan Kaya and Tsadoji can result in geological events such as landslides, often triggered by groundwater movement, prolonged rainfall, poor pit design, and negative slopes. These events can cause significant disruptions and damage to the local landscape. The impact on the geology of the proposed quarry sites in these communities is of moderate significance.

5.3.2.8 *Impact of Material Lay Areas*

Material lay areas for the project, which will be used for storing and managing construction materials though necessary for logistical efficiency, can cause several environmental and social impacts in the areas used for such activities.

Contamination of Water Resources: Runoff and leachate from stored materials can introduce hazardous chemicals, metals, and other pollutants into the nearby water bodies, especially at the Kazaure material lay area and groundwater sources at the site. The significance of this potential impact is considered moderate.

Air Pollution: Dust generated from handling materials like cement, sand, and aggregates can elevate particulate matter levels in the air, affecting local air quality and community health. Wind can exacerbate this effect by dispersing dust and particulate matter generated from stored materials storage and handling; particularly during the dry season and Harmattan period in the project area. The impact on residents of the project communities. where the lay areas are located, is moderate.

Noise Pollution: Activities such as loading and unloading materials can contribute to the overall noise pollution resulting from construction activities as extensively discussed in the previous section. The potential noise pollution from the lay areas is minimal.

Traffic Impacts: The increased vehicular movement to and from the lay areas is likely to lead to increased traffic on the adjoining roads such as Daura-Dumawa Road leading to the site with elevated risks of vehicular accidents. The significance of the impact could range from moderate to major, particularly if the traffic impacts lead to fatality or serious injuries.

Visual Impact: Large, exposed material lay areas can detract from the aesthetic quality of the landscape of the communities, impacting visual amenities for local communities near the material lay areas. This impact is considered minor

5.3.2.9 *Impacts of Workers Encampment*

Waste management: Major environmental problem that is likely to arise from workers encampment is solid waste generated from the camp. Most wastes from workers campsite are domestic wastes; food waste and food packaging containers, paper waste, discarded rags and fabrics, glass, plastic bags and nylons. In addition to solid wastes from campsites are liquid waste of domestic nature. This includes wastewater from kitchen, laundry, toilet and bathroom. Without proper waste management, the potential impact of campsites concerning waste is significant although it is considered moderate.

Impact on groundwater: Thousands of workers across the planned three (3) campsites for the rail project will depend on groundwater for domestic purposes. The daily water requirement of the workers and over the period of construction is significant. In addition, wastes from the campsite is capable of contaminating the soil around the site and seep into the groundwater. The impact is of moderate significance.

Employment and economic opportunities: Experts build Construction campsites, and this provides employment opportunities in particular for skilled labourers. Campsites typically attract people from nearby communities who engage in petty trading. Conversely and if the campsite is protected from visitors, workers go out to the host communities to purchase household items and basic domestic needs. As a result, commercial activities of adjacent settlements are improved; providing for the people additional or improved means of livelihood while the construction activities lasted.

Impact on community health and safety: Construction activities and encampment of workers are transient in nature. The possibility of some construction workers to indulge in indiscriminate sexual activities cannot be totally ruled out. Due to poor orientation and low level of education of some unskilled or semi-skilled construction workers, they are likely to engage in precarious sexual activities with some female residents in the project area. This unsafe behaviour might pre-dispose them and their sex partners to sexually transmitted infections (STIs). Infected workers can also infect other sex partners. STIs such as human immunodeficiency virus (HIV) and human papillomavirus (HPV) could be life threatening; and could progress to life-long chronic disease conditions such as AIDS and cervical cancer. Due to incurable nature of some of these infections, the effect of indiscriminate sexual activities of construction workers could be permanent. The impact is of high severity and major significance.

Security Impact: The likely effects of campsite on the security of the host communities are interrelated to community health, safety, and rights violation. Conflict between construction workers or their armed security personnel and members of the communities is likely. Use of excessive force by security officers guarding the campsite may lead to residents' (human) right abuse. This may be a threat to the security of both the members of the communities and the construction workers if conflict is escalated without amicable resolution. This is a high severity impact of major significance.

Workers Safety: Campsites minimise the risk associated with daily movements of workers to and from their places of residence. A fenced campsite that is well guarded ensures the safety of workers.

5.3.2.10 Impacts of Construction Waste Disposal

Construction wastes consist of a wide range of waste materials ranging from non-hazardous domestic wastes to debris and hazardous materials. Improperly managed construction waste can lead to soil contamination, significant impact on groundwater and adjacent water bodies. The huge volume of construction waste that is likely to be generated from this project would require high volume of traffic. Trucks would be used to move waste to dumpsite would temporarily impact the traffic of adjoining roads. Moreover, waste evacuation will lead to emission of air pollutants from trucks and evacuation equipment. Fugitive dust is likely to be generated during waste evacuation, especially during movement of trucks to the dumpsite. The likely overall impact of construction waste disposal is of major significance.

5.3.2.11 Impacts Associated with Completion of Construction Phase

At the end of construction phase, hundreds of construction workers will be out of job, which will adversely affect their livelihood. The domino effect extends to dependents and families of the workers. Additionally, there will be a major change in the demographics as migrant workers depart the communities and return to their places of residence. The overall effect is of major significance.

5.3.3 Potential Impacts of Operation and Maintenance Phase

5.3.3.1 Impacts of Rail Operations (Train movement)

Impact on groundwater: Water for domestic use by passengers and crew members at the train lavatories will likely be from groundwater sources regularly pumped into train water storage tanks. The volume of water required for each trip is expected to be high considering the possible high number of passengers per trip. The water demand will last through the lifetime of the project, which is considered to be of major significance.

Wastewater: Wastewater generated on board the rail will be commensurate with the volume of water used by passengers and crew.

Noise level and vibration: Noise and vibration are generated during train movement and braking because of contact between train wheels and rail tracks. Noise may also come from traction generated by train engine and cooling fans. Sensitive receptors who are exposed to repetitive noise and vibration are human settlements adjacent to the rail tracks and train stations. The potential impact is of major significance.

Solid waste management: Passengers will generate a significant volume of waste on board, which will require proper management from time to time. The overall probable impact is of moderate significance.

Traffic and transportation: With an estimated passengers of over 4,600 per day and freight volume of about 2,600 tonnes, train operations will service three state capitals and other major cities and towns which include Dutse, Kano, Dambatta, Kazaure, Daura, Mashi, Shargalle, Katsina, Jibiya and Maradi. Larger quantities of goods and passengers will be moved across the three northern states and the neighbouring Republic of Niger at a reduced travel time and lower cost.

Economic Impacts: The economic impact of the project is connected to the potential benefits associated with high volumes of passengers and goods that will be transported daily in the region. This is a major potential benefit of the rail project.

Risk of accident: Accidents involving train and motor vehicles, particularly at level crossings (rail-grade road intersections), have been reported globally. In some instances, pedestrians including children have been fatally injured by moving trains when they strayed into rail tracks. The Kano-Maradi will cross many roads including Birnin Mutum-Kanya Baba-Miltara Road in Minjibir LGA and Roni-Gwiwa Road in Gwiwa LGA. This poses high risk of accident such as collision with vehicles or straying children. Train accident may also result from derailment, which can lead to fatal or severe injuries for passengers and members of the public at the scene of accident. The potential impact severity is high and of major significance.

Potential employment opportunities: The operation phase of the project will open job opportunities for members of the public as train crew members. Train crew includes train engineers, guards (conductors), clerks, medical personnel, brakemen, firefighters or safety officers. This is a long-term career opportunity, in particular for Nigerians and Nigeriens, and it is a major potential benefit of the rail project during operation.

Security: The risk of attack is generally inherent in the movement of passengers and goods. Train may be a target of attack by armed criminal gangs with intent of kidnapping or robbing passengers. At night, female passengers to and from stations are potentially at risk of being attacked. The impact is of major significance.

Impact on livelihood of road transporters: The availability of rail transportation as an alternative mode of movement, which is cheaper, safer and more reliable, will impact on interstate transporters. Most passengers will abandon road transportation for train, and the source of livelihood of the road workers will be greatly impacted. This is an impact of major significance.

Impact on workers' safety and health: Workers are at risk of accident largely for those who work near moving train. Technicians working on faulty train facilities are at risk of trips, fall and electrical hazards. They are also at risk of being assaulted in the course of their duties by aggressive passengers. In instances where train accidentally hits a pedestrian or a suicidal person, train crew may suffer long-term trauma or guilt with severe impact on their mental health. The impact severity of train operations on workers safety is high and of major significance.

Transboundary Impacts: There are actions, activities and events associated with the project which may result in some impacts beyond the frontier of Nigeria in the Republic of Niger and vice-versa. This is a problem that is often faced by landlocked, developing countries (such as the Republic of Niger), which as a result of their geographical disadvantage face specific challenges in their attempts to integrate into the global trading system, mainly because goods coming from or going to a landlocked country are subject to additional trade barriers such as lengthy border-crossing procedures

(Woodburn et al., 2008). Illegal migration into and out of the two countries involved in this project is also a potential risk associated with the project. This poses key security risks to the countries.

5.3.3.2 *Impacts of Rail Operations (Train Station)*

Impact on groundwater: The volume of water used daily by passengers and staff at train station is high. The major water requirement is at lavatories, and the planned source of water for the train stations is groundwater (borehole). The likely high level of water demand at train stations will last through the lifetime of the project, and this is considered to be of major significance.

Wastewater: Wastewater generated at the station requires treatment before safe discharge. Wastewater will be commensurate with the water used by passengers and staff members at the station. The potential impact is of major significance.

Solid waste management: Passengers and staff will generate a substantial volume of waste, which will require proper management from time to time. The overall probable impact is of moderate significance.

Traffic and transportation: Traffic is typically impacted at road-rail crossings in the absence of bridges and tunnels. Vehicles are temporarily stopped from crossing whenever train is approaching level crossing, and this occasionally leads to traffic snarl although temporary.

Economic Impacts: The economic impact of train station is linked to commercial activities at and around train stations. Traders, shop owners and transporters will potentially benefit by providing goods and services to passengers and workers at the stations. This is another important potential benefit of the rail project.

Employment opportunities: Opportunities for jobs and career opportunities at the train stations for hundreds of people are some of the major benefits associated with the project during the operation phase. Each of the proposed 15 stations would require station manager and support staff, electrical engineers and technicians, cleaners, guards, pointman, tickets controllers, train dispatchers, and other support staff,

Workers' safety: Electrical technicians and maintenance engineers are exposed to electrical hazards such as high voltage at the train stations during repairs. The risk of fall from height during maintenance is real. In addition, ticketing officers at the train stations are at risk of armed robbery attacks, which could result in long-term trauma, severe or fatal injuries. The impact severity of train operations on workers safety is high and of major significance.

5.3.3.3 *Impacts of Fuel Storage*

The likely effects of fuel storage include contamination of soil with hydrocarbon materials, which may seep into the aquifer. Fuel storage facility poses a high risk of fire accident, and this may lead to destruction of lives and properties. Fire and explosion hazards are further discussed under the project risk in sub-section 5.3.5.3.

5.3.4 Cumulative Impacts

Cumulative impacts are impacts which result from the successive, incremental, and/or combined effects of an action, project, or activity (developments) when added to other existing, planned, and/or reasonably anticipated future ones. Thus, the major environmental and social impacts are often the result of cumulative impacts from a large number of activities that are for the most part individually insignificant. The importance of understanding the cumulative environmental and social impacts from infrastructural development projects and related activities over an extended period of time located in the area is worthy of note. According to Clarke (1994), the most ecologically devastating environmental effects and subsequent social consequences of development may result not from the direct effects of a particular action, project, or activity but from the combination of existing stresses and the individually minor effects of multiple actions over time.

The following cumulative impacts have been identified:

1. The Federal Government of Nigeria, through the Highway Development Management Initiative (HDMI) - Value Added Concession (VAC), is planning to concession some federal highways in Nigeria. Part of the roads includes the Shuwari (Jigawa State) – Wudil (Kano State) – Katsina highway. The initiative entails the expansion of the existing road, which affects some properties already marked for demolition. Some of the properties are residential; some are institutional while others are for commercial purposes such as fuel service stations, shopping complex and markets. The proposed rail project, with alignment close at some points to the Shuwari – Kano Road, will further contribute to physical displacement and impacts on livelihood along the axis. Other environmental impacts the road expansion and rail project will cause include increased impacts on environmental resources, vegetal loss, air emission and impact on the microclimate of the region.
2. The Great Green Wall project, aimed at combating desertification and promoting sustainable land management in northern Nigeria, faces several challenges due to existing human activities in the project area. As observed during baseline data gathering, farmers in the project area often clear vast land for agricultural purposes using slash-and-burn techniques in many cases. This practice has contributed to deforestation and loss of vegetation cover, which undermines the objectives of the Great Green Wall project. In addition, extensive grazing by livestock, particularly cattle, goats, and sheep, is another widespread practice in the project area. The high grazing pressure reduces vegetation regrowth and increases desertification risks. In addition, a significant portion of the rural population in the project area relies on wood as a primary fuel source for cooking and heating. Over-harvesting trees for fuelwood put the Great Green Wall at risk. These are existing impacts on the Great Green Wall, which the proposed rail project might exacerbate.

5.3.5 Project Risk and Hazard Assessment

Risk assessment is the process where hazards (menacing situations, processes and activities) are identified, and the risks associated with the identified hazards are evaluated to determine the best approach for their elimination or control. The main objective of risk assessment is to create a safe, healthy work environment by eliminating or guarding against identified hazard or reduction in the level of its risk by adding precautions or control measures, as necessary. The proposed project and project activities have inherent hazards and risk which require mitigation measures.

IFC Performance Standard 2 underscores the need for a safe and healthy work environment taking into account intrinsic risks associated with working in a particular sector and definite types of hazards with respect to the project. The performance standard strongly suggests the need to prevent, by elimination or reduction, as much as practicable, the potential causes of accidents and injuries associated with or that may occur in the course of work. Accordingly, it is imperative to first identify and evaluate the risks associated with the project; though some of these hazards have been mentioned earlier. The risk assessment matrix developed for evaluation of potential risk and consequences is presented in Table 5.10.

Table 5. 10: Occupational Risk Assessment Matrix

Probability of Occurrence	Severity				
	Insignificant 1	Minor 2	Moderate 3	Major 4	Critical 5
Almost certain (5)	Medium	Medium	High	Very High	Very High
Very Likely (4)	Low	Medium	High	Very High	Very High
Likely (3)	Low	Medium	Medium	High	High
Unlikely (2)	Low	Low	Medium	Medium	High
Rare (1)	Low	Low	Low	Low	Medium

5.3.5.1 Definitions for Probability of Occurrence

- Rare - Probability of occurrence is 2% (1 in a 50 chance; the risk/hazard event is expected to occur at least once in fifteen years)

- Unlikely - Probability of occurrence is 5% (1 in a 20 chance; the risk/hazard event is expected to occur at least once in ten years)

- Likely - Probability of occurrence is 10% (1 in 10 chance; the risk/hazard event is expected to occur at least once in three years)

- Very likely - Probability of occurrence is 20% (1 in 5 chances; the risk/hazard event is anticipated to occur at least once per year)

- Almost certain - Probability of occurrence is 50% (1 in 2 chances, the risk/hazard event is projected to occur more than once per year)

5.3.5.2 Definitions for Risk Severity

Potential severity of harm – When establishing potential severity of harm, information about the relevant work activity should be considered, together with:

1. Insignificant - No injuries (however, controls may be maintained to avoid it)

2. Minor – slight injuries, minor bruises or cut, irritation, temporary discomfort (requires first aid treatment)

3. Major – minor fracture, sprains, dislocation, prolonged illness; all requiring medical attention. The risk reduction measures should be put in place within a defined period. Arrangements should be made to ensure that controls are maintained

4. High – Severe or multiple injuries, major fracture, burns, partial disablement; requiring advanced medical attention. Risk reduction measures should be implemented immediately or consideration should be given to suspending or restricting the activity until safety is guaranteed.

5. Critical or catastrophic – Permanent incapacitation or death. This is unacceptable, risk control measures are necessary so that the risk is reduced to a tolerable or acceptable level. It becomes necessary to suspend any or all activities that may lead to catastrophic consequences until risk reduction/ elimination measures are put in place.

5.3.5.3 Project Specific Risks and Hazards

The potential risks and hazards associated with the construction and operation of the proposed rail project:

Fire and Explosion

Fire could result from static electricity, faulty electrical installations and equipment as well as careless handling of electrical appliances at the station. Overheating of electrical appliances which may result in ignition of combustible wire insulator are also potential sources of electrical fire. Outbreak of fire can deteriorate to precarious situations that may endanger lives and properties within the immediate vicinity of the fire incidence. The overall risk is critical, which requires appropriate mitigation measures.

Electric Shock / Electrocution

Electrical hazards represent a severe, common work-related danger faced at work place. Virtually all workers are exposed to electrical energy during the performance of their daily duties and some are oblivious of the potential electrical hazards in their work environment. Hazards occur as a result of electrocution from direct contact with high-voltage electricity. The leading cause of accidental contacts may be during the use of heavy-duty equipment (cranes, drill rigs, etc) for construction near an energised power distribution line. Workers may also be exposed to electrical hazards from electrical circuits during installation and maintenance. Electrocution at workplace is generally uncommon, and the probability of occurrence is less likely. The severity of risk is critical and may result in major injury such as burns or death.

Fall from Height

Falls are one of the greatest hazards on construction site, which normally result in a significant number of injuries and accounting for about 15% of all work-related deaths. According to OSHA, total deaths from falls annually are over 800 and more than 50% of this figure occurred during construction activities. The risk factors include working at an elevated slope or an uneven elevation, jobs involving grease or fluid, intensity and speed, or physical health condition of the worker. The severity of injuries is generally proportional to the elevation at which falls occur, and also on the surface features of the point of impact. Fall may occur while constructing bridges over roads, valleys and water bodies or at the roof top level during construction and maintenance of train stations. The probability of the hazards occurring is considered to be likely while its severity ranges from minor to critical (may lead to minor injury, major injuries, and in rear cases incapacitation or death). The overall significance is rated high.

5.3.6 Summary of Potential and Associated Impacts

The summary of potential project impacts and impact significance is presented in Tables 5.11, 5.12 and 5.13.

Table 5. 11: Pre-construction Project Activities and Impact Significance

Project Phase	Project Activity	Impact Description	Positive	Negative	Direct	Indirect	Short Term	Long Term	Reversible	Irreversible	Legal	Risk	Frequency	Importance	Public Perception	Total	F+I	Impact Sig.
Pre-Construction	Land acquisition for RoW and train stations	Economic and physical displacement		*	*			*		*	5	5	3	5	5	23	8	H
		Impacts on human rights									5	5	3	5	5	23	8	H
	Mobilisation of personnel, equipment and materials to Site	Impact on air quality and climate		*	*		*		*		0	3	1	3	3	10	4	M
		Influx of demographics		*	*		*		*		0	3	1	1	1	6	2	L
	Site preparation and clearing	Impact on air quality and Climate		*	*		*		*		0	3	3	3	3	12	6	M
		Noise and vibration		*	*		*		*		0	1	3	3	3	10	6	L
		Impact on soil		*	*		*		*		0	3	1	3	1	8	4	L
		Impact on groundwater		*	*		*		*		0	1	1	1	1	4	2	L
		Impact on surface water		*	*		*		*		0	1	1	3	1	6		
		Impact on biodiversity (loss of vegetation and habitat destruction)		*	*		*		*		0	1	1	1	1	4	2	L
		Local job opportunities, increased commerce and skills transfer	+								+	+	+	+	+	+	+	+
		Traffic Impact (obstruction and road accident)		*	*		*		*		0	1	1	1	1	4	2	L
		Impact on workers' health and safety		*	*			*		*	0	5	3	5	5	18	8	H

Table 5. 12: Construction phase and impact significance

Project Phase	Project Activity	Impact Description	Positive	Negative	Direct	Indirect	Short Term	Long Term	Reversible	Irreversible	Legal	Risk	Frequency	Importance	Public Perception	Total	F+I	Impact Sig.
Construction	Civil works, excavation, Construction of the rail tracks and train stations) installation of equipment and facilities)	Impact on community health and conflict		*	*			*		*	0	5	3	5	5	18	8	H
		Influx of workers		*		*	*		*		0	3	1	3	3	10	4	M
		Impact on air quality and Climate		*	*			*	*		0	3	1	3	3	10	4	M
		Noise and vibration		*	*		*		*		0	1	1	3	3	8	4	M
		Impact on land and soil		*	*		*		*		0	3	1	3	1	8	4	M
		Impact on groundwater		*	*		*		*		0	3	1	3	3	10	4	M
		Impact on surface water		*	*		*		*		0	3	1	3	1	8	4	M
		Impact on biodiversity (loss of vegetation and habitat destruction)		*	*			*		*	0	5	1	5	3	4	2	L
		Local jobs opportunities, increased commerce	+															+
		Traffic Impact (obstruction and road accident)		*	*			*		*	0	3	3	5	3	14	8	H
		Impact on construction workers (fall from height, injuries)		*	*			*		*	0	5	3	5	5	18	8	H
		Waste Impact		*	*			*	*		0	1	3	3	3	10	6	M

Table 5. 13: Operation and maintenance phase and impact significance

Project Phase	Project Activity	Impact Description	Positive	Negative	Direct	Indirect	Short Term	Long Term	Reversible	Irreversible	Legal	Risk	Frequency	Importance	Public Perception	Total	F+I	Impact Sig.
Operation and Maintenance	Train operation and maintenance activities	Impact on community health and conflict		*	*			*		*	0	5	3	5	3	16	8	H
		Influx of migrant workers, traders and job-seekers to communities adjacent the train stations		*		*	*		*		0	3	1	3	3	10	4	M
		Impact on air quality and Climate		*	*			*	*		0	3	1	3	3	10	4	M
		Noise and vibration		*	*		*		*		0	1	1	3	3	8	4	M
		Impact on land and soil		*	*		*		*		0	3	1	3	1	8	4	M
		Impact on groundwater		*	*		*		*		0	3	1	3	3	10	4	M
		Impact on biodiversity		*	*			*			0	1	1	1	1	4	2	L
		Local jobs opportunities, increased commerce	+															+
		Skills transfer to locals	+															+
		Traffic Impact		*	*			*		*	0	3	3	5	3	14	8	H
		Impact on workers (occupational hazards injuries, etc)		*	*			*		*	0	5	3	5	5	18	8	H
		Waste Impact		*	*			*	*		0	1	3	3	3	10	6	M
		Transboundary Impact and threat to national security																
		Impact on public safety and health																

6.0 CHAPTER SIX: MITIGATION MEASURES

6.1 INTRODUCTION

Impact mitigation is an all-important stage of the EIA process when practicable measures are identified to completely avoid, minimize to an acceptable level or remedy all the adverse impacts and enhance the beneficial impacts of the project, as identified in the previous chapter. The mitigation measures presented in this section are to be implemented as part of the process of impact management, together with any necessary adjustments to respond to unforeseen impacts.

Having identified the associated and potential impacts of the proposed rail project, the recommended mitigation measures proffered to safeguard the biophysical and the socioeconomic environment of the communities affected by the project and its ancillary facilities. It is also worth mentioning that throughout the project lifecycle, the opportunities for implementation of the mitigation measures shall be present.

6.2 OBJECTIVES OF MITIGATION

One of the fundamental objectives of the EIA is to develop and describe hands-on, commensurate and cost-effective mitigation measures that avoid, reduce, control, correct or compensate for negative impacts and enhance benefits. The purpose of mitigation, therefore, is to identify measures that safeguard the environment, the people and the communities that may likely be affected by the rail line and train stations. The objectives of mitigation are to:

- Find better alternatives and approach to project implementation;
- Enhance the environmental and social benefits of the project;
- Apply engineering controls to eliminate or minimise identified potential impacts
- Avoid, minimise or remedy adverse impacts;
- Ensure that residual adverse impacts are within acceptable levels.

- Make provision for replacement, restoration or compensation where the adverse impacts cannot be avoided or minimised (e.g. adequate monetary payment for loss of properties or damage).

Some adverse impacts and consequences of the proposed project are likely to occur far beyond the site boundaries. Therefore, a key part of the objectives of the mitigation measures and procedures are to ensure that the project costs are not borne by the host communities or the public at large.

6.3 MITIGATION MEASURES APPROACH

Cost-effective measures that are environmentally, socially and technically acceptable to manage and mitigate the identified project impacts highlighted in Chapter 5 have been defined, developed and presented in this chapter. These very important procedures, which when translated into action appropriately and promptly, will ensure the adverse impacts associated with the project are properly offset. The measures satisfying the mitigation requirement were established taking the following into consideration:

- Outcome of scoping workshops and concerns/inputs of stakeholders
- Regulatory requirements;
- Skills and competencies of project staff;
- Baseline conditions
- Best available technology for impact mitigation based on experience from similar rail projects

In developing these measures, the first consideration was on measures that are aimed at preventing or reducing identified negative impacts that may occur through the project design and management. This is in line with the 'hierarchy of mitigation measures (Figure 6.1), which establishes a structure to guide project development and application of measures to mitigate impacts on environmental and social values as well as their associated components.

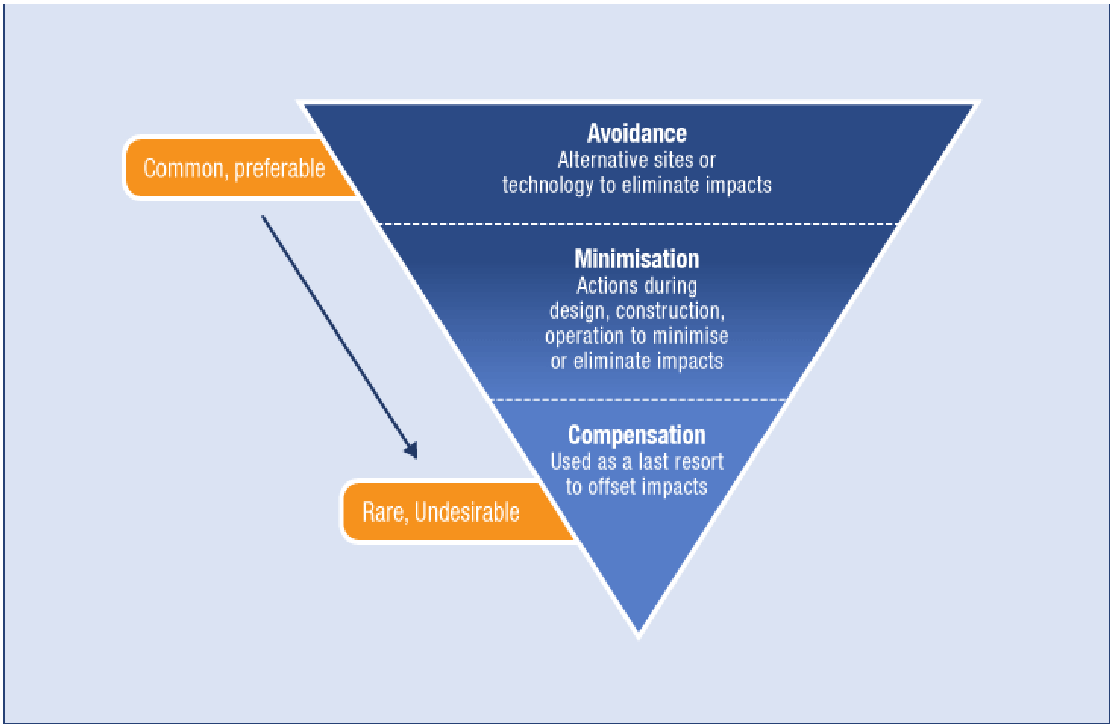


Figure 6. 1: The Hierarchy of Mitigation Measures
(Source: http://sustainability-research.mcgill.ca/)

As a result, preference has been given to prevention of negative impacts and minimisation to an acceptable level and appropriate compensation were only recommended where avoidance is impracticable.

The mitigation measures proposed in this report are both structural and non-structural measures to address the impacts. The structural measures are design modification, re-adjustment of rail alignment, or modification of project location and site management to prevent or minimise impacts environmental degradation or social impacts. Non-structural measures are economic incentives, policy instruments and involvement of community members in project implementation (through employment or contract) during construction activities and operation phases.

After implementation of the recommended measures, residual impact is likely to remain. Thus, this section also provides information on assessment of the residual impact significance.

6.4 MITIGATION MEASURES FOR PHYSICAL AND ECONOMIC DISPLACEMENT

Mitigation measures for physical and economic displacement are largely based on the concerns, comments and recommendations of the stakeholders. The PS 5 applies to the proposed rail project, and an assessment of alternative routes to completely avoid or minimize displacement have been carried out. So far and after considering the best of several route alignments and alternatives, displacement is inevitable. Nonetheless, forced eviction shall be avoided. Local and international guidelines shall be followed to ensure that displacement is not by intimidation or coercion. There have been series of consultation and stakeholders' engagement involving the FMT, the project affected communities and the people, even though land for the project has been acquired through legal means.

As rightly suggested by some project-affected persons, adequate notification of the affected persons, at least 6 months, before demolition or clearance of farmland is an important step towards ameliorating the impacts. A Resettlement Committee may be set up by the Federal Ministry of Transportation, to be headed by a top official of the ministry; and the committee shall include relevant agencies at the federal, state and local government levels. Heads of affected communities shall be included in sub-committees to ensure fairness and transparency.

As part of mitigation measures, an Escrow Account, having as its signatories the FMT, and other critical agencies responsible for land acquisition and compensation shall be opened in a bank strictly for the purpose of compensation payment. The committee shall also be responsible for resettlement of the affected property owners and farmers to new houses and farmland respectively for the purpose of restoring their habitats and means of livelihood. This is to ensure that the money paid for compensation is judiciously used by the affected individuals and guard against future problems for the project. Therefore:

- Resettlement Action Plan (RAP) shall be developed using Resettlement Policy Framework that is currently being developed as at the time of this report. Census shall be carried out to collect appropriate socio-economic baseline data to identify the persons who will be displaced by the project, determine who will be eligible for compensation and assistance, and discourage ineligible persons, such as opportunistic settlers, from claiming benefits. The FMT, through its RAP Consultants, shall establish a cut-off date for eligibility. Information regarding the cut-off date will be well documented and disseminated throughout the project area.
- FMT shall use and adhere to negotiated settlements with the affected people in compliance with the requirements of PS5.
- Compensation payment to all the displaced persons, which include farmers, land and property owners shall be transparent, equitable and consistent to all communities and persons affected by the displacement. Transparency of payment was also a point of concern echoed by some individuals in the project communities.
- FMT shall offer the PAPs adequate compensation for the land, farmland and properties at full replacement cost. In addition, some of the displaced persons or relations may be engaged during construction and operation phases of the project to assist them in restoring or improving their standards of living.
- The FMT shall ensure that compensation and any resettlement undertaken comply with extant laws as well as the objectives of Performance Standard 5.
- Records of consultations and compensations made shall be properly documented and kept for future reference.

- FMT shall neither take possession of nor commence any work on the project until full compensation has been made (except in a situation where there is ownership conflict on certain aspect of the land).
- FMT shall continually engage with the PAPs and PACs through the process of stakeholder engagement.
- The FMT shall ensure purchase agreement was witnessed and signed by heads of communities affected and heirs to family land.
- The FMT shall ensure that the perspectives of the vulnerable groups in the affected communities are obtained and their interests factored into all aspects of compensation.
- Mitigation of displacement will be considered complete only when all the affected people and communities have received full compensation and other assistance by the requirements of the PS5 and Resettlement Action Plan.
- Representatives of MACBAN and other stakeholders especially herders whose livelihood might be impacted by the fragmentation of cattle routes suggested an overbridge or underpass to avoid cutting off international cattle routes or grazing routes. It is worth noting that the project design avoided many grazing sites, particularly in

6.5 MITIGATION MEASURES FOR NOISE AND VIBRATION IMPACT

The potential and associated impacts of noise and vibration from the proposed project cut across the construction and operation phases. Therefore, the mitigation measures are phase-specific and are as presented in the subsections below.

6.5.1 Mitigation Measures for Pre-construction and Construction Phase

Noise impacts during mobilisation and construction activities are generally related to the sources such as vehicles used for movement of workforce and materials, workers conversations, construction equipment in relation to the proximity to the noise receptors.

Construction site is generally characterised by noise and vibration from diverse sources; and at the design stage, steps had been taken to ensure that the proposed sites for train stations, where practicable, are far-flung from sensitive noise receptors.

The following are examples of mitigation measures that shall be implemented to further minimise noise and vibration impacts from the project site during mobilisation and construction.

- New or properly serviced vehicles and equipment are less noisy than the old ones. Therefore, use of old, poorly maintained vehicles for movement of construction crew and materials shall be discouraged. Vehicles and equipment to be used for this purpose shall be well serviced.
- Vehicles and equipment shall be turned off when not in use for a prolonged period.
- When it is impracticable to get new equipment, well-serviced old equipment shall be modified, (such as integration of mufflers or sound-absorbing materials) to ensure the noise generated from the equipment is bearable.
- Construction equipment shall, on a regular basis, be checked for worn or chipped gear teeth, worn bearings, poor lubrication, imbalance in rotating parts, obstruction in airways, damaged silencers etc. as may be applicable. All identified anomalies or defects shall be corrected immediately.
- Less expensive temporary barriers and enclosures may be built around noisy stationary equipment to significantly reduce noise level.
- Noise level at receptors decreases with increase in distance from noise source. Thus, noisy, stationary equipment such as generators and compressors shall be located far from workers and residential settings.
- Noisy construction activities shall be, as much as practicable, synchronised and restricted to the least noise-sensitive period of the day (usually between 7am and 6pm). The combined noise levels produced may not be significantly greater than the level produced if the operations were performed separately. In addition, as much as

feasible, noisy activities shall be suspended during hours of prayer if the workstation along the route is close to any residence or mosque.

- Alternative construction techniques that are less noisy shall be considered.
- As much as practicable, communities near the construction site shall be pre-informed if there will any major noisy activities that may cause panic or high level of disturbance.
- To reduce workers exposure to noise impacts, work rotation may be considered for those whose tasks expose them to continuous high level of noise.
- Use of ear plugs by construction workers who are exposed to noise level up to 80 dB(A) over a prolonged period shall be encouraged as a personal protective measure against noise impact.
- Workers shall be encouraged to communicate in an orderly manner at construction site to minimise noise impacts.
- The Noise Management Plan (NMP) developed for this project shall be implemented to mitigate the acoustic impact of the project during construction.

6.5.2 Mitigation Measures for Operation and Maintenance Phase

- Construction of overhead bridges, tunnels instead of level crossings and protection of the rail tracks from indiscriminate public access will minimise use of train warning alarms
- The elasticity or flexibility of the track superstructures may be increased to minimise noise and vibration associated with train movement.
- There shall be regular maintenance of the rail running surface.
- Train speed during the operation phase shall be optimal as train movement at high speed generates significant level of noise.
- The NMP shall be implemented to mitigate the acoustic impact of the project during the operation phase.

6.6 MITIGATION MEASURES FOR IMPACT ON AIR QUALITY

The proposed measures to eliminate or reduce impact on air quality in the area are phase-specific, and they are as presented below.

6.6.1 Mitigation Measures for Pre-construction and Construction Phase

Dust control measures are imperative in the project area due to its arid nature where soil can become very dry and vulnerable to transport by high winds. The most effectual method of minimising air pollution is to control dust and other air pollutants at source before they are airborne. In compliance with IFC PS 3, general mitigation practices and principles that could apply during the construction phase of the project (including impacts resulting from material lay areas, quarry sites, and others) include the following:

- The project proponent and or contractors handling the project shall:
- Plan the routes for haulage vehicles to be away from residents and other sensitive receptors, such as residences, schools and medical facilities.
- Keep the routes in compacted condition, where practicable, using static sprinklers, water bowsers, or commercially available additives and dust binders.
- Minimise movement of vehicles as much as possible. This may be achieved by using large-sized vehicles, which are capable of hauling more materials to site compared to small or medium-sized vehicles that require more trips to move the same quantity of materials to the construction site.
- Ensure that speed of vehicles is controlled to as low as 15km/hr while moving through unpaved road which is likely to generate dust. Speed limit shall be enforced to ensure compliance.
- Ensure that engines and exhaust systems of equipment and vehicles used for construction are properly maintained to make certain emissions do not exceed statutory emission limits.
- Ensure that vehicles, equipment and internal combustion plant are not left idling, running unnecessarily. They shall be turned off if not in use for a prolonged period.

- Ensure that fine construction materials such as sand and cement that are likely to generate dust in transit are properly covered during haulage to prevent wind impact.
- Ensure that construction materials including the materials at the lay areas that are likely to generate dust if blown by wind are stored and covered in an enclosure or bunded area.
- Ensure that earthworks, excavation and digging, and removal of vegetal cover are done in discrete sections to guard against exposure of a vast expanse of loose soil particles prone to wind effect. Therefore, construction sequencing can greatly reduce problematic dust from a site.
- Ensure that, if the land must be disturbed, temporary stabilisation measures before disturbance shall be considered. Preferably, non-toxic chemical soil stabilizers according to manufactures' specifications may be applied. However, use of chemical soil stabilisers shall be done sparingly and only on mineral soils, to avoid contamination of soil and water resources.
- Ensure that, to the extent possible, dust-generating activities shall be minimised or avoided during windy and dry weather periods.
- Adopt water-suppression methods to minimise dust generation on site. Water may be sprinkled where necessary as dust suppressant to minimise airborne dust during earthmoving activities, prior to clearing, before excavating, backfilling, compacting, or grading. Applying water to exposed soils can be time intensive, and if done to excess, could result in excess runoff from the site or vehicles tracking mud onto public roads. Therefore, well-trained personnel shall be assigned this duty.
- Clean all vehicles properly before they leave the construction site if they are dusty.
- Train workers to handle construction materials and debris during construction to reduce fugitive emissions.
- Ensure that soil is kept moist while loading into dump trucks, and soil loads shall be kept below the freeboard of the truck to minimise drop heights.

- Encourage mulching at the site, which can be a quick and effective means of dust control for a newly disturbed area.
- Embark on air quality monitoring during the construction phase to ensure that they do not constitute nuisance or exceed recommended limits.
- For quarrying operations, continuously monitor air quality at and around the site to detect any exceedances of dust and particulate matter standards, enabling timely implementation of corrective actions.
- Cover piles of sand, gravel, and other materials with tarps or similar coverings to prevent windblown dust of materials.
- Regularly maintain and upgrade machinery and vehicles used for quarrying operations to ensure they operate efficiently, minimizing exhaust emissions.
- Use water sprays, as much as practicable, to dampen dust at source points. Employing dust suppressants on roads and surfaces can also reduce particulate matter.
- The Air Quality Management Plan (AQMP) for the project shall be implemented to enhance the mitigation measures.

6.7 MITIGATION MEASURES FOR IMPACTS ON VEGETATION

The recommended mitigation measures minimize project impacts on plant biodiversity in the area as presented in the subsections below.

6.7.1 Mitigation Measures for Pre-construction and Construction Phase

- Vegetated areas around the construction site shall not be cleared if unnecessary. Manual clearing of vegetation shall be encouraged, where practicable and especially around steep slopes, to minimize disturbance of plant species that are off-site.
- To prevent crop damage, site clearing activities may be delayed till after harvest of the annual crops on farmlands, which predominate the project corridor.
- Workers shall be educated about the Great Green Wall, and its ecological importance and existence of some plant species (such as *Andasonia digitata, Balanites aegyptiaca,*

among others), which are of high importance to the people in the area and the need for their protection during construction. This shall also apply to the potentially impacted forest reserves such as Damangu, Daura, and Gwiwa Korel forest reserves.

- Clearing of vegetation for the rail route shall be restricted to the RoW to significantly minimise the likely impact on plant species planted as part of the Great Green Wall; especially around Jibia, which is close to the Great Green Wall corridor.
- Forest reserves in the project area shall be avoided during route planning and design to minimize impacts of the project on ecologically sensitive areas. Where avoidance is not possible, greatest consideration will be applied to minimize habitat fragmentation at the design phase.
- Reforestation programmes shall also be implemented to reforest areas disturbed by the project activites using native plant species.
- Vehicles shall be kept on established access roads to reduce habitat disturbance.
- Soil restoration by minimizing soil compaction and increasing organic matter) will enhance vegetation regrowth.
- As much as practicable, opening new borrow pits for the project, which may necessitate clearing of vegetation shall be avoided.
- Contractors shall apply erosion controls that comply with local, state, or federal standards. Apply practices such as jute netting and silt fences.
- Use of dust abatement techniques on unpaved, un-vegetated surfaces to minimize airborne dust on plants shall be encouraged
- Topsoil removed site clearance shall be used to reclaim disturbed areas.
- Mature trees near the project site (off site) shall be clearly marked with high-visibility tape to prevent unnecessary removal or damage during construction activities.
- Excess cleared land shall be re-vegetated.
- To further enhance the mitigation measures, the Integrated Vegetation Management Plan (IVMP) and Biodiversity Management Plan (BMP) shall be implemented.

6.7.2 Mitigation Measures for Operation and Maintenance Phase

- Choice and use of herbicide for weed control along the route and in other parts of the project site shall be in strict compliance with safety standard.
- FMT shall ensure that clearing and maintenance of RoW is restricted to within the setback to guard against disturbing vegetation in the vicinity.
- The IVMP shall be implemented to further improve the impact mitigation outcomes.

6.8 MITIGATION MEASURES FOR IMPACT ON FAUNA

The mitigation measures recommended for implementation minimize the potential impacts of the proposed project on animal biodiversity in the area as presented in the subsections below.

6.8.1 Mitigation Measures for Pre-construction and Construction Phase

- To prevent or minimize mortality and disturbance of avifauna, bird nests shall be avoided, as much as practicable, and the risk of permanent habitat loss shall be minimised or controlled by restricting clearing to areas required for construction
- Buffer zones in the project vicinity, especially around important habitats and forest reserves may be established, where it is practicable.
- Around impacted forest reserves wildlife corridors and crossings such as overpasses / underpasses shall be constructed to maintain connectivity for species that need to move across rail lines and minimize impact of habitat fragmentation.
- There may be installation of wildlife crossings at strategic intervals in the impacted forest reserves (where it is deemed necessary) to facilitate the safe passage of animals across the rail line, thus reducing the risk of wildlife mortality.
- Habitat disturbance shall be reduced by keeping vehicles on established access roads and by minimising foot traffic in undisturbed areas.
- To minimise the mortality of earth-dwelling and slow-moving animals, manual clearing shall be encouraged at places where it is practicable.

- Where fauna species of conservation importance are encountered by chance during clearing or construction, the contractors shall notify the FMT officials who shall notify the FMEnv or other agencies responsible for conservation. Therefore, contractors and their employees shall be well-trained on the environmental aspects of their activities.
- The BMP shall be implemented to further improve the outcomes of the mitigation measures.

6.8.2 Mitigation Measures for Operation and Maintenance Phase

To minimize adverse impacts of the project on animals, the following mitigation measures shall be implemented:

- Awareness programme may be organised for herders and pastoralists across the project corridor on the need to avoid grazing their livestock near rail tracks to avoid train collision with the animals.
- Established grazing routes, which are likely to be fragmented by the rail route, shall be avoided through project design. This may involve the construction of overhead bridges for the animals to connect fragmented routes.
- Vegetations with tall trees, which will not interfere with the rail line, shall be maintained to provide landing options for birds.
- An ecological management plan shall be developed to further minimise the impacts of project operation on the biodiversity of the project area.
- The Proponent shall support afforestation project as part of mitigation measures.

6.9 MITIGATION MEASURES FOR IMPACT ON SOIL

The mitigation measures aimed at managing or minimizing the project's potential impacts on soil quality as presented in the subsections below.

6.9.1 Mitigation Measures for Pre-construction and Construction Phase

The FMT shall implement the following:

- Areas with unstable slopes along the route shall be avoided, as much as possible, during earth excavation and general construction. The construction contractors shall employ adequate slope protection techniques to prevent erosion.
- Compacting or other hardening of surface shall be avoided by minimising movement of vehicle and heavy machinery on open soil and areas with sensitive slopes.
- To ensure soil stability and minimise soil exposure to erosion, removal of vegetal cover shall be restricted to the construction site and adjoining points necessary for construction-related activities.
- Other erosion control and re-vegetation (after construction) plan shall be put in place for post-construction phase.
- Wastes generated during demolition and construction shall be properly managed and disposed in designated areas
- Runoff control features shall be designed to minimise soil erosion.
- Drainage ditches shall be constructed only where necessary. Structures at culvert outlets may be used to prevent erosion.
- Creating excessive slopes during excavation and other construction activities shall be avoided.
- Hazardous materials shall be carefully stored and handled to avoid accidental spill and soil contamination.
- Machinery, equipment and vehicles used during demolition, clearing and construction shall be properly serviced to ensure the possibility of fuel and lube oil leakage are eliminated and free of excess oil and grease.
- Fueling of equipment shall be carefully done to avoid spills on site.
- Spent oil, other hydrocarbon waste and hazardous wastes shall be collected into appropriate containers of sufficient capacity and stored prior to evacuation.

- Effective spill containment kits shall be provided on-site if hazardous materials are to be stored on the construction site. Unplanned spills shall be contained and cleaned up immediately.
- In addition, storage, handling and use of materials shall be undertaken in accordance with the instructions on Material Safety Data Sheet (MSDS) of the chemicals.
- Stockpile of materials shall be carried with plastic sheeting or tarps; with berm installed around the stockpile of materials to prevent runoff from leaving the area;
- Contaminated soil, which may result from accidental spill of hazardous materials, shall be promptly removed, evacuated and properly disposed of.
- Topsoil removed during excavation shall be used to backfill or reclaim disturbed areas. In addition, backfilling shall be carried out using suitable materials that meet the applicable land use standards to prevent ground subsidence. Where subsidence has occurred, additional backfill materials shall be used.
- Low impact excavation shall be implemented, and excavation shall not be carried out during a prevalent adverse weather condition.
- An adequate number of refuse bins shall be provided at the construction sites and campsites in designated waste bins.
- Waste shall be contained to the construction site and campsites. This shall be properly disposed of using government-licensed waste managers.
- Burrow pits sites selection shall be carried in a manner that avoids ecological sensitive ecosystems and least disruption to the local communities.
- Burrow pits shall also be designed with gentle slopes to minimize erosions and risks of landslides.
- The management of the burrow pits including the rehabilitation and restoration shall be in line with the specific burrow pits management plan (Appendix).
-

- The Waste Management Plan (WMP) – also in the appendix - shall be implemented to further protect the soil from project impacts.

6.9.2 Mitigation Measures for Operation and Maintenance Phase

- Bund wall shall be constructed around fuel storage tank(s) at train stations to contain fuel in the event of spill or accidental rupture.
- Waste generated on train and at the train stations shall be appropriately disposed of by engaging government-licensed waste managers.
- Hazardous chemicals such as persistent organic herbicide shall not be used for weed control along the rail route.

6.10 MITIGATION MEASURES FOR IMPACT ON SURFACE WATER

6.10.1 Mitigation Measures Pre-construction and Construction Phase

- Water exploitation from ponds and rivers for construction shall be carefully done to prevent contamination
- Runoff control features shall be designed to minimise soil erosion, which may impact receiving surface water.
- Wastes generated during demolition and construction shall be properly managed and disposed in designated areas.
- Drainage ditches shall be constructed only where necessary. Structures at culvert outlets may be used to prevent erosion.
- Creating excessive slopes during excavation and other construction activities shall be avoided.
- Hazardous materials shall be carefully stored and handled to avoid accidental spill and soil contamination.
- Machinery, equipment and vehicles used during demolition, clearing and construction shall be properly serviced to ensure the possibility of fuel and lube oil leakage are eliminated.

- Contaminated soil, which may result from accidental spill of hazardous materials, shall be promptly removed, evacuated and properly disposed of.
- Low-impact excavation shall be implemented, and excavation shall not be carried out during a prevalent adverse weather condition.
- Waste generated by construction workers shall be properly collected and disposed of.

6.11 MITIGATION MEASURES FOR IMPACT ON GROUNDWATER RESOURCE

The recommended mitigation measures minimize the potential impacts of the proposed project on groundwater resources in the area as presented in the subsections below.

6.11.1 Mitigation Measures for Pre-construction and Construction Phase

- Prior to construction, areas of groundwater discharge and recharge shall be identified. Hydrologic conduits between two aquifers shall be avoided.
- During construction over-abstraction of groundwater resources at campsites shall be avoided. Where necessary and as an alternative, contractors handling civil and construction works may source water off-site and convey it to the site using water trucks to complement the planned on-site borehole.
- Abstraction shall be controlled to guarantee moderate withdrawal, which does not exceed the sustainable yield of the aquifer.
- Mitigation measures aimed at preventing soil contamination through accidental spill, use, storage and transport of hazardous materials, shall be implemented. This will eliminate the likelihood of soil contaminants percolating into groundwater.
- Waste generated onsite shall be properly discarded in waste bins and disposed of using approved waste managers.
- The contractors, using accredited waste managers, shall dispose of excess excavation materials in approved areas to minimise leaching of hazardous materials.

6.11.2 Mitigation Measures for Operation and Maintenance Phase

- Bund wall shall be constructed around fuel storage tank to contain fuel in the event of spill or accidental rupture.
- Groundwater resource shall be carefully managed, especially during dry season such that water abstraction for domestic use is regulated.
- Solar-powered boreholes may be constructed, and only the required volume of water for use shall be drawn to conserve groundwater resource
- Regularly check to detect leaks in water taps, hose connections and other the plumbing installations shall be carried out and promptly fixed.
- Waste collected from trains and at the train stations shall be properly disposed of using government-licensed waste managers.

6.12 MITIGATION MEASURES FOR IMPACT ON TRANSPORT AND TRAFFIC

The mitigation measures presented below are recommended to minimize the potential impacts of the proposed project on traffic and transportation in the area as presented in the subsections below.

6.12.1 Mitigation Measures for Pre-construction and Construction Phase

A wide range of temporary traffic management measures shall be employed, as appropriate, to facilitate the construction works and mitigate the potential impacts on the traffic situation in this area. These measures shall include the following:

- The contractors in collaboration with the FMT shall develop a Traffic Management Plan. Consultation with local stakeholders (such as local government authorities and heads of communities) may be undertaken before the finalisation and implementation of the Traffic Management Plan.
- Traffic diversion signs shall be visibly placed at points where road users can easily make a detour to alternate routes.
- Traffic control officer shall be appointed to direct traffic when a part of the public road is closed for construction.

- Activities at the construction site shall be phased and properly timed, and measures shall be put in place to ensure safe access to and from the construction sites
- Transportation plan, particularly for oversized or overweight project components, shall be developed. The plan should consider component sizes, weights, origin, destination, and unique handling requirements.
- Drivers shall be instructed to adhere to safe speed limits to ensure safe and efficient traffic flow.
- Construction vehicle movement on public roadways shall be restricted to off-peak commuting times, if possible, to minimise impacts on local commuters.
- All personnel and contractors shall be instructed to adhere to speed limits to ensure safe and efficient traffic flow.
- Only licensed and experienced drivers shall be engaged to reduce road accidents on and off-site.
- The Traffic Management Plan (TMP) designed for the project shall be implemented to ensure effective mitigation of the potential traffic impacts.

6.12.2 Mitigation Measures for Operation Phase

It has been observed that the presence of a train station in an area attracts steady vehicular traffic in the direction of the train station throughout the lifetime of the rail operations. As a result, connecting roads to the train station may be expanded by authorities to absorb increased pressure on existing roads.

6.13 MITIGATIONS FOR IMPACT ON WORKER'S HEALTH AND SAFETY

In compliance with the IFC Performance Standard 2 (Labour and Working Conditions), which is partly guided by some Conventions of the International Labour Organization (ILO) and United Nations (UN), the project proponent shall implement the appropriate mitigation measures during the construction and operation phases:

6.13.1 Mitigation Measures for Pre-construction and Construction Phase

The FMT, its contractors and or sub-contractors shall ensure that:

- a safe and healthy work environment is provided for the workforce
- clear warning signs are installed at strategic locations on site
- Personal protective equipment, which are appropriate for tasks being carried out are provided, and its use mandatory while on site.
- No minor is engaged as a worker on or off-site. *According to the applicable laws in Nigeria, a minor is a person who is less than 18 years old. There are many examples of different ages enshrined in a multitude of legal texts and in customary law all over the country. The official report admits that laws affecting or defining who a child is are diverse in different legislations. The definitions vary depending on cultural background of the affected. According to the actual legislations, the age for being a child ranges from 7 to 21 years.*
- No person is coerced into any form of labour or activities regarding the proposed project.
- Compliance with organisational policy on health, safety and environment.
- there are procedures in place, which strongly discourages all forms of discrimination such as between migrant and local workers and
- Conflict is quickly and amicably resolved.
- workers welfare and fundamental rights are protected at all times
- Well-stocked first aid box, which is easily accessible for workers, is in place at the construction site before seeking external medical attention.
- overtime work shall be minimised or discouraged to guard against fatigue
- Use of alcohol, hard drugs and other substances capable of causing harms to the user and co-workers is prohibited on site.
- workers are protected from external aggressors by providing adequate security at the construction sites and campsites

- Workers are given proper orientation on responsible sexual behaviour to ensure none contract sexually transmitted infections. The workforce shall be properly enlightened on the consequences of indiscriminate sexual activities and unsafe sexual behaviours. There shall be implementation of initiatives, which target knowledge, attitude, behaviour, prevention, treatment and care in collaboration with relevant organisations.
- HIV/AIDS and other STIs awareness groups are created through the peer groups of the construction crew
- The Safety programme at construction site and campsites includes infection prevention protocols. In particular, the international protocols for the prevention of coronavirus disease (COVID-19) and other infectious diseases shall be put in place and adhered to while the pandemic subsists.
- The FMT and or its contractors allocate fund for the procurement of protective latex for distribution to workers, who shall be advised to use it properly if they cannot abstain from sex during the period of their stay in the area.
- No person works in isolation, especially along the rail route and in areas of high-security risk.
- A robust safety management plan shall be developed and implemented. This is anticipated to eliminate major occupational hazards and serious injuries. In the unlikely event of a serious accident involving a construction worker on site, fair and adequate compensation shall be paid to the affected worker or his/her next of kin.

6.13.2 Mitigation Measures for Operation and Maintenance Phase

- Only well trained, certified personnel shall be allowed to carry out installations, repairs and maintenance of electrical equipment at the train stations.
- To prevent electric shock and electrocution, energised cables shall be deactivated and properly grounded before carrying out repairs and maintenance of electrical installations and equipment.

- Workers shall carry out their tasks only when properly protected using appropriate tools and PPEs such as rubber gloves, non-slip safety boots, helmet, safety straps, leggings, etc.
- Access to high-risk area shall be restricted, and other workers not directly associated tasks in such area shall be prohibited.
- There shall be fall prevention programme (such as training in climbing techniques) in place for personnel working at elevations.
- Structures and tools used for climbing shall be tested for strength and integrity from time to time before use by workers.
- Workers shall not be deprived of their rights of association as long as it is a lawful society, group or association. Their welfare and fundamental rights shall be protected at all times.
- Security personnel shall be part of the train crew to protect staff from aggression or physical attack by any disgruntled passenger.
- Use of alcohol, hard drugs and other substances capable of causing harms to the user and co-workers shall be forbidden at workplace.
- No minor shall be engaged as a worker for this project either directly or through third party.
- No one shall be coerced into any form of labour or activities regarding the proposed project.
- Workers who are likely to suffer trauma or guilt because of accidents involving train and pedestrians/vehicles shall be referred to a clinical psychologist or relevant specialists for help.
- There shall be in place procedures, that strongly discourage all forms of discrimination such as tribal or gender discrimination or discrimination against physically challenged workers.

- Workers shall be protected from sexual harassment. Female workers are more vulnerable than male workers in the construction industry; they shall be given adequate protection from harassment.
- The HSE programme during train operations shall include an infection control programme. In particular, the internationally-recognized protocols for the prevention of coronavirus disease (COVID-19) and other infectious diseases shall be put in place and adhered to while the pandemic subsists.
- There shall be installation of fire-fighting equipment such as fire extinguishers and fire hydrants at the train stations and on the train.
- There shall be an emergency (alternative) exit door in the event of an emergency.
- A health and safety management plan shall be developed and implemented to further safeguard the health and safety of all stakeholders.

6.14 MITIGATION MEASURES FOR IMPACT ON COMMUNITY HEALTH AND SAFETY

The IFC Performance Standard 4 (Community Health, Safety and Security) underscores the importance of eliminating or minimising the risks associated with the proposed project in relation to the public in the project area. As a result, The FMT shall implement the following mitigation measures during the construction and operation phases:

6.14.1 Mitigation Measures for Pre-construction and Construction Phase

- There shall be adequate and visible hazard/safety signs at and around the construction site such as access restriction and traffic hazards
- Speed limit shall be enforced to ensure vehicles used for haulage of materials do not pose threat to public safety.
- Communities that are near construction sites shall be informed ahead if there are any activities or emissions that could affect their well-being, and the area shall be cordoned off.
- Rail tracks shall be regularly maintained to guard against train derailments and accident.

- Other recommended mitigation measures, which are aimed at preventing or minimising potential adverse health impacts of the project and its related activities (such as possible spread of STIs) shall be implemented.
- Mitigation measures aimed at protecting groundwater and surface water in the project area shall be implemented to safeguard the health of communities which depend on the water resources for domestic purposes. This may also require periodic monitoring throughout the period of construction.
- In addition, air quality shall be intermittently monitored to ensure that emissions from construction sites are checked, corrected and threshold (recommended) limits are not exceeded.

6.14.2 Mitigation Measures for Operation and Maintenance Phase

- Overpass and tunnels incorporated into the project design will minimise risk of accident/collision between train and vehicles during operations.
- Overhead pedestrian bridges shall be constructed to link fragmented communities.
- The rail track shall be protected from public access through palisade fencing where necessary to protect members of the communities especially children from accidents.
- During operation, an infection control programme, which ensures the spread of infectious diseases shall be put in place at the stations and on board.

6.15 MITIGATION MEASURES FOR GREENHOUSE GAS EMISSION

6.15.1 Mitigation measures during mobilisation and construction

Impacts on greenhouse gas emissions shall be mitigated by applying the mitigation measures for air quality impact.

- These shall include regular servicing of machinery and equipment to ensure that emissions are minimal.
- In addition, renewable energy such as solar energy may be used to power the campsites instead of using fossil fuel-powered generating sets.
- In addition, unnecessary cutting down of plant materials shall be avoided.

- Tree planting at the train stations and along the rail route may be adopted to partly offset the potential project impact on the existing carbon sink.
- *Mitigation measures during operation and maintenance phase*
- The train stations may be powered by using clean energy alternatives such as solar system or wind turbines. The 10 MW wind farm at Lamba Rimi, Katsina State, which is near completion may serve as a source of clean energy for Katsina and the train stations in Katsina such as solar energy may be used to power the train stations instead of using fossil fuel-powered generating sets.
- In addition, unnecessary cutting down of plant materials shall be avoided.
- Tree planting at the train stations and along the rail route may be adopted to partly offset the potential project impact on the existing carbon sink.

6.16 MITIGATION MEASURES FOR IMPACT ON CULTURAL HERITAGE

6.16.1 Mitigation Measures for Pre-construction and Construction Phase

- Burial ground shall be avoided if encountered within the RoW during clearance of site and routes
- If tombs are found within the RoW, the affected families shall be engaged and collaborated with on relocation of the tombs
- The Rinian Sacred Forest shall be avoided as much as practicable during construction phase.
- Relevant state governments and stakeholders shall be engaged to identify and preserve international livestock routes.
- The international livestock routes, which are likely to be fragmented, shall be promptly linked after route clearance. Temporary measures will be put in place to preserve the routes pending the completion of the rail line construction.
- The livestock routes shall be permanently linked during construction through overhead bridges or tunnels, as much as practicable.

- If it becomes impracticable to reconnect all international livestock routes through the construction of bridges and tunnels, all the relevant stakeholders shall be engaged in the establishment of major international livestock routes.
- The Cultural Heritage Management Plan for the project shall be implemented.

6.17 MITIGATION MEASURES FOR IMPACT ON ECOSYSTEM SERVICES

A vast expanse of farmlands and grazing area will be impacted, which will affect food production – a major ecosystem service derived from the project area.

- As part of mitigation measures for economic displacement (of farmers), affected farmers and herders shall be assisted in acquisition of new farmlands and grazing area not far from their places of residence or near original land they were displaced from.
- As much as practicable perennial plants used by adjoining communities for medicinal purposes and as food may be protected if they are unlikely to interfere with project activities.
- The IVMP shall be implemented to preserve the ecosystem services derivable by members of the project communities.

6.18 MITIGATION FOR IMPACT ON THE LIVELIHOOD OF TRANSPORTERS

The affected road transporters shall be engaged and sensitized before the operation phase on the need for alternative transport routes to sustain their livelihood.

- The project will create new opportunities such as cab services from and to train stations for road transporters. Some of the affected transporters may be encouraged or enlightened during further stakeholders' consultation to embrace this potential opportunity.

6.19 MITIGATION MEASURES FOR SECURITY RISKS

- Security of passengers and workers at the train station and on train shall be guaranteed. The likelihood of terrorist attack shall not be ruled out. To forestall that, strict security measures such as installation of close-circuit television (CCTV), security SCREENING at the entrance of the train station shall be put in place and closely monitored.

- Well-trained and properly armed security personnel shall be stationed at the train stations. They shall be trained on respect for human rights, right use of force and security emergency response.

6.20 MITIGATION MEASURES FOR TRANSBOUNDARY IMPACTS

The transboundary impact mitigation in this context is not related to the Espoo Convention on Environmental Impact Assessment in a Transboundary Context of 1991. The mitigation focuses on curbing illegal transnational movement, particularly of criminal gangs and individuals of high security threat through rail from Niger Republic to Nigeria and vice-versa. To achieve that, immigration officers in collaboration with other security personnel shall screen passengers at the border stations before they are allowed to proceed across transnational boundaries.

6.21 GRIEVANCE MECHANISM AND CONFLICT MANAGEMENT

There shall be a grievance mechanism developed to address possible misunderstanding between the members of the communities and FMT or members of staff. Social conflicts are likely to occur when expectations of the people in the communities about the project are not met. For example, if the local people did not get adequate or expected jobs or economic opportunities from the project and if their rights are violated, it may trigger conflict, instability and resentment between the resident youth and migrant workers. To ensure that local communities have opportunities to earn incomes during the construction phase, contractors and FMT shall ensure that employment priority for unskilled jobs be given to local communities without prejudice to female residents in the area. Also, the FMT shall identify training priorities and skills acquisition for the local people engaged in the project for proper job execution.

Public awareness about the project activities and available job opportunities shall be made in a timely manner to ensure that local people are availed equal opportunities to get engaged for the project. The contractor shall be gender-sensitive, especially when incorporating women into the construction activities. Moreover, contractors shall aim at procuring locally available materials and make use of local suppliers, to the extent possible.

Any aspect of the project activity that may lead to conflict with the community shall be avoided or properly mitigated. In addition to the earlier stated mitigation measures for physical and economic displacement, FMT shall establish an effective mechanism to receive and address specific concerns about compensation that are raised by displaced persons or members of host communities.

6.21.1 Grievance Redress Mechanism Framework

The primary objectives of the Grievance Redress Mechanism (GRM) are to:

- Establish a transparent, culturally appropriate, and accessible process for receiving and resolving grievances related to the project.
- Ensure grievances are addressed promptly and effectively to maintain community trust and project integrity.
- Promote constructive engagement between project stakeholders and affected communities, enhancing project outcomes.

Grievance Redress Committee (GRC) Setup

The project Grievances Redress Mechanism (GRM) will be coordinated through the RAP management committees, which include the Resettlement Steering Committee (RSC), Resettlement Management Committee (RMC) and Community Resettlement Committee (CRC). All grievances would be collected by GOs or CLOs present in the project-affected communities in each state. These grievances would be collated, recorded, and referred to the CRC for resolution at the community level. Unresolved grievances by the CRC shall be escalated to the RMC for resolution.

a. Local Government Level GRC:

- **Chairperson:** This shall be a representative from the affected Local Government Area (LGA), either an elected official or senior administrative officer.
- **Secretary:** The Project's Community Liaison Officer shall be responsible for coordinating and documenting all grievance-related activities.
- **Members:**
  - Representatives from the affected communities, ensuring broad community representation.
  - Women and youth representatives to ensure gender and age inclusivity.
  - Environmental and Social Safeguard Specialists with experience in managing project impacts.
  - Traditional leaders or community leaders.
  - Where practicable, representatives from local NGOs/CSOs actively work in the project area, especially those focused on social and environmental issues.

Functions of the GRC:

- **Receive and Document Grievances:** Establish and maintain a detailed log of all grievances received.
- **Acknowledge Receipt:** Formally acknowledge the receipt of each grievance within seven days.
- **Investigate and Evaluate:** Conduct thorough investigations to assess the validity and nature of grievances.
- **Facilitate Mediation and Negotiation:** Engage with all relevant parties to mediate and negotiate a resolution.

- **Provide Feedback:** Offer regular updates to complainants on the status of their grievances.
- **Monitor and Report:** Continuously monitor the grievance resolution process and prepare regular reports for project stakeholders.

Grievance Receiving Modalities:

a. Channels for Receiving Grievances:

- **Walk-ins:** Establish grievance boxes and designated GRC offices at project sites and local government offices for in-person submissions.
- **Hotlines:** Set up dedicated mobile numbers with dedicated persons to receive grievances by phone.
- **Online:** Create a dedicated email address and a grievance submission form on the project website for online submissions.
- **Community Meetings:** Schedule regular community meetings where grievances can be raised and discussed.
- **Written Submissions:** Accept letters and forms submitted to GRC offices or designated points within the community.

b. Documentation:

- Develop a comprehensive grievance log that includes the complainant's name, contact information, a detailed description of the grievance, the date received, and the status of the grievance.

Grievance Resolution Process:

a. Receipt and Acknowledgment:

- **Acknowledge Receipt:** Provide written acknowledgment of the receipt of grievances within seven days, including a reference number for tracking purposes.

b. Assessment and Investigation:

- **Preliminary Assessment:** Conduct a preliminary assessment within 14 days to determine the validity and potential impact of the grievance.

- **Detailed Investigation:** Assign valid grievances to appropriate parties for detailed investigation, which should be completed within 30 days.

c. Resolution and Feedback:

- **Resolution Plan:** Develop a resolution plan in consultation with the complainant and relevant stakeholders.
- **Implementation:** Implement the agreed-upon resolution within 45 days.
- **Feedback:** Provide detailed feedback to the complainant, explaining the actions taken and ensuring their satisfaction with the resolution.

d. Appeal Process:

- **Independent Review:** If the complainant is dissatisfied with the resolution, they can appeal to a higher-level GRC or an independent mediator for an impartial review.
- **Final Resolution:** Ensure that the independent review and resolution process is completed within a timeframe of 30 days, ensuring timely and effective responses to any disputes or concerns that arise.

Monitoring and Reporting:

a. Monitoring:

- **Continuous Monitoring:** Regularly monitor the grievance resolution process to ensure adherence to the GRM procedures and timelines.
- **Compliance Checks:** Conduct periodic compliance checks to verify that all grievances are being handled appropriately.

b. Reporting:

- **Quarterly Reports:** Prepare and submit quarterly reports to project stakeholders, summarizing grievances received, resolutions achieved, and lessons learned.
- **Transparency:** Make reports available to the public to ensure transparency and accountability.

Capacity Building and Awareness:

a. Training:

- **GRC Training:** Provide comprehensive training for GRC members and project staff on GRM procedures, cultural sensitivity, and conflict resolution techniques.
- **Community Training:** Conduct training sessions for community representatives on how to use the GRM effectively.

b. Awareness Campaigns:

- **Information Dissemination:** Implement awareness campaigns in affected communities to inform them about the GRM, how to access it, and their rights within the process.
- **Cultural Sensitivity:** Use local languages and culturally relevant communication methods to ensure understanding and participation.

Recommendations for GRC Members:

- **Local Government Officials:** Include officials with knowledge of the area and project impacts.
- **Community Representatives:** Ensure broad representation from affected communities, including elders and local leaders.
- **Women and Youth Representatives:** Incorporate gender and age diversity to reflect the community's demographic.
- **NGO/CSO Representatives:** Engage representatives from local NGOs/CSOs working in social and environmental domains.
- **Environmental and Social Experts:** Include experts to provide technical insights into the project's impacts and potential mitigation measures.

Cultural Appropriateness:

- **Respect Local Customs:** Ensure the GRM respects and incorporates local customs and traditions in the grievance resolution process.
- **Engage Local Influencers:** Involve traditional leaders and local influencers who are respected by the community.
- **Cultural Communication:** Use local languages and culturally relevant communication methods to facilitate understanding and participation.

6.22 ENHANCING POSITIVE IMPACTS OF PROPOSED PROJECT

Employment opportunities for locals and citizens and a boost in economic activities of the project area have been identified as the potential benefits of the rail project. As a result, the following measures shall be implemented to enhance the benefits:

- A Labour and Employment Management Plan (LEMP, which follows local and international employment guidelines and the requirements of relevant IFC Performance Standards, shall be developed before the commencement of construction activities. The LEMP shall include the percentages and numbers of the workforce to be sourced from the local communities and the local procurement and supplies targets). The contractor will initiate training and skills development programmes before the commencement of construction, as a means of ensuring that members of the local workforce are un-skilled and can be employed on the Project.
- Additionally, electricity generation can be enhanced through regular monitoring and maintenance of the power plant. Monitoring of plant performance can be achieved remotely by the original equipment manufacturer (OEM), and spare parts for plant inventory and equipment failures shall be purchased from the OEM or an alternative supplier.

6.23 MITIGATION MEASURES FOR CUMULATIVE IMPACTS

6.23.1 Mitigation Measures for Cumulative Physical Displacement and Livelihood Impacts

- The Project design shall optimize the rail route alignment where feasible to minimize overlap with the development projects project such as the Kano-Katsina Highway expansion and the Kano–Shuwari Highway Road Development Project, which trigger economic and physical displacement. This will reduce the cumulative displacement impacts.
- There shall be timely and fair compensation for all affected properties, considering market value.

6.23.2 Mitigation Measures for Cumulative Impacts on the Great Green Wall Project

The FMT may collaborate with other government agencies and local NGOs to:

- Encourage and support sustainable farming practices that minimize land clearance, such as agroforestry and conservation agriculture, with training and capacity-building programs for local farmers.
- Work with local communities to develop and implement controlled grazing systems, including designated grazing areas, rotational grazing practices, and the introduction of fodder crops to reduce pressure on natural vegetation.
- Introduce and promote alternative energy sources for cooking and heating, such as solar cookers and improved cook stoves, ensuring these alternatives are affordable and accessible.
- Establish community-managed woodlots to sustainably supply fuelwood, reducing pressure on natural forests under the Great Green Wall project.
- Collaborate with the Great Green Wall initiative to align rail project activities with the goals of combating desertification, including joint monitoring and mitigation efforts where the rail project intersects with the Great Green Wall corridor.
- Conduct awareness campaigns to educate local communities about the importance of the Great Green Wall project and promote sustainable land-use practices.

Table 6. 1: Summary of Impacts, Mitigation Measures and Residual Impacts

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
Pre-construction Phase	Land Acquisition	Economic and Physical Displacement	High	Local and international guidelines shall be followed to ensure that displacement is not by intimidation or coercion. Adequate notification of the affected persons, at least 6 months, before demolition or clearance of farmland is an important step towards ameliorating the impacts. A Resettlement Committee may be set up by the Federal Ministry of Transportation, to be headed by a top official of the ministry; and the committee shall include relevant agencies at the federal, state and local government levels. Heads of affected communities shall be included in sub-committees to ensure fairness and transparency. As part of mitigation measures, an Escrow Account, having as its signatories the FMT, and other critical agencies responsible for land acquisition and compensation shall be opened in a bank strictly for the purpose of compensation payment. The committee shall also be responsible for resettlement of the affected property owners and farmers to new houses and farmland respectively for the purpose of restoring their habitats and means of livelihood. This is to ensure	Moderate

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				that the money paid for compensation is judiciously used by the affected individuals and guard against future problems for the project. Therefore: Resettlement Action Plan (RAP) shall be developed using Resettlement Policy Framework that is currently being developed as at the time of this report. Census shall be carried out to collect appropriate socio-economic baseline data to identify the persons who will be displaced by the project, determine who will be eligible for compensation and assistance, and discourage ineligible persons, such as opportunistic settlers, from claiming benefits. The FMT, through its RAP Consultants, shall establish a cut-off date for eligibility. Information regarding the cut-off date will be well documented and disseminated throughout the project area. It is strongly recommended that FMT use and adhere to negotiated settlements with the affected people in compliance with the requirements of PS5. Compensation payment to all the displaced persons, which include farmers, land and property	

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				owners shall be transparent, equitable and consistent to all communities and persons affected by the displacement. FMT shall offer the PAPs adequate compensation for the land, farmland and properties at full replacement cost. In addition, some of the displaced persons or relations may be engaged during construction and operation phases of the project to assist them in restoring or improving their standards of living. The FMT shall: - ensure that compensation and any resettlement undertaken are in compliance with extant laws as well as the objectives of Performance Standard 5. Records of consultations and compensations made shall be properly documented and kept for future reference. - neither take possession of nor commence any work on the project until full compensation has been made (except in a situation where there is ownership conflict on certain aspect of the land). - continually engage with the PAPs and PACs through the process of stakeholder engagement.	

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				- ensure purchase agreement was witnessed and signed by heads of communities affected and heirs to family land. - ensure that the perspectives of the vulnerable groups in the affected communities are obtained and their interests factored into all aspects of compensation. Mitigation of displacement will be considered complete only when all the affected people and communities have received full compensation and other assistance in accordance with the requirements of the PS5 and Resettlement Action Plan.	
Pre-construction Phase and construction	Mobilization of materials and equipment, personnel Land clearance, earthworks, construction of rail tracks and train stations	Noise and vibration	Moderate	The following are mitigation measures that shall be implemented to further minimise noise and vibration impacts from the project site during mobilisation and construction: - New or properly serviced vehicles and equipment are less noisy than the old ones. Therefore, use of old, poorly maintained vehicles for movement of construction crew and materials shall be discouraged. Vehicles and equipment to be used for this purpose shall be well serviced. - Vehicles and equipment shall be turned off when	Low

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				not in use for a prolonged period of *idling* time. - When it is impracticable to get new equipment, well-serviced old equipment shall be modified, (such as integration of mufflers or sound-absorbing materials) to ensure the noise generated from the equipment is bearable. - Construction equipment shall, on a regular basis, be checked for worn or chipped gear teeth, worn bearings, poor lubrication, imbalance in rotating parts, obstruction in airways, damaged silencers etc. as may be applicable. All identified anomalies or defects shall be corrected without delay. Less expensive temporary barriers and enclosures may be built around noisy stationary equipment to significantly reduce noise level. Noise level at receptors decreases with increase in distance from noise source. Thus, noisy, stationary equipment such as generators and compressors shall be located far from workers and residential settings. Noisy construction activities shall be, as much as practicable, synchronised and restricted to the least noise-sensitive period of the day (usually between 7am and 6pm). The combined noise levels	

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				produced may not be significantly greater than the level produced if the operations were performed separately. In addition, as much as feasible, noisy activities shall be suspended during hours of prayer if the work station along the route is close to any residence or mosque. Alternative construction techniques that are less noisy shall be considered. As much as practicable, communities near the construction site shall be pre-informed if there will any major noisy activities that may cause panic or high level of disturbance. To reduce workers exposure to noise impacts, work rotation may be considered for those whose tasks expose them to continuous high level of noise. Use of ear plugs by construction workers who are exposed to noise level up to 80 dB(A) over a prolonged period of time shall be encouraged as a personal protective measure against noise impact. Workers shall be encouraged to communicate in an orderly manner at construction site to minimise noise impacts.	

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
Operation and Maintenance Phase	Train movement and train station operations	Noise and vibration	Moderate	Construction of overhead bridges, tunnels instead of level crossings and protection of the rail tracks from indiscriminate public access will minimise use of train warning alarms The elasticity or flexibility of the track superstructures may be increased to minimise noise and vibration associated with train movement. There shall be regular maintenance of the rail-running surface. Train speed during the operation phase shall be optimal as train movement at high speed generates significant level of noise.	Low
Pre-construction and Construction Phase		Air pollution	Moderate	Dust control measures are in particular imperative in the project area due to its arid nature where soil can become very dry and vulnerable to transport by high winds. The most effectual method of minimising air pollution is to control dust and other air pollutants at source before they are airborne. In compliance with IFC PS 3, general mitigation practices and principles that could apply during the construction phase of the project include the following: The project proponent and or contractors handling	Low

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				the project shall: Plan the routes for haulage vehicles to be away from residents and other sensitive receptors, such as residences, schools and medical facilities Keep the routes in compacted condition, where practicable, using static sprinklers, water bowsers, or commercially available additives and dust binders. Minimise movement of vehicles as much as possible. This may be achieved by using large-sized vehicles, which are capable of hauling more materials to site compared to small or medium-sized vehicles that require more trips to move the same quantity of materials to the construction site. Ensure that speed of vehicles is controlled to as low as 15km/hr while moving through unpaved road which is likely to generate dust. Speed limit shall be enforced to ensure compliance. Ensure that engines and exhaust systems of equipment and vehicles used for construction are properly maintained to make certain emissions do not exceed statutory emission limits. Ensure that vehicles, equipment and internal	

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				combustion plant are not left idling, running unnecessarily. They shall be turned off if not in use for a prolonged period of time. Ensure that fine construction materials such as sand and cement that are likely to generate dust in transit are properly covered during haulage to prevent wind impact. Ensure that construction materials that are likely to generate dust if blown by wind are stored and covered in an enclosure or bunded area. Ensure that earthworks, excavation and digging, removal of vegetal cover are done in discrete sections to guard against exposure of a vast expanse of loose soil particles prone to wind effect. Therefore, construction sequencing can greatly reduce problematic dust from a site. Ensure that, if land must be disturbed, temporary stabilisation measures before disturbance shall be considered. Preferably, non-toxic chemical soil stabilizers according to manufactures' specifications may be applied. However, use of chemical soil stabilisers shall be done sparingly and only on mineral soils, to avoid contamination of soil and water resources.	

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				Ensure that, to the extent possible, dust-generating activities shall be minimised or avoided during windy and dry weather periods. Adopt water-suppression methods to minimise dust generation on site. Water may be sprinkled where necessary as dust suppressant to minimise airborne dust during earthmoving activities, prior to clearing, before excavating, backfilling, compacting, or grading. Applying water to exposed soils can be time intensive, and if done to excess, could result in excess runoff from the site or vehicles tracking mud onto public roads. Therefore, well trained personnel shall be assigned this duty. Clean all vehicles properly before they leave the construction site if they are dusty. Train workers to handle construction materials and debris during construction to reduce fugitive emissions. Ensure that soil is kept moist while loading into dump trucks, and soil loads shall be kept below the freeboard of the truck to minimise drop heights. Encourage mulching at site, which can be a quick and effective means of dust control for a newly	

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				disturbed area. Embark on air quality monitoring during the construction phase to ensure that they do not constitute nuisance or exceed recommended limits.	
Pre-construction and construction phase	Clearance of site and route,	Impact on plant species and vegetation	Moderate	Vegetated areas around the construction site shall not be cleared if unnecessary. Manual clearing of vegetation shall be encouraged, where practicable and especially around steep slope, to minimise disturbance of plant species that are off-site. To prevent crop damage, site clearing activities may be delayed till after harvest of the annual crops on farmlands, which predominate the project corridor. Workers shall be educated with respect to the existence of some plant species (such as *Andasonia digitata, Balanites aegyptiaca,* among others), which are of high importance to the people in the area and the need for their protection during construction. Vehicles shall be kept on established access roads	Low

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				to reduce habitat disturbance. Soil restoration by minimising soil compaction and increasing organic matter) will enhance vegetation regrowth. As much as practicable, opening new borrow pits for the project, which may necessitate clearing of vegetation shall be avoided. Contractors shall apply erosion controls that comply with local, state, or federal standards. Apply practices such as jute netting and silt fences. Use of dust abatement techniques on unpaved, un-vegetated surfaces to minimise airborne dust on plants shall be encouraged Topsoil removed site clearance shall be used to reclaim disturbed areas. Mature trees in the vicinity of the project site (off site) shall be clearly marked with high-visibility tape to prevent unnecessary removal or damage during construction activities. Excess cleared land shall be re-vegetated.	

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
Operation phase	Weed control and RoW maintenance	Impact on plant species	Moderate	Choice and use of herbicide for weed control along the route and in other parts of the project site shall be in strict compliance with safety standard. The FMT shall ensure that clearing and maintenance of RoW is restricted to within the setback to guard against disturbing vegetation in the vicinity.	Low
Pre-construction and construction phase	Clearance of site and route,	Impact on fauna species	Moderate	To prevent or minimise mortality and disturbance of avifauna, bird nests shall be avoided, as much as practicable, and the risk of permanent habitat loss shall be minimised or controlled by restricting clearing to areas required for construction Buffer zones in the project vicinity, especially around important habitats may be established. Habitat disturbance shall be reduced by keeping vehicles on established access roads and by minimising foot traffic in undisturbed areas. To minimise mortality of earth-dwelling and slow-moving animals, manual clearing shall be encouraged at places where it is practicable. Where fauna species of conservation importance are encountered by chance during clearing or construction, the contractors shall notify the FMT	Low

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				officials who shall notify the FMEnv or other agencies responsible for conservation. Therefore, contractors and their employees shall be well-trained on the environmental aspects of their activities.	
Operation and maintenance phase	Train movement	Impact on fauna species (especially domesticated)	Moderate	To minimise adverse impacts of the project on animals, the following mitigation measures shall be implemented: Awareness programme may be organised for herders and pastoralists across the project corridor on the need to avoid grazing their livestock near rail tracks to avoid train collision with the animals. Established grazing routes, which are likely to be fragmented by the rail route, shall be avoided through project design. This may involve construction of overhead bridge for the animals to connect fragmented routes. Vegetations with tall trees, which will not interfere with the rail line, shall be maintained to provide landing options for birds. An ecological management plan shall be developed to further minimise impacts of project operation on the biodiversity of the project area.	Low

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
Pre-construction and construction phase	Excavation, site clearance, earthworks and construction of train station and rail tracks	Impact on soil	Moderate	Areas with unstable slopes along the route shall be avoided, as much as possible, during earth excavation and general construction. The construction contractors shall employ adequate slope protection techniques to prevent erosion. Compacting or other hardening of surface shall be avoided by minimising movement of vehicle and heavy machinery on open soil and areas with sensitive slopes. To ensure soil stability and minimise soil exposure to erosion, removal of vegetal cover shall be restricted to the construction site and adjoining points necessary for construction-related activities. Other erosion control and re-vegetation (after construction) plan shall be put in place for post-construction phase. Wastes generated during demolition and construction shall be properly managed and disposed in designated areas Runoff control features shall be designed to minimise soil erosion. Drainage ditches shall be constructed only where necessary. Structures at culvert outlets may be	Low

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				used to prevent erosion. Creating excessive slopes during excavation and other construction activities shall be avoided. Hazardous materials shall be carefully stored and handled to avoid accidental spill and soil contamination. Machinery, equipment and vehicles used during demolition, clearing and construction shall be properly serviced to ensure the possibility of fuel and lube oil leakage are eliminated and free of excess oil and grease. Fueling of equipment shall be carefully done to avoid spills on site. Spent oil, other hydrocarbon waste and hazardous wastes shall be collected into appropriate containers of sufficient capacity and stored prior to evacuation. Effective spill containment kits shall be provided on-site if hazardous materials are to be stored on the construction site. Unplanned spills shall be contained and cleaned up immediately. In addition, storage, handling and use of materials	

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				shall be undertaken in accordance with the instructions on Material Safety Data Sheet (MSDS) of the chemicals. Stockpile of materials shall be carried with plastic sheeting or tarps; with berm installed around the stockpile of materials to prevent runoff from leaving the area; Contaminated soil, which may result from accidental spill of hazardous materials, shall be promptly removed, evacuated and properly disposed of. Topsoil removed during excavation shall be used to backfill or reclaim disturbed areas. In addition, backfilling shall be carried out using suitable materials that meet the applicable land use standards to prevent ground subsidence. Where subsidence has occurred, additional backfill materials shall be used. Low impact excavation shall be implemented, and excavation shall not be carried out during a prevalent adverse weather condition. An adequate number of refuse bins shall be provided at the construction sites and campsites in	

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				designated waste bins. Waste shall be contained to the construction site and campsites. This shall be properly disposed of using government-licensed waste managers.	
Operation and maintenance phase	Storage of fuel for generating sets, waste collection	Impact on soil	Moderate	Bund wall shall be constructed around fuel storage tank(s) at train stations to contain fuel in the event of spill or accidental rupture. Waste generated on train and at the train stations shall be appropriately disposed of by engaging government-licensed waste managers. Hazardous chemicals such as persistent organic herbicide shall not be used for weed control along the rail route.	Low
Pre-construction and construction phase	Clearance and construction of rail tracks and train stations	Impact on surface water	Moderate	Water exploitation from ponds and rivers for construction shall be carefully done to prevent contamination Runoff control features shall be designed to minimise soil erosion, which may impact receiving surface water.	Low

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				Wastes generated during demolition and construction shall be properly managed and disposed in designated areas. Drainage ditches shall be constructed only where necessary. Structures at culvert outlets may be used to prevent erosion. Creating excessive slopes during excavation and other construction activities shall be avoided. Hazardous materials shall be carefully stored and handled to avoid accidental spill and soil contamination. Machinery, equipment and vehicles used during demolition, clearing and construction shall be properly serviced to ensure the possibility of fuel and lube oil leakage are eliminated. Contaminated soil, which may result from accidental spill of hazardous materials, shall be promptly removed, evacuated and properly disposed of. Low impact excavation shall be implemented, and excavation shall not be carried out during a prevalent adverse weather condition.	

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				Waste generated by construction workers shall be properly collected and disposed of.	
Pre-construction and construction phase	Demolition and site clearance, disposal of waste materials, groundwater exploitation,	Impact on groundwater	Moderate	Prior to construction, areas of groundwater discharge and recharge shall be identified. Hydrologic conduits between two aquifers shall be avoided. During construction over-abstraction of groundwater resource at campsites shall be avoided. Where necessary and as an alternative, contractors handling civil and construction works may source for water off-site and convey to site using water trucks to complement the planned on-site borehole. Abstraction shall be controlled to guarantee moderate withdrawal, which does not exceed the sustainable yield of the aquifer. Mitigation measures aimed at preventing soil contamination through accidental spill, use, storage and transport of hazardous materials, shall be implemented. This will eliminate the likelihood of soil contaminants percolating into groundwater. Waste generated onsite shall be properly discarded in waste bins and disposed of using	Low

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				approved waste managers. The contractors, using accredited waste managers, shall dispose of excess excavation materials in approved areas to minimise leaching of hazardous materials.	
Operation phase	Fuel storage for generating set; groundwater exploitation for domestic purposes (at train stations and on board).	Impact on groundwater	Moderate	Bund wall shall be constructed around fuel storage tank to contain fuel in the event of spill or accidental rupture. Groundwater resources shall be carefully managed, especially during dry season such that water abstraction for domestic use is regulated. Only the required volume of water for use shall be drawn to conserve groundwater resource. Regularly check to detect leaks in water taps, hose connections and other the plumbing installations shall be carried out and promptly fixed. Waste collected from trains and at the train stations shall be properly disposed of using government-licensed waste managers. Construction of solar-powered boreholes.	Low
Pre-construction	Movement of	Impact on traffic	Moderate	A wide range of temporary traffic management	Low

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
and construction phase	equipment, trucks and machinery Demolition and clearance of site	and transportation		measures shall be employed, as appropriate, to facilitate the construction works and mitigate the potential impacts on traffic situation in this area. These measures shall include the following: A Traffic Management Plan shall be developed by the contractors in collaboration with the FMT. Consultation with local stakeholders (such as local government authorities and heads of communities) may be undertaken prior to the finalisation and implementation of the Traffic Management Plan. Traffic diversion signs shall be visibly placed at points where road users can easily make a detour to alternate routes. Traffic control officer shall be appointed to direct traffic when a part of the public road is closed for construction. Activities at the construction site shall be phased and properly timed, and measures shall be put in place to ensure safe access to and from the construction sites Transportation plan, particularly for oversized or overweight project components, shall be developed. The plan should consider component	

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				sizes, weights, origin, destination, and unique handling requirements. Drivers shall be instructed to adhere to safe speed limits to ensure safe and efficient traffic flow. Construction vehicle movement on public roadways shall be restricted to off-peak commuting times, if possible, to minimise impacts on local commuters. All personnel and contractors shall be instructed to adhere to speed limits to ensure safe and efficient traffic flow. Only licensed and experienced drivers shall be engaged to reduce road accidents on and off-site.	
Operation phase	Train operations	Impact on traffic and transportation	Moderate	It has been observed that presence of a train station in an area attracts steady huge vehicular traffic in the direction of train station throughout the lifetime of the rail operations. As a result, connecting road to the train station may be expanded by authorities to absorb increased pressure on existing roads.	Low

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
Pre-construction and construction phase	Construction activities	Impact on workers' health and safety	High	The FMT, its contractors and or sub-contractors shall ensure that: a safe and healthy work environment is provided for the workforce clear warning signs are installed at strategic locations on site personal protective equipment which are appropriate for tasks being carried out are provided and its use mandatory while on site. no minor is engaged as a worker on or off-site. *According to the applicable laws in Nigeria, a minor is a person who is less than 18 years old. There are many examples of different ages enshrined in a multitude of legal texts and in customary law all over the country. The official report admits that laws affecting or defining who a child is are diverse in different legislations. The definitions vary depending on cultural background of the affected. According to the actual legislations, the age for being a child ranges from 7 to 21 years.* no person is coerced into any form of labour or activities regarding the proposed project. compliance with organisational policy on health,	Moderate

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				safety and environment. there are in place procedures, which strongly discourages all forms of discrimination such as between migrant and local workers and conflict is quickly and amicable resolved. workers welfare and fundamental rights are protected at all times well-stocked first aid box, which is easily accessible for workers, is in place at the construction site before seeking external medical attention. overtime work shall be minimised or discouraged to guard against fatigue use of alcohol, hard drugs and other substances capable of causing harms to the user and co-workers is prohibited on site. workers are protected from external aggressors by providing adequate security at the construction sites and campsites workers are given proper orientation on responsible sexual behaviour to ensure none contract sexually transmitted infections. The workforce shall be properly enlightened on the	

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				consequences of indiscriminate sexual activities and unsafe sexual behaviours. There shall be implementation of initiatives which target knowledge, attitude, behaviour, prevention, treatment and care in collaboration with relevant organisations. HIV/AIDS and other STIs awareness groups shall be created through the peer groups of construction crew The Safety programme at construction site and campsites shall include infection prevention protocols. In particular, the international protocols for the prevention of corona virus disease (COVID-19) and other infectious diseases shall be put in place and adhered to while the pandemic subsists. The proponent and or its contractors may allocate fund for procurement of protective latex for distribution to workers, who shall be advised to use it properly if they cannot abstain from sex during the period of their stay in the area. no person works in isolation especially along the rail route and in areas of high security risk. A robust safety management plan shall be developed and implemented. This is anticipated to	

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				eliminate major occupational hazards and serious injuries. In the unlikely event of a serious accident involving a construction worker on site, fair and adequate compensation shall be paid for the affected worker or his/her next of kin.	
Operation phase	Train station operations and train movement	Impact on workers 'safety and health	High	Only well trained, certified personnel shall be allowed to carry out installations, repairs and maintenance of electrical equipment at the train stations. To prevent electric shock and electrocution, energised cables shall be deactivated and properly grounded before carrying out repairs and maintenance of electrical installations and equipment. Workers shall carry out their tasks only when properly protected using appropriate tools and PPEs such as rubber gloves, non-slip safety boots, helmet, safety straps, leggings, etc. Access to high-risk area shall be restricted, and other workers not directly associated tasks in such area shall be prohibited. There shall be fall prevention programme (such as training in climbing techniques) in place for	Low

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				personnel working at elevations. Structures and tools used for climbing shall be tested for strength and integrity from time to time before use by workers. Workers shall not be deprived of their rights of association as long as it is a lawful society, group or association. Their welfare and fundamental rights shall be protected at all times. Security personnel shall be part of the train crew to protect staff from aggression or physical attack by any disgruntled passenger. Use of alcohol, hard drugs and other substances capable of causing harms to the user and co-workers shall be forbidden at work place. No minor shall be engaged as a worker for this project either directly or through third party. No one shall be coerced into any form of labour or activities regarding the proposed project. Workers who are likely to suffer trauma or guilt as a result of accident involving train and pedestrian / vehicles shall be referred to clinical psychologist or relevant specialists for help.	

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				There shall be in place procedures, which strongly discourages all forms of discrimination such as tribal or gender discrimination or discrimination against physically-challenged workers. Workers shall be protected from sexual harassment. Female workers are more vulnerable than male workers in the construction industry; they shall be given adequate protection from harassment. The HSE programme during train operations shall include infection control programme. In particular, the internationally-recognised protocols for the prevention of corona virus disease (COVID-19) and other infectious diseases shall be put in place and adhered to while the pandemic subsists. There shall be installation of fire-fighting equipment such as fire extinguishers and fire hydrant at the train stations and on the train. There shall be emergency (alternative) exit door in the event of emergency.	
Pre-construction and construction phase	Demolition, site clearance, earthworks and construction of	Impact on community health and safety	High	There shall be adequate and visible hazard/safety signs at and around the construction site such as access restriction and traffic hazards	Low

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
	rail tracks and train stations			Speed limit shall be enforced to ensure vehicles used for haulage of materials do not pose threat to public safety. Communities that are near construction sites shall be informed ahead if there are any activities or emissions that could affect their well-being and the area shall be cordoned off. Rail tracks shall be regularly maintained to guard against train derailment and accident. Other recommended mitigation measures, which are aimed at preventing or minimising potential adverse health impacts of the project and its related activities (such as possible spread of STIs) shall be implemented. Mitigation measures aimed at protecting groundwater and surface water in the project area shall be implemented with the objective of safeguarding the health of communities which depend on the water resources for domestic purposes. This may also require periodic monitoring throughout the period of construction. In addition, air quality shall be intermittently monitored to ensure that emissions from construction sites are checked, corrected and	

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				threshold (recommended) limits are not exceeded.	
Operation phase	Train station operation and train movement	Impact on community health and safety	High	Overpass and tunnels incorporated into the project design will minimise risk of accident / collision between train and vehicles during operations. Overhead pedestrian bridges shall be constructed to link fragmented communities. The rail track shall be protected from public access through palisade fencing where necessary to prevent members of the communities especially children from accidents. During operation, infection control programme, which ensures spread of infectious diseases shall be put in place at the stations and on board.	Low
Pre-construction and construction phase / Construction	Land acquisition, demolition of structures, construction security services,	Human rights infringement	High	Human rights violation during construction may include sexual and gender-based violence especially against female workers and residents of the host communities. Discrimination against persons with disabilities is an infringement of their rights and this shall be discouraged.	Low

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				Use of force by security personnel at construction site against members of the public shall be strongly discouraged. This shall be avoided at all cost through training, awareness on human rights protection. Erring security personnel, who violates rights of people through physical attack or use of weapon, shall be severely sanctioned to deter others. Local and international human rights standards shall be adhered to at all times, and FMT shall engage parties to any conflict to minimise human rights infringement.	
Operation phase	Train transport services	Infringement on human rights	High	The FMT and any of its agencies shall: ensure fair treatment of employees, contracted workers, or supply chain workers, and provide for them equal opportunities without any form of discrimination. clearly communicate the working conditions and terms of employment to employees in the language they understand. The human resource policy shall plainly state the workers' rights and privileges, wages, allowances, bonuses, leaves, etc. promote a safe and healthy work environment and	Low

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				conditions. ensure that child labour or forced labour is strictly prohibited. compensation to workers, passengers or any affected member of the public is adequately and promptly paid if such a need arises. Such a situation may include but not limited to accident or injuries suffered in the course of duty or by an act related to the activities of the rail services. ensure that no passenger is maltreated by any of its employees, third-party workers or security personnel or denied due privileges at the station and or while on board. ensure that conflicts are promptly and fairly resolved.	
Pre-construction and construction phase	Land clearance, demolition, earthworks, construction of rail tracks and train stations	Greenhouse gas emission	Moderate	Impacts on greenhouse gas emissions shall be mitigated by applying the mitigation measures for air quality impact. These shall include regular servicing of machinery and equipment to ensure that emissions are minimal. In addition, renewable energy such as solar energy may be used to power the campsites instead of	Low

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				using fossil fuel-powered generating sets. In addition, unnecessary cutting down of plant materials shall be avoided. Tree planting at the train stations and along the rail route may be adopted to partly offset the potential project impact on the existing carbon sink.	
Operation and maintenance phase	Use of fossil fuel-powered generators for electricity	Climate change	Moderate	The train stations may be powered by using clean energy alternatives such as solar system or wind turbines. The 10 MW wind farm at Lamba Rimi, Katsina State, which is near completion may serve as a source of clean energy for Katsina and the train stations in Katsina such as solar energy may be used to power the train stations instead of using fossil fuel-powered generating sets. In addition, unnecessary cutting down of plant materials shall be avoided. Tree planting at the train stations and along the rail route may be adopted to partly offset the potential project impact on the existing carbon sink.	Low

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
Pre-construction and construction phase	Land clearance, demolition, earthworks, construction of rail tracks and train stations	Impact on cultural heritage	Moderate	Burial ground shall be avoided if encountered within the RoW during clearance of site and routes If tombs are found within the RoW, the affected families shall be engaged and collaborated with on relocation of the tombs The Rinian Sacred Forest shall be avoided as much as practicable during construction phase. Relevant state governments and stakeholders shall be engaged to identify and preserve international livestock routes. The international livestock routes, which are likely to be fragmented, shall be promptly linked after route clearance. Temporary measures will be put in place to preserve the routes pending the completion of the rail line construction. The livestock routes shall be permanently linked during construction through overhead bridges or tunnels, as much as practicable. If it becomes impracticable to reconnect all international livestock routes through construction of bridges and tunnels, all the relevant stakeholders shall be engaged on the establishment of major international livestock	Low

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				routes.	
Pre-construction and construction phase	Land clearance, demolition, earthworks, construction of rail tracks and train stations	Impact on ecosystem services	Moderate	A vast expanse of farmlands and grazing area will be impacted, which will affect food production – a major ecosystem service derived from the project area. As part of mitigation measures for economic displacement (of farmers), affected farmers and herders shall be assisted in acquisition of new farmlands and grazing area not far from their places of residence or near original land they were displaced from. As much as practicable perennial plants used by adjoining communities for medicinal purposes and as food may be protected if they are unlikely to interfere with project activities.	Low
Operation phase	Train service operations	Impact on livelihood of transporters	High	The affected road transporters shall be engaged and sensitized prior to operation phase on the need for alternative transport routes to sustain their livelihood. The project will create new opportunities such as cab services from and to train stations for road transporters. Some of the affected transporters may be encouraged or enlightened during further stakeholders consultation to embrace this potential opportunity.	Low

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
Operation phase	Train services	Security risk	High	Security of passengers and workers at the train station and on train shall be guaranteed. The likelihood of terrorist attack shall not be ruled out. To forestall that, strict security measures such as installation of close-circuit television (CCTV), security screening at the entrance of the train station shall be put in place and closely monitored. Well-trained and properly armed security personnel shall be stationed at the train stations. They shall be trained on respect for human rights, right use of force and security emergency response.	Low
Operation phase	Train services (movement of passengers and freight	Transboundary impact	High	The transboundary impact mitigation in this context is not related to the Espoo Convention on Environmental Impact Assessment in a Transboundary Context of 1991. The mitigation focuses on curbing illegal transnational movement, particularly of criminal gangs and individuals of high security threat through rail from Niger Republic to Nigeria and vice-versa. To achieve that, immigration officers in collaboration with other security personnel shall screen passengers at the border stations before they are allowed to proceed	Low

Project Phase	Project Activity	Potential Impact	Overall Impact Rating	Mitigation Measures	Residual Impact
				across transnational boundary.	

7.0 CHAPTER SEVEN: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

7.1 INTRODUCTION

Environmental and Social Management Plan ESMP is an environmental management tool generally used to ensure that avoidable adverse impacts of a development project are prevented or minimized while enhancing its (the project) potential benefits. It is a site-specific, strategic programme aimed at ensuring that reasonably avoidable or unanticipated impacts of a proposed project, which were not identified, are controlled and minimized to an acceptable level. Having painstakingly considered the potential impacts associated with the railway development project and associated activities / facilities, mitigation measures were also proposed to avoid, ameliorate or compensate for the anticipated impacts. The evaluation of the likely residual impacts of the project suggests that mitigated impacts are acceptable if the measures recommended are properly implemented. The FMT, its EPC Contractor and Agencies (particularly the Nigeria Railway Corporation, which shall be responsible for the operation of the project) are fully committed to execute the project in accordance with existing laws on environmental protection and the principles of sustainable development.

Having carefully evaluated the potential and associated impacts of the proposed Kano – Maradi with Dutse Branch Line Rail Project, mitigation measures were also proposed in the previous chapter (Chapter 6) to eliminate, ameliorate or compensate for the anticipated impacts. The evaluation the residual influences of the project suggests that mitigated impacts are acceptable if the measures recommended are properly implemented.

The IFC Performance Standard 1 highlights the import of managing environmental and social performance of development project throughout its life cycle. Residual impact after implementation of mitigation measures will likely persist, which may be insignificant, minor or moderate. As a result, the Environment Management Plan is to ensure effective management of potential and residual impacts of the project through allocation of responsibilities for implementation at different phases of the planned rail project.

7.2 OBJECTIVES OF ESMP

The primary objective of an ESMP is to ensure that a project is sustainable by ensuring excellent environmental and social performance. Therefore, this ESMP builds upon the mitigation measures outlined in the previous chapter, and it has been developed to ensure that impacts which cannot be mitigated are reduced to possible minimum extent. The plan deals with how mitigation measures proposed are implemented, and it assigns the responsibility for its implementation. It is anticipated that this ESMP will serve as a dependable source of information to relevant regulatory agencies with respect to the environmental performance of the Project Proponent and its collaborators as the mitigation measures apply to the entire project life.

This plan was developed in line with applicable national and international standards on environmental and social management. The plan entails the mitigation and enhancement measures the FMT, Mota-Engil and NRC are committed to implementing throughout the life of the project, and it includes desired outcomes; performance indicators; monitoring; and timing for actions and responsibilities. It shall be the responsibility of the FMT to ensure that all measures outlined in the ESMP are strictly adhered to, but may delegate responsibility to its contractors, where appropriate, and monitor the implementation.

The specific objectives of the ESMP are to:

- Promote environmental management and communicate the aims and goals of the ESIA;
- Ensure that all workers, subcontractors and others involved in the project meet all legal and regulatory requirements with regard to environmental management;
- Incorporate environmental management into project design and operating procedures;

- Address concerns and issues raised by relevant stakeholders and those concerns that will likely continue to arise during the project's lifetime;
- Prepare and maintain records of project environmental performance (i.e., monitoring, audits and non-compliance tracking).
- Protect the environment from potentially adverse project activities, and vice versa.

7.3 ENVIRONMENTAL MONITORING AND INSPECTION PROGRAMME

Environmental monitoring programme serves as an integral part of the operational activities to generate the requisite information for environmental management and environmental information dissemination. It is equally anticipated that monitoring of key environmental and social parameters will be conducted throughout construction and operation phases of the project. This plan will play a critical role in ensuring that the trends for specific parameters are tracked; and it will provide information on compliance with regulations, set guidelines or desirable operational limits; and form the basis for corrective actions and modification of project activities if necessary. The intensity of sampling will depend on the time and location of the activities as well as results derived from monitoring data.

Inspection and monitoring of the associated and potential impacts of project activities will enhance effectiveness of recommended measures aimed at mitigating the impacts. In addition, it will assist the FMT in ensuring that all the contractors and sub-contractors stringently comply with the mitigation measures and all legal requirements in relation to the proposed project activities. The key components of the proposed environmental monitoring plan are:

- Monitoring Objectives
- Monitoring Requirements
- Roles and Responsibilities
- Training and Capacity Building
- Contingencies, Complaints and Incident Reporting

- Monitoring Plan Reporting
- Reporting procedure
- Environmental Awareness Training Programme
- Community Consultation and Disclosure
- Monitoring: Measurements and Procedures
- Environmental Nonconformities

7.3.1 Monitoring Objectives

The aim of monitoring is to establish appropriate criteria to verify the predicted impacts of the project, and to ensure that unforeseen impacts are detected at the early stage, and the proposed mitigation measures are promptly adjusted where needed. The personnel in charge of monitoring shall keep relevant records to ensure compliance with sound environmental procedures. The monitoring plan will ensure that mitigating measures and impacts of the project during construction and operation phases are implemented.

The monitoring plan will help to detect whether any environmental change adducible to the project activities has occurred and to forewarn the proponent of unanticipated adverse impacts or changes in impact trends. In addition, the overriding goals of the monitoring plan are to:

- Check the effectiveness of the proposed mitigation measures recommended in chapter 6;
- Demonstrate that the project activities (construction, operation and in an unlikely scenario of abandonment/decommissioning) are carried out in accordance with the prescribed mitigation measures and extant regulatory procedures; and
- Provide early warning signals whenever an impact indicator approaches a critical level.

Impact indicators, in this context, are considered to be the carrying capacity, threshold limits, regulations and enforcement standards. Implementation of the ESMP will allow FMT (including its EPC Contractors and Agencies) to potentially control and manage the timing, location and level of impacts and possibly provide the cause-and-effect data for the empirical substantiation or validation of various predictive models of action/impact relationships.

Construction Phase

At the construction phase of the project, the aim will be to assess the mitigation measures for displacement and human rights infringement, noise and vibration, air quality, groundwater quality, surface water quality, soil quality, workers safety and public safety. The nature and extent of impacts and pollution observed for environmental matrices will be determined by laboratory analyses of samples taken from site. Grievances and conflict may serve as key indicator for unmitigated social impacts while traffic congestion on link roads to project site may serve as a parameter for improper traffic management. Appropriate measures shall thereafter be taken to rectify the problem.

Operation and Maintenance Phase

The monitoring plan at this phase will ensure that the negative impacts at the operation phase of the project are reduced to the barest minimum. This will guarantee the safety and health of workers, passengers, the host communities, and the public at large.

7.3.2 Monitoring Requirements

The monitoring program requires several components to ensure effective results. These include:

- Relevant baseline data, as presented in chapter four, against which to monitor project results;
- Verifiable objective indicators for the project and project components for which monitoring will be conducted;
- An independent, competent consultant, who shall be responsible for monitoring of key environmental parameters;

- Monitoring shall be on a regular basis;
- An effective monitoring reporting mechanism including feedback and commitment to action on monitoring results and recommendations.

The Environmental Monitoring Programme highlights the environmental monitoring requirements to ensure that all the mitigation measures identified in this ESMP are implemented effectively. Environmental monitoring methodology for this project includes:

- Audit of detailed designs
- Audit and approval of site environmental planning documents
- Consultations with communities and other stakeholders as required
- Routine inspection to confirm or otherwise the implementation and effectiveness of required environmental and social mitigation measures

Routine monitoring shall focus mainly on construction supervision and raising awareness in the context of human health and safety and environmental protection. Non-compliance to environmental mitigation measures identified in the ESMP will be advised to the concerned parties by the Safety Department of the FMT, Mota Engil and NRC as may be required. The non-compliance notification will identify the problem, including the actions the concerned parties must take and a time frame for implementing the corrective action.

7.3.3 Roles and Responsibilities

The implementation of this ESMP and its requirements shall be the responsibility of the FMT, the contractors and subcontractors and its agency (NRC during the operation phase). There shall be adequate collaboration with relevant government agencies and parastatals with specific responsibilities as assigned in this document. The FMT through its Safety Department, shall also be responsible for the implementation and supervision of social and environmental check-list and for the overall supervision of both the contractors and the consultants on the entire project phases. The African Development Bank (AfDB) will conduct regular and thorough supervision to ensure the effective implementation of the

Environmental and Social Management Plan (ESMP). This aims to guarantee that all environmental and social impacts are managed in accordance with international standards, promoting sustainable and responsible project execution. A summary of roles and responsibilities is presented in Tables 7.1 and 7.2.

7.3.4 Training and Capacity Building

The Safety Department shall work alongside the Human Resources Unit to build employees capacity and raise contractors' environmental and social awareness. This is to ensure adequate understanding of all the environmental and social aspects of the project and how their roles impact on the biophysical and human environment. A training budget shall be put aside to enable this capacity building.

7.3.5 Contingencies, Complaints and Incident Reporting

Complaints and incidents shall be referred to the Head of Safety Department or Liaison Officer, who shall undertake complaint/incident investigation procedures. All complaints shall be acknowledged with the complainant within 24 hours. The following procedure shall be followed:

- Log complaint/incident, date of receipt and acknowledge complaint receipt.
- Investigate the complaint/incident to determine its validity and to assess the source of the problem.
- Identify and undertake any action required, communicate response action to complainant (if requested by complainant).
- Log the date of resolution.
- Report the complaint in monthly monitoring report including actions, resolution status and any outstanding actions required.

7.3.6 Monitoring Plan Reporting

Throughout the construction phase and during operations, the FMT, Mota Engil and or NRC (as the case may be) shall, through its HSE Unit or Environmental Consultants, include results of the ESMP monitoring report for submission to the FMEnv and or other regulatory agencies. The format of the report shall be agreed with all concerned agencies but is recommended to include the following aspects:

- Description and results of monitoring activities undertaken during the month/quarter.
- Status of implementation of relevant mitigation measures pertaining to the works.
- Key environmental and or social problems encountered and actions taken to rectify problems.
- Key issues to be addressed in the coming month/quarter.

7.3.7 Reporting procedure

The HSE Unit / Department of the responsible organization or the Environmental Consultant shall, on behalf of the organization, prepare a bi-annual report that will form the framework assessment of environmental and social performance. The report shall contain, in addition to the results of the environmental monitoring, the need for plan adjustment where necessary. A regular report comprising the results will be prepared and made available to FMEnv, NESREA, or State Ministries of Environment in the areas of their jurisdiction.

7.3.8 Environmental Awareness Training Programme

It is the responsibility of the Project Proponent to ensure that contractors provide adequate environmental awareness training for site personnel and that all construction workers receive induction training on the importance and implications of the ESMP. For the employees of the NRC during the operation phase, adequate and regular environmental awareness training shall be provided concerning individual and collective responsibilities about their specific roles.

The NRC shall identify, plan, monitor, and record training needs for personnel whose work may have a significant adverse impact upon the environmental or social conditions. The project recognises that it is important that employees at each relevant function and level are aware of the company’s environmental policy; potential influences of their activities; and roles and responsibilities in achieving conformance with the policy and procedures. The presentation shall be conducted in English Language or as much as practicable, in the employees' language of choice. As a minimum, training shall include:

- Explanation of the importance of complying with the ESMP;
- Discussion of the potential environmental impacts of project activities
- The benefits of improved personal performance;
- Employees' roles and responsibilities, including emergency preparedness
- Explanation of the mitigation measures that must be implemented when carrying out their activities;
- Explanation of the specifics of this plan and its specification;
- Explanation of the management structure of individuals responsible for matters pertaining to the ESMP.

The Safety Department /HSE Unit and Human Resources Department shall keep records of all environmental training sessions, including names, dates, and the information presented.

7.3.9 Community Consultation and Disclosure

During consultation with project-affected stakeholders and communities, the HSE or Public Relations Unit shall interact with the individuals/communities in the form of questions and answer sessions on issues that shall be considered and investigated under the project. Consultation and disclosure remain crucial aspects of ESMP because of the large number of PAPs. The consultation and disclosure process for the project will need to address the entire range of stakeholders' expectations and concerns, and it may be modified to suit the requirements of the project. Consultations shall be recorded and documented. Any issues raised, including specific grievances, shall be handled preferably at the community level. Where the interventions of local or state authorities are required, the issues may be escalated promptly for quick resolution.

7.3.10 Monitoring: Measurements and Procedures

Systematic observation and measurement of selected project variables shall be undertaken to identify the nature and magnitude of the long-term impacts of the project. Accordingly, the regulatory authorities with responsibility for oversight functions, in the monitoring and enforcement of environmental quality at the federal level (FMEnv and NESREA) and state level (the state ministry of environment in Jigawa, Kano and Katsina) shall work in collaboration with the HSE or Safety Department of the FMT (or and its operating agency) during the course of the project operation phase to ensure compliance with relevant national and international legislations in respect of the mitigation measures and that monitoring indicators during the project phases are within permissible level.

7.3.11 Environmental Nonconformities

The purpose of the environmental non-conformities system procedure is to establish a process explaining how project proponent will manage actual and potential deviation from legal requirements and documented mitigation measures so that corrective or preventive action can be taken as required. In accordance with ISO 14001 requirements, the FMT shall establish, implement and maintain a procedure for dealing with actual and potential nonconformities and for taking corrective action and preventive action, which shall be appropriate to the magnitude of the problems and the environmental impacts encountered. The FMT shall ensure that necessary changes are made to environmental management system documentation. The process for managing any environmental nonconformity will be as follows:

- All identified nonconformities shall be recorded in the Environmental Actions Register
- The status of logged non-conformities shall be monitored to ensure timely closure, and
- The negative trends shall be identified and analysed, and preventive actions initiated and implemented to prevent recurrence.

7.4 PROPOSED ENVIRONMENTAL MANAGEMENT PLAN

Land acquisition, construction, and operation (as well as the unlikely decommissioning phase) of the rail project could adversely impact on the environment and the socio-cultural activities of the people in the host communities and the entire project corridor. Therefore, the development of a practicable and effective ESMP became necessary for sustainable development and the prevention of costly remedial measures. As a result, the environmental and social impacts mitigation measures, presented in Table 7.1, shall be adopted for implementation by the FMT and Mota Engil as well as their sub-contractors. The measures shall be made obligatory as a component of the conditions for the contract concerning the project.

It is important to state that in controlling the adverse impacts of development projects, the most appropriate mitigation measure is an improved process and procedures while carrying out specific tasks. It is the most cost-effective control measure as it eliminates the need to prevent impacts at point sources and cuts down the cost of impact management. Figure 7.1 below illustrates the cost-effectiveness of implementing an EMP.

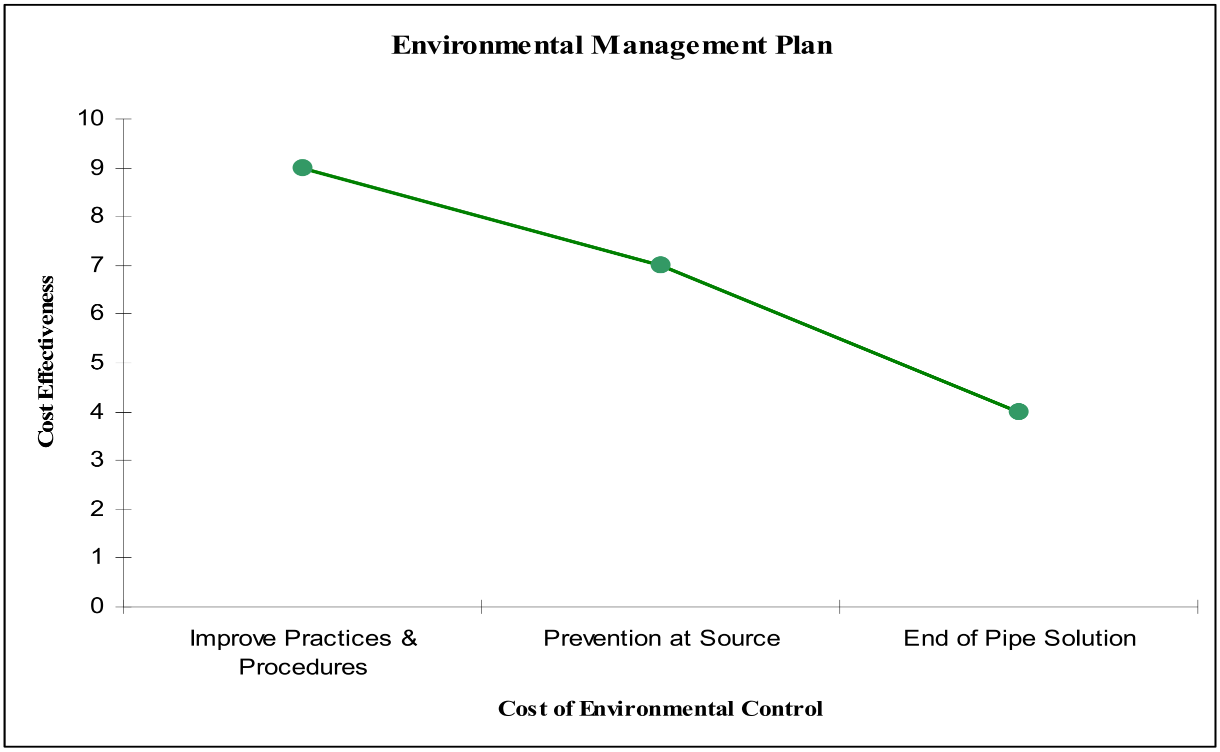


Figure 7. 1: Environmental Management Options & Cost Effectiveness

Therefore, the FMT shall pay close attention to project design and process modification as a proactive environmental management alternative to minimise the need for responsive mitigation of project impacts. This is most appropriate for pollution cases.

Table 7. 1: Environmental and Social Management Plan: Pre-Construction and Construction Phase

Potential Impacts	Sources of Impacts	Mitigation Measures	Monitoring	Timing / Frequency	Responsibility	Approx. Cost of Implementation (Naira)
Air Quality / Dust Management Plan						
SPM from dust, noise, vibration and emissions from construction equipment.	Movement of equipment, materials and workforce to site, clearing of site, earthworks, and emissions from vehicles and construction equipment	Ensure that fine construction materials such as sand and cement that are likely to generate dust on transit are properly covered during haulage to prevent wind impact and dust generation. Ensure that construction materials that are likely to generate dust if blown by wind are stored and covered in an enclosure or bunded area. Ensure that, during earthworks, excavation and digging, removal of vegetal cover is done in discrete sections to guard against exposure of a vast expanse of loose soil particles prone to wind effect. Therefore, construction sequencing can greatly reduce problematic dust from a site. Ensure that, to the extent possible, dust-generating activities shall be minimized or avoided during windy and dry weather periods.	Visual observation, site inspection and monitoring during demolition and construction works Perimeter sampling and measurement of ambient noise and air quality parameters such as SPM, CO, NOx, SOx.	Daily Weekly and throughout construction	To be implemented by contractors and monitored by the FMT through its Environmental Consultant. FMEnv and State Ministries of Environment shall be the Agencies to which monitoring report is submitted quarterly.	373,740,750 ($227,633.53)

Potential Impacts	Sources of Impacts	Mitigation Measures	Monitoring	Timing / Frequency	Responsibility	Approx. Cost of Implementation (Naira)
		Adopt water-suppression methods to minimise dust generation on site. Water may be sprinkled as dust suppressant where necessary to minimize airborne dust during earthmoving activities. All vehicles shall be properly cleaned before they leave the construction site if they are dusty. Workers shall be trained to handle construction materials and debris during construction to reduce fugitive emissions. Air quality monitoring shall be carried out during the construction phase to ensure that they do not constitute nuisance or exceed recommended limits. -				
Noise Quality Management Plan						
		Use of old, poorly maintained vehicles for movement of construction crew and materials shall be discouraged. New or well-serviced vehicles and construction equipment are less noisy than old ones. Vehicles to be used for this				46,509,960 ($28,327.73)

Potential Impacts	Sources of Impacts	Mitigation Measures	Monitoring	Timing / Frequency	Responsibility	Approx. Cost of Implementation (Naira)
		purpose shall be well serviced. If it is impracticable to get new equipment, well-serviced old equipment shall be modified, (such as integration of mufflers or sound-absorbing materials) to ensure the noise generated from the equipment is bearable. Vehicles and equipment at construction site shall be turned off when not in use for a prolonged period of *idling* time. Construction equipment shall, on a regular basis, be checked for worn or chipped gear teeth, worn bearings, poor lubrication, imbalance in rotating parts, obstruction in airways, damaged silencers etc as may be applicable. All identified anomalies or defects shall be corrected without delay. Noise level at receptors decreases with increase in distance from noise source. Thus, noisy, stationary equipment such as generators and compressors shall be located far from workers camp				

Potential Impacts	Sources of Impacts	Mitigation Measures	Monitoring	Timing / Frequency	Responsibility	Approx. Cost of Implementation (Naira)
		and residential settings. Noisy construction activities shall be, as much as practicable, synchronised, and restricted to the least noise-sensitive period of the day (usually between 7am and 6pm). The combined noise levels produced may not be significantly greater than the level produced if the operations were performed separately. In addition, as much as feasible, noisy activities shall be suspended during hours of religious activities if the workstation is close to any religious gathering. Alternative construction techniques that are less noisy shall be considered. As much as practicable, the communities around the project site shall be informed ahead if there will be blasting or any major noisy activities that may cause panic or disturbance. Use of ear plugs by construction workers who are exposed to noise				

Potential Impacts	Sources of Impacts	Mitigation Measures	Monitoring	Timing / Frequency	Responsibility	Approx. Cost of Implementation (Naira)
		level up to 80 dB(A) over a prolonged period shall be encouraged as a personal protective measure against noise impact. Construction workers shall be advised regularly to communicate in an orderly manner to minimise noise impacts. Ensure that engines and exhaust systems of equipment and vehicles used for construction are properly maintained to make certain emissions do not exceed statutory emission limits. Ensure that vehicles, equipment and internal combustion plant are not left idling, running unnecessarily. They shall be switched off if not in use for a prolonged period of time.				
Groundwater Quality and Quantity						
Contamination of groundwater resource, over-abstraction,	Spills from project equipment or site activities;	Over-abstraction of groundwater resource in the project area shall be avoided. As an alternative, water may be sourced off-site from rivers and ponds and conveyed to	Groundwater quality (physico-chemical and microbial properties) assessment with focus on hydrocarbon	Monthly during construction period	To be implemented by HSE Supervisor / Coordinator and have the report	150,000,000 ($91,360.20)

Potential Impacts	Sources of Impacts	Mitigation Measures	Monitoring	Timing / Frequency	Responsibility	Approx. Cost of Implementation (Naira)
	abstraction	site using water trucks to complement the planned on-site borehole. The FMT and or its contractors shall identify sustainable yields of groundwater, and abstraction shall be controlled to guarantee moderate withdrawal, which does not exceed the sustainable yield of the aquifer. As much as possible, accidental spill of hazardous materials, which may percolate and contaminate groundwater, shall be prevented. Waste generated onsite shall be properly discarded in waste bins and disposed of using approved waste managers. An appropriate spill prevention, containment, and clean up contingency plan for hydrocarbon products (e.g. fuel, oil, hydraulic fluid, etc.), and other hazardous substances shall be put in place prior to commencement of construction activities.	content, heavy metals and coliforms Monitoring of specific yield. Of monitoring interest is the iron content of the groundwater sources in the project area.		submitted to FMEnv, NESREA and State Ministries of Environment	

Potential Impacts	Sources of Impacts	Mitigation Measures	Monitoring	Timing / Frequency	Responsibility	Approx. Cost of Implementation (Naira)
Surface Water Quality						
Contamination of surface water during off-site sourcing of water for construction.	Accidental spills from water trucks	Caution must be taken to ensure that the surface water is not contaminated while getting water into water trucks from the river. Specifically, accidental spill of fuel or oil from trucks to be used for conveying water the river or other surface water in the area are avoided. Also, accidental spills of hazardous materials on-site, which may be washed off through run-off during rainfall, shall be guarded against. In the event of accidental spills, there shall be an immediate response to clean up to ensure surface water down the slope is not contaminated with run-off from the site. Waste generated onsite shall be properly discarded in waste bins and disposed of using approved waste managers. The contractors shall dispose of excess excavation materials using any licensed waste managers to	Surface water quality (physico-chemical and microbial properties) assessment. Also, the iron content should be closely monitored.	Monthly	To be implemented by HSE Supervisor / Coordinator and have the report submitted to FMEnv, NESREA and State Ministry of Environment	200,000,000 ($121,813.60)

Potential Impacts	Sources of Impacts	Mitigation Measures	Monitoring	Timing / Frequency	Responsibility	Approx. Cost of Implementation (Naira)
		minimize run-off of hazardous waste materials into the river(s).				
Soil Quality						
Soil contamination, degradation and disturbance, soil compaction, increased soil erosivity potential,	Site clearing and preparation, removal of topsoil, earthworks, accidental spill of hazardous chemicals during fuelling, movement, operation and servicing of construction equipment and vehicles. Accidental spill of materials at storage site	Areas with unstable slopes shall be avoided, as much as possible, during earth excavation and general construction activities. The construction contractors shall employ adequate slope protection techniques to prevent erosion. Compacting and hardening of soil surface shall be avoided by minimising movement of vehicle and heavy machinery on areas with sensitive slopes. To ensure soil stability and minimise soil exposure to erosion, removal of vegetal cover shall be restricted to the construction site and adjoining points necessary for construction-related activities. Other erosion control and re-vegetation (after construction) plan shall be put in place by the proponent and or its contractors for post-construction phase.	Visual inspection of storage area and construction machineries Construction workers are expected to be trained on spill response procedures. Soil physicochemical properties shall be monitored with focus on hydrocarbon content, heavy metals and coliform.	Monthly	FMT and or its contractors	275,000,000 ($167,493.70)

Potential Impacts	Sources of Impacts	Mitigation Measures	Monitoring	Timing / Frequency	Responsibility	Approx. Cost of Implementation (Naira)
		Runoff control features shall be designed to minimize soil erosion. Drainage ditches shall be constructed only where necessary. Appropriate structures at culvert outlets shall be used to prevent erosion. Excessive slopes shall be minimised during excavation and other construction activities. Hazardous materials shall be carefully stored and handled to avoid accidental spill and soil contamination. Contaminated soil, in the event of accidental spill of hazardous materials, shall be evacuated and properly disposed of. Topsoil removed during excavation shall be used to backfill or reclaim disturbed areas. In addition, backfilling shall be done using suitable materials to prevent ground subsidence. Where subsidence has occurred, additional backfill materials shall				

Potential Impacts	Sources of Impacts	Mitigation Measures	Monitoring	Timing / Frequency	Responsibility	Approx. Cost of Implementation (Naira)
		be used. Low impact excavation shall be implemented, and excavation shall not be carried out during adverse weather conditions. Waste generation shall be contained to the project sites. Adequate number of refuse bins shall be provided at the construction sites. The Contractor shall ensure that all personnel dispose of their domestic wastes in the waste bins provided.				
Solid waste management						
Solid waste generation	Domestic waste generated by construction workers	The contractor(s) shall follow relevant guidelines on waste management The contractors(s) shall ensure clean-up in compliance with relevant national and international guidelines, involving the removal of the waste, etc The contractor(s) shall ensure proper waste handling and	Visual monitoring and aesthetics of site.	Daily	FMT and or Contractors	350,000,000 ($213,173.80)

Potential Impacts	Sources of Impacts	Mitigation Measures	Monitoring	Timing / Frequency	Responsibility	Approx. Cost of Implementation (Naira)
		disposal methods				
Biodiversity						
Loss of economic plant species, loss of habitat and habitat defragmentation, migration of animals and possible death of soil-dwelling fauna species	Site clearing and excavation	Manual clearing of vegetation shall be encouraged, where practicable, to minimise disturbance of plant species that are off-site To prevent crop damage, site clearing activities may be delayed till after harvest of the annual crops. Workers shall be educated with respect to existence of some plant species, which are of high importance to the people in the area and the need for their protection during construction. Use of dust abatement techniques on unpaved, unvegetated surfaces to minimize airborne dust. To minimise mortality of earth dwelling and slow-moving animals, manual clearing shall be encouraged. Other mitigation measures for potential impacts on plant and	Visual site inspection of project site and adjacent area.	Regularly throughout the construction phase.	Construction contractor	375,000,000 ($228,400.50)

Potential Impacts	Sources of Impacts	Mitigation Measures	Monitoring	Timing / Frequency	Responsibility	Approx. Cost of Implementation (Naira)
		animal biodiversity, as presented in Chapter 6 of the EIA report shall be implemented.				
Stakeholder Engagement Plan						
Physical displacement from homes, impacts on livelihood and allocation of alternate farmlands to farmers	Land-take for project	The FMT shall use and adhere to negotiated settlements with the affected people in compliance with the requirements of PS5. Payment of compensation to all the displaced land owners, property owners, farmers and herders, etc, shall be transparent, equitable and consistent to all communities and persons affected by the displacement. The FMT shall offer the affected people in the host communities' compensation for the land and properties acquired at full replacement cost. In addition, some of the affected persons or relations may be engaged during construction and operation phases of the project to assist them in restoring or improving their standards of living.	Regular meeting with heads of affected communities and affected persons until all concerns are resolved.	Prior to construction and during construction	To be implemented by The FMoT.	149,005,000

Potential Impacts	Sources of Impacts	Mitigation Measures	Monitoring	Timing / Frequency	Responsibility	Approx. Cost of Implementation (Naira)
		The FMT shall neither take possession of nor commence any work on the site for the train stations and the rail alignment until full compensation has been made (except in a situation where there is ownership tussle on certain aspect of the land). All other mitigation measures recommended for land-take and impacts on livelihood, especially for farmers, as contained in chapter 6 of this report shall be implemented.				
Grievance Redress Mechanism Offices, Toll free Calls, Software, Office Staff, Running Cost, State/National Steering Committee & Contigency	Land-take for project	Compensation for land intake and Livelihood Restoration. Including monitoring and Evaluation.	Regular meeting of Resettlement Action Committees until all concerns are resolved.	Prior to construction and during construction	To be implemented by The FMT.	624,855,000
Community Health, Safety and Security						

Potential Impacts	Sources of Impacts	Mitigation Measures	Monitoring	Timing / Frequency	Responsibility	Approx. Cost of Implementation (Naira)
Community Health, Safety and Security	Movement of trucks and construction equipment, Risk of accidents. Conflict between workers or security personnel and members of the public Environmental pollution (air and water pollution)	There shall be adequate and visible hazard/safety signs at and around the construction site such as access restriction and traffic hazards. Speed limit shall be enforced to ensure vehicles used for haulage of materials do not pose threat to the safety of people in the project (construction) area. The communities shall be informed in advance if there are any activities or emissions that could affect their well-being and the area shall be cordoned off. Mitigation measures to manage air pollution, soil degradation and adverse impact on water quality shall be implemented.	Visual observation of compliance to safety measures and documentation of near accident for corrective measures. Conflict and complaints from members of the public about the project activities and or construction workers. Reported incidence of severe pollution or disease resulting from project activities or construction workers.	Daily	To be implemented by contractors and monitored by FMT.	100,000,000 ($60,906.80)

Potential Impacts	Sources of Impacts	Mitigation Measures	Monitoring	Timing / Frequency	Responsibility	Approx. Cost of Implementation (Naira)
	Inter-relationship between male construction workers and female members of host communities	Other recommended mitigation measures, which are aimed at preventing or minimising potential adverse health impacts of the project and its related activities (such as emissions and possible spread of STIs) shall be implemented.				
Traffic						
Increased vehicular traffic, obstruction in the flow of traffic, and possibility of accident	Movement of materials to site, movement of workers to and from campsite, general construction activities	Traffic management plan shall be developed and implemented by the Contractor. For safety of pedestrians and road users in the area, all project vehicles and trucks shall comply with the proposed speed limit (20km/hr or less especially along adjoining routes to the project site). There shall be presence of flagman at the entrance and exit of the project site in order to control vehicles and truck movement. Notice of diversion shall be boldly	Monitoring of road traffic control measures to ensure compliance Investigation of complaints from residents or authority on non-compliance with speed limit or unnecessary obstruction of traffic flow.	Daily	To be implemented by EPC Contractor and monitored by the FMT.	100,000,000 ($60,906.80)

Potential Impacts	Sources of Impacts	Mitigation Measures	Monitoring	Timing / Frequency	Responsibility	Approx. Cost of Implementation (Naira)
		and clearly placed at locations where motorists can easily and quickly make detour to alternative routes to their destinations. Other transport safety practices, traffic warning signs and mitigation measures as contained in chapter 6 of the EIA shall be employed to prevent traffic accident.	Corrective actions shall be taken afterwards to forestall future occurrence.			
Occupational Health and Safety						
Forced or underaged labour; unsafe working conditions; injuries or death and impacts on general well-being of workers Risk of being kidnapped for ransom or other atrocious purposes.	Hazards at construction site due to use of vehicles, heavy machineries, fall from elevation, electric shock or electrocution; working along the rail route (especially in isolated areas far from human settlements)	The Contractors shall install warning signs, provide and enforce use of appropriate personal protective devices. The FMT shall ensure that no minor is engaged as a worker on or off-site. No one shall be coerced into any form of labour or activities regarding the proposed project. The environmental and safety management system of the third-party contractors are monitored to ensure compliance with organisational policy of HSE.	Monitoring of compliance to safety measures, national and international labour laws and standards.	Daily	To be implemented by EPC Contractor and monitored by FMT.	150,000,000 ($91,360.20)

Potential Impacts	Sources of Impacts	Mitigation Measures	Monitoring	Timing / Frequency	Responsibility	Approx. Cost of Implementation (Naira)
		There shall be in place procedures, which strongly discourages all forms of discrimination. There shall be in place a well-stocked first aid box. Use of alcohol, hard drugs, and other substances capable of causing harm shall be prohibited on site. Properly armed and well-trained security personnel shall be deployed to the campsites and construction sites.				
Other Environmental and Social Management Plans / Mechanisms During Operations						
Training and Capacity Building						77,295,000 ($47,202.77)
Independent Annual Environmental and Social Audit						150,000,000 ($91,360.20)
Burrow-Pit Managenent Plan						888,160,947 ($540,950.41)
Cultural Heritage Management Plan						16,000,000 ($9,745.09)
TOTAL ESTIMATE						**N4,025,566,657 $1,980,635.33**

Note: The prevailing exchange rate as of August 2024 was ₦1,639.34 to 1 USD ($). This rate is subject to fluctuation.

Table 7. 2: Environmental and Social Management Plan: Operation and Maintenance Phase

Potential Impacts	Sources of Impacts	Mitigation Measures	Monitoring	Timing / Frequency	Responsibility	Approx. Cost of Implementation (Naira)
Air Quality and Noise						
SPM from dust, emission of air pollutants such as CO, NOx, SOx, etc. Noise and vibration from train movement	Regular movement of passenger vehicles and private cars to and from train stations Use of fossil fuel-powered electric generators as source of power for the stations	Shuttle services which can move a large number of passengers out of the station will minimise sources of emissions. Power-generating sets shall be serviced periodically to ensure emissions are within threshold limits. Alternative (renewable) energy such as solar power system may be used to power the proposed train stations.	The FMT through NRC shall ensure periodic air quality and noise level assessment is carried out by the EMPs	Monthly/Quarterly monitoring and reporting	HSE Unit of NRC or FMT; report shall be submitted to FMEnv / NESREA and State Environmental Protection Agencies (SEPAs)	60,000,000 ($36,544.08) per annum.
Groundwater Quality and Quantity						
Possible contamination of groundwater; over-abstraction of groundwater resource due to	Diverse sources such as accidental spill of fuel at the storage section	Groundwater resource shall be carefully managed, especially during dry season such that water abstraction for use at the train station are properly regulated. Bund walls shall be constructed for the fuel storage tank to serve as containment in the event of accidental leak or rupture of	Groundwater quality assessment and evaluation of specific yield. Also, the iron content should be closely monitored during the operation	Monthly/Quarterly monitoring and reporting throughout the project life.	NRC or FMT; report to be submitted to FMEnv and NESREA	75,000,000 ($45,680.10) per annum

Potential Impacts	Sources of Impacts	Mitigation Measures	Monitoring	Timing / Frequency	Responsibility	Approx. Cost of Implementation (Naira)
wastage leading to decline in water table, dry wells and higher cost of pumping.		storage tanks Soil contamination during routine maintenance activities, which may further lead to contamination of groundwater, shall be avoided. Only the required volume of water for use shall be drawn to conserve groundwater resource. There shall be regularly check for leaks in water taps, hose connections and other the plumbing installations, which shall be promptly fixed upon detection.	phase.			
Solid waste and sewage generation	Domestic waste generated by employees and waste from maintenance activities; wastes generated at train stations and inside passenger trains.	NRC shall ensure clean-up and disposal of all wastes including sewage generated at the stations and in the trains – in compliance with relevant national guidelines, involving waste management. NRC shall ensure proper waste handling and disposal methods.	Visual monitoring and aesthetics of site and odour	Daily	NRC or FMT through its waste management contractors and SEPAs	350,000,000 (213,173.80) per annum

Potential Impacts	Sources of Impacts	Mitigation Measures	Monitoring	Timing / Frequency	Responsibility	Approx. Cost of Implementation (Naira)
		Good housekeeping practice shall be maintained at all times.				
Occupational Health and Safety						
Injuries, fall from heights; risk of electrocution Risk of being attacked by robbers or assaulted by passengers Workers right infringement	Electrical hazards, working at elevation during routine maintenance at the train stations or on the train, Working as ticketing officer, or on train as a crew member.	Only well-trained, certified personnel shall be allowed to carry out installations, repairs, and maintenance of electrical equipment. To prevent electric shock and electrocution, energized cables shall be deactivated and properly grounded before carrying out repairs and maintenance of electrical installations and equipment at the station or inside the train. Workers shall carry out their tasks only when properly protected using personal protective devices. Access to high-risk area shall be restricted, and other workers not directly associated with maintenance works shall be disallowed from accessing high risk	Incidents and accident with man-hour loss, near misses.	Daily, throughout the operation phase	HSE Unit / HR Department of NRC / FMT	150,000,000 (91,360.20) per annum

Potential Impacts	Sources of Impacts	Mitigation Measures	Monitoring	Timing / Frequency	Responsibility	Approx. Cost of Implementation (Naira)
		areas. There shall be fall prevention programme (such as training in climbing techniques) in place for personnel working at elevations. Structures and tools used for climbing shall be tested for strength and integrity from time to time before use by workers. Workers' welfare and fundamental rights shall be protected at all times. Use of alcohol, hard drugs and other substances capable of causing harms to the user and co-workers shall be prohibited at work place. No minor shall be engaged as a worker for this project either directly or through third party. No one shall be coerced into any				

Potential Impacts	Sources of Impacts	Mitigation Measures	Monitoring	Timing / Frequency	Responsibility	Approx. Cost of Implementation (Naira)
		form of labour or activities regarding the proposed project. There shall be in place procedures, which strongly discourages all forms of discrimination such as between migrant workers (from southern part of Nigeria) and local workers (from the north) and enhances conflict resolution. There shall be installation of fire-fighting equipment such as fire extinguishers and fire hydrant at strategic places across the proposed facility. In addition, offices on site shall have an emergency (alternative) exit door in the event of fire occurrence.				
Impact such as accidents involving members of the public and vehicles or energised equipment	Unauthorised access to high-risk area, accident involving trucks and vehicles moving to and from the project site	The station waiting lounge shall be protected from unauthorised access. In the event of any unsafe condition as a result of faulty electrical installation with potential threat to public safety, the affected electrical	Incidents and accident, near misses.	Daily	FMT and NRC	25,000,000 ($15,226.70)

Potential Impacts	Sources of Impacts	Mitigation Measures	Monitoring	Timing / Frequency	Responsibility	Approx. Cost of Implementation (Naira)
within the site		installation shall be immediately de-energised and restored. Vehicles passing through the communities to and from the train stations shall maintain safe speed limits to minimise the risk of accident and or collision with other road users. Properly armed and well-trained security personnel shall be deployed to the train stations and in train in case of security emergency.				
Other Environmental and Social Management Plans / Mechanisms During Operations						
Periodic Environmental Audit (EAR) for Submission to FMEnv/NESREA (Every 3 years)						150,000,000 ($91,360.20)
Total Estimate Per Annum (excluding the EAR)						₦660,000,000 $401,984.88

Note: The prevailing exchange rate as of August 2024 was ₦1,639.34 to 1 USD ($). This rate is subject to fluctuation.

Table 7. 3: Monitoring Plan for the Implementation of the ESMP

Activity	Mitigation Measure Implementation (Status)	Monitoring Activity	Frequency	Responsibility	Amount (₦)
Implementation of Air Quality / Dust Management Plan	Mitigation measures in the ESMP table being implemented, In Progress / or Pending	Visual observation, site inspection, perimeter sampling, air quality monitoring: Covering of Materials: Ensure that fine construction materials like sand and cement are properly covered during transportation to prevent dust. Storage of Materials: Verify that materials prone to generating dust are stored in covered enclosures. Earthworks Management: Check that earthworks are done in discrete sections to minimize exposure of loose soil, and water suppression methods are being used to minimize dust. Vehicle Cleaning: Confirm that vehicles are cleaned before leaving the construction site to prevent dust dispersion. Worker Training: Ensure workers are trained on handling materials to minimize dust and emissions.	Daily and Weekly	Contractors, monitored by FMT, FMEnv, AfDB	50,000,000 ($30,453.40)

Activity	Mitigation Measure Implementation (Status)	Monitoring Activity	Frequency	Responsibility	Amount (₦)
		Air Quality Monitoring: Look for records of air quality measurements (SPM, CO, NOx, SOx) and check if they comply with recommended limits.			
Noise Quality Management Plan	Mitigation measures in the ESMP table being implemented, In Progress / or Pending	Visual observation, inspection of equipment, noise level monitoring: Equipment Condition: Inspect whether vehicles and equipment are well-maintained and equipped with noise reduction devices like mufflers. Operational Practices: Verify that noisy activities are restricted to less sensitive times of the day and equipment is turned off when not in use. Worker Protection: Ensure that workers exposed to high noise levels are using ear protection. Noise Monitoring: Review noise level assessments near sensitive receptors and ensure compliance with noise thresholds.	Weekly throughout construction	Contractors, monitored by FMT, FMEnv, State Ministries of Environment	25,000,000 ($15,226.70)
Groundwater Quality	Mitigation measures in the ESMP table being	Groundwater quality assessment (physico-chemical, microbial properties, specific yield):	Monthly	HSE Supervisor / Coordinator,	50,000,000 ($30,453.40)

Activity	Mitigation Measure Implementation (Status)	Monitoring Activity	Frequency	Responsibility	Amount (₦)
Management Plan	implemented, In Progress / or Pending	Spill Prevention: Check for the implementation of spill prevention and containment measures, and whether hazardous materials are stored properly. Waste Management: Confirm proper disposal of waste to prevent groundwater contamination. Groundwater Monitoring: Review the groundwater quality assessment reports, focusing on hydrocarbon content and heavy metals.		reports to FMEnv, NESREA, State Ministries of Environment	
Surface Water Quality Management Plan	Mitigation measures in the ESMP table being implemented, In Progress / or Pending	Surface water quality assessment (physico-chemical, microbial properties, iron content): Spill Management: Verify that caution is exercised to prevent spills during water collection from surface sources and during transportation. Runoff Control: Check if measures are in place to prevent contaminated runoff from construction sites from entering surface waters.	Monthly during construction	HSE Supervisor / Coordinator, reports to FMEnv, NESREA, State Ministries of Environment	50,000,000 ($30,453.40)

Activity	Mitigation Measure Implementation (Status)	Monitoring Activity	Frequency	Responsibility	Amount (₦)
		Waste Disposal: Ensure that excess excavation materials are properly disposed of to prevent contamination of surface water bodies. Surface Water Monitoring: Review the quality assessment reports for surface water, particularly focusing on physicochemical, hydrocarbon and heavy metals.			
Soil Quality Management Plan	Mitigation measures in the ESMP table being implemented, In Progress / or Pending	Visual inspection, soil physicochemical properties monitoring (hydrocarbon content, heavy metals): Slope Stability: Inspect construction sites to ensure unstable slopes are avoided and proper slope protection measures are in place. Vegetation Management: Ensure that removal of vegetation is restricted to necessary areas and erosion control measures are implemented. Hazardous Material Handling: Check for proper storage and handling of hazardous materials to prevent soil contamination. Soil Monitoring: Look for monitoring data on soil physicochemical properties, particularly	Monthly during construction	FMT and contractors, reports to FMEnv, State Ministries of Environment	50,000,000 ($30,453.40)

Activity	Mitigation Measure Implementation (Status)	Monitoring Activity	Frequency	Responsibility	Amount (₦)
		hydrocarbon content and heavy metals.			
Solid Waste Management Plan	In Progress / or Pending	Visual monitoring, site aesthetics assessment: Waste Handling and Disposal: Verify that the contractor follows relevant waste management guidelines and that waste is properly handled and disposed of. Site Cleanliness: Ensure the construction site is kept clean, with adequate waste bins provided, and that domestic waste is properly managed.	Weekly	FMT and contractors, reports to FMEnv, State Ministries of Environment	25,000,000 ($15,226.70)
Biodiversity Management Plan	Implemented / In Progress / Pending	Visual site inspection of the project site and adjacent areas: Vegetation Clearing: Confirm that manual clearing of vegetation is preferred and that crop damage is minimized by delaying clearing until after harvest. Wildlife Protection: Ensure measures are in place to minimize impact on fauna species of ecological importance and that workers are educated on the importance of preserving certain biotic species including plant species within the Great Green Wall Corridor.	Regularly throughout construction	Construction contractor	50,000,000 ($30,453.40)
Stakeholder	Implemented / In	Regular meetings with community leaders and	Monthly or	FMoT	50,000,000

Activity	Mitigation Measure Implementation (Status)	Monitoring Activity	Frequency	Responsibility	Amount (₦)
Engagement Plan	Progress / Some are pending	affected persons: Compensation and Negotiation: Review records of compensation payments and verify that they are transparent and equitable. Community Engagement: Confirm that regular meetings with affected communities are held, and that grievances are addressed promptly and fairly.	Quarterly (as the need arises)		($30,453.40)
Grievance Redress Mechanism	Implemented / In Progress / Pending	Regular meetings of Resettlement Action Committees. Grievance Documentation: Ensure that a mechanism is in place to record, monitor, and resolve grievances from affected persons or communities. Committee Meetings: Check that Resettlement Action Committees meet regularly and that all concerns are being resolved.	Quarterly	FMT	25,000,000 ($15,226.70)
Community Health, Safety, and Security	Implemented / In Progress / Pending	Visual observation of compliance, conflict monitoring, incident reporting: Safety Signage: Inspect the presence of hazard and safety signs around the construction site.	Daily throughout construction	Contractors, monitored by FMT	25,000,000 ($15,226.70)

Activity	Mitigation Measure Implementation (Status)	Monitoring Activity	Frequency	Responsibility	Amount (₦)
		Traffic Management: Verify that speed limits are enforced and that the community is informed of potentially hazardous activities. Incident Reporting: Look for records of accidents or conflicts and confirm that corrective measures are implemented promptly.			
Traffic Management Plan	Implemented / In Progress / Pending	Monitoring road traffic control measures, and investigation of complaints: Traffic Control Measures: Monitor compliance with the traffic management plan, including the presence of flagmen and the use of diversion signs. Speed Limit Enforcement: Check that project vehicles adhere to prescribed speed limits, especially in sensitive areas. Traffic Report: Review traffic incident report including accident or incidents such as traffic congestion, obstruction or violations involving project vehicles.	Monthly	EPC Contractor, monitored by FMT	25,000,000 ($15,226.70)
Occupational Health and Safety	Implemented / In Progress / Pending	Monitoring compliance with safety measures, labor laws, and standards:	Daily throughout construction	EPC Contractor, monitored by	25,000,000 ($15,226.70)

Activity	Mitigation Measure Implementation (Status)	Monitoring Activity	Frequency	Responsibility	Amount (₦)
		Worker Protection: Ensure that workers are provided with and are using appropriate personal protective equipment (PPE). Safety Training: Verify that safety training programs are in place and regularly conducted. Incident Response: Monitor compliance with safety protocols and review records of any incidents or near misses.		FMT	
Training and Capacity Building	Implemented / In Progress / Pending	Evaluation of training effectiveness and skill development: Training Effectiveness: Evaluate the effectiveness of training programs in enhancing workers' skills and ensuring compliance with safety and environmental standards.	During construction	FMT, in collaboration with contractors	25,000,000 ($15,226.70)
TOTAL ESTIMATE**					**475,000,000 ($289,307.30)**

Note: The prevailing exchange rate as of August 2024 was ₦1,639.34 to 1 USD ($). This rate is subject to fluctuation.

*** The total estimate contains some periodic expenses (mostly annual)*

TOTAL COST OF ESMP $ IMPLEMENTATION = ₦5,160,566,657 ($2,671,927.51)

The ESMP implementation monitoring is projected to cost ₦475,000,000 (approximately $289,307.30). The operation and maintenance phase is estimated at ₦660,000,000, which equates to about $401,984.88. Meanwhile, the construction phase is anticipated to require ₦4,025,566,657, translating to approximately $1,980,635.33. The total cost, combining the ESMP implementation monitoring, operation and maintenance phase, and construction phase, is estimated at ₦5,160,566,657, which equates to approximately $2,671,927.51.

7.5 WASTE HANDLING AND MANAGEMENT PROGRAMME

7.5.1 Scope and Objectives

The Waste Handling and Management Programme has been developed by Mota-Engil to define the general guidelines to ensure a proper waste handling and management. The procedures here by presented intend to ensure a proper waste handling, segregation and forwarding to final disposal or treatment seeking to guarantee solutions of reuse and recovery destinations at the expense of controlled elimination. The guidelines in this section are applicable to operations under direct supervision of Mota-Engil, and its subcontractors.

7.5.2 Waste Classification and Management

In order to ensure that waste is managed most adequately, first, is important to establish a classification, and according to that act properly either when handling, storing or disposing. The classification below does not overlap or substitute local legal requirements and others that apply to the specific contract (e.g., client requirements).

7.5.2.1 General Waste

The typical breakdown of general waste is presented in Table 7.4.

Table 7. 4: General waste categorisation

Category	Definition
Domestic Waste	Domestic (general) waste is a generic term for waste that due to its composition and characteristics, does not pose any significant threat to public health or the environment if properly managed i.e., waste that is free from infectious, radioactive, or hazardous chemical contamination. Examples of domestic waste include kitchen waste, paper waste, crockery, furniture etc. Domestic waste must be disposed of at a General (Non-hazardous) Waste Disposal Site, or it can be composted on site.
Paper and Cardboard Waste	Solid waste composed of paper and cardboard and typically found in offices and administrative areas as well as goods receiving / dispatch areas where materials often arrive packaged in cardboard boxes.
Printer/Ink Cartridges	Empty printer and copier ink cartridges.
Building Rubble	Waste building materials, packaging and rubble resulting from construction, remodelling and demolition operations.
Plastic Waste	Wastes generated by polyethylene terephthalate (PET) containers, cleaning product containers, plastic bags, polystyrene cups and packaging.
Rubber Waste	Rubber is generated primarily from the processing of natural synthetic and reclaimed rubber materials. The final rubber products are produced through various processes including vulcanising, cementing, moulding, extruding and lathe-cutting. Tyres are made up largely of rubber in addition to a metal and fabric support structure. Tyres and inner tubes are made from natural or synthetic rubber.
Metal Waste (including Scrap Steel)	Ferrous and non-ferrous metal are usually generated as a result of servicing and general maintenance. In addition, this can include aluminium cans (soda cans) and steel food containers.
Glass Waste	These include containers for food and drink and any other glass.
Wood Waste	Wood waste consists of oversized cable reels, wooden packaging boxes, palettes and other wooden materials wooden materials.

(Source: Mota – Engil)

General Waste Handling

Generally, handling this kind of waste does not result in major health and safety risks, however preventive measures along the use of proper PPE must be assured. On the environmental perspective, is crucial to handle every kind of waste in a proper way, avoiding incompatible mixtures and ensure a proper storage that will facilitate a segregation according to waste type and its final disposal. For a proper handling, users must be aware of the content of the Safety Data Sheet (SDS), of the respective products.

General Waste Storage

- An adequate number of general waste bins/recipients must be arranged around the construction camps and/or work zones, to collect all domestic refuse, and to minimise littering;
- In a way to ensure a proper segregation, the recipient's location shall take in consideration each waste type characteristics in order to avoid incompatible waste
- Recipients shall be clearly marked/labelled for efficient control and safe disposal of waste;
- Recipients shall provide protection against rain;
- Whenever deemed as necessary, and according to waste characteristics, the waste recipients shall be placed inside retention basins to mitigate eventual spills;
- Different waste recipients, for waste streams must be provided to ensure correct waste separation. These bins must be emptied regularly and dropped off at a central collection point for recycling-by-recycling companies/certified operators;
- General waste recipients shall be cleaned out on a regular basis to prevent any windblown waste and/or visual disturbance. These bins must be emptied into skips placed in designated areas for collection by an approved waste collection company.
- Hazardous waste in not to be mixed or combined with general waste earmarked for disposal at the municipal dump site.
- Under no circumstances is waste to be burnt or buried on site.

- For a proper storage, it must be implemented the measures foreseen in the Safety Data Sheet (SDS), of the respective products.

7.5.2.2 Hazardous Waste

Hazardous waste produced includes:

- Oil and other lubricants, diesel, paints, solvent.
- Containers that contained chemicals, oils or greases.
- Equipment, steel, other material (rags).
- Soil, gravel and water contaminated by hazardous substances (oil, fuel, grease, chemicals, cement, concrete or bitumen.

The typical breakdown of hazardous waste is presented in Table 7.5:

Table 7. 5: Hazardous waste categorisation

Category	Definition
Hydrocarbon Waste	Oily substances arising as a waste product of the use of oils / greases in a wide range of industrial and commercial activities, such as engineering, power generation and vehicle maintenance. Liquid and solid waste containing hydrocarbons which occur as a result of spillages, as waste oils from maintenance, hydrocarbon containers and oil contaminated materials.
Fluorescent Tube Waste	Burnt out fluorescent light bulbs containing toxic materials such as mercury, cadmium and lead.
Medical Waste	Anatomical materials used in the clinic such as soiled surgical dressings, hypodermic needles, sharps and other materials requiring special disposal procedures.
Chemical Waste	Chemical waste includes solids, liquids or gases containing or contaminated with any of the following: (these include certain paints, disinfectants, cleaning agents, batteries, explosives etc.)
	Flammable wastes;
	Leachate toxic materials (e.g., heavy metals, pesticides);
	Corrosives;
	Reactive such as oxidizers, explosives, unstable materials and water-reactive materials;

Category	Definition
	Toxic materials including mutagenic, carcinogenic, acute or chronic toxicity materials;
	Polychlorinated biphenyls (> 50 ppm concentration).
Mixed Waste	Waste that has not been subjected to any form of screening and/or separation and therefore comprises an undetermined ratio of general and hazardous waste. Waste of this type is considered hazardous by means of the precautionary principle.
Battery Waste	Battery waste includes lead acid automotive type batteries and nickel cadmium rechargeable or 'secondary' batteries commonly used in power tools.
E-Waste	E-Waste if generate from electronic equipment. Certain electronic components may be considered as hazardous waste due to the presence of toxic substances (e.g., lead).
Sewage Waste	Untreated sewage requiring treatment in sewage treatment.

Hazardous Waste Handling

Some of the properties of these type of waste also result in specific health and safety risks. In this sense, safety data sheets, risk assessment and method statements measures shall be implemented during hazardous waste handling.

On the environmental perspective, is crucial to handle every kind of waste in a proper way, avoiding incompatible mixtures and ensure a proper storage that will facilitate a segregation according to waste type and its final disposal.

Hazardous Waste Storage

- Hazardous waste recipients must be clearly marked/labelled, stored in a contained area (or have a drip tray) and covered (either stored under a roof or the top of the container must be covered with a lid);
- A hazardous waste disposal certificate must be obtained from the approved waste removal company as evidence of correct disposal at a Permitted Hazardous Waste Dumpsite.

- It may be feasible for the hazardous waste to be transported to a central point where it can be collected in bulk by the waste removal company. It should however be noted that:
  - Transport of hazardous materials must be done in accordance with legislative control; and
  - Relevant Codes of Practice should be adhered to.
- Whenever deemed as necessary, and according to waste characteristics, the waste recipients shall be placed inside retention basins to mitigate eventual spills;
- Waste recipients shall be cleaned out on a regular basis to prevent any windblown waste and/or visual disturbance. These recipients must be emptied into skips placed in designated areas for collection by an approved waste collection company.
- Hazardous waste in not to be mixed or combined with general waste earmarked for disposal at the municipal dumpsite.
- Under no circumstances is waste to be burnt or buried on site.
- For a proper storage, it must be implemented the measures foreseen in the Safety Data Sheet (SDS), of the respective products.

7.5.3 Final Destination

All the waste should be reduced and reused or recovered whenever possible. In case it is not feasible to mitigate the quantity of disposal waste, the waste should be incinerated in the campsite in a dedicated incinerator but only the non-hazardous waste. In case there is no incinerator, the waste should be transported to a Permitted Hazardous Waste Dumpsite.

In case of hazardous waste, it should be managed properly (subsection 7.5.2.2) and transported to/ by a permitted waste management operator, according to the Nigerian environmental legislation.

7.5.4 Emergency Response

Every emergency (as spills, fire, uncontrolled dispersion, etc.), either involving general and/or hazardous waste is to be considered as an environmental emergency and treated as foreseen in the respective emergency scenario (emergency response plan/program).

7.5.5 Waste Management Supervising and Inspection

Every employee must be alert when it is detected that any known procedure is not being followed. The supervisor/foreman of the respective area shall be immediately alerted for the fact and the situation shall be reported to the site environmental manager. Besides the continuous monitoring that each team leader/supervisor and foreman shall ensure, periodic and targeted inspections shall be conducted by the site environmental management team in order to verify the implementation the procedures regarding to:

- Waste production;
- Waste proper segregation;
- Waste handling;
- Waste storage;
- Waste disposal and control and collection by certificated operators;
- Existence of product safety data sheets referring to existing waste (as applicable), and compliance with respective instructions.

These inspections shall be documented in a structured report.

7.5.6 Training and Awareness

Training regarding waste management is included in the environmental training and awareness program. Training is divided in several types of sessions:

- Induction;
- Specific training and information;
- Toll box talks.

7.5.6.1 Induction

Before the commencement of any work on site, including any site clearance for surveying or construction work, respective contractors/suppliers shall attend an induction session in which the following topics are considered (along with other environmental matters)

- Reinforce reduce, reuse and recycle principles;
- Provide relevant examples of good and bad practices;
- Provide information of the type and location of waste recipients and collection areas for recycling and waste;
- Provide basic information of the classification of waste material;
- The need to be aware of the safety data sheets content when handling and storing waste.

7.5.6.2 Specific Waste Management Training

Whenever the roles and/or operation to perform demand, specific sessions are conducted in a way to disclose important information such as:

- Procedures when handling specific hazardous waste;
- Study of safety data sheets regarding to waste storage (e.g. warehouse and facilities supervisors);
- Procedures for waste segregation and control of disposal and collection by certificated operators;
- Procedures for waste storage inspections.

7.5.6.3 Toolbox Talks

Every day before the commencement of work, each team leader promotes a toolbox talk. In these sessions, periodically and whenever the operation to perform demands, waste management the applicable and most relevant waste management topics shall be reinforced.

7.6 ADDITIONAL MANAGEMENT PLANS

There are other detailed policies and plans, which shall be developed to support the implementation of this EMP. The timing of the development of the plans shall be staged, to ensure that appropriate focus and level of detail is provided for construction and operational activities. Where required, the documents will be finalized by FMT in consultation with the Federal Ministry of Environment and State Ministries of Environment as well as other major stakeholders. The documents shall be prepared strictly in line with the requirements set out in the relevant IFC Performance Standards and the World Bank/IFC EHS policies and guidelines for railway project development as well as other applicable national and local guidelines.

Additional stand-alone management plans required for the proposed project may include:

- Resettlement Action Plan / Livelihood Restoration Plan
- Labour and Employment Management Plan;
- Construction Traffic Management Plan;
- Compensation and Resettlement Action Plan;
- Health and Safety Management Plan;
- Site Security Plan;
- Water Use Management Plan;
- Stakeholder Engagement and Corporate Social Responsibility (CSR) Plan, including Grievance mechanism;
- Emergency Response Plan;
- Site Closure and Restoration Plan

8.0 CHAPTER EIGHT: DECOMMISSIONING AND ABANDONMENT PLAN

8.1 PROJECT DECOMMISSIONING

Generally, development projects are designed with an expected lifespan. Most projects eventually close out regardless of routine maintenance efforts put in place, although routine maintenance can prolong their lifespan. In addition, the project lifespan may sometimes be shorter than planned. Appropriate provisions shall be made to cover the cost of decommissioning right from operational phase before the life span of the proposed rail project. The longevity of the proposed project is dependent on several factors including:

- The economic potential and viability of rail transport across the project corridor
- Favourable successive government policies and encouraging business environment.
- Durability of the rail/train facilities.
- Regular maintenance of the facilities
- Protection of the rail infrastructure against vandalism
- Absence of conflict, especially armed conflict of catastrophic proportion in the project corridor and the regions linked together.

In Nigeria, there are rail lines, which are either closed or no longer used. Some of these lines have been vandalized with their sleepers and tracks removed by miscreants. However, rail infrastructures are hardly abandoned except for the adoption of modern rail technologies. They are usually designed with a lifespan of not less than 100 years. It is most likely that a time will come when the facilities, the train type, the tracks, and technologies being deployed for the project will either be outdated or its operation no longer economically viable.

The Federal Government of Nigeria, through its ministry or agency, shall decommission the project when such situation arises. While this is not expected to occur within the next 50 years, it is, all the same, necessary to start planning at the early stage for the closure stage of the project, when the use of the facility would have to be discontinued and abandoned. This would ensure a safe, environmentally friendly, and efficient decommissioning/abandonment programme. In most cases, potential impacts associated with project decommissioning are similar to project impacts at the construction stage due to similarity of activities. It is therefore, anticipated that mitigation measures applicable to pre-construction and construction phase apply.

8.2 DECOMMISSIONING/ ABANDONMENT PLAN

The Federal Government of Nigeria shall follow widely accepted decommissioning/abandonment procedures, and this shall be carried out in collaboration with the government of the Republic of Niger due to the transboundary nature of the rail project. Before abandonment, the Proponent shall develop abandonment and decommissioning plans, which shall cover:

- All the rail facilities and infrastructure to be abandoned or removed,
- Environmental aspects of the decommissioning activity,
- Methods for re-use of abandoned or decommissioned facilities for another purpose, recycling, disposal, removal or abandonment of other materials installed during construction,
- Proper consultation with all stakeholders,
- Efforts to mitigate negative environmental impacts and appropriately rehabilitate the route,
- Programmes for restoring the environment in accordance with national and international best-practices and regulatory requirements,
- Scope of work to assess possible residual impacts of the project on the environment; specifically, any future restrictions on other activities.

The content of the plan shall take into consideration the extent of the decommissioning (temporary or permanent, partial or complete abandonment), plans for future use of the infrastructure, and the condition of the route and adjoining environment at the time of decommissioning. A detailed post-operational study of the impact of the project on the environment shall be conducted to determine appropriate restoration and remedial measures. The social and economic impacts of decommissioning shall also be evaluated and reported with appropriate mitigation measures. Decommissioning activities shall be conducted in compliance with applicable regulations and guidelines that could be in force at the time of decommissioning. The plans will also include regulations and risk-and-cost analysis of the various options. The abandonment plan shall consider all facilities associated with the Project.

A decommissioned train station may be converted to other public use while road can be constructed along the abandoned rail route after the tracks would have been completely removed – although this is a rare scenario. Conversion generally helps to minimise costs of reconstruction and keeps down potential environmental impacts associated with the need to build new public facilities.

As a general procedure for decommissioning of rail infrastructure, the following steps shall be taken:

- Public notice on the plan to discontinue the rail service along the route;
- Post-decommissioning study shall be carried out;
- The rolling stocks may be sold to competent and licensed waste managers for recycling and materials recovery;
- Removal of support structures shall be to a depth of not less than three feet below surface levels;
- All electronic and electrical installations at the train stations and along the tracks shall be removed;

- Areas disturbed during decommissioning activities shall be restored. Disturbed areas shall be graded as close as reasonably possible to its original contours and the soils shall be restored to a condition consistent with other resource uses.

Particular attention shall be paid to the following:

- Protection of the workers and the general public from accident and air emissions;
- Protection of people from noise and vibration;
- Demolition waste handling and management;
- Spill containment and management.

9.0 CHAPTER NINE: CONCLUSION AND RECOMMENDATIONS

9.1 RECOMMENDATIONS

The Federal Government of Nigeria and its counterpart in Niger Republic have shown remarkable commitment to implementing this project in an environmentally and socially friendly manner that will reduce associated negative impacts. In particular, the FMT has been at the forefront of ensuring the project is executed in a sustainable manner. There is appreciable level of commitment to building good relationship with stakeholders, PAPs and PACs, and regulatory agencies, which will no doubt enhance the sustainability and successful implementation of the proposed project.

It is therefore recommended that:

- All project activities from the planning, construction to operational phases are carried out under the overall monitoring of relevant environmental regulatory agencies.
- The FMT and its contractors shall ensure strict adherence to all specifications and standards for design and construction, mitigation measures and recommended EMP in its implementation of this rail project.
- Continuous consultations with all relevant stakeholders shall be maintained.
- Mitigation measures prescribed in the report shall be strictly followed while complying with regulatory guidelines and standards throughout the implementation of the project.
- When and where unforeseen project impacts occur, mitigation measures shall be modified to effectively manage the impacts.
- All safety measures shall be strictly implemented and enforced as they relate to workers at all phases.
- The Environmental Management Plan (EMP) designed for the project shall be implemented throughout the project life cycle; from construction, through operation to decommissioning.

- In the event of decommissioning, an Abandonment Plan shall be developed. The concept of greenway and railbanking may be adopted to convert the rail infrastructure to further public/commercial use.

9.2 CONCLUSION

Given the detailed description of baseline environmental characteristics of the project area and the impact assessment, mitigations and EMP that has been presented in this report, it is therefore concluded that:

- The technology, equipment and facilities to be deployed or constructed are among the best available and environmentally friendly technology, which has been used in different parts of Nigeria. An example is the Lagos – Ibadan rail project, which is operational at the time of preparing this report, and which has been widely accepted by different categories of people in the society as a reliable mode of transportation.
- The project has significant benefits and positive impacts such as employment opportunities, reduced traffic on road, shorter travel time for freight and passengers, cheaper mode of transportation, enhanced regional and transnational economy, among others. The project will be a major source of revenues for government at all levels. The potential benefits outweigh the potential adverse impacts. In spite of the potential negative impacts identified, the mitigation measures recommended for this project will eliminate some impacts, minimise some and offset others if properly implemented.
- In addition, with good management practice, the residual impacts shall be short-term, mostly localized and reversible on the environment.

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APPENDICES

APPENDIX I

Socioeconomic Survey Instruments and Evidence of Stakeholders Engagement

A: A Sample of Survey Instrument Used

06 IDV: INDIVIDUALS (Women, Men & Youth)

2 IDV	REF	STATE			LGA				COMMUNITY		M/F
1	GENERAL						Specify		COMMENTS		
1.1	Rel HH:		Residency (T/P)		1.6	Student (Course)					
1.2	Age		Children (No.)		1.7	First Lang					
1.3	Marital Status		Dependents (No)		1.8	Birthplace					
1.4	Education				1.9	Own Land					
					1.10						
State	1) Jigawa ,2) Kano 3) Katsina										
L.G.A	**Kano:** 1) Makoda 2) Minjibir 3) Danbatta 4) Dawakin Tofa 5) Kumbotso 6) Gwale 7) Ungoggo **Katsina**: 1)Jibiya 2)Batagarawa 3) Mani 4) Sandamu 5) Rimi 6) Mashi 7) Katsina 8)Dutsi 9) Daura 10) Kaita **Jigawa:** 1) Yan Kwashi 2) Roni 3) Kazaure 4) Dutse										
REL: (1)Spouse (2) Son (3) Daughter (4) Grandchild (5) In-Law (6) Other dependant (7) Tenant (8) Employee.											
EDUCATION STATUS: 1) None 2) FSLC 3) SSCE 4) OND/NCE 5) HND 6) Degree 7) MASTERS 8) PhD 9) OTHERS											
MAR: (1)Monogamous (2)Polygamous (3)Single (4)Widowed (5)Divorced (6)Seperated (7)Other (specify)											
2	**LIVELIHOODS**		**SPECIFY**		3	**Key Expenditure** (p/m)			4	**Income: Dry** (p/m)	
2.1	**Farrming**				3.1	**Purchase of Grains**			4.1		
2.2	**Fishing**				3.2	**Hospital Bills**			4.2		
2.3	**Food Processing**				3.3	**School Fees**			4.3		
2.4	**Business**				3.4	**House Rent**			4.4	**Income: Wet** (p/m)	
2.5	**Livestock**				3.5	**Farm Inputs**			4.5		
2.6	**Services**				3.6	**Transportation**			4.6		
2.7	**Artisan**				3.7	**Fuel**			4.7		
2.8	**Other**					**TOTAL**				**TOTAL**	
5	**SKILL**		**TYPE**				6	**VULNERABILITY**			

	SETS								
5.1	Wood Work						6.1	Disabled	
5.2	Technical						6.2	Old	
5.3	Mechanical						6.3	Infirm	
5.4	Artisinal						6.4	Orphaned	
5.5	Other						6.5	Incapacitated	
							6.6	Other - Specify	
8	During your last pregnancy, did you attend Antenatal care (ANC)?						9	During your last child birth, who assisted you with the delivery?	
8.1	Yes						9.1	Doctor	
8.2	No						9.2	Nurse/Midwife	
8.3	If yes, where , did you attend Antenatal Care (ANC)?						9.3	CHEW	
8.4	Public Health facilitry						9.4	TBA	
8.5	Private Health facilitry						9.5	Relative/Friend	
8.6	Prayer House						9.6	No one (Alone)	
8.7	Home								
10	During the last sickness where did you take the child for treatment?						11	Where does your household get water from?	
10.1	Public hospital						11.1	Borehole	
10.2	Private hospital						11.2	Well	
10.3	Chemist shop						11.3	Rain collected at homestead	
10.4	use Traditional Herbs						11.4	River /spring	
10.5	Home treatment						11.5	Water sold by other people	
12	During your last childbirth, where did you deliver?						13	How far is the closest Health Care facility from your house?	
12.1	Public health facility						13.2	Less than 30 Min walkng distance	
12.2	Private health facility						13.3	More than 30 Min walkng distance	
12.3	Prayer House								
12.4	Home								

CHEW: Community Health and Extension Worker TBA) Traditional Birth Attendants
Potential Impact of the New Railway Line
14) What do you know about the railway line project passing through your community?
15) Potential impact of the new railway line
16) How do you think the railway line will affect your family life?
17) How do you think the railway line will affect your income?
18) How do you think the railway line will affect your environment?
19) How do you think the railway line will affect your health and safety?
20) What do you think can be done to reduce the effect of the railway line on your household?
21) Any Other Comments on railway
Health Issues
22) What are some of the reasons that make it difficult for you and your family to go to the healthcare facility to access care?
23) What are some of the problems with the services provided by the healthcare facility in your community?

	Interviewer		**Date**		**QA**	

HHH: HEAD OF HOUSEHOLD

1: REF	2. STATE	3: LGA	4: COMMUNITY	5: WARD

HOUSEHOLD MEMBERS

	6.1	6.2	6.3	6.4	6.5	6.6	6.7
	Gender M/F	AGE	Dependents Yes=1 / No= 2	Marital Status	Livelihood	Relationship to HHH	Education Status
6.1							
6.1							
6.1							
6.1							
6.1							
6.1							
6.1							
6.1							

State	1) Jigawa ,2) Kano 3) Katsina
L.G.A	Kano: 1) Makoda 2) Minjibir 3) Danbatta 4) Dawakin Tofa 5) Kumbotso 6) Gwale 7) Ungoggo1 Katsina:1) Jibiya 2) Batagarawa 3) Mani 4) Sandamu 5) Rimi 6) Mashi 7) Katsina 8) Dutsi 9) Daura 10) Kaita Jigawa: 1) YanKwashi 2) Roni 3) Kazaure 4) Dutse
MARITAL STATUS: 1) Monogamous 2) Polygamous, 3) Single, 4) Widowed, 5) Divorced 6) Separated (SP).	
REL: 1) Head 2) Spouse 3) Son 4) Daughter 5)Rikko 6) Grandchild 7) In-law 8) Parent 9)Other dependent(s) 10) Tenant 11) Employee	
EDUCATION STATUS:	1) None 2) FSLC 3) SSCE 4) OND/NCE 5) HND 6) Degree 7) MASTERS 8) PhD 9) OTHERS
LVL: 1) Trader, 2) Farmer, 3) Pastoralist, 4) Civil Servant, 5) Employed, 6) Labourer 7) Artisan 8)Other	
LAND STATUS 1) Own Land 2) Family Land 3) Rented Land 4) Jingina 5) Borrowed 6) Communal	

	LIVELIHOOD (Y/N)		**LAND**		**ACRES**
7	**Livelihood 1 Dry Season**		9	**Livelihood Land**	
8	**Livelihood 1 Wet Season**		10	**Residential Land**	

11. HH INCOME (PM)	**12: HH Expenditure Per Month**			**13: Vulnerable? Y/N**	**14. Type of Vulnerability**
		Item	**Expenditure**		
	11.1	Food			
	11.2	Sch fees			**Type of Vulnerability** 1) Old Age 2) Disability 3) infirmity 4) Others
	11.3	Medical			
	11.4	Rent			
	11.5	Others			

Income : 1) N10,000.00-N15,000.00 **2)** N16,000.00-N20,000.00 **3)** N21,000.00-N25,000.00 **4)**N26,000.00-N30,000.00 **5)** N31,000.00-N40,000.00 **6)** N50,000.00-N80,000.00 **7)**N100,000.00 above	**Expenditure** : 1) 0-N5,000.00 2) N5,000.00-N10,000.00 3) N10,000.00-N15,000.00 4)N15,000.00-N20,000.00 5) N20,000.00-N30,000.00 6) N50,000.00 above

15: HH ASSETS		**Y/N**	**16: HH LIVESTOCK**		**Num**	**17**	**UTILITIES**	**TYPE**	**Distance from Residence (minutes)**
15.1	House		**16.1**	Cattle		**17.1**	Energy Source		
15.2	Motorbike		**16.2**	Sheep/Goats		**17.2**	Water Access		
15.3	Bicycle		**16.3**	Chickens		**17.3**	Solid Waste		**Distance:** 1) 0-5 2)10- 15

15.4	Radio		**16.4**	Guinea Fowl		**17.4**	Vegetative Waste		3) 15-25 4) 25-30 5) 30-45 6) 45-60 7) others
15.5	Generator		**16.5**	Horses		**17.5**	Livestock Waste		
15.6	Kiosk		**16.6**	Donkeys		**17.6**	Plastic Waste		
15.7	Shop		**16.7**	Dogs		**17.7**	Toilet		
15.8	Solar Power		**16.8**	Camels		**17.8 COMMENT**			
15.9	Mobile Phone		**16.9**	Others Specify					

WASTE: 1) Recycle, 2) Burn, 3) Bury - **Toilet**: 1) Pit Latrine 2)Flush Toilet

WATER: 1) River, 2) Well, 3) Pipe 4) Stream 5) Bore Hole

ENERGY SOURCE 1) Electricity , 2) Lamp, 3)Kerosine, 4) Charcoal ,5) Wood, 6) Solar , 7) Other

Potential Impact of the New Railway Line

18) What do you know about the railway line project passing through your community?				
19) How do you think the railway line will affect your family life?				
20) How do you think the railway line will affect your income?				
21) How do you think the railway line will affect your environment?				
22) How do you think the railway line will affect your health ?				
23) How do you think the railway line will affect your safety?				
24) What do you think can be done to reduce the negative effects of the railway line on your household?				
INTERVIEWER			**DATE:**	**QA:**

02 HLT	**HOD LGA: HEALTH FACILITIES**				
REF	**STATE**	**LGA**	**SURNAME**	**NAME**	**M / F**
02HLT					

1.1 List and Location of Health Facility in Affected Community

Name		**Location**	**Facilities**	**Ownership**	**Type**	**Services**	**Vaccinations**				
							BCG.	Pent	Pent	mi.	sle a ea
1.1											

State	1) Jigawa ,2) Kano 3) Katsina
L.G.A	Jigawa: 1) YanKwashi 2)Kazaure 3)Dutse Kano: 4) Makoda 5) Minjibir 6) Danbatta 7) Dawakin Tofa 8) Kumbotso 9) Gwale 10) Ungoggo Katsina: 11) Jibiya 12) Batagarawa 13) Sandamu 14)Rimi 15)Mashi 16) Katsina 17) Dutsi

	18)Daura
Facilities: 1. General Health Care 2. Paediatrics 3. Maternal Health 4. HIV/AIDS Unit 5. Operating Theatre 6. Accident & Emergency 7. Laboratory	
Ownership: 8. Federal 9. State 10. LGA 11. Community 12. Private	
Type: 13. Referral Hospital 14. General Hospital 15. PHC 16. Clinic	
SERVICES: 17.Ante-Natal Clinic 18 Post Natal Clinic 19. HIV Testing 20. Malaria Testing/ Treatment 21. Physiotherapy	
VACCINATIONS: 1)BCG 2) Penta-1 3) Penta-3 4) Vitamin A 5) Measles	

Potential Impact of the New Railway Line		
2) What is the estimated population of this LGA?		
3) Are there enough health facilities in this LGA to cater for the needs of people?		
4) What are the common illnesses affecting people in this LGA? Kindly list the causes of such illnesses?		
5) What are the commonest causes of death in this LGA?		
6) How do you think the railwayline project will affect health services in the area?		
7) What are the challenges you encounter in carrying out your duties?		
8) What measures do you think should be taken to maximize the positive health impact of the railway project on the health and safety of people in this LGA?		
9)What measures do you think should be taken to minimize the negative impact of the railway project on the health and safety of people in this LGA?		
10) From the map of the railway line before you, what are the main uses of the land around the area affected by the project? Are there any special features that are very important to the community?		
Interviewer:	**Date:**	**QA**

PHOTOLOG

Plate AP1: Cross-sections of participants at the scoping workshop in Jigawa and Kano States

Plate AP2: A Cross-section of stakeholders at the workshop in Kano State

Plate AP3: Environmental Consultant being interviewed concerning the project by media organisations in Kano

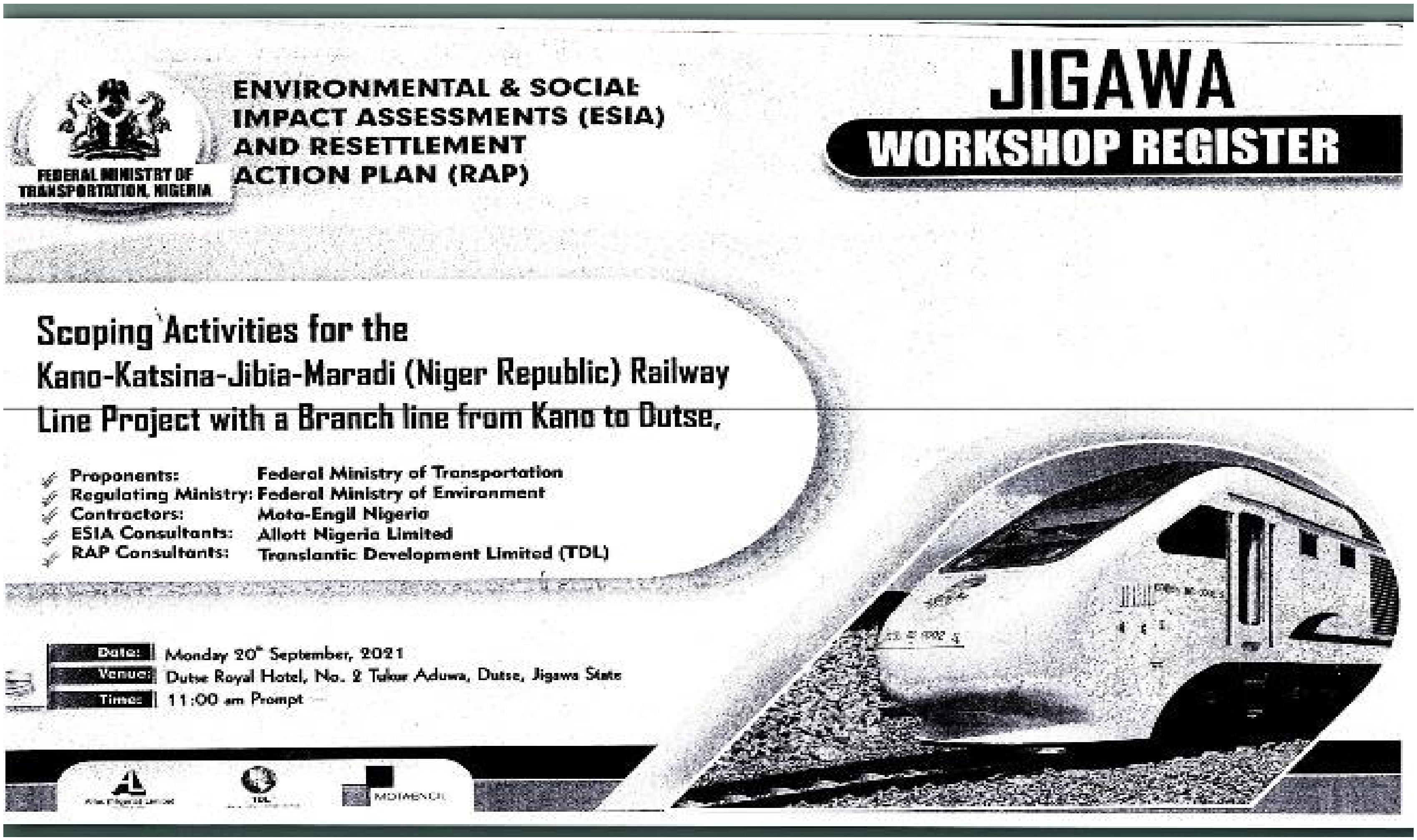
Plate AP4: Interview session with traditional leaders in Kano State

Plate AP5: Group photograph with traditional leaders in Kano after stakeholders consultation

Plate AP6: A cross-section of participants at the scoping workshop in Katsina

Plate AP7: A section of women at the scoping workshop for the rail project in Katsina

Attendance Registers



ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENTS (ESIA) AND RESETTLEMENT ACTION PLAN (RAP)

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51	[illegible]	Surveyor	[illegible]	[illegible]	08062066946	
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ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENTS (ESIA) AND RESETTLEMENT ACTION PLAN (RAP)

WORKSHOP REGI

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ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENTS (ESIA) AND RESETTLEMENT ACTION PLAN (RAP)

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86	Engr. Bashir B. Danjiya	FMT/PCB	FMT	[illegible]@gmail.com	08058518707	
87	Hon. Muhammad Ahmad	Chairman	Yankwashi LGA	[illegible]@gmail	08146121212	
88	Hj. Hadiza T. Abdulwahab	Chair	RICORD	[illegible]@[illegible]	08066001655	
89	Sluman K. Haruna	S A	NCA	[illegible]@[illegible]	08[illegible]822495[illegible]	
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91	Umar Akilu Majeri	Reporter	D/Head of The Guardian Ltd	Umar[illegible]@gmail	08023140707	
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100	[illegible]	Chairman	AES	[illegible]@gmail	080[illegible]	
111	[illegible] Ibrahim [illegible]	Chairperson Nawoj	Nawoj	[illegible]@gmail	08037429391	
112	Hauwa'u Usman	Member	Nawoj	[illegible]@yahoo	08065564602	
113	Asabe A. [illegible]	Chairperson [illegible]	Fomwan	[illegible]@[illegible]	0706[illegible]3651143	
114	Adama [illegible] Babura	Chairman	Miyetti Allah	[illegible]	080[illegible]4296	
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117	Attahiru Usman	MD	Allott Nigeria	attahiru[illegible]@yahoo.com	08053[illegible]5724	
118	Dr. Meshack Ojile	SIA Consultant	Allot Nig Ltd	[illegible]@[illegible]	08033410061	
119	[illegible]	Managing Consultant	TAL	[illegible]@[illegible].org	080255[illegible]	
120	[illegible]	Consultant	TAL	[illegible]@[illegible]	+324855[illegible]9855	
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ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENTS (ESIA) AND RESETTLEMENT ACTION PLAN (RAP)

JIGAWA

WORKSHOP REGISTER

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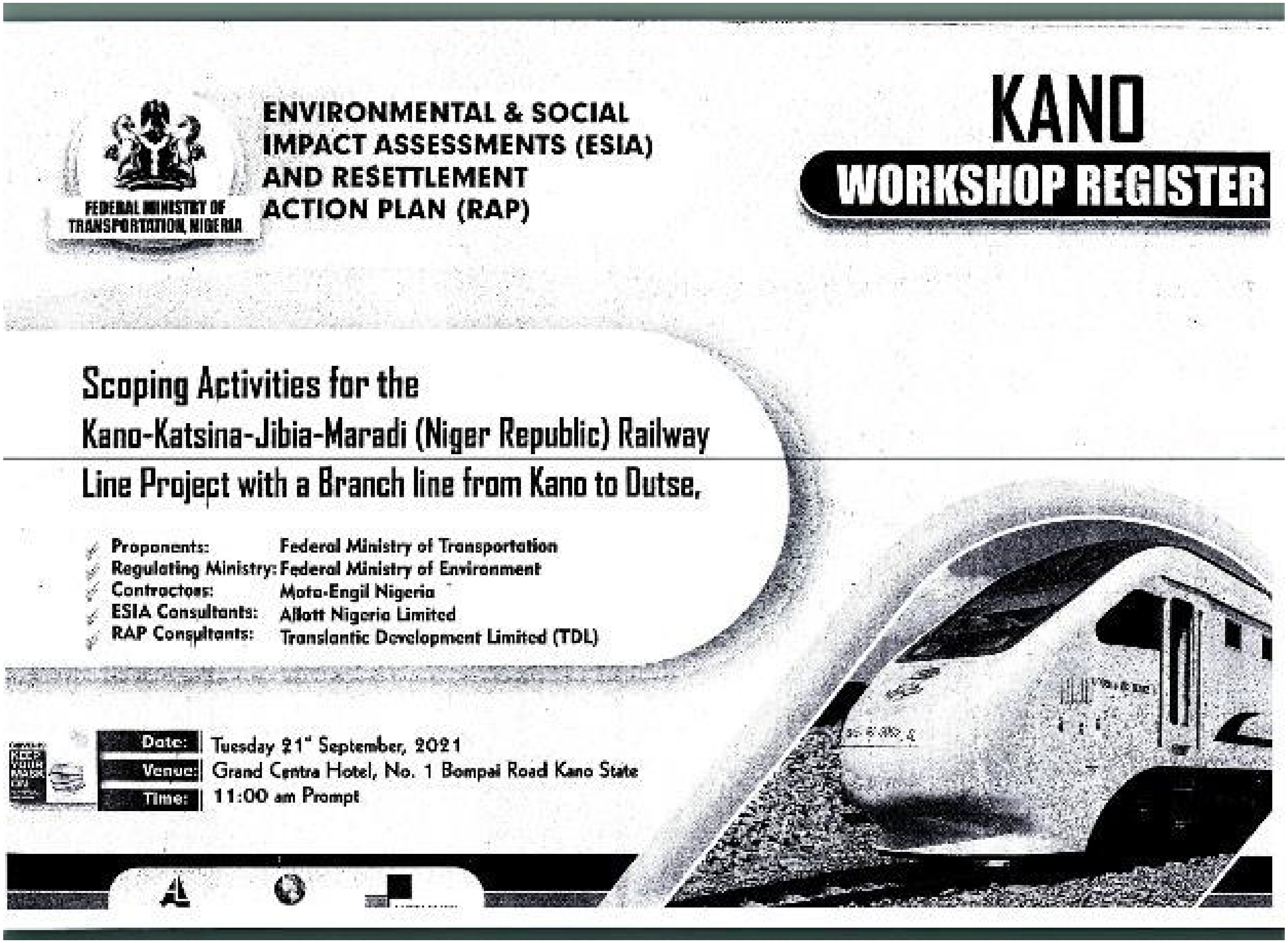
124	Ayo Johnson Obalisa	Media	AllAt	ayojohnsonobalisa@gmail.com	08150344406	
125	Bilal Muhammad	media	Allot	[illegible]@gmail.com	07037729374 44	
126	ABDULRASHEED A-IMAM	CEO	ALLOTT	[illegible]@gmail.com	07036062095	
127	[illegible]	CLO	ALLOTT	[illegible]	08037891248	
128	[illegible] Muhammad	Mota-Engil	Mota-Engil	[illegible]	07035488141	



FEDERAL MINISTRY OF TRANSPORTATION, NIGERIA

ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENTS (ESIA) AND RESETTLEMENT ACTION PLAN (RAP)

KANO

WORKSHOP REGISTER

Scoping Activities for the Kano-Katsina-Jibia-Maradi (Niger Republic) Railway Line Project with a Branch line from Kano to Dutse,

- Proponents: Federal Ministry of Transportation
- Regulating Ministry: Federal Ministry of Environment
- Contractors: Mota-Engil Nigeria
- ESIA Consultants: Allott Nigeria Limited
- RAP Consultants: Translantic Development Limited (TDL)

Date: Tuesday 21st September, 2021

Venue: Grand Centra Hotel, No. 1 Bompai Road Kano State

Time: 11:00 am Prompt

ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENTS (ESIA) AND RESETTLEMENT ACTION PLAN (RAP)

KANO WORKSHOP REGIS

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3	Sadiya Hashim	Social Cons.	TBL	[illegible]	080[illegible]	
4	SANI ABDULRAZAK	MC	NTA	[illegible]	08037[illegible]1243	
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8	Dr. Mashood Ojo	SIA Consultant	A.C.OT NIG LTD	drojo[illegible]@gmail.com	08033410061	
9	Dr. Wale Folarin	[illegible] Consultant	[illegible] Nig. Ltd	folarin[illegible]@gmail.com	0802838[illegible]	
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11	Fatima Saeed		CERD	[illegible]	0905655[illegible]	
12	SABIU OYEYEMI IBRAHIM	[illegible]	CERD	[illegible]	0[illegible]	
13	ABBALIAS TANDA YAKASAI	SEC. KIA	Kano-Katsina-Maradi Corr. [illegible]	[illegible]	080 65761911	
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24	Baba Muhammad Sani	Asst. Admin	Kano State [illegible] Development [illegible]	[illegible]	08036188875	
25	Sunday Umar	CEO	TOL	[illegible]	[illegible]	
26	Musa Dan'Zamani	F.O	Ag. TOL	[illegible]@gmail.com	08026357311	

ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENTS (ESIA) AND RESETTLEMENT ACTION PLAN (RAP)

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44	Abdulrahman [illegible] Abdullahi	S/Protocol	FRSC	[illegible]	07038768830	
45	Abdulkadir Ahmed	S/Hoops	FRSC		08036548987	
46	Ibrahim Ahmad		WOGEND	[illegible]	08065417677	
47	Maryam Adamu [illegible]	[illegible]	WUGEAN	[illegible]	07038960948	
48	Tijjani Ahmad Ahmad	Rep Director	DSS	[illegible]	08032264550	
49	Murja [illegible]	PR [illegible]	DSS	[illegible]	0803886431	
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51	[illegible]	[illegible] Program Officer	YEDA	[illegible]	[illegible]	
52	Muhd Auwal Wada	PD (AT/P)	HJRBDA	[illegible]	08023085387	

ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENTS (ESIA) AND RESETTLEMENT ACTION PLAN (RAP)

WORKSHOP REGIST

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55	Muhammad Abdullahi Kore	Chairman ABT	Ministry for LG	—	08037024585	
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57	Idris B. Musa	D/[illegible]	SWOFED	[illegible]	08033847218	
58	[illegible]	Chairman	[illegible]	[illegible]	08033705327	
59	Al-Zubairu Ibrahim	SCC	Miyetti Allah	[illegible]	08034310514	
60	Hon. Nasiru [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
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63	Ibrahim [illegible]	[illegible]	[illegible]		07063954086	
64	Muhammed Yahaya Alodan	DCC	NSCDC	[illegible]	08064876944	
65	Abubakar Bashir Isah Bin	SC	NSCDC	[illegible]	08066527905	
66	Dr Gaafar [illegible]	Livestock Spe.	KSADP	[illegible]	08131659711	
67	Ted Odogwu	Correspondent	The Punch	[illegible]	08063532623	
68	Aliyu Tukuru Aliyu	ASC II [illegible]	NSCDC	[illegible]	08066300086	
69	Muhammad Isyaku	Youth Leader [illegible]	LG [illegible] LG		08169855014	
70	Sunusi Aliyu	Inspector	N.S.C.D.C		07068957112	
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78	Usman Manga Dulitan	Sec. BOT	FULDAN	[illegible]	08065934101	

ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENTS (ESIA) AND RESETTLEMENT ACTION PLAN (RAP)

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79	Hon. Muntari Garba?	[illegible]	Chairman	[illegible]	0803?985857	
80	Abdullahi Musa		WIFT?	[illegible]	08135198654?	
81	Murtala Isah [illegible]	[illegible]	WIFT?	[illegible]	08064413697?	
82	Alh. Idris Musa [illegible]	"	"	[illegible] L.G.	07068825031	
83	Umaru Ahmed	Editor	[illegible] Times		08031135015	
84	Yakubu Sabo	Engr	FMEnv. Abuja	sabokata@gmail...	08173528428?	
85	Engr Hassan Usman	Snr Engr	F.M. Transport	[illegible]	[illegible]	
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88	Nasiru Inuwa Wada	Kano Emirate	Magajin Garin Kano	[illegible]	08035861001	
89	Habibu Bello Dankadai?	Kano Emirate	Fagacin Kano	—	08159703223?	
83	[illegible]	Bichi Emirate	[illegible]	—	08064828054?	
82	Abubakar Maharazu?	CEO	[illegible]	[illegible]@yahoo...	[illegible]	
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93	Yusuf Abdullahi	Chairman	[illegible]	—	[illegible]	
94	Abu Bura Bello [illegible]	Chairman	Potato	[illegible]	[illegible]	
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96	[illegible]	Prog. Officer	[illegible]	[illegible]	[illegible]	
97	Usman M. Aliyu	Finance Officer	[illegible]	[illegible]	[illegible]	
98	Gen. Abdulwasiu A. Taan?	SLD [illegible]	ALLOTT?	[illegible]@gmail.com	08036502099?	
99	Aminu Abbas	Ch. AFAN	AFAN	[illegible]	[illegible]	

ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENTS (ESIA) AND RESETTLEMENT ACTION PLAN (RAP)

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102	Ismail [illegible] Usman	Village Head [illegible]	Jan Gias	[illegible]@[illegible].com	08035553794	
103	Musa Isah Muhammad	Village Head	Gobirawa	[illegible]	08035944482	
104	Yahaya Uba	Ward Head	Shagotara			
105	Aminu Garba	Ward Head	Kurna Asabe		08091688611	
106	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
107	Abdulhamid Uba Musa	Ward Head	Gobirawa (A)	[illegible]	09047357866	
108	Yasiu M Shuaibu	Ward Head	Fagin Bene	—	08167877663	
109	Muntari Isah Muhammad	" "	Gobirawa Dukawa	[illegible]@gmail.com	08099991917	
110	Salihu Isah Muhammad	" "	Gobirawa Tanlarda		08167345774	
111	Hassan Garba	Ward Head	Gobirawa 'B'		08028455114	
112	Ali Muhammad Kiru [illegible]	President	Biampan	[illegible]@[illegible].com	08063472173	
113	Abdullahi Muhammad	S/Gandu Ward Head	S/Gandu	[illegible]@gmail.com	[illegible]	
114	Isyaku Ibrahim	Ward Head	[illegible] Bareq		08160061311	
115	Magaji Abdullahi	Ward Head	Sharada [illegible]		08028911434	
116	[illegible] Muhammad	Mata-Gaji	Mata-Gaji	magajiyamuhammad	08052988161	
117	[illegible] Ibrahim Yakubu	V/H [illegible]	Kano [illegible]	[illegible]@	08085407591	
118	Kabiru Bara'u Maikano	Stakeholder	[illegible] L.G	[illegible]@gmail.com	08064110[illegible]	
119	Attahiru Bala Usman	Allo HMA	Allott	attahiruuyahoo.com	08058465324	
120	Engr. Ibrahim Magaji	P.M	Allott	ibromagj@gmail.[illegible]	08037020129	
121						
122						
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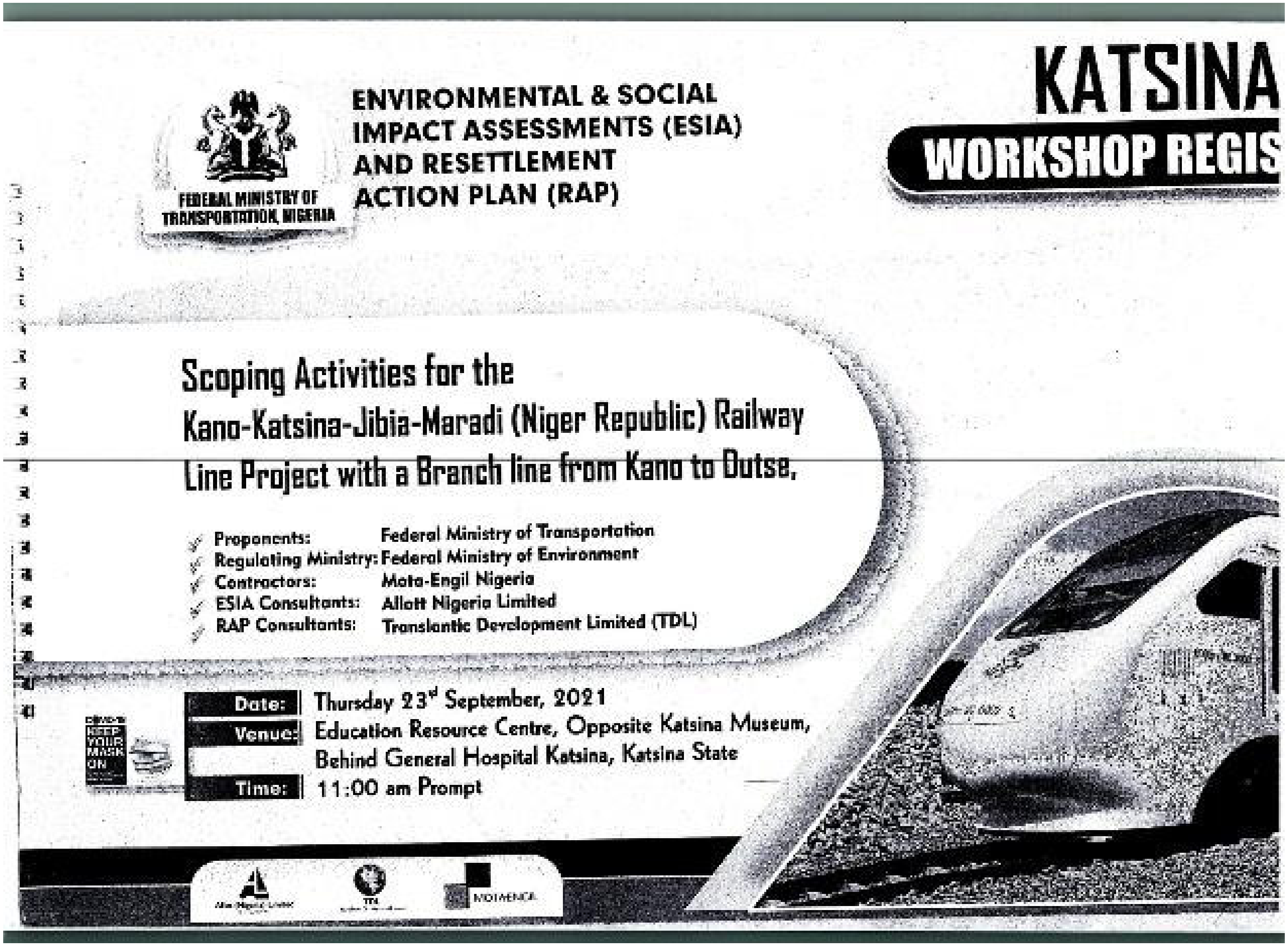
KATSINA
WORKSHOP REGIS
FEDERAL MINISTRY OF TRANSPORTATION, NIGERIA
ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENTS (ESIA) AND RESETTLEMENT ACTION PLAN (RAP)
Scoping Activities for the Kano-Katsina-Jibia-Maradi (Niger Republic) Railway Line Project with a Branch line from Kano to Dutse,
Proponents: Federal Ministry of Transportation
Regulating Ministry: Federal Ministry of Environment
Contractors: Mota-Engil Nigeria
ESIA Consultants: Allott Nigeria Limited
RAP Consultants: Translantic Development Limited (TDL)
Date: Thursday 23rd September, 2021
Venue: Education Resource Centre, Opposite Katsina Museum, Behind General Hospital Katsina, Katsina State
Time: 11:00 am Prompt
KEEP YOUR MASK ON

ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENTS (ESIA) AND RESETTLEMENT ACTION PLAN (RAP)

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KATSINA WORKSHOP REGIST

ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENTS (ESIA) AND RESETTLEMENT ACTION PLAN (RAP)

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29	Alh. Lawal Mani	Dallatun [illegible]		[illegible]	08038379 3191	
30	Lamido Lemamu	Waziri Majigiri	Dr Majigiri KT		08061155702	
31	Salihu Ahmad Tijjani	Field Officer	[illegible]	[illegible]	09051499838	
32	Hon Musa Aliyu	[illegible]	MASW	[illegible]	08086265169	
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~~36~~	~~Sanusi Ahmed Gora~~	~~[illegible]~~		~~[illegible]~~	~~[illegible]~~	
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43	Kabir Umar Abubakar	MASW L.G	MASW	[illegible]	08031533 64	
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APPENDIX II

Field Notes: Stakeholders Engagement and Social Impact Assessment Among Pastoralist Communities Along the Kano – Maradi Rail Project Corridor

Research methods, findings, and limitations

Fieldwork was carried out in pastoral communities along the railway line, from Dutse to Kano and Kano to Jibiya. This covers the three Nigerian states the railway will pass through – Jigawa, Kano, Katsina. Note that the route of the railway was clearly demarcated from Kano to Katsina and part way to Jibiya, but the branch line from Kano to Dutse in Jigawa state was not clearly marked. This means that the fieldwork from Kano to Jibiya closely followed the route, and using GPS we recorded the points where the migration and grazing routes of livestock crossed the line. These intersections between livestock routes and the railway line were visible in the field from Kano to Katsina but where the railway route was unclear, it was not possible to plot the exact points at which cattle routes will transect the line. Instead, we recorded the main cattle routes in those areas to assist future planning.

As well as using GPS to mark the position of livestock routes in relation to the railway, the position of water points and grazing areas were also located using GPS. The fieldwork also involved widespread consultations with pastoral groups and pastoral and village leaders along the railway, with interviews and discussions focusing on ten main topics, outlined below. These all relate directly to the perceptions and potential benefits and impacts of the railway, and mitigations needed while the railway line is being constructed.

A Note on GPS Coordinates

Note that the GPS coordinates follow the Railway line perfectly from Dawakin Tofa, Kano State, until the end of the line at Jibiya, Katsina State. The GPS coordinates were recorded for the livestock migration routes and the access routes of livestock to grazing areas and water points where they intersect with the railway or where the railway line is being built on them. It was only possible to achieve this level of precision in our GPS work where the proposed Railway route was clearly marked by the surveyors. That made it possible to mark the exact points where the cattle routes met the line. From Dawakin Tofa to Jibiya the planned route of the Railway line was clearly marked and therefore we precisely located where the cattle routes meet the line. However, from Kano to Dutse the branch line was not clearly marked and for that section of the line we could only mark the major cattle routes and water points in the area in general; we could not know exactly where the Railway would intersect with them.

JIGAWA STATE – 22 - 24 January, 2022

Dutse

Kalagari village, Karniya District, Dutse LGA

Interview with Muhammed Jabire, 22/1/22 – former chairman of Miyetti Allah, Dutse LGA, and head of the group of camps in Kalagari. About 85 years old. The majority of Fulbe in that area are Bornanko'en by clan. There are other clans too: Majanko'en, Tsinkanko'en, Saabaranko'en, and Rumbanko'en. They live together and there are a lot of intermarriages between them, so they form one community. They are settled there together. There are other pastoralists who come seasonally, during the dry season. They are nomadic Fulani, who migrate along the big cattle routes in the area and use the small community grazing reserve there as a resting point while on migration.

Settled agro-pastoralists in Kalagari

The local agro-pastoral Fulani have been settled in Kalagari for a long time, but their cattle are herded from one place to another and between wet and dry season pastures. It was said to be an old settlement and most of them are mixed farmers. They do a lot of crop farming and they raise animals, but they keep a smaller number of animals than the more nomadic pastoralists. They raise cattle, sheep, goats, and some birds including guinea fowl (Hausa: kaji) and chickens. They cultivate millet, guinea corn, beans, and groundnuts – all in the wet season, only; they do not do dry season farming, due to lack of water.

There was a forest reserve nearby which accommodated and attracted many pastoralists from different places, but most of it has now been taken over by farmers and government for infrastructure (including an airport and military barracks). At Kalagari they now have a reduced area for grazing consisting of a small community grazing area. There is insufficient land for them to keep their animals in the area throughout the year. This forced them to reduce the number of animals they have and to send their herders to graze the animals in other parts of Jigawa during the wet season (which is the main farming season). This reduction in the number of animals they own reduced their standard of living, making most of them poorer than 15 years ago. They do not have water for dry season, irrigated farming in their area, and most of their youth are now unemployed. That is one of the reasons why they are happy to have this railway line in the area, as it may help provide employment for their youth. Despite the unemployment, they do not have any major security challenges in the area.

Nomadic pastoralists passing through Kalagari

Kalagari serves as a junction, because it has two major cattle routes: one from the west to the east, starting in Kaduna State, passing through parts of Zamfara and Katsina to Kano, and passing through them in Jigawa to Yobe and Borno State. The other large cattle route through Kalagari is from north to south, from Niger Republic to Jigawa to Bauchi, Gombe, and Taraba. Transhumant pastoralists pass through the area at different times of year with their cattle, sheep and camels. The migrant herders from Niger to the north migrate southwards in the dry season, while those migrating from west to east pass through during the rainy season and then return from the northeast to the northwest after harvest in the early dry season. The migrant herders coming from Niger in the dry season return northwards in the early rainy season, after the first two rains.

Most of the pastoralists coming from the north are sheep rearers, mainly Uda'en (Udawa), and some of them have red cattle. There are also camel herders who come in the dry season and they are mostly Arab and Tuareg (known as Buzaye, in Hausa).

Pastoral leaders in Dutse LGA

A group meeting was held with pastoral leaders from different villages in Dutse LGA.

Ahmadu Jafaru - Vice-Chairman of Miyetti Allah Kautal Hore, Jigawa State

Umaru Abubakar - Chairman, Miyetti Allah Kautal Hore, Dutse LGA

Muhammadu Jabire – former Chairman of Miyetti Allah Cattle Breeders' Association (MACBAN), Dutse LGA. He's elderly and experienced and is respected as he is regarded as honest.

Abubakar Umaru – Ardo, head of his camp.

Adamu Audu – community leader / camp head

Abdullahi Adamu – community leader / camp head

Sale Muhammed – community leader / camp head

Kula da Kayanka Yafi Ban Cigiya - 'prevention is better than cure'

This is the name of the local vigilante group, with members from across ethnic lines – Fulani, Hausa, and others, supervised by the traditional rulers in the Emirate of Dutse. This has played a vital role in the reduction and prevention of crimes within their communities. When there is crime they will investigate to find out who committed the crime and if their find the culprit they will punish him in public and demand that he does not repeat it again. They flog the perpetrator in public. Crimes are typically local theft and by controlling this they prevent any escalation into armed robbery, kidnapping or banditry.

According to them their main challenge is that most of their children did not get an opportunity to go to school and their pastoral livelihoods are drastically reduced due to the reduction in grazing land. These youths need activities to engage them. In Kalagari they have a functioning school with a bore hole, which is also the community water source. There is no clinic in the village but there are clinics in nearby places.

Barnawa camp – on the north side of the road between Dutse and Gaya, north-west side of Dutse. This is an old pastoral settlement, estimated at 100-120 years old. The main Fulbe group there is Bornanko'en. None of them migrate. They farm crops and herd animals – agro-pastoralists. They raise cattle, sheep, and goats and cultivate millet, guinea corn, beans, groundnut. The head of the camp is Malam Musa Usman. Raising livestock used to be their main economic activity, but now this is changing due to loss of grazing land, especially due to the construction of the military barracks in the area. They now have no option but to send their cattle to Yobe state and Niger Republic during the rainy season, when most of the land in their area is cultivated. The cattle are herded on the wet season migration by young men. Mostly they move without women, but a few go with their wives. They return to Barnawa after the harvest, in the dry season, and stay for 2-3 months before sending their cattle to the Gaya – Wudil area to graze on crop residues. According to Malam Musa they receive a large number of pastoralists during the dry season, most of whom come from Niger with sheep, cattle, and camels. Those people stay for some time, usually about 3 months, with their sheep, and leave after rain begins falling.

There are two important livestock routes in the area. One of the routes is at the southern side of Barnawa camp and it goes to Borno. This is the same east-west route that goes through Kalagari (described above), but at a point further west on the route. About 3-4 km east of Barnawa is near the same north-south route as passes through Kalagari. There are smaller routes that link them to the main cattle routes, but these minor routes are often blocked by farmers, which pushes them onto the main road. There are two water points in the area. One of them is within their grazing area, now mainly occupied by farmers, at the western side of their camps. The second watering point is to the north, about 2-3 kms from the camps, near the military barracks and not farmed.

The position of railway line will be on the south side of the main road, so the railway project does not directly impact grazing land or routes in the Barnawa camp area, but it would be relevant for some economic activities, to transport cattle or provide employment. They lost most of the natural vegetation in the area due to clearance of the bush by farmers. Trees were felled and either not replanted or they were replaced with neem trees, mainly. However, some species remain – barkeje, bummeje, ɓulɓe, jamme, nelɓe. The reason these trees were conserved is that they have fruit, or they have traditional value, so farmers do not allow them to be cut down.

Their economic situation is not good. They have lost most of their cattle due to the loss of grazing land. They said they have fewer cattle now compared to some years ago when there was more grazing land. Most of them now rely on rain-fed farming. The level of poverty has increased also among pastoral women in that area, as there is less milk to sell in the market, and the youth are also more impoverished due to a reduction in the number of small ruminants (sheep, goats). This has increased the economic pressure on household heads, who must sell cattle to meet household expenses, at a higher rate than the herds are reproducing. Their stock numbers have therefore decreased.

Shuwari livestock market

This is the main market in the Dutse area, located 8km northeast of the Jigawa state capital of Dutse. It is a large market and is very important to pastoralists in the area, for the selling of livestock and milk, and for obtaining provisions. The livestock market has different sections, consisting of small ruminants (sheep, goats), different breeds of cattle, and in the dry season, camels. It is also important for birds, especially guinea fowls, and local chickens. The agricultural section with vegetables and cereal crops is also large and supplies both individuals and traders. People bring animals from near and far, including from neighbouring states like Yobe and Bauchi, and from Niger Republic. Buyers come from Abuja, Kano and elsewhere, due to the size of the market and its strategic location along the new express route from Kano to Maiduguri. It is local herders and farmers and dealers who supply most of the cattle to Shuwari market. The veterinary buildings in the market are dilapidated, but there are veterinary staff present there. This is also a place that pastoral leaders congregate. The camels in the market are traded in the dry season by Arabs, some of whom are based in Niger but migrate to Nigeria for transhumance during the dry season, while others are resident in Nigeria for trade purposes. The National Union of Camel Rearing / Selling Association of Nigeria has members who control the camel market in Shuwari.

Kula da Kayanka Yafi Ban Cigiya - met the vigilante group leader in the market. In each camp they have a vigilante group member and if any crime is committed there, it is the vigilante who will identify the culprit and either administer punishments himself for minor crimes (such as stealing a fowl) or refer it to leaders for larger ones (such as cattle theft). This is helping to maintain security in the area and the emirate is supporting the vigilante group. These vigilante groups work with all the security agencies. They are close to the police, SSS, and state government. The Railway Line and Station in Dutse will assist and increase the economic activities of Shuwari market, as traders will be able to travel from far away and use the railway to transport their goods or the livestock they buy or sell more easily.

KANO STATE

Gaya LGA

Group discussion in Mahaka village, Gaya LGA. Two days of fieldwork in Gaya, for the meeting and to mark points near the proposed railway line, which lies to the south of the town. We used the map that was provided to locate the approximate route of the line.

Chairman of Miyetti Allah Cattle Breeders Association (MACBAN), Gaya LGA, and the Secretary of MACBAN were in attendance. Pastoral leaders were also there, including Alhaji Iliyasu Isa and Alhaji Inusa (who is Sullubankeejo). They came from the vicinity and gathered in the camp at Mahaka. Others were also in attendance.

Abubakar Wakili dan Mokoyo - the head of the camp at Makaka.

The clan at Mahaka is Kumanko'en, but others call them Gayanko'en. They settled in that particular camp 16 years ago; they were in the area for many years before that, but before they were nomadic (migrating from one place to another). Now they have settled in the area, but up to now their cattle migrate seasonally. They migrate to Falgore area (Kano forest), southwest of Gaya, for the rainy season, and some of them migrate up to Niger during the rainy season. They return to Gaya in the dry season, after the harvest, to feed the animals on farm residues. They stay in Gaya for the whole dry season; not necessarily at home, but between Gaya and Wudil, from one field to another, to graze their animals on crop residues.

They are in a precarious situation, because their grazing area was sold to a traditional title area in the Kano Emirate and they do not own the farms they farm or the land they live on. Since the land was sold, they have to rent the land they farm on. But the land owners do not charge rent for grazing, only for farming. They do rain-fed and dry season farming, which is profitable. In previous years it was only Hausa people who did irrigated farming, but now the pastoral Fulani settled in the area are also doing it. Dry season farming is an important income source and it is also beneficial to their cattle, because the crop residues provide feed throughout the dry season. This has led to growth of their herds, so they are wealthier now than in the past. Due to the availability of dry season crop residues they are able to keep milking cows at home throughout the year. Milk production has increased and the economic situation of the pastoral women has improved. But due to the expansion of farming in the rainy season by both Hausa and Fulani farmers, there is very little grazing land left during the rainy season. This forces livestock owners to send their animals to Niger Republic and Yobe state with herders – young men from their household, often their sons – during the wet season.

In Gaya they have three major cattle routes for migration.

1. In Mahaka, which leads to Falgore, then into Kaduna state and to Nasarawa, and from there to Kogi and Benue. It is an important international route for migrant pastoralists, as it

also leads north to Niger. This route intersects the railway line.

2. Within Gaya town – this route also leads to Falgore, from Gaya town, and upwards to meet the other route to the north, leading to Niger. This route intersects the railway line.

3. A minor route linking Gaya and Mahaka leading to a water point that has standing water throughout the year. But this is to the north of the proposed railway line, so is unaffected.

There is not an important cattle market in Gaya; they depend on Wudil, which has a very large market.

Wudil LGA

Yusuf Shehu, Sarkin Fulani, Wudil and Kano State Vice-Chairman of Miyetti Allah Cattle Breeders Association. He is about 67 years old and his origins are in Azare, but he moved to Wudil at the age of 18. He is Gorkankeejo, the main clan in the area around Wudil. There are also other clans like Jaahunanko'en and Bogganko'en, which are also in the Wudil area. The only non-Fulani 'indigenes' in Wudil are Hausa. There are other pastoralists who come to Wudil from the north in the dry season, the majority of whom are Sullubanko'en, followed by Katsinanko'en. Sullubanko'en nomads migrate to Wudil from Zamfara, Katsina, and other parts of Kano state with their cattle, sheep, and goats. They come in the dry season only, to graze their animals on the crop residues in Wudil. Other pastoral groups migrate to Wudil from Niger during the dry season – mostly with camels, sheep, and red cattle. Pastoral Arabs come with camels, and Uda'en herders come with sheep and a few red cattle. The Arabs do not migrate further south than Wudil and they migrate back to Niger with the first rains, to avoid cultivated areas and because camels do not tolerate the wet season in the area. The Uda'en migrate a bit further south, to the Falgore area, but they also migrate back northwards with the first rains before the farming season starts. According to all sides, there is no tension or conflict between the migrant herders from Niger and local farmers and pastoralists in Wudil.

In Wudil LGA the pastoralists complain about the lack of grazing land in the area during the rainy season. They have lost most of their grazing areas due to high rates of population growth, which increases demand for land, and due to pastoral land being taken over by politicians and businessmen. The lack of space after cultivation starts in the rainy season means they have to move their animals out of Wudil for the whole of the rainy season, to Niger Republic, parts of Jigawa state – around Babura and Gumel - and to parts of Yobe state. A small number go to Falgore. The majority spend the rainy season in Niger.

Despite the pressure on land, economically the herders are doing relatively well in Wudil, as they reported their herds are growing. This is mainly due to the benefits of irrigated farming providing residues for their animals to feed on throughout the long dry season. Many of the pastoralists who have permanent camps in Wudil are themselves engaged in dry season farming, while also owning livestock and sending their animals out of the area on transhumance with herders during the wet season. The nomadic pastoralists tend not to farm, as they are there temporarily for the crop residues. But while there are economic benefits for pastoralists and in local communities from the expansion of dry season farming, it has also caused increased competition around water sources – rivers, streams, and standing water that accumulates in the holes dug during the construction of the Kano-Maiduguri expressway. Some of these holes dug to extract sand for the road building now hold water throughout the dry season. The larger ones could be defined as quarries. If the Railway construction requires such quarrying, this could also have benefits to local people, as access to water and water storage is a major problem in the dry season.

Wudil cattle market is very big, reportedly the largest in Kano state (northern Nigeria's most populous state). An estimated 150 trailers (lorries) load 35-40 cattle weekly each, mainly to southern Nigeria. In addition, there are smaller lorries that supply Kano city, Kaduna, and Abuja. The market leaders estimated that between 3,000 and 5,000 cattle are brought to Wudil market weekly. The large traders buy animals in the market to supply major cities, but there are also individual buyers - mainly farmers and herders from the region - who buy animals in the market. The price range of cattle sold in Wudil is 120,000 naira to 1 million naira, depending on the size and breed of the animal. Cattle are brought to Wudil market from Plateau, Bauchi, Katsina, Borno, Taraba, Adamawa, and from Chad. It was estimated that 70% of the cattle in the market are supplied from Nigeria and about 30% from outside. Hausa dealers control the cattle trade in the market, but the cattle come from pastoralists and from farmers who fatten them, use them as traction, and then sell them at profit.

The dealers said the number of cattle in Wudil market had increased over the past 5 years. This increased supply is partly due to a shift of part of the trade away from the Chad Basin to Wudil, due to the Boko Haram insurgency. However, the supply is higher in the dry season than in the rainy season, as herders migrate with their cattle out of Wudil and Kano state when cultivation begins after the first rains.

Karaba – under Yar Gaya town – Dawakin Kudu LGA, Kano State

Sarkin Fulani, Saleh Burti

Interviewed on 29 January, 2022.

He is an old man of about 98 years. He said that even his grandfather was buried in Karaba, so it is an old settlement. The pastoral Fulani live in a permanent camp (ruga) outside Karaba village. He is from a clan called Galleeji, under Daneeji'en. There are other Fulani groups and clans living with them:

- Humaranko'en
- Geroji'en
- Yaaɓaaji

More than a century ago, Buzayi (Tuareg) from Niger settled in the area.

The last group to settle in the area were Hausas, a specific Hausa subgroup referred to by the Fulbe as Kutubanko'en – part of Maguzawa.

There is a grazing area called Tudun Mai Gizo, located in Adamawan Yar Gaya.

The old man – Sarkin Fulani – said the grazing area is still there, but it is not in tact – it has been encroached by farmers. They have some interesting natural vegetation within the grazing area. Some of the tree species that remain include:

1. Bummeeje
2. Banuje
3. Shakehi
4. Dundeeje
5. Jamme
6. Jaddumbeje

The above trees, while still present, have mainly been cleared due to farming activities. The Sarkin Fulani complained about the loss of so many trees. The Sarkin Fulani was very knowledgeable about usable plants, including for medicinal purposes. Many people come to him to collect herbal medicine, which he makes from plants. For example to women complaining of complications during pregnancy, for treatment of stomach complications in children, and treatment of piles.

There are also important grasses in the grazing area:

1. Harhandeho (the main one and it is still there but now in low quantity due to heavy encroachment of farmers into the area)

They live peacefully there but they have disputes resulting from the destruction of crops by cattle.

When he was young, they could graze their animals nearly everywhere due to the lower population at that time. But now there is very little grazing land and not much bush. He also complained bitterly about social changes within Fulani communities, with young men not as honest and straightforward as before. These changes in behaviour have occurred due to interactions with Hausa and other communities in town and villages. Before, they were further from other settlements, but the expansion of settlements has brought them into closer contact. Despite this, they have a low crime level in the area. The main issue is small-scale theft of animals, especially small ruminants.

He said the number of animals they own has reduced compared to 10-15 years ago. This is due to the reduction in available grazing land. Some of the families with larger herds were forced to migrate out of the area, due to lack of land. He does not know where they went (as he stays in the area without going far away). Sarkin Fulani is very aged but he is well known, including in Kano Emirate Council. When he was much younger, he worked with Miyetti Allah, but he has retired now. The railway line will pass close to their camp and Sarkin Fulani is happy about this. It may provide jobs for their youth and enable them to transport goods to the market. It is not something they ever expected to see, so they are pleased. As their cattle are reducing it could provide their children and grandchildren with jobs.

Eggi also sighted camels in the area. They come en masse from Niger, but only during the dry season. Wider discussions with the community revealed they are very unhappy with the lack of provision for the movement of cattle across the expressway. Just two weeks before our work in the area, there was a serious accident on the road that killed eight cows. No crossing point was provided for them when the expressway was built. It illustrates the need for crossing points.

They would be happy if they can have crossing point across the Railway line, where their cattle route – which is well marked – meets the line.

Babban Gida Wajila – Bichi LGA, Kano State

1 February 2022

Malam Nuhu Muhammad, aged about 80 years. He is the head of the village.

He is Yerimanko'en by clan.

Babban Gida Wajila is a cluster of camps, together comprising what could be described as a village.

They are mixed farmers, with livestock and crop farming. Malam Nuhu said it is difficult to keep large herds of cattle in the area, due to lack of grazing land, meaning that they only tend to raise small numbers of cattle. They used to have a large grazing area but this has been cultivated by farmers. Now they depend on crop residues to feed their cattle. They are essentially agro-pastoralists; they also do dry season farming in the area. Initially they did not see the dry season farming as a business, but rather as a source of feed for their animals. But now it has become an important economic activity for them too. They are constrained, however, as the water sources are quite far from them and their wells and bore holes are deeper than elsewhere. The deeper the bore hole used for irrigation the more money is needed for pumping the water.

Malam Nuhu said the number of animals they own has drastically reduced over the past 15 years and they are getting poorer. Even though they are making some money from irrigated farming, it cannot be compared to when they had larger herds of cattle with adequate pasture and a higher reproduction rate in the herds. Due to their currently low level of livestock ownership they now get only a little milk from the cows. Their milk is now only for domestic consumption; they no longer sell it, due to the reduced quantity.

The railway passes through the area and they have a cattle route that crosses the line. This is marked with GPS. This route is used by local herders and migrant herders. Migrant herders come to their area in the dry season, with larger herds. They complained that the migrant herders, who are wealthier due to their large number of animals, push up the price of the crop residues. They can pay more for the residues than the pastoralists in Babban Gida Wajila, and this demand inflates the prices and limits the access of the local herders to residues. The local herders can only keep as many cattle as they can afford to feed, and the high cost of residues / feed reduces their number.

Tangaji Pogayo – a Fulani village consisting of a cluster of permanent camps, in Bichi LGA

Kano State

2 February 2022

Eggi met the maiangwa, called Maiangwa Musa Saleh Tangaji. He is about 78 years old.

By origin, he is Daneejijo by clan.

It is a very old settlement, estimated by the maiangwa at 400 years old.

They are mixed farmers and they hardly keep their cattle in the area during the rainy season due to the massive scale of rainfed farming in the area. They mainly send their cattle to northern Jigawa (Babura LGA), and some up to Niger Republic, after the rains start. Their herders then migrate back with the cattle in the dry season, for the residues. Pastoralists from Niger and other parts of northern Nigeria also migrate into the area during the dry season. Most of the nomadic herders come with large herds of cattle and large flocks of sheep and goats. According to them, most of the nomads migrating into the area from within Nigeria are Sullubanko'en. Most of those from Niger are Uda'en, with sheep. The migrant pastoralists all tend to leave the area in the early rainy season, while the local herders tend to delay a bit longer until moving their animals. The Railway Line crosses a migrating cattle route and a cattle route to a nearby water point, in about three places. See GPS coordinates.

Maiangwa Musa said that the dry season farming assists them a lot. It provides them with good income from farming and it enables them to keep their livestock in the area during the dry season due to the availability of crop residues. However, the poverty level is high due to their large families. One of his sons has 22 children and said that if this year his tomatoes do well he will marry another wife!

Tabeta – or Jibgan Fulani (they use both names). It is a large village, predominantly settled Fulani.

Date visited: 2/2/22

Sani Ado – the Wakilin Maiangwa – was interviewed. He is in his 70s.

He is from a clan called Jibganko'en.

The village is their origin – Jibgan Fulani – that is why they are Jibganko'en. In his early life they were pure pastoralists, but now they are mixed farmers who even do more farming than rearing. They have lost most of their cattle. Not all households / compounds in this village even have cows. Some only have small ruminants. They largely depend on farming. What they mainly cultivate is: millet, cassava, guinea corn, groundnuts, beans. A few people also cultivate maize.

The lack of grazing areas is the main thing that made them put more concentration on farming than cattle rearing. The maiangwa said something interesting – when he was young they used to see a lot of wild animals in the area. He listed dilla (fox), barewa (a species of antelope / gazelle?), chewa. But they have all gone; it is even hard to see birds. The entire grazing area / bush has been turned to farmland.

The loss of grazing land has resulted in a high level of poverty. They are very poor, with a very low standard of living. Nearly everyone is living hand to mouth and most of their youth are forced to go out and seek work in towns and other villages in the dry season. Some go to Kano city. It is a very dry area and there is no dry season farming in the area due to lack of water. But they are lucky in that there's no security challenge in the area – there's no kidnapping or cattle rustling. It is a peaceful area, despite the high level of poverty. We marked some of the cattle routes that they have around them using GPS. They cattle routes are demarcated with shrubs along the edges and the routes themselves are a little overgrown as they have not been cleared for cultivation. The places where the routes cross the line are clear. Migrant herders come into the area during the dry season only. When they had bush in the area, migrants also came in the wet season, but no longer. The migrant herders come in the early dry season and stay until the residues from the rainfed farming finish and until the local water source dries up, then they move on.

Danya – Danbata LGA, Kano State

3 February 2022

Interview with Abdul Salam Abdul Kadir, the village head (mainangwa). He is about 45 years old. He inherited the title nine years ago from his late father.

Danya village is about 65 years old. All the villagers are Hausa but there are many Fulani camps around them. According to the maiangwa, they have a good relationship with the pastoralists in the area, most of whom are sedentary practising mixed farming – livestock and crops. The cattle of the pastoralists in this area are different to the cattle in the areas visited up to this point. It seems to mark a different zone in terms of cattle breeds. The cattle here are mixed – interbred - between the white cattle (yaakanaaji) typical of the Fulani in other areas surveyed, and red cattle from Niger (short horned, not the larger boɗeeji, the breed kept mainly by semi-settled Fulbe, not the larger breed typical in nomadic herds).

There are herders who migrate into the area during the dry season, from other parts of the north-west, particularly Katsina, and from Niger Republic. They come very early in the dry season, immediately after the harvest. They feed their cattle, sheep, and goats on the crop residues around Danya, and then they proceed southwards to a dam along the river, between Danbatta and Kano. There is a lot of dry season farming in around the dam, therefore pastoralists and farmers in that area depend on it. It is a large water body, along the main road. The dam is too far from people in Danya to use. They do not do dry season farming in Danya, but they harvest cassava in the dry season – it is planted in the early rainy season and stays in the ground for a year before harvest. This is profitable for them. From Danya the migrant herders migrate westwards to the valley, which then links with the dam to the south. This is the next stage of their migration after Danya. Near Danya there is a large migrating cattle route and a water point route, both of which cross the railway line. There are disputes in the area but not violent conflict. Disputes arise when migrant herders bring their cattle to Danya before crops are harvested and encroach onto farms.

Jedawa – Danbatta LGA, Kano State

3 February 2022

Met with Abubakar Umaru, the village head of Jedawa. It is a cluster of camps that are permanently settled. The settlement is 52 years old and they are mixed farmers and cattle rearers. They are not far from the boundary between Kano and Jigawa states and they have one main migration route and one livestock grazing route. The Railway Line crosses both of them. We plotted both on GPS but they are not very far apart, so a single crossing point over the railway would be sufficient. The best place to build the crossing point over the line would be from the main livestock migration route, then a linking route to that point could be made across the farmland from the more minor cattle grazing route (which is used for accessing daily grazing areas). Most of the farmland in the area is owned by the community in Jedawa who also raise livestock.

Pastoralism used to be very economically important to people in Jedawa, but due to diminished grazing areas as a result of high population growth and agricultural expansion the number of cattle they have has reduced. They only keep cattle in the area during the dry season. Some keep a small number of milking cows in Jedawa during the rainy season, but the rest of the cattle migrate to Jigawa state and Niger Republic in the rainy season. They return in early dry season, after the harvest, and they then feed the cattle on crop residues from their farms. This sustains the cattle for part of the dry season but not all of it. After their own crop residues have been consumed they send the cattle to the valleys where there is dry season. They return to Jedawa after the rains start, and then continue to Jigawa and Niger. The time the cattle spend at home in Jedawa is therefore limited. This impacts particularly on milk production for the women. Their living standards have fallen, because they have fewer cattle than before and the cattle they do have spend most of the time away due to the lack of grazing land where they live.

Most of the inhabitants of Jedawa rely on farming. They farm millet, sorghum, and beans, all during the rainy season. This is primarily for subsistence. The beans are grown partially as a cash crop. Their Hausa neighbours rely mainly on cassava farming, which is a source of dispute between communities. Disputes arise because cassava has a long cycle; it is typically planted in the middle of the rainy season, it grows for the whole dry season, and is only cultivated in the next rainy season. This is a 12-month cycle, but there are some varieties which have an 8-9 month cycle. The crop is therefore vulnerable to damage by livestock, especially by small ruminants which normally graze freely in the dry season. This has led to demands from farmers for pastoralists to keep their sheep and goat tied up. In general the area is peaceful. Only cases of small-scale theft of guinea fowls, chickens, sheep, and goats were reported to be present.

They are worried about the construction of the Railway Line, because it passes through their farms. Their concern is that the size of land that will be taken by the railway is large and this will be built on their farms. They are not expecting any resistance, however.

Danbatta cattle market

6 February, 2022

Eggi went to Kazaure and then returned to Danbatta at around 3pm and went to the market.

Malam Suleiman Danbatta – conversation / interview.

He is from Dankaba in Danbatta town and is a dillali (middle man) in the market.

He is about 55 years old and has been in the cattle business for 23 years. He goes around different markets, including in Katsina state up to the border with Niger – especially to Mai Adua.

He said that most of the cattle in Danbatta market come from the north – meaning Niger.

Local farmers also contribute a lot, because they have a culture of buying young bulls, raising them for some time and fattening them, then returning them to the market to sell.

Most of the cattle coming from Niger do not come directly from herders to market. The origin is in Niger but the animals are first bought by local farmers, often in border markets, then after fattening them the farmers sell them in Danbatta market. It is rare to see a good bull from the Fulanis in that area; most of the large bulls are traction animals, as indicated by the rope through the nose. They are used in the fields and for transportation, typically pulling carts. Before they are sold they are kept for a month and fed well, without doing any work, to fatten them. An example is a farmer in the market who bought a bull there two years ago for 212,000 naira and brought it back to the same market two years later – during our fieldwork – and sold it for 524,000 naira. One of the advantages farmers have is that they can feed their bulls on crop residues, so it does not cost very much to raise them compared to their value. Some have four, others have six bulls, etc. Most of the large bulls are actually owned by the farmers, not by the pastoralists. Malam Suleiman said that every market day in Danbatta he makes 15-20,000 naira. Danbatta market is weekly but he also goes to other markets. Every week in Danbatta they load 20-25 trailers and each trailer carries 25-30 cattle. These trailers go to southern Nigeria, adding up to between 500-750 cattle sold weekly in Danbatta for the southern market. Smaller lorries go to Kano city and there are also transactions at the local level.

Alhaji Audu Muhammed. He is a cattle dealer who normally buys big bulls from Mai Adua, a border town in Katsina state, and sells them in Wudil and Danbatta. He normally sells them to big cattle dealers who are transporting them to the south, to Port Harcourt and Lagos. He deals only in big bulls. These large bulls are mainly sold by the farmers, not the pastoralists, who nowadays tend to sell younger bulls and bullocks ages 1-2 years old, mostly to farmers, who keep them for two years or more under intensive care so that they grow big and gain value. The farmers then sell them for a high price before buying more young bulls from the herders. The herders have a larger turnover of animals to meet their expenditures and do not tend to keep bulls long enough for them to grow large, unless it is a breeding bull for the herd (which is rarely sold). The farmers buy the young animals from pastoralists and then grow and fatten them, also using them for traction and transport before selling them.

Alhaji Audu said the prices of the bulls in the north are a little lower now than 3 months ago. This is probably due to the festivals in the south – they are higher in Nov-Dec-Jan, when there are more weddings and Christmas, new year – then the price drops in Feb-March. This affects the buying price in the north. He also sells to butchers from Kano and Abuja who buy two or three large bulls per market day to slaughter. They are important for his business. The Railway is to be located on the western side of Danbatta town. It would be useful because the town is important for the cattle trade and for agricultural produce, both rain-fed and dry season vegetable farming. Trailers of vegetables and other crops also load and transport out of Danbatta. All these products could be transported by railway.

Badori, Kazaure LGA, Jigawa State

7 February, 2022

Interview with Idris Useini, the village head.

His Fulbe clan is Jallanko'en, whose origin is Kunchi LGA of Kano State. His parents settled where they are now about a century ago. He is now in his 60s. They were formerly nomadic Fulani, migrating from place to place, and Badori was their wet season grazing area. Then his father decided to settle there. Presently they are doing mixed farming, but grazing is the most significant part of their lives. They reply on cattle more than on crop farming. They raise white cattle, but that is not the cattle their parents left them with. They used to have red cattle, but those were not well adapted to the environment where they are now so they changed them to white cattle. They also have sheep and goats. They keep their animals there throughout the year, as they have a grazing reserve to the north of their village. They said about 30% of the grazing reserve is still there while the rest has been taken over by farmers.

Due to overgrazing, the pasture is not as good as before. There are a lot of cattle also coming from other places both in the rainy season and in the dry season. In the rain season, the migrant herders mainly come from Katsina and Kano and some parts of Jigawa.

Sullubanko'en from Zamfara also come to the area in the rainy season. The herders who come in the dry season are from Niger Republic, with sheep and red cattle, and some with camels. They are not too happy with those who are coming into the area, because they are cutting trees in the grazing reserve. It is particularly those coming from Niger in the dry season who do this, to feed their animals. They cut the branches, not the whole tree, but this is not the culture of the local pastoral Fulani, who normally graze their cattle on leaves etc. on the ground. The cutting of branches has impacted the trees of the area. There are other non-Fulbe groups – Hausas - living together with them, close by. But as the head of the community, they are under him. They have a primary school and a nomadic school, and one of his sons is a university graduate. They also have a clinic. It is thus a well-established community.

According to the village head, they are doing well economically. They do not have major problems sustaining their livestock numbers – sometimes they increase in number, sometimes they go down, but they have sustained their herds. From five years ago until date, the village head said their wealth has increased – i.e. their herds have increased. The Railway crosses two cattle routes in the area. We marked both points using GPS. The village head said they have no problem with the planned Railway line – they see it as a good development because they think it will provide employment for their youths and will make transportation easier for them.

He was a nice man; well organised.

Kurman Ruwa – Gwiwa LGA, Jigawa State

Halilu Abubakar (nickname: Na Barirah). He is the Wakili – his brother is village head.

He is 70 years old, still looking healthy and strong.

They are Dabanko'en. There is another Fulani group there too, Dabaranko'en. They intermarry.

They are mixed farmers, cultivating crops and keeping a significant number of animals.

The keep the white zebu cattle, yakanaaji, but some cross-breed them with red cattle. Kurman Ruwa is a semi-fadama area in the wet season, but it has a lot of trees, including plantations of fruit trees and species such as eucalypt. They cultivate millet, guinea corn, and maize in the rainy season. In the dry season they cultivate carrots, tomatoes, green pepper, and other vegetables.

Kurman Ruwa is an old settlement containing both Fulani and Hausa before, but the Hausas migrated and left the area 25-30 years ago when a road was constructed in the area. The Hausas relocated to near the road, but the Fulani decided to stay where they were. The relocation of the Hausa farmers gave the remaining inhabitants more space for grazing and farming and that has allowed most of the herders to keep their animals in the area throughout the year. But some do migrate. They said they have recorded an increase in their animals over the past ten years. The main reason for this increase is the introduction of dry season farming, which provides the feed for animals in the dry season, and it serves as a cash crop for them, reducing the pressure on the cattle. Na Barirah said that this year he sold carrots worth 1.5 million for his family, which he and his children farm. But they invested a lot of money in the farm, so that is not the profit. On his farm he also has a plantation of cashews, mangoes, and guava, which give some income. He sells cattle only occasionally, such as when there is a wedding or another ceremony, but day-to-day expenses are covered from the farm profits, not from their herds, which gives the cattle a chance to regenerate and increase in number. In previous years, they only did rain-fed farming, but now dry season farming has improved their standard of living.

He said they do not have any major security challenges in the area. Sometimes there is some small-scale theft of animals, especially in the dry season when other Fulani groups come into the area. But it is not a very serious issue. The Railway Line will pass through his farm and across a major migrating cattle route. After crossing the migration route there is a place where the Railway also ***follows*** this international migration route for a long distance (but we did not measure it to know the exact number of kilometres). From Kurman Ruwa the route goes through Katsina State and then into Niger.

Angwan Gamji, Daura LGA, Katsina State

9 February, 2022

Aliyu Ismaila, Maiangwan Gamji – Daura District, Daura. He is the village head.

The village was established 55 years ago. They left their former location, which is not too far away (only about 5km), due to a lack of water in that area.

It is a mixed agro-pastoral community comprising both Hausas and Fulbe. They cultivate guinea corn, groundnuts, and millet, and a few of them cultivate maize. Both the Hausas and Fulbe also have the culture of keeping animals – cattle, sheep, goats. They estimated they have 600-700 cattle in the village, 1000-1500 sheep, and an uncertain number of goats, as many are owned by women. There is a large movement of nomadic pastoralists into the area early in the dry season, from other parts of Katsina and from Niger Republic. They normally face some difficulties when these herders come, because they usually arrive before the farmers have finished harvesting their crops or before they have finished packing their farm products. This is causing a lot of problems – the farmers are not happy with the early coming of the pastoralists, but the leaders always try their best to manage the problems so that it does not escalate into violence. They normally call the elders the pastoralists and they sit together and sort out any problem that arises.

Malam Aliyu said their area is short of water. They have no dam or river, which makes it impossible for them to do any dry season farming. They completely depend on rainfall, which even during the rainy season fluctuates. Some years the rains will be okay, but in other years it is not, leading to food shortages. In years when rainfall is low, they have to sell animals to buy food. This is one reason why they are seeing a reduction in their animals and getting poorer. They have a low standard of living and most of their youths leave in the dry season to seek work on irrigation farms elsewhere or to work in towns as labourers. A few have motorcycles which run between villages. But overall, their economic condition is bad. Due to their poverty, when they heard about the Railway project, they were extremely happy. They hope it will provide jobs and open their area to other parts of the country and lead to investment that will improve their standard of living. Their main challenge is the size of the land that the railway will take. It goes through their farms and their economic trees, which is a problem. They will need good compensation, but they support the project. The area is peaceful, and people are free to do their business without any problem. Their wish is that when the see the railway construction work in their area and people working on the project coming to the area.

Mazojin Fulani – Mazoji district, Daura LGA, Katsina State

project starts labourers will be employed from their community. They will be happy to

10 February, 2022

Mai Gari Isa Ibrahim – he is about 65 years old and is the head of the community.

He said they do not know the real location of the railway line in the area.

He said the village is an old settlement of Fulani and Hausawa and they are mixed farmers. They do a lot of crop farming and keeping animals on a small scale, due to the lack of grazing land in the area. Most of their pastureland was taken over by the expansion of activities from Daura town, with a lot of construction on their grazing areas. That includes the federal university of transport, the federal polytechnic Daura, the Nigerian air force hospital. All these institutions took land that previously was used by this community for grazing their livestock. The loss of grazing land led to a reduction in their livestock ownership and increased their poverty. People are just struggling to find food to eat. With all these projects going on, their youths hardly get any work. The contractors bring labour from outside the locality to work on projects, they do not employ local people. The people in Mazojin Fulani are unhappy about this.

They are pleading that when this Railway project takes off, they should be considered for employment to reduce the poverty level within their community. According to the village head there is no serious security challenge in the area. There is no history of kidnapping or robbery. They are peaceful and ready to work closely with the railway contractors who come to work in their area.

Mbela camps – Mazoji district, Daura LGA

Suleiman Adamu is the head of the camps. He is about 45 years old.
He said the pastoral settlement at Mbela is old, estimated at 155 years. They migrated from Raba, in Dutsi LGA of Katsina state. They are agro-pastoralists: they raise animals and do a lot of farming. The reason they went more into farming is because the number of their animals is drastically reducing. They said this mostly due to shortages of rainfall. There is low rainfall there and they must sell animals to buy food for the family. The village head does some agro-forestry, as he has some land near a river. The river course is dry in the dry season, but it carries water in the wet season. He has a well or bore hole on the farm. He grows mangos, oranges, guava, moringa. He also has a garden where he grows vegetables like alayaho etc to sell. His father advised him to do this, and he has been growing these crops from a young age. People come from town to buy his garden products, giving him an income.

The general economic situation in these camps is bad. Others without the economic opportunities outlined above live in poverty. The community is getting poorer. The main problem is low rainfall, and there is no irrigated farming there due to lack of water in the dry season. The railway line passes through their grazing area and divides it into two. They have only one water point, so when the animals need to drink, they will have to cross the railway line if they are on the other side of the line. The construction of a water point on each side of the line would reduce the need to cross the line. They said they would prefer the dams / water points to be dug than to have a bridge or other crossing point. They could also use the water points for other activities.

They had a bad experience from government when a military barracks was constructed in the area. It is a new barracks, opposite the community, constructed during Buhari's tenure. They said the barracks have taken 15km^2 of their land and work began in the rainy season after their crops had been planted. Their crops were destroyed, and no compensation was paid, neither for the land nor the crops. According to one story, the federal government released money for the compensation, but the contractor refused to pay, and the community could not get the compensation from him as he is from the area and influential. They hope that the railway line will compensate them for any land that is taken from them. Due to their previous bad experiences, they are upset about the railway line, but they are not planning to challenge it. Please also consider their urgent need for water.

Darugawa – Daura LGA, Katsina state

10 February, 2022

Maiangwa Bako Musa. He is about 65 years old and the head of the community. He is Hausa. He said most people in the area are Hausa, but while they do a lot of farming, they also have some animals. They keep the animals in the area throughout the year. They also farm in rainy and dry seasons, as there is water in the area. In the rainy season they cultivate millet, maize, guinea corn, and beans. In the dry season they grow beans, pepper, tomatoes, cabbage, carrots, and other vegetables.

They said they make more money from rainy season farming than from the dry season, which is more intensive and requires more expensive capital investments. But they are happy with it as it keeps them occupied throughout the year and provides some income. It is a new dam (water point) that was constructed in the area, that is what enables irrigated farming. It is rare to see someone from this area leaving in the dry season in search of work; no cin rani in this area.

A lot of pastoralists migrate into the area in the dry season, to buy residues from their dry season farms, which also raises the economic status of the area (the pastoralists bring income). The pastoralists too are happy, as the residues provide feed for their animals, keeping them healthy.

Their main challenge is the access road. There is some distance from where they are to the main road, which makes it difficult to bring out their farm produce. They use oxen and carts to bring out their agricultural produce. It is a bad road that gets waterlogged in the rainy season, and in the dry season it is not motorable, even for cars. They have to load vehicles on the main road after bringing the produce out on carts.

The farmers have a good relationship with the pastoralists in the area. The crime rate is low. The Railway line crosses their main migratory route. We marked that point with GPS.

Karawa camps, Mashi LGA, Katsina State. They are under the district of Mashi.

11 February, 2022

Alhaji Sani Lauje – he his the Chairman of Miyetti Allah Kautal Hore in Dutsi LGA.

He is from Karawa camps, from a Fulɓe clan called Gellanko'en. They have an origin in Sirika village, also in Dutsi LGA.

Karawa is an old settlement. They stay there with other Fulani clans including Hontorɓe, Silanko'en. There are also Hausa people in the village.

They are all mixed farmers, raising livestock and growing crops, but they are more into farming than grazing. They mostly farm millet, guinea corn, groundnut, and cassava. They rear cattle, camels, sheep, and goats. In general, their animals in the area are reducing. They reason is due to the high rate of population growth, which makes it difficult for them to get enough land to graze their animals due to farming activities. The reduction in their animals has increased the poverty level in the community.

The Chairman said that most of their children go to primary school, but few go to secondary school. The main reason they do not go to secondary school is poverty, according to the chairman. But there is a secondary school in nearby Sirika. Also, the low quality of education is a big problem. A child will finish primary school without being able to read or write. They are in a dry area – there is no water there for dry season farming. They have a community forest in the area. They mostly use this for grazing. Its dimensions are about 8km by 4km. It is also used as a base for nomadic Fulani who migrate to the area in the dry season and rainy season. The migrant herders who come in the dry season are mostly from Niger, with camels, red cattle, and sheep. They normally leave in the early rain season and go back to Niger. Those who come in the wet season are from contiguous parts of Nigeria. Some come from Malumfashi area, while others come from Zamfara. They come before the middle of the rainy season.

The Railway line passes through this forest reserve. It also crosses some important migrating cattle routes that even lead to Niger. It also affects their water point – the proposed railway station is located very close to their water point, which is relatively small in size and only functions in the wet season. Alhaji Sani requests that two dams / water points should be constructed for them by the railway company. The railway passes through the middle of the forest, so one water point should be to the north of the line and one to the south of the line. That would assist the community and reduce the number of cattle that cross the line.

They even named the places where they want the dams to be located:

1. Maakawol
2. Nagatau

If water points / dams were located there it would solve their problem. If the holes were dug deep enough they would sustain them throughout the year.

The area is peaceful – there is not much crime there. The Chairman said the secret to this is unity in the community and cooperation from the traditional leaders. They received a directive from the traditional leader in Shargalle to report any suspicious behaviour by community members. Shargalle is less than 2km away from these camps. [This led to arrests of a group of people who had invited bandits to come and kidnap. Those arrested were

Hausa, not Fulani. From then, stability was restored and there were no further problems.

Shiraka camps, in Kurori

Visited a Buzayi camp and interviewed Babangida Abdullahi Buzu. He is about 30 years old and he is Buzu from Dakoro town in Maradi region, Niger Republic. They arrived in this camp a year ago and have been there for the whole time, without moving. They have camels and goats. Why did they come to this place? It is part of their culture to move around from place to place and graze their animals. It is normal for a camel herder to come to this area and graze his animals before returning to Niger. He said that the grazing conditions in this area, especially in the dry season, are far better than in Dakoro. Here there are enough trees for their camels to feed on, and enough drinking water. This makes it more favourable for the growth and health of their camels. This is leading to a higher reproduction rate. From the time he started coming into Nigeria he never faced any difficulties or problems with anyone. There are not many farms in the area where they stay – there is a large forest reserve where they are – and he said he has never faced any difficulties with the farming communities in the area. Even if there is damage to crops by camels or goats, they fix the problem through discussion without any problem.

Their camp is located very close to the proposed railway line. How will the railway affect his life? He replied that the land does not belong to him, when they come and start construction, he will leave the area with his animals. He said he does not have a problem with it, that it is a good development. In any case his plan is to return to Niger at the end of this dry season. He may spend some years in Niger before he returns to Nigeria. That is just to stay in his family, as already his animals have increased, especially the goats.

We note that the large forest in the area is not a haven for criminals because the communities and especially traditional leaders under the Emir of Daura and vigilante on security issues. Every Friday they gather in juma'at mosques and slaughter a ram and pray for peace and security in the area.

Preliminary recommendations

The railway line crosses livestock routes at many different points, along the whole length of the line. Through fieldwork, we recorded exact points where the line intersects with stock routes. We also interviewed pastoralists and found out the economic importance and use of these routes.

Herders move livestock along these routes both for daily grazing and large-scale migration of animals between wet and dry season pastures. The animals that move along these routes are: cattle, sheep, goats, and camels. It will be important to build crossing points over or underneath the railway for livestock, at the points where the railway line intersects livestock routes.

There are two main types of stock route: (1) major international migration routes; (2) daily grazing routes that are used by local herders to access grazing areas and water points. As well as crossing livestock routes, there is a section of the railway that is actually *following* a livestock route. This means it is being built on the stock route and following the course of the stock route. A new stock route will need to be opened in this section, possibly running parallel with the railway. On the above point, and on many other points specified here, the solutions are simple but they are best achieved through close liaison with the village heads and pastoral leaders who live in the area (i.e. do not bring in people from outside, speak to the local people in settlements along the line to find solutions).

In some areas, the railway line splits herders off from their local water sources. Such issues can be resolved by constructing new water points on each side of the line. These can be relatively low-cost – earth dams (i.e. holes deep enough to store water throughout the dry season), bore holes, or wells. Quarrying during the construction of the Kano – Maiduguri expressway created deep pits that have inadvertently become very useful water sources for pastoralists in the area, and for dry season irrigation farming. Would similar water sources be a by-product of railway construction? It is a semi-arid zone and water storage is a big issue.

Nearly all pastoral settlements around the Railway were enthusiastic about the line and optimistic about the economic opportunities it may bring them. It must be understood that many – but not all – pastoralists in the area have become *poorer* over the past decade, due to loss of grazing land. This has led to a reduction in the herd sizes of many pastoral households, thus reducing their wealth. Due to widespread poverty, pastoral communities are very enthusiastic for their youth to be employed as workers on the railway line, in construction work or other employment. These same communities note that they have not gained jobs from other government projects in the area, such as road building and institutional developments, which used outside labour for construction. It would be great if the Railway could employ local labour.

That would increase local support and enthusiasm for the project. As well as the settled agro-pastoralists who reside in the area, there are nomadic pastoralists who migrate with large numbers of animals into the area in the dry season, from surrounding areas of northern Nigeria and from Niger Republic. There is also a northwards wet season migration of local herders in the area up into Niger Republic, and the return migration of the herders from Niger. Dry season irrigated farming has greatly expanded in areas near the railway line, with economic benefits to local farmers. The railway may increase opportunities for them to transport their crops to the market. The economic picture is therefore mixed – there are increases in wealth due to dry season farming, which enables production throughout the year rather than only in the few months of the rainy season, but the hydrology and climate of the area means that some places are too dry for irrigated farming, and those areas tend to be poorer. But despite high levels of poverty, the route the line follows is peaceful, with the exception of some security challenges in Jibiya LGA of Katsina state.

APPENDIX III
Results of Laboratory Analysis

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CERTIFICATE No.0327

Sample Reference: LA/328/ANL/WS/22

CERTIFICATE OF ANALYSIS

Client: ALLOT Nigeria Limited
Sample Type: Soil Samples
Sampling Location: Jigawa, Kano, Katsina States
Date Sampled: December 10 – 21, 2021
Date Reported: January 21, 2021

I, the undersigned PUBLIC ANALYST, Registered Number 00656, hereby certify that on December 21, 2021, fifteen (15) water samples and seven (7) sediment samples were received at the laboratory. The samples, while in the same conditions as sampled, were analysed / examined under my supervision. The findings are here under and in subsequent pages:

Groundwater

Parameters	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8
pH	6.58	6.95	6.6	6.3	6.7	6.5	6.6	6.5
Temp (°C)	28.1	28.3	28.1	28.1	27.8	29.8	30.1	29.9
TDS (mg/L)	149.5	72.5	96	83	41	63	95	84
Electrical Conductivity (µS/cm)	317.7	155	205	196.8	133	197.1	224	259
Turbidity (mg/L)	0	0	0	0	3	2	5	3
TSS (mg/L)	0.87	1.05	2.7	3.9	5.6	3.87	2.5	1.33
THC (mg/L)	0	0	0	0	0.05	1	0	0
DO (mg/L)	4.78	5.1	5	4.5	5	6	5	4
Nitrate (mg/L)	5.7	18.1	21.6	11.1	4.2	4.87	8.45	4.94
BOD (mg/L)								
Phosphate (mg/L)	0.3	0.7	1.09	2.7	1.1	1.7	1.11	0.49
Ammonium (mg/L)	0.72	1.21	1	1.8	1.5	0.98	0.09	0.91
Calcium (mg/L)	32.06	30	18.4	6.9	18.8	5.2	10.8	6.9
Magnesium (mg/L)	22.86	12.86	70	13.6	2.4	3.1	24.4	13.7
Potassium (mg/L)	3.8	2.17	5.19	4.1	2.9	1.62	2.81	1.94
Sodium (mg/L)	9.84	13.2	13.12	21.8	16.4	23.7	21.4	20.7
Lead (mg/L)	0	0	0	0	0	0	0	0
Total Iron (mg/L)	0.04	0.07	0.16	0.73	0.19	1.82	0.45	0.34
Copper (mg/L)	0.004	0.006	0.006	0.02	0.05	0.01	0	0.21
Zinc (mg/L)	0.813	1.07	1.5	1.15	0.67	0.17	0.83	0.65
Manganese (mg/L)	0	0.04	0.03	0.025	0	0.02	0	0

Parameters	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8
Cadmium (mg/L)	0	0	0	0	0	0	0	0
Total Chromium (mg/L)	0.003	0.006	0.006	0.004	0	0	0.04	0
T.Coliform (cfu/ml)	11	4	2	9	6	11	2	13
E.Coli (cfu/ml)	<0.02	<0.02	<0.02	0	0	0	0	0
THF (cfu/ml)	2	2	2	3	2	3	2	2

Surface water samples

Parameters	SW1	SW2	SW3	SW4	SW5	SW6	SW7
pH	6.1	6.1	7.8	6.4	6.2	7.5	7.3
Temp (°C)	29.4	28.6	28.9	29.1	28.2	28.5	28.4
TDS (mg/L)	103	201	195	67	159	275	191
Electrical Conductivity (µS/cm)	189.6	389.4	219	211.8	256	412	311
Turbidity (mg/L)	12	15	7	11	6	12	5
TSS (mg/L)	4.7	10.6	6.3	8.4	4.7	7.3	3.5
THC (mg/L)	0.01	0.23	0.05	0.01	0	0	0.15
DO (mg/L)	8	11	12.5	8.9	9.4	6.3	8.1
Nitrate (mg/L)	30.9	23.6	23.7	8.1	8.1	8.1	15.1
BOD (mg/L)	4.1	2.1	2.1	2.1	2.1	2.1	3.8
Phosphate (mg/L)	3.5	1.1	2.7	5.2	11.5	6.4	3.9
Ammonium (mg/L)	0.56	0.82	1.56	1.32	1.66	4.21	0.88
Calcium (mg/L)	26.4	25.1	11.6	17.2	0.85	3.12	5.15
Magnesium (mg/L)	1.3	1	13.5	2.4	3.2	2.6	1.1
Potassium (mg/L)	3.2	1.63	7.43	8.26	3.73	1.85	6.4
Sodium (mg/L)	48.2	5.89	13.6	27.4	15.2	6.95	5.97
Lead (mg/L)	0	0	0.12	0	0.33	0	0
Total Iron (mg/L)	2.4	1.6	0.53	0.57	1.28	1.74	1.11
Copper (mg/L)	0.18	0.68	0.03	0.11	0.23	0.38	0.2
Zinc (mg/L)	0.39	0.16	1.04	0.59	2.12	0.16	0.54
Manganese (mg/L)	0	0	0.04	0.02	0	0.05	0
Cadmium (mg/L)	0	0	0	0.03	0	0.02	0
Total Chromium (mg/L)	0.16	0.21	0	0.23	0.03	0.38	0.18
T.Coliform (cfu/ml)	105	21	103	32	21	25	34
E.Coli (cfu/ml)	9	2	6	0	0	1	0
THF (cfu/ml)	5	17	10	8	8	9	12

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Sediment samples

Parameters	SD1	SD2	SD3	SD4	SD5	SD6	SD7
PH (33.6^{c})	5.9	6.1	4.8	6.2	6.4	7.3	8.2
THC (mg/kg)	2.56	1.69	4.22	5.31	1.06	7.22	0.49
Ext. Nitrate (mg/kg)	1.6	2.1	4.8	2.6	1.9	7.3	11.7
Ext. Sulphate	3.2	0.2	2.5	3.7	4.8	2.2	3.9
Ext. Phosphate	1.56	9.34	2.1	11.8	0.39	5.7	1.87
Total Iron (mg/kg)	17.4	28.4	5.67	23.13	2.42	1.62	2.84
Copper	1.21	1.47	0.38	0.39	1.66	1.29	0.43
Lead	0	0.48	0.62	0.3	0	0	0
Nickel	0	0	0	0	0	0	0
Zinc	0.18	0.37	0.11	0.24	0.14	0.69	0.18
Manganese	0	0	0	0	0	0	0
Chromium	0.05	0.02	0.01	0.02	0.04	0.02	0.13
PCB (mg/kg)	0	0	0	0	0	0	0
Cadmium(mg/kg)	0.03	0.03	0.05	2	0.03	0.04	0.04
Mercury (mg/kg)	0	0	0	0	0	0	0

KMSS52	KMSS53	KMSS54	KMSS55	KMSS56	KMSS57	KMSS58	KMSS59	KMSS60
6.12	7.48	7.83	4.70	5.90	8.50	6.97	8.24	7.41
139.86	115.23	326.51	136.80	73.66	144.97	81.60	153.67	345.00
13.22	30.11	29.53	24.35	124.48	86.02	20.38	36.26	27.86
2.47	1.36	1.42	1.93	2.86	2.87	0.90	1.62	1.85
0.19	0.44	0.30	0.27	0.72	0.24	0.52	0.50	0.38
4.46	12.83	12.84	16.34	12.65	13.92	13.55	16.28	989.77
0.24	0.18	0.11	2.79	11.13	5.22	3.01	3.53	0.37
0.28	1.11	1.67	0.19	1.17	2.16	0.20	1.45	1.23
9.86	3.72	2.40	1.38	0.77	0.86	0.72	0.99	6.51
0.02	0.02	2.24	0.02	1.14	0.01	0.02	0.35	0.02
1.99	0.71	0.39	1.04	1.30	0.88	1.16	0.00	0.02
5.01	0.89	3.22	1.71	2.21	3.72	1.59	4.28	0.51
45.20	0.02	145.87	0.01	0.00	12.70	0.01	78;88	1.11
1.28	2.60	1.57	0.57	1.40	0.00	0.00	0.00	0.00
8.18	2.65	1.26	2.68	0.00	1.11	2.62	0.46	0.09
0.01	0.01	0.05	0.00	0.01	0.17	0.02	0.01	0.02
0.90	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00
0.02	0.05	0.04	0.00	0.02	0.00	0.00	0.00	0.01
0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.01	0.00
92.46	30.08	34.56	17.92	55.08	63.18	24.99	66.12	8.50
0.00	1.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	103.60	105.56	65.13	49.45	75.40	52.20	62.64
0.00	0.00	8.28	108.10	72.57	74.67	66.74	42.30	29.14

KMSS43	KMSS44	KMSS45	KMSS46	KMSS47	KMSS48	KMSS49	KMSS50	KMSS51
7.44	6.39	7.24	6.79	5.87	6.63	9.60	6.79	7.34
388.28	392.43	1124.32	100.33	97.01	123.60	144.78	132.61	90.48
35.55	21.66	27.86	14.97	23.39	29.41	9.58	22.19	42.48
2.29	2.42	1.85	2.15	3.06	1.19	2.29	2.56	2.84
1.96	3.17	0.38	0.50	0.27	0.33	0.25	0.61	0.26
2.80	3.62	10.77	5.39	5.19	14.12	14.85	8.04	6.27
0.19	0.13	0.37	0.14	0.27	0.19	0.09	0.43	0.27
0.37	0.18	0.48	0.89	0.20	1.16	1.76	0.28	0.44
10.37	6.67	5.03	9.66	13.94	3.33	7.35	7.74	6.89
0.00	0.00	0.00	0.01	0.03	0.02	0.04	0.02	3.27
0.00	0.01	0.02	0.10	0.31	0.00	0.07	1.17	1.30
0.57	0.00	1.04	3.33	1.68	1.73	3.19	0.84	2.21
0.34	1.87	0.01	11.70	34.98	0.01	134.00	23.00	19.90
0.02	0.03	0.02	0.01	0.00	0.01	0.01	2.45	1.99
0.24	0.50	0.87	0.39	0.90	0.13	0.37	3.84	5.18
0.01	0.08	0.02	0.00	0.01	0.00	0.05	0.00	0.00
0.31	0.00	1.16	0.68	1.90	0.98	1.48	2.63	1.03
0.20	0.24	0.00	0.00	0.00	0.00	0.00	0.02	0.01
0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
13.97	5.64	13.50	78.00	69.42	39.52	59.36	60.52	62.73
0.00	0.00	0.00	0.00	1.35	0.00	0.00	0.00	0.00
55.68	66.12	77.72	52.90	97.20	62.10	34.50	87.75	53.44
31.02	39.48	41.36	33.92	89.70	121.80	104.40	182.16	202.95

KMSS34	KMSS35	KMSS36	KMSS37	KMSS38	KMSS39	KMSS40	KMSS41	KMSS42
6.22	7.75	8.29	7.00	5.92	7.40	8.83	5.20	8.89
682.04	937.30	1938.00	2352.00	1324.32	2039.40	190.38	82.11	249.98
87.69	14.82	82.08	38.73	84.28	111.72	11.47	65.52	27.88
0.83	1.48	2.66	2.12	0.67	1.48	3.28	6.28	2.98
0.17	0.30	0.41	0.51	0.52	0.13	0.34	1.97	3.01
0.96	140.04	409.40	156.80	307.80	373.44	2.30	3.22	4.95
1.89	1.51	1.61	4.28	2.16	1.21	0.15	0.26	0.86
0.45	1.15	1.05	0.33	0.14	0.17	0.11	1.23	1.34
3.90	0.03	0.30	0.59	1.03	0.17	20.98	12.79	10.37
0.00	0.00	0.06	0.64	0.02	0.00	0.00	0.00	0.02
0.00	0.00	0.00	0.00	0.01	0.00	0.61	0.01	0.04
0.02	0.00	0.26	0.00	0.31	0.17	0.26	0.12	0.12
24.98	1.30	23.00	1.91	21.00	0.46	0.91	8.84	12.09
0.00	0.03	0.02	0.04	0.19	0.12	0.03	0.01	0.14
0.00	0.35	0.01	0.93	2.97	0.00	0.69	0.02	1.20
0.38	0.00	0.00	0.00	0.21	0.32	0.05	0.00	0.57
0.35	0.00	0.45	0.00	2.04	0.00	1.91	1.44	0.00
0.00	0.03	0.62	0.04	0.09	0.06	0.01	0.02	0.00
0.35	0.00	0.00	0.00	0.00	0.00	0.03	0.05	0.02
48.51	5.17	3.25	11.50	7.12	6.24	11.20	4.56	18.36
7.43	1.66	0.00	0.00	0.00	0.00	0.00	1.72	0.00
16.24	49.88	73.08	57.50	79.65	55.20	23.00	44.01	63.46
98.70	81.78	109.98	46.64	41.40	42.00	46.80	19.08	47.97

KMSS25	KMSS26	KMSS27	KMSS28	KMSS29	KMSS30	KMSS31	KMSS32	KMSS33
6.44	6.72	8.29	4.85	9.23	8.96	6.26	6.75	6.33
2494.80	627.90	1938.00	1332.80	1324.32	1001.16	1505.94	1229.60	3645.53
55.86	15.17	82.08	52.93	84.28	135.66	54.02	255.84	207.36
2.57	1.69	2.66	1.06	0.67	0.78	1.76	1.26	0.47
0.00	0.00	0.41	0.48	0.52	0.15	0.18	0.74	0.59
156.80	127.20	409.40	358.40	307.80	0.30	1.80	1.22	2.79
1.90	1.25	4.72	2.59	4.19	1.50	1.81	3.36	2.67
0.57	0.33	0.20	0.33	0.20	0.13	0.47	0.03	1.16
5.34	4.37	5.55	4.99	4.09	2.84	9.30	3.35	5.72
0.00	2.87	1.89	0.58	5.33	0.00	0.47	0.00	0.00
0.00	1.33	3.28	2.07	0.46	0.00	0.00	0.01	0.04
0.24	0.26	0.36	0.47	0.23	0.03	0.01	0.54	0.03
65.00	0.00	409.40	336.00	313.20	0.05	35.98	2.08	1.67
0.00	1.72	0.00	3.29	0.00	0.01	0.00	0.04	0.01
0.00	2.13	0.00	1.50	1.45	0.00	0.00	0.03	0.02
0.00	0.00	0.07	0.02	0.11	0.59	0.14	0.00	0.35
0.03	0.00	0.00	0.00	0.00	2.94	1.70	1.24	0.56
0.00	0.00	0.01	0.04	0.00	0.18	0.26	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.14	0.48	0.00	1.97
126.96	52.64	35.34	101.25	62.64	5.76	2.56	26.01	25.74
0.00	1.68	0.00	1.23	0.00	0.00	0.00	0.00	0.00
109.35	49.84	33.80	75.40	20.47	75.60	24.36	36.74	20.70
164.97	34.85	76.80	106.22	103.50	24.12	79.90	157.44	35.91

KMSS17	KMSS18	KMSS19	KMSS20	KMSS21	KMSS21	KMSS22	KMSS23	KMSS24
7.48	5.30	7.24	6.79	6.09	5.84	4.89	6.14	8.58
86.36	124.70	136.80	100.33	809.90	1110.34	1938.00	1744.40	863.04
20.46	31.01	27.86	14.97	11.18	46.74	28.12	57.62	160.72
2.45	1.43	1.85	2.15	3.17	0.31	2.77	3.01	0.63
0.47	0.15	0.38	0.50	0.55	0.32	0.30	0.55	0.25
12.32	10.62	10.77	5.39	68.40	128.37	621.00	182.40	307.80
0.13	0.18	0.37	0.14	2.97	0.75	2.01	5.00	4.43
1.15	1.63	0.85	0.25	0.48	1.13	0.57	1.78	1.06
3.67	4.85	5.03	5.64	12.14	1.81	11.25	7.62	2.77
0.05	0.01	0.02	4.18	0.00	0.00	0.06	0.03	0.02
1.23	0.75	1.51	1.45	0.00	0.00	0.00	0.00	0.01
0.78	0.00	1.04	3.33	0.00	0.05	0.42	0.00	0.43
0.97	0.00	0.01	12.00	1.80	4.19	2.43	1.02	1.17
4.90	0.84	0.33	0.00	0.00	0.00	0.00	0.00	0.00
0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.01
1.44	1.50	0.00	0.20	2.19	1.34	0.00	1.46	0.02
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15.44	42.77	23.25	52.90	57.85	23.40	42.56	54.29	82.62
3.30	0.00	2.57	0.00	0.00	1.78	0.00	2.56	1.46
49.88	64.96	47.56	72.45	122.85	41.40	29.90	122.85	56.78
136.30	103.40	103.40	171.72	182.16	212.80	171.60	212.52	115.62

KDSS8	KDSS9	KDSS10	KDSS11	KDSS12	KMSS13	KMSS14	KMSS15	KMSS16
6.54	5.98	8.08	6.95	6.81	6.85	8.58	7.22	8.61
1332.80	1532.64	2257.20	1092.00	1513.00	2018.80	1696.32	1366.20	696.58
52.93	111.72	105.84	7.51	65.36	76.38	36.26	152.88	42.31
1.06	0.31	2.30	2.24	3.67	1.40	0.50	2.98	2.40
0.48	0.28	0.15	0.51	0.66	0.30	0.47	0.08	0.80
11.70	58.90	284.80	58.80	262.20	373.44	13.89	368.00	13.92
2.59	2.76	1.84	3.76	5.54	2.14	1.52	1.81	0.67
0.96	1.24	0.20	1.49	0.39	0.47	0.78	1.15	0.94
4.99	1.88	3.40	8.51	9.30	3.14	4.44	3.59	5.30
0.02	0.01	0.00	0.00	0.05	0.02	0.02	0.00	0.02
0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	1.22
0.10	0.60	0.10	0.00	0.21	0.00	0.11	0.11	1.19
1.84	1.47	3.65	4.09	1.81	2.36	1.02	3.65	0.01
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.33
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
0.01	0.01	0.12	0.00	0.01	0.04	0.02	0.01	0.00
0.06	0.00	0.00	0.00	0.12	0.01	0.00	0.01	1.03
0.01	0.00	0.04	0.00	0.01	0.00	0.01	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
33.08	26.32	11.25	62.10	30.26	48.36	60.48	30.21	85.68
0.00	0.00	0.00	1.34	0.78	0.00	0.00	0.00	0.00
78.88	52.20	104.40	51.75	71.55	74.75	24.84	74.33	71.81
142.88	152.28	146.64	45.58	179.40	218.40	145.20	43.20	186.96

Parameters	Unit	KDSS1	KDSS2	KDSS3	KDSS4	KDSS5	KDSS6	KDSS7
pH		8.84	5.70	5.69	9.40	8.32	8.83	9.87
Sodium	µS/cm	1108.08	879.00	188.68	282.22	653.50	527.80	2261.00
Sodium	mg/kg	12.95	98.70	134.16	184.68	41.07	21.32	97.28
Potassium	mg/kg	1.21	0.83	1.34	0.23	1.76	2.98	3.45
Magnessium	mg/kg	0.17	0.35	0.55	0.36	0.09	0.74	0.59
Calcium	mg/kg	45.89	1.49	0.60	2.12	1.16	138.00	703.80
Ammonium	mg/kg	0.39	0.29	0.69	0.41	0.15	4.62	4.76
	mg/kg							
Nitrate	mg/kg	0.34	0.20	0.12	0.27	1.53	0.06	0.13
Phosphate	mg/kg	7.44	4.19	0.46	0.26	3.67	5.77	0.47
	mg/kg							
Cadmium	mg/kg	0.17	0.00	0.00	0.00	0.00	0.00	0.02
Chromium	mg/kg	0.00	0.00	0.01	0.02	0.00	0.00	0.00
Zinc	mg/kg	0.02	0.32	0.38	0.12	0.02	0.00	0.00
Iron	mg/kg	23.00	45.00	1.36	2.54	0.10	2.76	2.78
Lead	mg/kg	0.00	0.00	0.00	0.03	0.00	0.00	0.01
Copper	mg/kg	0.01	0.00	0.02	0.02	0.00	0.00	0.00
	mg/kg							
TPH	mg/kg	0.00	0.00	0.63	0.00	0.00	0.05	0.03
Oil and Grea	mg/kg	0.12	0.00	1.05	1.34	0.00	0.56	0.22
Phenols	mg/kg	0.00	0.02	0.01	0.00	0.01	0.01	0.05
Benzene	mg/kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Toluene	mg/kg							
Total Coliform	cfu/g	49.02	108.75	64.96	27.52	16.32	55.08	60.84
E.Coli	cfu/g	1.56	0.00	0.00	0.00	0.00	0.67	0.00
Fungi	cfu/g	30.60	86.52	62.73	75.60	64.96	75.15	14.95
AMB	cfu/g	128.04	177.84	58.58	18.36	122.20	175.89	92.91

SPECIFIC ENVIRONMENTAL AND SOCIOCULTURAL MANAGEMENT PLANS