IFF Line 2 Fertilizer Project

PREPARED FOR

Indorama Fertilizer FZE

DATE
09 July 2026

REFERENCE
0802778



DOCUMENT DETAILS

DOCUMENT TITLE	IFF Line 2 Fertilizer Project
DOCUMENT SUBTITLE	Environmental & Social Impact Assessment Report
PROJECT NUMBER	0802778
DATE	09 July 2026
VERSION (delete field if unneeded)	01
AUTHOR	Lumka Notuku, Cheyenne Dawcharan, Sihle Dambuza, Christie Hazell-Marshall, George Chatzigiannidis, Maitshoko Tumane, Helen Seyler, Ewa Matuszewska, Victor Mutavhatsindi, Amanda Gilmore, Mpho Malema, Danielle Sanderson, Rofhiwa Ramasala, Tenele Ciosi, Jacquelin Stapelberg, Byron Fynn, Ben Sussman, Jessica McIver
CLIENT NAME	Indorama Fertilizer FZE

DOCUMENT HISTORY

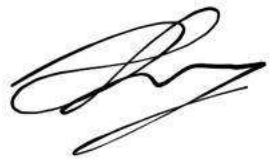
				ERM APPROVAL TO ISSUE		
VERSION	REVISION	AUTHOR	REVIEWED BY	NAME	DATE	COMMENTS
Version	001	Lumka Notuku, Cheyenne Dawcharan, Sihle Dambuza, Christie Hazell-Marshall, George Chatzigiannidis, Maitshoko Tumane, Helen Seyler, Ewa Matuszewska, Victor Mutavhatsindi, Amanda Gilmore, Mpho Malema, Danielle Sanderson, Rofhiwa Ramasala, Tenele Ciosi, Jacquelin Stapelberg, Byron Fynn, Ben Sussman, Jessica McIver	Nigel Seed	Nigel Seed	Scheduled for 17 June 2026	

SIGNATURE PAGE

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Environmental & Social Impact Assessment Report

0802778



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ACRONYMS AND ABBREVIATIONS

Acronym	Description
AGPC	Assa North – Ohaji South Gas Processing Company
AfDB	African Development Bank
ALARP	As Low As Reasonably Practicable
AMR	Annual Monitoring Report
ANSI	American National Standards Institute
AQS	Air Quality Standard
ASME	American Society of Mechanical Engineers
ATA	Agriculture Transformation Agenda
BCF	Billion Cubic Feet
BFW	Boiler Feed Water
BOD	Biological Oxygen Demand
CAGR	Compound Annual Growth Rate
CAP	Laws of the Federation of Nigeria (Compilation Reference)
Cd	Cadmium
CDC	Community Development Committee
CH_4	Methane
CLO	Community Liaison Officer

Acronym	Description
Cl^-	Chloride
CIA	Cumulative Impact Assessment
CN^-	Cyanide
COD	Chemical Oxygen Demand
CO_2	Carbon Dioxide
CPI	Corrugated Plate Interceptor
CTA	Common Terms Agreement
Cu	Copper
DCS	Distributed Control System
DEF	Diesel Exhaust Fluid
DFI	Development Finance Institution
DM	Demineralized (Water)
DO	Dissolved Oxygen
EAE	Environment Agency for England
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EIB	European Investment Bank (referenced in standards context)
EIS	Environmental Impact Statement
EP4	Equator Principles (4th Edition)
EPC	Engineering, Procurement and Construction
EPRP	Emergency Preparedness and Response Plan
ERM	Environmental Resources Management
ESAP	Environmental and Social Action Plan
ESIA	Environmental and Social Impact Assessment
ESMMP	Environmental and Social Management and Monitoring Plan
ESMS	Environmental and Social Management System
ETP	Effluent Treatment Plant
FCU	Feed Conditioning Unit
Fe	Iron
FMEnv	Federal Ministry of Environment (Nigeria)
GBVH	Gender-Based Violence and Harassment
GIIP	Good International Industrial Practices
GHG	Greenhouse Gas
GT / GTG	Gas Turbine / Gas Turbine Generator

Acronym	Description
HWMP	Hazardous Waste Management Plan
H_2S	Hydrogen Sulphide
Hg	Mercury
HRSG	Heat Recovery Steam Generator
HSE	Health, Safety and Environment
HTS	High Temperature Shift
IChemE	Institution of Chemical Engineers
ICE	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IEPL	Indorama Eleme Petrochemicals Limited
IFC	International Finance Corporation
IFF	Indorama Fertilizer FZE
IFZ	Indorama Fertilizer Zone / Indorama Eleme Fertilizer & Chemicals (post-2026 naming)
ILO	International Labour Organization
IRPA	Individual Risk Per Annum
K^+	Potassium
kg/cm^2	Kilogram per square centimetre
KOD	Knockout Drum
LAeq	A-weighted Equivalent Continuous Sound Level
LSIR	Location Specific Individual Risk
LTS	Low Temperature Shift
Mg	Magnesium
MDEA	Methyl Diethanolamine
Mg/L	Milligrams per Litre
MMSCFD	Million Standard Cubic Feet per Day
MMTPA	Million Metric Tons Per Annum
MP	Medium Pressure
MSDS	Material Safety Data Sheet
MTPD	Metric Tonnes Per Day
MW / MWH	Megawatt / Megawatt Hour
NACE	National Association of Corrosion Engineers
NCCC	National Council on Climate Change
NDC	Nationally Determined Contribution

Acronym	Description
NESREA	National Environmental Standards & Regulations Enforcement Agency
NG	Natural Gas
NGFCP	Nigerian Gas Flare Commercialization Programme
NMDPRA	Nigerian Midstream and Downstream Petroleum Regulatory Authority
NO_x	Nitrogen Oxides
NO_3^-	Nitrate
NSR	Noise Sensitive Receptor
NTU	Nephelometric Turbidity Unit
O&G	Oil and Grease
OBL / OSBL	Outside Battery Limits
OPRC	Oil Pollution Preparedness, Response and Cooperation Convention
OS	Operational Safeguard
P&ID	Piping and Instrumentation Diagram
PB	Lead
PC	Process Contribution
PEC	Predicted Environmental Concentration
PFI	Presidential Fertilizer Initiative
PIE	Project Implementing Entity
PM / PM_{10} / $PM_{2.5}$	Particulate Matter
PPE	Personal Protective Equipment
PS (IFC)	Performance Standard
QA	Quality Assurance
QC	Quality Control
QRA	Quantitative Risk Assessment
RIWAMA	Rivers State Waste Management Agency
RSMENV	Rivers State Ministry of Environment
SEP	Stakeholder Engagement Plan
SEAH	Sexual Exploitation, Abuse and Harassment
S.I.	Statutory Instrument
SME	Subject Matter Expert
SO_4^{2-}	Sulphate
SON	Standards Organisation of Nigeria
SOP	Standard Operating Procedure

Acronym	Description
STP	Sewage Treatment Plant
TDS	Total Dissolved Solids
TMP	Transport Management Plan
TSS	Total Suspended Solids
UF-85 / UFC-85	Urea Formaldehyde Concentrate (85%)
UNFCCC	United Nations Framework Convention on Climate Change
VOC	Volatile Organic Compounds
VAPP	Violence Against Persons (Prohibition) Act
WBG	World Bank Group
WHO	World Health Organization
Zn	Zinc

EXECUTIVE SUMMARY

ES1.0 Introduction

This Environmental and Social Impact Assessment (ESIA) has been prepared for the proposed Indorama IFF Line 2 Fertilizer Project (the Project), located within the precincts of Indorama Free Zone of broader Indorama Manufacturing Complex in Eleme Local Government Area, Rivers State, Nigeria.

The Project involves the development of a new brownfield ammonia–urea production line, IFF Line 2 (the fourth line at the complex, also referred to as Line 4), immediately adjacent to IFF Line 1. The wider Indorama Manufacturing Complex hosts the operational petrochemical production plants, power plant, utilities and other associated facilities. Indorama Free Zone hosts the operational IFZ Line 1 (commissioned in 2016) and IFZ Line 2 (commissioned in 2021), together with IFF Line 1, which was commissioned in June 2026. IFF Line 2 will employ the same technology as these three lines and will be engineered and constructed by the same contractors.

The Project comprises an Inside Battery Limits (IBL) configuration – a Feed Conditioning Unit designed to process approximately 200 MMSCFD of natural gas, a 2,300 MTPD Ammonia Plant, a 4,000 MTPD Urea Plant and a 150 MTPD UFC-85 unit – and Outside Battery Limits (OBL) infrastructure, including natural gas receiving facilities, water treatment and cooling systems, effluent treatment and drainage systems, emergency flares, fire and gas protection systems, product evacuation infrastructure and a 120,000-tonne urea storage building. Granulated urea will be transported to the MM FZE Port within the Onne Port Complex, approximately 20 km from the manufacturing site, for storage and export. The Project is described in ES6.0 and its justification in ES4.0.

The ESIA has been undertaken in accordance with the **Environmental Impact Assessment Act (Cap E12, LFN 2004)** and other applicable Nigerian legislation, while meeting the requirements of the **African Development Bank (AfDB) Integrated Safeguards System (ISS, 2023), Operational Safeguards (OSs), the IFC Performance Standards**, and the **World Bank Group Environmental, Health and Safety (EHS) Guidelines**.

The ESIA evaluates the potential environmental and social impacts associated with the construction, operation and, where applicable, decommissioning of the Project, and identifies mitigation measures and management controls to ensure impacts are reduced to acceptable levels.

Project Proponent and ESIA Team

The Project Proponent is Indorama Fertilizer FZE (IFF), registered in the Republic of Nigeria as a Free Zone enterprise (NEPZA Form RCI/01419) and operating from Indorama Free Zone, Eleme Local Government Area, Rivers State. Environmental Resources Management Southern Africa (Pty) Ltd (ERM) was appointed by IFF as the independent international ESIA consultant and is responsible for leading the ESIA process, integrating specialist studies, quality assurance of baseline data and alignment with Nigerian regulatory requirements, the IFC Performance Standards, the AfDB Operational Safeguards and the WBG EHS Guidelines.

Baseline data collection was undertaken by Messrs Safespace Resources Limited, an FMEnv-accredited Nigerian consultant (the Local Consultant, LC), under FMEnv supervision, with ERM

providing methodology guidance, technical oversight, QA/QC review, gap closure and lender-standard alignment. One ERM Subject Matter Expert joined the LC team during the dry-season field data collection in February 2026. ERM reviewed the LC baseline data against the approved ToR and international standards, and data gaps were addressed through clarification or additional information requests. The contact details of the Proponent and the ESIA consultant are summarised in Table ES-1.

TABLE ES-1: PROPONENT AND ESIA CONSULTANT DETAILS

Item	Project Proponent	ESIA Consultant
Name	Indorama Fertilizer FZE (IFF)	Environmental Resources Management Southern Africa (Pty) Ltd (ERM)
Registration / role	NEPZA Form RCI/01419, Republic of Nigeria	International ESIA consultant: technical oversight, quality assurance and alignment with international lender standards
Address	Indorama Free Zone, Eleme Local Government Area, Rivers State, Nigeria	ERM Southern Africa, Building 27, 1st Floor, The Woodlands Office Park, Woodlands Drive, Woodmead, Johannesburg, 2148, South Africa
Contact person	Dr Jain Mahendra, Head of Environment	Sihle Dambuza (Project Manager); Nigel Seed (Partner in Charge)
Telephone / email	+234 807 032 4523; mahendra.jain@indorama.com	+27 11 802 8263; Sihle.dambuza@erm.com
Local Environmental Consultant	–	Messrs Safespace Resources Limited (FMEnv-accredited Nigerian consultant)

Regulatory Process and Project Categorisation

The ESIA has been prepared in accordance with the Environmental Impact Assessment Act (CAP E12 LFN 2004) and the Environmental Impact Assessment Procedures and Charges Regulations (S.I. No. 109 of 2021). It also considers the IFC Performance Standards, the WBG General and sector-specific EHS Guidelines (notably the Nitrogenous Fertilizer Production guideline), the AfDB Integrated Safeguards System and Indorama's internal Health, Safety and Environment policies. The Federal Ministry of Environment (FMEnv) is the regulatory authority responsible for screening, approval of the Terms of Reference (ToR), oversight of baseline data collection and review of the ESIA. The FMEnv-approved ToR (Appendix A) confirmed a Category 1 pathway with supervised baseline requirements. For the purposes of the Equator Principles review, the Project is classified as a Category A project.

Scope of the ESIA

The IFF Line 2 ESIA builds on the methods applied in the IFF Line 1 (IEFCL Train 3) ESIA, supplemented with updated baseline information specific to the new footprint and the FMEnv-approved ToR. The scope comprised:

- review of applicable Nigerian and international frameworks, including the EIA Act, S.I. No. 109 of 2021, the IFC Performance Standards and the WBG General and Nitrogenous Fertilizer EHS Guidelines;
- preparation, submission and FMEnv approval of the ESIA ToR;
- literature and data review for the Project Area of Influence (AoI) and the wider Indorama complex to inform scoping and identification of receptors;

- consideration of feasible Project alternatives;
- description of ISBL/OSBL activities, utilities and off-site infrastructure as inputs to assessment and modelling;
- wet- and dry-season baseline data collection by the LC under FMEnv supervision, with ERM methodology guidance, QA/QC review and gap closure;
- identification and evaluation of environmental and socio-economic impacts, including secondary and cumulative effects of the combined IFF Line 1 and IFF Line 2 scenario, using expanded IFF Line 1 air quality and noise models;
- development of mitigation and management measures and preparation of the ESMMP, including post-ESIA actions linked to lender readiness; and
- engagement with stakeholders, host communities and authorities, aligned with the operations-wide SEP and a project-specific SEP for IFF Line 2.

The ESIA covers the IFF Line 2 footprint within Indorama Free Zone, including the on-site natural gas receiving station and all pipelines located within the Free Zone and the defined Project footprint. The new underground 20-inch, 65 km natural gas pipeline (capacity 300 MMSCFD) from the new supplier, together with other gas transmission infrastructure and off-site pipeline corridors, is subject to separate permitting and regulatory approval and is not assessed in this ESIA; the ESIA for the pipeline was approved by FMEnv by letter reference FMEnv/EA/EIA/7236/Vol.I/289 dated 24 March 2025. Similarly, the installation and permitting of GT-8 and the associated HRSG facilities are addressed under separate approvals for the broader Indorama complex; this ESIA assesses only the Project's use of available power and steam capacity and the associated incremental operational demands. Where longer-term actions are required to achieve full compliance with the IFC Performance Standards, these shall be documented as post-ESIA commitments in the ESMMP.

Use of Existing Studies and Data

In line with IFC PS1 and AfDB OS1, the ESIA combines newly collected primary data with pre-existing information, all of which was reviewed for relevance, reliability and applicability to the Project. The principal sources are:

- previous ESIA documentation, in particular the 2023 ESIA for the IEFCL Train 3 Project, used for historical baseline context, methodology and continuity of stakeholder engagement;
- site-wide social management instruments, including the site-wide and Train 2 SEPs (2018–2026), the Stakeholder/Community Grievance Management Procedure (2018), the Memorandum of Understanding with host communities (2019), the 2018 Train 2 SIA, the 2023 Train 3 Stakeholder Engagement Report and the Train 3 Local Hiring Plan;
- operational datasets from the Indorama Manufacturing Complex, including borehole inventories and abstraction records, wastewater treatment and effluent performance data, drainage and hydrology information, and shared utilities data used to define the GHG boundary;
- complex-level specialist studies, notably the groundwater sustainability study (2025) and its 2026 variable-density (SEAWAT) re-modelling, and the 2023 Train 3 Air Quality Impact Assessment; and

- secondary sources, including the ERM Global Climate Database, IBAT, aerial imagery and published biodiversity, archaeological and historical literature.

Pre-existing data were verified through wet- and dry-season field surveys, cross-checked against current operational data and, where data gaps or uncertainty persist (for example, flood extent and long-term groundwater behaviour), conservative assumptions were applied and additional monitoring or follow-up studies identified. Recognised limitations include the allocation-based (rather than measured) approach to shared-utility GHG emissions and the absence of any previous Indorama biodiversity or cultural heritage study, which were therefore informed by new surveys and desk-based sources.

Cross-Reference to Lender Requirements

To support lender due diligence, Chapter 1 includes a consolidated cross-reference between the requirements of IFC PS1–PS8 and the ESIA sections where compliance is demonstrated (Table 1-4), and an equivalent cross-reference for the AfDB ISS (2023) Operational Safeguards (Table 1-5). Detailed compliance status, gap identification and corrective actions are tracked in the Project's internal IFC Compliance Checklist and reflected in the ESMMP.

Structure of the ESIA Report

In line with the FMEnv Procedural Guidelines, the ESIA Report is organised into 12 chapters:

- Chapter 1 – Introduction: Project overview, ESIA objectives and scope.
- Chapter 2 – Legal and Administrative Framework: national, state and international requirements applicable to the Project.
- Chapter 3 – Project Justification and Alternatives.
- Chapter 4 – Project Description.
- Chapter 5 – ESIA Process and impact assessment methodology.
- Chapter 6 – Stakeholder Engagement.
- Chapter 7 – Description of the Environment (physical, biophysical and socio-economic baseline).
- Chapter 8 – Associated and Potential Environmental and Social Impacts, including cumulative impacts.
- Chapter 9 – Mitigation Measures and residual impacts.
- Chapter 10 – Environmental and Social Management and Monitoring Plan.
- Chapter 11 – Conclusions and Recommendations.
- Chapter 12 – References.

The report is supported by Appendix A (ESIA ToR Approval by FMEnv), Appendix B (Stakeholder Engagement Plan) and Appendix C (ESMMP).

ES2.0 ESIA Objectives

The primary objective of the ESIA is to integrate environmental and social considerations into Project planning and decision-making by describing the proposed development and its alternatives, establishing baseline environmental and socio-economic conditions, identifying and assessing potential environmental and social risks and impacts, including cumulative and climate-related impacts, applying the mitigation hierarchy to develop appropriate mitigation measures, preparing an Environmental and Social Management and Monitoring Plan (ESMMP),

and demonstrating compliance with applicable national legislation and international lender requirements.

The ESIA followed the FMEnv EIA process through a structured sequence of activities: scoping, review of existing information, baseline data collection, stakeholder engagement, identification and evaluation of potential impacts (including secondary and cumulative impacts), development of mitigation measures in line with the mitigation hierarchy (avoid, minimise, restore and offset), preparation of the ESMMP setting out how mitigation will be implemented and environmental performance managed throughout the Project life cycle, and compilation of the ESIA Report presenting the findings in a clear and concise manner.

A harmonised approach has been adopted to meet both Nigerian regulatory requirements and international lender expectations. Where national and international requirements differ, the more stringent standard has been applied. FMEnv permits the use of international benchmarks, such as the WHO air quality guidelines, where they provide a higher level of protection, provided the justification is documented in the ESIA.

IFF, as Proponent, is responsible for registering the Project with FMEnv, submitting the ESIA Report and facilitating all regulatory reviews required for approval. The accredited Nigerian consultant manages all FMEnv-facing activities, including baseline fieldwork, stakeholder engagement and data collection under FMEnv supervision, while ERM provides technical oversight and quality assurance and ensures that the ESIA meets applicable international standards.

ES3.0 Policy, Legal and Administrative Framework

The Project has been assessed against applicable Nigerian environmental legislation, regulatory requirements and institutional responsibilities, together with relevant international environmental and social standards, including the AfDB Integrated Safeguards System (ISS), IFC Performance Standards, World Bank Group EHS Guidelines and other applicable international conventions ratified by Nigeria. Collectively, these instruments establish the legal and institutional framework for environmental protection, pollution prevention, occupational health and safety, biodiversity conservation, stakeholder engagement, climate resilience and sustainable resource management throughout the Project life cycle. The applicability of, and compliance with, AfDB Operational Safeguards OS1 to OS10 is summarised in Table ES-3 below.

Institutional Framework

The Federal Ministry of Environment (FMEnv) is the principal authority for the regulation and enforcement of environmental laws in Nigeria and administers the EIA Act (CAP E12 LFN 2004) and the Environmental Impact Assessment Procedures and Charges Regulations (S.I. No. 109 of 2021, Official Gazette No. 105, Vol. 108, September 2021), which set out the EIA procedure from project conception to commissioning, including the required follow-up activities. FMEnv consults the State Ministries of Environment during the EIA permitting process. The National Environmental Standards and Regulations Enforcement Agency (NESREA), established in 2007 as an agency of FMEnv, enforces environmental laws, guidelines, standards and regulations, specifically during the operational phase of projects.

The Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA) regulates midstream and downstream petroleum operations under the Petroleum Industry Act, 2021, including natural gas processing, transportation, storage and distribution. For the Project,

NMDPRA regulates gas supply systems, gas processing facilities, pipelines and associated installations, issues the related permits, licences and approvals, and enforces the applicable technical, safety and environmental requirements in coordination with FMEnv. As the Project lies within a designated Export Processing Zone, the Nigeria Export Processing Zones Authority (NEPZA) also exercises regulatory oversight over IFF as a Free Zone enterprise.

National Legislative Framework

The national policies and regulations with environmental and social implications for the Project, and their compliance implications for IFF, are summarised in Table ES-2. Free Zone status does not exempt the Project from Nigerian environmental legislation: the Project remains subject to the EIA Act and to all environmental, health, safety and labour obligations not expressly excluded under the Nigeria Export Processing Zones Act.

TABLE ES-2: KEY NATIONAL LEGISLATION AND COMPLIANCE IMPLICATIONS FOR IFF

Instrument	Key requirement	Compliance implication for IFF
EIA Act CAP E12 LFN 2004; EIA Procedures and Charges Regulations, S.I. No. 109 of 2021; National EIA Procedural and Sectoral Guidelines, 1994	EIA mandatory where a project is likely to significantly affect the environment; prescribed EIA procedure and methodology	ESIA required before commencement; IFF shall obtain FMEnv approval and implement the ESMMP and all FMEnv licence conditions
National Environmental (Permitting and Licensing System) Regulations, 2009	Consistent application of environmental laws, regulations and standards	Maintain applicable FMEnv environmental licences
Pollution Abatement in Industries and Facilities Generating Wastes Regulations, 1991 (S.I. 9)	Restrictions on toxic releases; pollution monitoring units, pollution-combating machinery and contingency plans	Install and maintain pollution control and response systems
Effluent Limitation Regulations, 1991 (S.I. 8)	Pollution abatement equipment; limits on liquid, solid and gaseous discharges	Meet effluent standards and operate compliant treatment units
Management of Solid and Hazardous Wastes Regulations, 1991 (S.I. 15); Sanitation and Wastes Control Regulations, 2009 (S.I. 28); National Policy on Solid Waste Management, 2022	Segregation at source; use of government-approved waste management agents	Segregate, store and dispose of waste through licensed operators; maintain site hygiene
Surface and Groundwater Quality Control Regulations, 2011 (S.I. 22); Water Resources Act CAP W2 LFN 2004	Protection of surface and groundwater quality and existing uses; coordinated management of water resources	Prevent water pollution, meet water quality limits and manage abstraction responsibly
Soil Erosion and Flood Control Regulations, 2011 (S.I. 12)	Flood protection of vulnerable sites by design	Incorporate flood and erosion controls in engineering design
Air Quality and Control Regulations, 2021 (S.I. 88)	Emission standards for stationary and mobile sources; ambient air quality	Comply with emission limits and undertake air quality monitoring
Noise Standards and Control Regulations, 2009 (S.I. 35)	Permissible noise exposure levels and noise control	Meet permissible noise levels at noise-sensitive receptors
Climate Change Act, 2021; National Policy on Climate Change, 2013	Net-zero target for 2050–2070; carbon budget; National Climate Change Action Plan	Integrate climate adaptation, monitor GHG emissions and align with national targets

Instrument	Key requirement	Compliance implication for IFF
Control of Alien and Invasive Species Regulations, 2013; Endangered Species Act CAP E9 LFN 2004 (amended 2016)	Control of invasive species; prohibition of hunting, capture or trade in endangered species without licence	Prevent the spread of invasive species and avoid harm to protected species
Labour Act CAP L1; Factories Act CAP F1; Employee Compensation Act, 2010; National Minimum Wage Act, 2019; Pension Reform Act, 2014; Trade Unions Act, 2005; National Policy on Occupational Safety and Health, 2021	Employment terms, wages, workplace safety and welfare, injury compensation, pensions and freedom of association	Lawful contracts and wages, statutory OHS and welfare systems, compensation and pension compliance, and respect for workers' right to organise
Violence Against Persons (Prohibition) Act; National Gender Policy, 2021	Prohibition of all forms of violence; gender equality and social inclusion	Zero tolerance of GBV; gender-responsive consultation and non-discrimination
Land Use Act CAP L5 LFN 2004	Land vested in the State Governor, who allocates land	IFF has legally secured rights to the Project land; maintain secure tenure documentation
Nigeria Export Processing Zones Act, 1992; NEPZA Investment Procedures, Regulations and Operational Guidelines, 2004	NEPZA licensing, regulation and supervision of Free Zone enterprises, including environmental safety, pollution control, monitoring and reporting	Register as an approved enterprise and comply with NEPZA licensing, inspection and reporting requirements throughout the Project life cycle
Other: Construction Sector Regulations, 2011 (S.I. 19); Ozone Layer Protection Regulations, 2009; Harmful Waste Act CAP H1; SON Act No. 14, 2015; Criminal Code	Best available technology in construction; ODS prohibition; prohibition of harmful waste; product and material standards; environmental offences	Minimise construction impacts, phase out ODS-containing equipment, prohibit harmful waste, use certified materials and avoid environmental or public health offences

State Laws and Institutions

Section 20 of the 1999 Constitution requires the State to protect and improve the environment and safeguard the water, air, land, forest and wildlife of Nigeria, and the EIA Act encourages states to establish environmental agencies to support FMEnv. The Rivers State Ministry of Environment (RSMENV), created from the former Rivers State Environmental Protection Agency and operating under Edict No. 2 of 1994, published the Interim Guidelines and Standards on Environmental Pollution Control and Management in Rivers State (2002, revised 2013), which regulate the generation, handling, storage and disposal of all wastes, regulate physical development and seek to protect the State's flora and fauna. The Rivers State Waste Management Agency (RIWAMA), created in 2013 (formerly the Rivers State Environmental Sanitation Authority), is responsible for environmental enhancement and sanitation. The Rivers State Noise Control Edict No. 20 of 1985 sets occupational and community noise exposure limits for industrial sources, and the Rivers State Environmental Protection and Management Law, CAP A42, 2019 lists the manufacturing and non-manufacturing activities requiring state environmental permits and governs the registration of environmental consultants.

International Conventions

Nigeria is a signatory to a number of international conventions relevant to the Project (Table 2-2). Under the Paris Agreement (2015) and the UNFCCC (1992), IFF is required to manage and reduce GHG emissions in line with national climate commitments. The International Health Regulations (2005) and the ILO Guidelines on OSH Management Systems (2001) require internationally recognised public health measures and a structured OSH management system. The Convention on Biological Diversity, the Bonn Convention on Migratory Species (1979) and

its MoUs on West African aquatic mammals (2008) and Atlantic-coast marine turtles (1999), and the African Convention on the Conservation of Nature and Natural Resources (1968) require the avoidance of unnecessary habitat disturbance and protection of species and ecological corridors. The International Convention on Oil Pollution Preparedness, Response and Co-operation (1990) and the 1981 Protocol on combating pollution emergencies in the West and Central African region require emergency response plans, spill prevention and cooperation with national authorities. The Montreal Protocol (1987) and Vienna Convention (1985) require the avoidance and phase-out of ozone-depleting substances, and the Rio Declaration (1992), Principles 4 and 17, reinforces the integration of EIA into project planning.

Compliance with AfDB Operational Safeguards

The ESIA demonstrates that the Project has been designed and assessed in accordance with the applicable requirements of the AfDB Integrated Safeguards System. Operational Safeguards relating to environmental and social assessment, biodiversity conservation, pollution prevention, community health and safety, labour and working conditions, vulnerable groups, cultural heritage and stakeholder engagement have been addressed through the ESIA process and supporting management plans, while safeguards relating to involuntary resettlement and financial intermediaries are not applicable because the Project will be developed within an existing industrial facility and is not financed through a financial intermediary.

TABLE ES-3: AFDB OS APPLICABILITY

AfDB Operational Safeguard	Key Requirements	Applicability to IFF Line 2 Project	Compliance Measures	ESIA Reference
OS1 – Assessment and Management of Environmental and Social Risks and Impacts	Identify, assess and manage environmental and social risks and impacts throughout the project life cycle; apply the mitigation hierarchy; undertake stakeholder engagement; prepare ESMP/ESMMP; establish monitoring and reporting arrangements.	**Applicable**	A comprehensive ESIA has been undertaken in accordance with Nigerian legislation, AfDB ISS (2023), IFC Performance Standards and the World Bank Group EHS Guidelines. Environmental and social risks, cumulative and climate-related impacts were assessed, mitigation measures developed following the mitigation hierarchy, and an Environmental and Social Management and Monitoring Plan (ESMMP) prepared.	Executive Summary; Chapters 1–11; ESMMP

OS2 – Labour and Working Conditions	Promote fair labour practices, occupational health and safety, non-discrimination, workers' rights, grievance mechanisms and prevention of child and forced labour.	**Applicable**	The Project will implement labour management procedures, occupational health and safety systems, contractor management, workers' grievance mechanisms, emergency response procedures and training programmes consistent with national legislation and international labour standards.	Occupational Health and Safety; ESMMP
OS3 – Resource Efficiency and Pollution Prevention and Management	Promote efficient use of energy, water and raw materials; prevent pollution; minimise emissions, wastes and greenhouse gases using best available techniques.	**Applicable**	The Project incorporates energy-efficient ammonia–urea production technology, emission control systems, wastewater treatment, waste minimisation, spill prevention, resource recovery and environmental monitoring consistent with international good practice. Air emissions, effluent, noise and GHG emissions have been assessed and appropriate controls identified.	Project Description; Impact Assessment; ESMMP
OS4 – Community Health, Safety and Security	Protect communities from project-related health, safety and security risks, including hazardous materials, traffic, emergencies and security arrangements.	**Applicable**	Community health and safety risks, including traffic, hazardous chemicals, accidental releases, fire and explosion, and emergency response, have been assessed. Emergency preparedness, traffic management, community awareness, security management and grievance mechanisms have been incorporated into the Project.	Risk Assessment; Community Health and Safety; ESMMP
OS5 – Land Acquisition, Restrictions on Access to Land and Land Use, and Involuntary Resettlement	Avoid or minimise physical and economic displacement and restore affected livelihoods where resettlement cannot be avoided.	**Not Triggered**	The Project will be developed entirely within Indorama's existing industrial footprint. No land acquisition, physical displacement or economic resettlement is anticipated. Should project design change, appropriate safeguards will be implemented in	Project Description; Socio-economic Baseline

			accordance with AfDB requirements.	
OS6 – Habitat and Biodiversity Conservation, and Sustainable Management of Living Natural Resources	Avoid or minimise impacts on biodiversity, critical habitats and ecosystem services; apply mitigation hierarchy and restore habitats where necessary.	**Applicable**	The Project is located within an existing industrial complex, limiting habitat disturbance. Baseline ecological surveys were completed, sensitive habitats identified, and biodiversity protection measures incorporated into the ESMMP. Habitat clearance will be minimised and disturbed areas rehabilitated where practicable.	Baseline Environment; Biodiversity; Impact Assessment; ESMMP
OS7 – Vulnerable Groups	Avoid disproportionate impacts on vulnerable or disadvantaged groups and ensure equitable access to project benefits through meaningful engagement.	**Applicable**	The socio-economic assessment identified potentially vulnerable groups within the area of influence. Inclusive stakeholder engagement, accessible grievance mechanisms and targeted mitigation measures have been incorporated to ensure equitable participation and benefit sharing.	Socio-economic Baseline; Stakeholder Engagement; ESMMP
OS8 – Cultural Heritage	Protect tangible and intangible cultural heritage and implement chance-find procedures where necessary.	**Applicable**	Baseline cultural heritage studies indicate no known cultural heritage resources within the Project footprint. A Chance Finds Procedure will be implemented during construction, and works will cease immediately if archaeological or cultural resources are encountered.	Cultural Heritage; ESMMP
OS9 – Financial Intermediaries	Ensure environmental and social risk management systems are established for projects financed through financial intermediaries.	**Not Applicable**	The Project is being assessed as a direct investment and does not involve financial intermediary lending.	Not Applicable
OS10 – Stakeholder Engagement and Information Disclosure	Conduct meaningful stakeholder engagement throughout the project life cycle; disclose information; establish grievance mechanisms; ensure continued consultation.	**Applicable**	Stakeholder engagement has been undertaken throughout the ESIA process with government agencies, host communities and other interested parties. A Stakeholder Engagement Plan (SEP) and Grievance Redress	Stakeholder Engagement; ESMMP; SEP

			Mechanism (GRM) have been prepared to support ongoing consultation, disclosure and stakeholder participation during project implementation.	

IFC Performance Standards and WBG EHS Guidelines

The ESIA has also been benchmarked against the IFC Performance Standards on Environmental and Social Sustainability (2012) and the WBG General and Nitrogenous Fertilizer Production EHS Guidelines. PS1 (Assessment and Management of E&S Risks and Impacts), PS2 (Labour and Working Conditions, covering direct workers, contracted workers and primary supply chain workers), PS3 (Resource Efficiency and Pollution Prevention), PS4 (Community Health, Safety and Security), PS6 (Biodiversity Conservation) and PS8 (Cultural Heritage, tangible and intangible) are relevant to the Project. For PS5, IFF has legally secured rights to the Project land, and any securing of land and access restrictions affecting surrounding communities shall be in line with PS5 requirements. PS7 is not triggered, as no recognised Indigenous Peoples are affected. The existing environmental, social, OHS and human resource plans, policies and procedures of IFZ's Port Harcourt operations will be extended to IFF and implemented through an overarching Environmental and Social Management System (ESMS).

Equator Principles (EP4)

The Project has committed to comply with the Equator Principles (EP4), which together with the IFC Performance Standards and the EHS Guidelines form the international benchmark for the ESIA. The Project is classified as Category A (Principle 1); an internationally compliant ESIA and ESMMP have been prepared in accordance with the IFC Performance Standards and EHS Guidelines (Principles 2–3); commitments shall be implemented through an overarching ESMS (Principle 4); stakeholder consultation, disclosure and a Project grievance mechanism are being implemented (Principles 5–6, Chapter 6 and SEP); the Project lenders will appoint independent experts to review Project documentation and to undertake independent monitoring (Principles 7 and 9); and IFF shall comply with Nigerian legislation and ESMMP commitments and prepare annual reports documenting their implementation (Principle 8). EPFI reporting (Principle 10) is not IFF's responsibility.

Given the anticipated participation of AfDB in the lender consortium, the Project has been reviewed against the AfDB ISS (2023) Operational Safeguards (Table ES-3 above; Chapter 2, Table 2-4; Chapter 1, Table 1-5). In accordance with OS1, where Nigerian requirements differ from the ISS and the EHS Guidelines, the more stringent requirement shall be achieved; this principle is applied in the environmental quality standards adopted for the Project, summarised below.

The effective implementation of the IFF Line 2 Project will depend on the capacity of the Project Proponent, contractors, government agencies, regulators and host communities to fulfil their respective environmental and social responsibilities. Consequently, the table below outlines the roles and responsibilities of each group, including their institutional and administrative capacity.

TABLE ES-4: ROLES, RESPONSIBILITIES AND INSTITUTIONAL CAPACITY OF PROJECT IMPLEMENTATION STAKEHOLDERS

Institution/Entity	Principal Roles and Responsibilities	Institutional and Administrative Capacity
Indorama Fertilizer FZE (IFF)	Overall responsibility for implementation of the ESMP; provision of financial, human and technical resources; obtaining and maintaining statutory approvals; integrating E&S requirements into project design, procurement and contracts; ensuring contractor compliance; stakeholder engagement; grievance management; environmental and social monitoring; incident reporting; corrective actions; and periodic review of ESMP performance.	Indorama has an established organisational structure, experienced management and technical personnel, and an operational **Environmental and Social Management System (ESMS)** supported by HSE procedures. The existing facility has established systems for environmental monitoring, regulatory compliance, incident management, emergency response, contractor management, stakeholder engagement and reporting. These existing systems provide the institutional foundation for implementing and maintaining the ESMP for the proposed Project. Additional resources will be provided as required during construction and operation.
Project Management Team	Incorporate ESMP requirements into project planning, engineering, procurement, construction and commissioning; coordinate contractors and consultants; ensure that environmental and social commitments are incorporated into work packages and contractor obligations.	The Project Management Team will comprise experienced project, engineering, construction, HSE and environmental/social personnel. The team will have defined reporting lines and authority to incorporate E&S requirements into project decisions, approve work plans, coordinate contractors and track ESMP performance. Project-specific E&S responsibilities will be included in project implementation procedures and work packages.
HSE/Environmental and Social Management Team	Day-to-day implementation and supervision of ESMP measures; environmental	Indorama maintains an established HSE and environmental

	monitoring; inspections and audits; waste management; pollution prevention; occupational and community health and safety; biodiversity and resource management; incident investigation; record keeping and regulatory reporting.	management function with personnel experienced in industrial environmental management, occupational health and safety, environmental monitoring, regulatory compliance and emergency response. The team will be strengthened with additional competent personnel and specialists where required, particularly during peak construction activities. It will have authority to conduct inspections, identify non-conformances, initiate corrective actions and escalate significant issues to management.
Engineering/Operations Department	Ensure that environmental and social controls are incorporated into engineering design, equipment selection, operation and maintenance; implement resource-efficiency, emission-control and pollution-prevention measures.	The Engineering and Operations teams possess technical and operational experience in the design, construction, commissioning and operation of large-scale ammonia–urea plants (IFZ Line 1, IFZ Line 2 and IFF Line 1). Their established maintenance, process-control and operational procedures provide capacity to integrate pollution prevention, energy efficiency, emission controls, waste minimisation and environmental safeguards into project design and operation. Specialist engineering support will be engaged where necessary.
Procurement/Contract Management	Incorporate E&S requirements, performance standards and applicable regulatory obligations into contractor and supplier agreements; monitor contractor performance and enforce contractual corrective actions.	Existing procurement and contract-management procedures provide a mechanism for incorporating HSE, environmental and social requirements into tender documents, contracts and purchase orders. Contractors will be prequalified based on

		relevant technical and HSE competence, and contractual performance requirements will include compliance with the ESMP, applicable legislation and Indorama's HSE requirements.
Contractors/Subcontractors	Implement all applicable ESMP, HSE and environmental requirements within their areas of responsibility; prepare method statements and task-specific plans; provide competent personnel and PPE; undertake monitoring and reporting; manage wastes and hazardous materials; report incidents and implement corrective actions.	Contractors will be required to demonstrate adequate technical, financial, HSE and environmental capacity before mobilisation. Each major contractor will designate competent HSE/environmental personnel and implement project-specific HSE and environmental plans. Contractor performance will be subject to induction, routine inspections, audits, toolbox meetings, monitoring and corrective-action tracking by Indorama.
Federal Ministry of Environment (FMEnv)	Regulatory oversight of the ESIA process and environmental compliance; review and approval of the ESIA/ESMP; monitoring of compliance with approval conditions; inspections and enforcement in accordance with applicable environmental legislation.	FMEnv has the statutory mandate, technical departments and established procedures for ESIA review, environmental compliance monitoring, inspection and enforcement. The Ministry will provide regulatory oversight through review of the ESIA/ESMP, approval conditions, inspections, monitoring and review of compliance reports.
Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA)	Regulatory oversight of applicable midstream/downstream petroleum and gas-related activities; review and enforcement of relevant technical, safety, environmental and operational requirements within its statutory mandate.	NMDPRA has specialised regulatory and technical capacity covering applicable gas and petroleum-sector activities, including technical, operational and safety oversight. Its established inspection, permitting, monitoring and enforcement mechanisms will support regulatory compliance for applicable gas-related aspects of the Project.

Rivers State Ministry of Environment / relevant State authorities	State-level environmental oversight, inspections, coordination and monitoring; participation in environmental compliance activities and community-related environmental matters.	The Rivers State environmental authorities provide state-level environmental oversight and have established personnel and administrative structures for environmental monitoring, inspection, stakeholder engagement and coordination with federal regulators. The Ministry will support implementation through periodic monitoring, participation in inspections and engagement on state and community-level environmental matters.
Relevant Local Government Authorities	Local administrative coordination, support for stakeholder engagement and community-level implementation of relevant project commitments.	The relevant Local Government Authorities provide an established administrative interface between the Project, host communities and state government. Their capacity will primarily support local coordination, communication, community mobilisation and participation in implementation of relevant community-level commitments.
Host Communities/Community Representatives/CDCs	Participate in consultation, disclosure, grievance management and participatory environmental monitoring; provide community feedback and assist in identifying emerging environmental and social concerns.	Existing community leadership structures, Community Development Committees (CDCs) and community representatives provide an established platform for stakeholder engagement and community participation. Their capacity will be strengthened through regular consultation, environmental awareness, grievance-management procedures and participation in **Participatory Environmental Monitoring (PEM)**.
Consultants/Independent Specialists	Provide specialist environmental and social expertise, baseline studies, monitoring, audits, capacity	Qualified and appropriately accredited consultants and specialists will be engaged where

	building and independent technical support where required.	specialist expertise is not available internally. Consultants will support environmental and social monitoring, audits, technical studies, capacity building and independent verification. Their engagement will be subject to defined scopes of work, competency requirements and quality-control procedures.
Development Finance Institution/AfDB, IFC/WB where applicable	Oversight of applicable environmental and social requirements under the AfDB Integrated Safeguards System, including monitoring of implementation of relevant safeguard commitments.	Where applicable, AfDB, IFC/WB will provide independent safeguard oversight through review of environmental and social documentation, monitoring of ESMP implementation and engagement with the PIE and relevant stakeholders. The PIE will maintain appropriate documentation and reporting mechanisms to demonstrate compliance with applicable AfDB safeguard requirements.

Capacity assessment. In line with Section J and Annex 2 (item 3) of the AfDB Borrower Guidance Note on OS1, the review of the Nigerian environmental and social framework and of the implementing institutions concluded that: (i) the Federal and State regulators (FMEnv, NESREA, NMDPRA, NEPZA and RSMEnv) have clear statutory mandates and established EIA review, permitting and inspection procedures. (ii) IFF, as the Project Implementing Entity (PIE), operates an existing ESMS, HSE and Community Relations & Development functions and a grievance mechanism for the existing IFZ Line 1, IFZ Line 2 and IFF Line 1 and the wider Indorama complex. (iii) contractors are required by contract to provide qualified HSE/E&S personnel and a Contractor ESMP; and (iv) community structures (CDCs, cluster heads and CLOs) need training in grievance handling and participatory monitoring.

Environmental Quality Standards Adopted for the Project

Chapter 2 consolidates the numeric standards for ambient air, noise, point-source emissions and treated effluent from Nigerian statutory standards, the IFC/WBG General EHS Guidelines and the IFC sector-specific EHS Guidelines for Nitrogenous Fertilizer Production. Nigerian standards are mandatory and form the regulatory baseline; IFC/WBG guidelines apply concurrently; where both apply to the same parameter and averaging period the more stringent value is adopted; and where one framework is silent, the value from the other framework or a recognised international benchmark is adopted. The resulting Project-Adopted Standards (Table ES-5) are used as the benchmark for air dispersion and noise modelling at sensitive receptors, as the compliance criteria for significance and residual impact ratings, and as the performance thresholds for mitigation, operational controls and ESMMP monitoring.

TABLE ES-5: PROJECT-ADOPTED ENVIRONMENTAL QUALITY STANDARDS

Medium / Parameter	Nigeria standard	IFC/WBG guideline (General / Sector)	Project-Adopted Standard	Adoption basis
Ambient air – NO_2 (annual / 1-hour)	80 / 200 µg/m³	40 / 200 µg/m³	40 / 200 µg/m³	IFC more stringent (annual); equivalent (1-hour)
Ambient air – PM_{10} (annual / 24-hour)	60 / 150 µg/m³	70 / 150 µg/m³ (IT-1)	60 / 150 µg/m³	Nigeria more stringent (annual); equivalent (24-hour)
Ambient air – $PM_{2.5}$ (annual / 24-hour)	20 / 40 µg/m³	35 / 75 µg/m³ (IT-1)	20 / 40 µg/m³	Nigeria more stringent
Ambient air – NH_3 (annual / 1-hour)	200 / 600 µg/m³	No IFC/WHO value (UK EA: 180 / 2,500 µg/m³)	180 / 600 µg/m³	UK EA benchmark (annual); Nigeria more stringent (1-hour)
Noise – operational, residential/institutional/educational (day/night)	50 / 35 dB(A)	55 / 45 dB(A); max. +3 dB above background	55 / 45 dB(A) + 3 dB rule	As stated in Table 2-7: "IFC more stringent for receptor class"
Noise – construction, sensitive receptors	60 / 50 dB(A)	No IFC construction limit	60 dB(A) daytime	Nigeria standard adopted
Noise – mixed residential/industry (day/night)	55 / 45 dB(A)	70 / 70 dB(A)	55 / 45 dB(A)	Nigeria more stringent
Stack – NH_3, PM (ammonia plant) and urea dust, NH_3, PM (urea granulation)	Not specified	Sector: 50 mg/Nm³	50 mg/Nm³	Only the sector guideline provides a value
Stack – NO_x, ammonia primary reformer	National combustion standards may apply	Sector: 300 mg/Nm³	300 mg/Nm³	Sector guideline is the only numeric limit
Effluent – pH / temperature increase	6.5–8.5 / not specified	6–9 / <3°C	6.5–8.5 / <3°C	Nigeria narrower range; IFC/sector temperature limit
Effluent – TSS / BOD / COD	30 / 30 / 150 mg/L	TSS 30 mg/L (sector); BOD and COD principle-based	30 / 30 / 150 mg/L	Nigeria = sector (TSS); Nigeria numeric limits (BOD, COD)
Effluent – NH_3 / Total N / Urea	5 mg/L / not specified / not specified	Sector: 5 / 15 / 1 mg/L	5 / 15 / 1 mg/L	Nigeria = sector (NH_3); sector only (Total N, urea)
Effluent – oil and grease / heavy metals	10 mg/L / parameter-specific limits	Approx. 10 mg/L (GIIP) / non-numeric	10 mg/L / Nigerian limits	Nigeria explicit numeric limits

For process-related requirements without numeric limits, the Project shall combine Nigerian legal requirements with IFC good international industry practice: flaring shall comply with

national flaring rules and IFC good practice to minimise flaring and ensure complete combustion; hazardous materials, including spent catalysts, shall be managed under the Nigerian hazardous waste regulations and IFC GIIP; and oily water and drainage systems shall meet the Nigerian numeric discharge limits with oil–water separation and IFC GIIP controls.

Indorama Corporate EHS and Social Policies

The following policies (all 2026, Rev. 2), currently implemented for IFZ, will be extended to the IFF Line 2 Project: the Non-Discriminatory Policy (equal opportunity in recruitment, compensation, promotion and termination); the Child Labour Prohibition Policy (no employment of persons under 18 years, zero tolerance, age records open to verification, implemented by Human Resources); the Human Rights and Labour Policy (guided by the Universal Declaration of Human Rights, the ILO Declaration on Fundamental Principles and Rights at Work and the African Charter, and covering freedom of association, expression and worship, safe and healthy work, non-discrimination, freedom from bullying and sexual harassment, and fair hearing); the Independent Contractors' Policy (requiring contractors to comply with IFZ policies on grievance handling, including anonymous grievances, child labour, human rights, non-discrimination, retrenchment, discipline, security and safety, and compensation); the Gender Based Violence and Harassment Policy (zero tolerance of GBVH); the Anti-Retaliatory Policy; the Community and Stakeholder Policy; the Environmental and Climate Change Policy (environmental management systems compliant with national, regional and local regulations and GIIP); the Occupational Health, Safety and Wellbeing Policy (goal of zero harm); the Product Stewardship Policy; the Responsible Business Policy; the Social Media Policy; and the Confidential Reporting Policy (reporting of Code of Conduct violations, illegal acts and abuse of authority, with protection from retaliation).

ES4.0 Project Justification

The proposed IFF Line 2 Project is intended to expand Indorama's fertilizer production capacity to meet increasing domestic and international demand for urea while reinforcing Nigeria's position as a leading fertilizer producer. The Project will contribute to improved fertilizer availability, support national food security and agricultural productivity, promote gas-based industrialisation through productive utilisation of domestic natural gas resources, generate employment and export earnings, and contribute to sustainable economic growth in line with national development priorities.

Production Context and Market Demand

Indorama currently operates IFZ Line 1 and IFZ Line 2, each producing 2,300 MTPD of ammonia and 4,000 MTPD of urea, with all ammonia captively converted to approximately 2.8 million tonnes of granular urea per year; Indorama is recognised as the largest fertilizer producer in Sub-Saharan Africa. Following commissioning of IFF Line 1 in June 2026, the combined installed capacity is 4.2 million tonnes per year, and with all four lines in operation Indorama will be able to produce approximately 5.6 million tonnes of urea annually. Urea from IFF Line 2 will be primarily for export to Latin America, Europe, the USA and West Africa, while allowing Indorama to serve domestic offtake flexibly. Indorama does not currently sell ammonia as a standalone product, although its use as a hydrogen carrier may create future opportunities. Globally, the urea market continues to expand on the back of rising food demand and industrial applications, with medium-term growth assessed at 3–4% CAGR through 2029–2034.

Food Security and National Agricultural Need

Sub-Saharan Africa has the lowest nitrogen fertilizer usage in the world. Nigeria's national fertilizer consumption was only 4.2 kg/ha in 2023, against a global average of approximately 120 kg/ha and a Sub-Saharan Africa target of 50 kg/ha, indicating a substantial need for investment in fertilizer supply. Farming and livestock rearing are the main livelihood for approximately 70% of households in Nigeria, agriculture is predominantly subsistence-based, and agriculture contributed 29.94% of nominal GDP in the third quarter of 2021. Low fertilizer use is a major factor in the under-realisation of Nigeria's agricultural potential, and population growth (Nigeria 2.06% per year in 2026) and climate change are increasing food security pressures. Additional, reliable upstream production from IFF Line 2 will support government programmes, including PFI 3.0, that aim to stabilise fertilizer supply to blending plants and farmers in Nigeria and West Africa.

Gas Utilisation and Flare Reduction

The Project is consistent with Nigeria's gas-based industrialisation and flare-reduction objectives, including the Petroleum Industry Act 2021 and the Nigerian Gas Flare Commercialisation Programme (NGFCP, launched in December 2016). Nigeria's gas reserves were estimated by NMDPRA at approximately 209 trillion cubic feet as of March 2022, the highest in Africa. Of total gas production of 7.5 BCF/day, approximately 1.4 BCF/day is supplied to the domestic market, 3.5 BCF/day exported, 2.0 BCF/day reinjected and 0.6 BCF/day flared. In 2021 approximately 600 MMSCF of gas was flared daily, and as of 2024 Nigeria ranked 7th in the world for gas flaring, despite a 68% reduction in flaring since 1996. A new fertilizer plant consumes about 90 MMSCF of gas per day, so the Project has the potential to reduce flaring by an equivalent amount, avoiding approximately 3.4 MMTPA CO_2-eq, where that gas would otherwise be flared in the absence of other downstream users. Approximately 80% of the natural gas used is feedstock for fertilizer production and 20% is used for fuel and power generation.

TABLE ES-6: KEY INDICATORS SUPPORTING THE NEED FOR THE PROJECT

Indicator	Value	Source
Installed urea capacity – IFZ Line 1 and Line 2	~2.8 million t/yr	Ch 3.2
Installed urea capacity – after IFF Line 1 (June 2026)	4.2 million t/yr	Ch 3.2
Urea capacity with all four lines including IFF Line 2	~5.6 million t/yr	Ch 3.3
IFF Line 2 design capacity	2,300 MTPD ammonia; 4,000 MTPD urea; 150 MTPD UFC-85	Ch 1.1
Global urea market growth	3–4% CAGR through 2029–2034	Ch 3.2
Fertilizer consumption – Nigeria / global / SSA target	4.2 kg/ha (2023) / ~120 kg/ha / 50 kg/ha	Ch 3.2
Share of Nigerian households dependent on farming and livestock	~70%	Ch 3.2
Agriculture share of nominal GDP (Q3 2021)	29.94%	Ch 3.2
Nigerian gas reserves (March 2022)	~209 trillion cubic feet	Ch 3.2

Indicator	Value	Source
Gas flared in Nigeria (2021)	~600 MMSCF/day; 7th globally (2024)	Ch 3.2
Potential flare-gas displacement	~90 MMSCF/day, equivalent to ~3.4 MMTPA CO_2-eq	Ch 3.2; Ch 3.4.4

Value of the Project

The investment is aimed at improving domestic production, promoting downstream blending plants, enhancing supply and distribution networks and providing new employment opportunities for Nigeria's growing young population. The Project will help improve the share of agriculture in national GDP, earn foreign exchange from exported urea and improve the local economy in the immediate Project area.

Technical Sustainability

The Project is expected to be technically sustainable because: natural gas has a higher hydrogen content than other feedstocks, while heavier feedstocks such as coal and oil are more complex to process and increase GHG emissions; ammonia and urea will be produced in the same plant, allowing the carbon dioxide by-product of ammonia production to be used in urea production; the Project will employ the same technology as IFZ Line 1, IFZ Line 2 and IFF Line 1, which have demonstrated a high degree of operability and reliability and set a benchmark in process safety; it will be engineered and constructed by the same contractors; natural gas for feed and fuel has been secured; and Indorama has technically competent personnel who were involved in the design, construction, commissioning and operation of the existing lines. The Project shall be designed, constructed and operated in accordance with internationally accepted codes and standards, including ANSI, ASME, NACE, NFPA, International Electrotechnical Commission and IEEE standards.

Environmental Sustainability

ERM considers that, provided the mitigation and management measures in this ESIA and the ESMMP are implemented and the recommended ways forward are made conditions of authorisation, there are no environmental or social fatal flaws or red flags that inhibit authorisation of the Project. Following submission of the ESIA, additional studies and detailed design will continue; their findings and any further changes to the Project scope shall be re-evaluated for their influence on impact significance and, where necessary, the ESMMP shall be amended so that negative impacts are mitigated and positive impacts enhanced.

Economic and Social Sustainability

The Project is economically sustainable owing to gas supply contracts exceeding requirements, sound technology, experienced contractors and operations staff, easy access to the Port and an established marketing and sales team, supported by the Federal Government's strategy to reduce associated-gas flaring. It will help correct the existing supply–demand imbalance for urea and will benefit the local economy and the development of downstream medium-scale industries such as NPK blending, generate foreign exchange from exports, and create direct and indirect employment, including substantial indirect employment in plant construction, transportation and support services. Socially, the Project supports national fertilizer demand as a key enabler of food security and will provide employment during construction and operation.

Indorama's engagement with host communities has established a positive relationship, and IFF shall sustain stakeholder consultation throughout the Project life as set out in the SEP.

ES5.0 Analysis of Project Alternatives

Basis for the Analysis of Alternatives

The EIA Act (CAP E12 LFN 2004) requires an ESIA to consider technically and economically feasible alternatives for carrying out a project, including an assessment of their environmental effects, and the EIA Procedures and Charges Regulations (S.I. No. 109 of 2021) require alternatives to be considered on the basis of technology, site, energy and water requirements. The ESIA has therefore considered location alternatives, technology (feedstock and process) alternatives, and the No Project, Delayed Project and Proceed as Planned options, together with site layout, process and energy-efficiency design options.

Location Alternatives

The Project will be established within Indorama Free Zone, inside the existing Indorama Manufacturing Complex, on land in the industrial zone with no existing settlements, so no physical resettlement will be required. The site has access to existing power, water supply and wastewater treatment utilities and to established infrastructure such as roads. Further advantages are soil conditions similar to the existing Line plots; support from the existing power plant, utilities and Environment, Safety, Occupational Health, Social, Emergency and Security Management teams; availability of the existing Operations and Maintenance support team during construction and operation; positive relations with host and neighbouring communities; E&S impacts that can be adequately managed with no fatal flaws or red flags; and proximity to the Proponent's Port at Onne. A greenfield site outside the complex, while technically feasible, would involve high capital costs for land acquisition and duplicated infrastructure, and greater habitat disturbance, land take and community displacement risk. Location alternatives were therefore not considered financially feasible and were not taken further.

Technology Alternatives

Natural gas-based production is preferred over coal and biomass because of feedstock availability, process reliability and compatibility with existing facilities. The alternatives would require greater transport, storage and land resources, with additional costs and environmental pressures.

Natural gas will be available at the plant's battery limit under a separate authorisation, and reserves will suffice well beyond the life cycle of the Project and the existing lines. Coal as a feedstock would require approximately 4,500 TPD (1,642,500 tonnes per year) of imported coal, and coal gasification produces significant amounts of CO_2: without carbon capture, hydrogen from natural gas generates about 9 kg CO_2 per kg H_2 compared with approximately 20 kg CO_2 per kg H_2 from coal. Biomass would require approximately 6,000 TPD (equivalent to 90 MMSCFD of natural gas), which preliminary assessments indicate could not feasibly be sourced; fermentation also results in CO_2 emissions, and gasification has poor operational efficiency, risks interruption of syngas supply to an ammonia process that must operate continuously, and forms tars that can poison catalysts. Coal or biomass would also require road

transport of feedstock for the life of the Project, with associated community and occupational safety risks, additional land take with loss of vegetation and biodiversity, higher site development costs, and would not complement the NGFCP objective of commercial gas utilisation. Feedstock and process alternatives were therefore found not to be financially or environmentally reasonable, and the Project will use the same natural gas-based technology as the existing lines.

No Project and Delayed Project Alternatives

The no-project option would avoid development-related impacts but forgo additional production, employment and economic benefits. Delaying implementation would postpone these benefits while potentially increasing costs and market uncertainty. Neither option is selected in the assessment.

The No Project Alternative assumes that the Project is not established within any time period. Its principal disadvantages identified in the ESIA are:

- lost opportunity to supply growing global fertilizer demand, with world population projected at 8.30 billion by mid-2026 and Africa growing faster than the global average (Nigeria 2.06% per year in 2026);
- lost contribution to fertilizer supply for Nigeria and other West African countries, undermining national and regional food-system resilience and the drive to raise Nigeria's fertilizer consumption to 50 kg/ha;
- long-term loss of a commercially sustainable gas utilisation project, with continued flaring of the equivalent of approximately 90 MMSCF per day, approximately 3.4 MMTPA CO_2-eq at source, and the release of unburnt methane;
- loss of additional employment, local development and revenue for local, regional and national government; and
- potential increases in fertilizer prices in Nigeria and West Africa, affecting price stability for fertilizer and agricultural food products.

The Delayed Project Alternative would postpone implementation to a future date. It would defer, but not eliminate, construction-related environmental and social impacts, while delaying community investments, corporate social responsibility programmes and other Project benefits, and would introduce economic and financial losses through cost escalation and inflation, deferred revenue and socio-economic benefits, extended administrative and holding costs, and market and opportunity risk. Both the No Project and Delayed Project alternatives were therefore considered unreasonable and were not taken further.

Proceed as planned Option

The assessment favours a natural gas-based expansion within the existing manufacturing complex, using efficient technology and shared infrastructure. Implementation remains subject to regulatory approval, completion of necessary studies and fulfilment of environmental and social commitments.

The Proceed as Planned Option involves implementing the Project at the proposed location using the design, technology and schedule assessed in the ESIA. It would deliver increased production, employment, local procurement and wider economic development and make use of existing infrastructure, utilities and operational expertise. It would also introduce impacts from

construction, resource consumption, emissions, waste generation, traffic and workforce influx, which shall be managed through the ESMMP, continued stakeholder engagement, effective grievance management and emergency preparedness. Selection of this option is conditional on completing outstanding studies, incorporating their findings into detailed design and demonstrating that significant risks are adequately addressed, with monitoring results and changing Project conditions informing corrective actions and updates to management measures.

Preferred Option

The availability of reliable natural gas feedstock at the Indorama Manufacturing Complex, and the efficiencies of shared infrastructure and personnel from IFZ Line 1, IFZ Line 2 and IFF Line 1, favour the selected location, while coal and biomass were found to be neither environmentally preferred nor economically viable. Natural gas-based production of IFF Line 2 within the existing Indorama Manufacturing Complex/Indorama Free Zone has therefore been selected as the preferred option, incorporating a brownfield layout with buffer zones, advanced high-efficiency process systems and energy-efficient design. The alternatives considered are compared in Table ES-7 and the design options in Table ES-8.

TABLE ES-7: COMPARISON OF PROJECT ALTERNATIVES

Alternative	Key merits	Key demerits	Outcome
No Project	Avoids all Project construction and operational impacts	Loss of fertilizer supply, food security, employment and revenue benefits; continued flaring (~90 MMSCF/day, ~3.4 MMTPA CO_2-eq); potential fertilizer price increases	Rejected
Delayed Project	Temporarily defers construction-related environmental and social disturbance	Impacts only deferred, not avoided; delayed community benefits; cost escalation, deferred revenue, holding costs and market risk	Rejected
Alternative (greenfield) location outside the complex	Technically feasible	High capital cost (land acquisition, duplicated infrastructure); greater habitat disturbance, land take and community displacement risk	Rejected – not financially feasible; higher footprint
Coal feedstock	–	~4,500 TPD imported coal; ~20 kg CO_2/kg H_2 versus ~9 kg for natural gas; road transport risks; land take; higher capital cost	Rejected
Biomass feedstock	–	~6,000 TPD required and not feasible to source; CO_2 from fermentation/gasification; poor gasification reliability and catalyst poisoning; land take	Rejected
Proceed as Planned – natural gas-based line within Indorama Free Zone	Secured gas supply; proven technology; shared infrastructure, utilities and expertise; no resettlement; production, employment and economic benefits; supports flare reduction	Construction, resource use, emission, waste, traffic and workforce influx impacts requiring ESMMP implementation	Selected (preferred option)

TABLE ES-8: ALTERNATIVES ANALYSIS MATRIX FOR SITE LAYOUT, PROCESS AND ENERGY EFFICIENCY (CONDENSED FROM TABLE 3-1)

Category	Option considered	Cost / implementation	Environmental and social implications	Outcome
Site / layout	Greenfield site outside existing complex	High capital cost (land acquisition, infrastructure duplication)	Increased habitat disturbance, land take, community displacement risk	Rejected – higher footprint and cost
Site / layout	Expansion within existing industrial footprint (brownfield)	Lower capital cost through shared infrastructure	Reduced land disturbance; avoidance of new receptors	Selected
Site / layout	Compact plant layout with buffer zones	Moderate design optimisation cost	Reduced noise, air and safety risk exposure to receptors	Selected
Technology / process	Conventional process systems	Lower capex but lower efficiency	Higher emissions intensity and resource use	Rejected
Technology / process	Advanced high-efficiency process systems	Higher capex, lower opex over life cycle	Lower emissions; reduced energy consumption	Selected – aligns with GIIP and IFC PS3
Energy efficiency	Standard energy consumption design	Lower initial cost	Higher GHG emissions and operating costs	Rejected
Energy efficiency	Energy-efficient systems (heat recovery, optimisation)	Moderate capex increase, payback through opex savings	Reduced energy demand and emissions	Selected

ES6.0 Project Overview

Project Overview and Location

The proposed IFF Line 2 Fertilizer Project is an expansion within the existing Indorama Free Zone in Eleme Local Government Area, Rivers State. It will occupy approximately 80 hectares adjacent to IFF Line 1 and use established production technology, shared utilities and supporting infrastructure.

The ESIA assesses the project's incremental demands and interactions with existing facilities.

The IFF Line 2 development is a brownfield urea fertilizer production line (Line 4 of the Indorama complex) that replicates the design and technology of the operating IFF Line 1 (formerly IEFCL Train 3). The Indorama Free Zone is an established 250-hectare industrial precinct within the wider Indorama Manufacturing Complex. The approximately 80-hectare IFF Line 2 plot lies directly north of IFF Line 1. It is bounded by the Indorama Manufacturing Complex to the south and by undeveloped land to the north, east and west. The Indorama Free Zone, which includes the IFF Line 2 plot, lies between approximately 4°49'33.64"N and 4°50'50.03"N and between 7°06'16.72"E and 7°07'16.46"E.

The ESIA covers the incremental demands, interfaces and operational interactions of IFF Line 2 with existing Indorama infrastructure, utilities and shared systems. No expansion, modification or re-authorisation of existing facilities outside the IFF Line 2 footprint is proposed or assessed, except where the report states otherwise. Existing facilities shown outside the Line 2 footprint are included for context only.

Main Project Components

The development comprises:

- A Feed Conditioning Unit processing approximately 200 million standard cubic feet of natural gas daily.
- An ammonia plant producing 2,300 tonnes per day.
- A urea plant producing 4,000 tonnes per day.
- A Urea Formaldehyde Concentrate plant producing 150 tonnes per day.
- A 120,000-tonne urea storage facility, conveyors and truck-loading infrastructure.
- Cooling towers, water treatment systems, drainage, gas-receiving facilities and integrated safety systems.

Temporary facilities will include construction offices, laydown areas and fabrication yards.

The Project's main permanent and temporary components are summarised in Table ES-9. IFF Line 2 will duplicate the equipment design, process flow sheets and layout of IFF Line 1, and IFF has already engaged Engineering, Procurement and Construction (EPC) Contractors. The internal road and drain network will be 8 to 10 metres wide.

TABLE ES-9: MAIN COMPONENTS OF THE IFF LINE 2 PROJECT

Component	Capacity / key parameter	Function and main features
Feed Conditioning Unit (FCU)	200 MMSCFD raw natural gas	Slug catcher, NG knock-out drum, condensate stabiliser, mercury bed, amine treating (CO_2, H_2S, mercaptans), molecular-sieve dehydration to 0.1 ppm water, cryogenic methane recovery and flare. Produces feed of 99.8% methane; C_2+ (recovery above 98%) and stabilised heavies are sent to IEPL.
Ammonia Plant	2,300 MTPD (single train)	Desulphurisation, primary and secondary reforming, process air compression, HTS/LTS shift, CO_2 removal, methanation, syngas drying, cryogenic purification, synthesis gas compression, ammonia synthesis and refrigeration, loop purge ammonia recovery and process condensate stripping
Urea Plant	4,000 MTPD granular urea	Synthesis of ammonia and CO_2, purification (69–71 wt% solution), vacuum concentration (~97 wt%), spout-bed fluid granulation, scrubbing of granulator exhaust, product handling
UFC-85 Plant	150 MTPD	Catalytic oxidation of methanol to formaldehyde with excess air, heat recovery, absorption into demineralised water and urea solution, and catalytic incineration of tail gas. UFC-85 is used as an anti-caking and granulation additive.
Urea storage and truck loading	120,000 t	Enclosed warehouse with air-handling units, portal scraper reclaimer and conveyors, and bulk truck loading for product evacuation to MM FZE Port, Onne
Cooling towers (2)	26,000 m^3/hr (ammonia) and 16,000 m^3/hr (urea) circulation	Blowdown is routed to the wastewater recovery plant
Natural gas receiving station and pipeline	300 MMSCFD	New receiving station plus on-site underground pipeline (metering and supply to the FCU)

Component	Capacity / key parameter	Function and main features
Water treatment	Normal demand ~710 m³/hr	Existing boreholes plus three new back-up boreholes, decarbonation, filtration, DM water from the integrated existing IEPL/IFZ DM plants, and mixed-bed condensate polishers
Wastewater recovery and ETP (existing, shared)	Treats 580 m³/hr and recovers 522 m³/hr (90%)	Treats process condensates, urea hydrolyser effluent, amine-contaminated water and cooling tower blowdown for reuse
Safety systems	–	Flares for emergency, start-up and shutdown conditions; Fire and Gas System (detectors, alarms, deluge, FM-200, hydrants, 24-hour manned fire station); integrated DCS/ESD
Temporary (construction only)	–	Contractor and project management offices, material laydown areas, prefabrication yards and construction warehouse zones

Construction and Implementation

Construction will commence following ESIA approval and involve site preparation, earthworks, foundations, equipment installation and piping. Activities are planned for daytime, with separate access arrangements for personnel and materials.

Construction is expected to take approximately 33 months, within an overall project completion programme of approximately 35 months. The peak workforce is estimated at 4,500 Nigerian personnel and 750 expatriates, with priority given to qualified Nigerian workers.

Project Phases

The Project will be developed in four phases: design, construction, operation and decommissioning. Each phase depends on the successful completion of the one before it, and the ESIA covers all four. During the design phase, the full Project scope will be engineered. Planning and design refinement will continue, taking account of continued engineering studies, the findings of this ESIA and the ESMMP, and further post-ESIA environmental and social studies.

Construction shall begin only after the ESIA is approved. It will include erection of a temporary site fence, clearance of secondary vegetation, grading, civil works (in particular piling and equipment foundations), equipment installation, piping erection and construction of the supporting infrastructure. No construction activities will be undertaken at night.

Construction equipment will be used intermittently and not all at the same time. It will include excavators, crawler and hydraulic cranes, piling cranes, dump and mixer trucks, concrete pumps, a batch plant, loaders, graders, rollers, forklifts, man lifts, air compressors, generators, welding machines, trailers, cargo trucks, buses, minibuses, pick-ups, jeeps and ambulances. The combined equipment and vehicle fleet peaks at about 262 units in Month 21. Construction traffic is expected to average about 25 trucks or containers per day for equipment and materials, and about 100 buses per day at peak manpower. Personnel and materials will use separate access routes.

Construction utilities will comprise: (i) about 230,000 m³ of treated water from the existing operation; (ii) about 4,000 KL of diesel, averaging about 46 KL/month for the first seven months and about 112 KL/month thereafter; (iii) about 2 MW of construction power from the existing power generating units; and (iv) compressed air from portable air compressors.

The construction workforce will peak at 4,500 national staff (skilled, semi-skilled and unskilled) and 750 expatriate staff. Qualified and skilled Nigerians shall be recruited first. Table ES-10 shows the recruitment targets for national staff by origin. About 4,019 workers (around 89%) are expected to come from the Niger Delta, including 1,323 from Eleme and 1,800 from elsewhere in Rivers State.

TABLE ES-10: RECRUITMENT TARGETS FOR NATIONAL STAFF DURING CONSTRUCTION

Origin	Skilled	Semi-skilled	Unskilled	Total
Eleme (Niger Delta)	270	837	216	1,323
Rivers State (Niger Delta)	540	1,116	144	1,800
Other Niger Delta states	338	558	–	896
Sub-total Niger Delta	1,148	2,511	360	4,019
Others	203	279	–	482
Total	1,350	2,790	360	4,500

Implementation Schedule

Mechanical completion is expected about 32 months after the start of construction, and overall Project completion in about 35 months. The construction equipment schedule also covers Months 1 to 35. The chapter shows the anticipated Project schedule in Figure 4-15.

Production Processes and Operating Life

The Feed Conditioning Unit removes contaminants and heavier components from natural gas before downstream processing. The ammonia plant produces ammonia, while recovered carbon dioxide and ammonia are combined to manufacture granular urea.

The UFC-85 plant supplies a conditioning additive that improves urea strength and handling. Finished product will be stored and loaded for transport to Onne Port.

The facility is designed for approximately 30 years of operation, operating around 330 days annually, with major maintenance shutdowns planned every four years.

Feed Conditioning Unit. The FCU will condition raw natural gas into a stable, methane-rich feed for the ammonia primary reformer. A slug catcher and knock-out drum will separate liquids, and a mercury bed will capture trace mercury. An amine contactor will remove CO_2, H_2S and mercaptans, and molecular sieves will dry the gas. A cryogenic section (expander and demethaniser) will recover methane. Recovered C_2+ and stabilised condensate heavies will be sent to IEPL, and a lean gas compressor will deliver conditioned gas at battery-limit pressure. CO_2 will be compressed and polished for the urea plant, and an acid gas treater will remove residual H_2S.

Ammonia plant. Natural gas will arrive at the ammonia plant battery limit at about 48 kg/cm² and 15–25°C. It will be used as both feed and reformer fuel, and waste gas generated in the plant will supplement the fuel. Feed gas will be desulphurised over cobalt-molybdenum and zinc oxide beds to less than 0.1 ppm sulphur. It will then be reformed with steam over nickel catalyst in the primary reformer and with process air in the secondary reformer. Next, it will be shifted (HTS/LTS) to less than 0.30% vol. CO, stripped of CO_2 with a proprietary solvent (the

recovered CO_2 is compressed and sent to the urea plant), methanated to less than 5 ppmv carbon oxides, dried and cryogenically purified. Finally, it will be compressed and converted to ammonia over iron-based catalyst in a three-bed converter. Waste heat will be recovered as high-pressure steam (126 kg/cm²(g), superheated to 510°C) to drive the compressor turbines. Warm ammonia product (minimum 99.90 wt%) will be piped to the urea plant. If the urea plant is shut down, cold ammonia will be sent to an existing Train 1 ammonia storage tank. Process condensate will be stripped and polished for reuse.

Urea plant. Ammonia and CO_2 will react to form ammonium carbamate, which partly dehydrates to urea. Unconverted carbamate will be decomposed in a falling-film stripper and in two decomposer stages, then recycled. Inerts will be washed in a washing column and sent to the flare stack. The purified urea solution (69–71 wt%) will be concentrated in a vacuum concentrator to about 97 wt%, mixed with UFC-85 as an anti-caking agent, and granulated using spout-bed fluid granulation. Granules will be screened, with undersize recycled as seed and oversize crushed and recycled. Product will be conveyed to the 120,000 t storage building. Granulator and cooler exhaust air will be scrubbed to recover urea dust and ammonia, and the scrubber water will be recycled. All relief valves and pressure control devices in the ammonia and urea plants are designed for worst-case conditions and connected to a dedicated flare.

UFC-85 plant. Vaporised methanol will be oxidised with excess air over an iron-molybdenum oxide catalyst in a tubular fixed-bed reactor, cooled by circulating heat-transfer oil. The hot gas will be quenched in a waste heat recovery boiler, which recovers heat and suppresses by-products such as formic acid. Formaldehyde will then be absorbed into demineralised water and urea solution to form UFC-85. The absorber tail gas contains residual methanol, formaldehyde, carbon monoxide and dimethyl ether. It will be treated in a dedicated catalytic incineration unit that normally needs no support fuel and converts these compounds to carbon dioxide and water vapour.

Utilities and Resource Requirements

Power and steam will be supplied through the complex's existing captive generation and utility networks. Certain additional power and steam facilities, together with the off-site gas transmission pipeline, are covered by separate approvals.

Normal operational water demand is approximately 710 cubic metres per hour, supplied from existing boreholes with three additional backup boreholes. Demineralisation, condensate polishing and wastewater recovery will support reuse and reduce freshwater demand. The existing recovery plant is reported to recover approximately 90% of its treated flow.

Power. Power for construction and operation will come from the existing captive power plant, which has seven operating Gas Turbine Generators (GTGs) of about 33 MW each. An eighth unit (GT-8) shall be added for redundancy, giving a total of about 264 MW. The Project will add about 40 MW to the existing demand of about 142 MW, for a total of about 182 MW. The Indorama grid is not connected to the state grid and runs on an N+1+1 philosophy, so the loss of one turbine would not cause load shedding. The petrochemicals complex also has five emergency diesel generators with 14 MW of emergency capacity, which the report finds adequate for IFF Line 2.

Steam. Medium-pressure steam will come from the existing common MP steam network, which is fed by fuel-fired boilers and heat recovery steam generators (HRSGs). A new HRSG-6, linked

to GT-8, shall be connected to this network, so no separate auxiliary boiler is needed for IFF Line 2. GT-8 and HRSG-6 are installed and permitted under separate approvals for the wider Indorama complex. This ESIA assesses only how IFF Line 2 uses the available power and steam capacity.

Raw water, demineralised water and condensate polishing. Raw water will be decarbonated to remove dissolved CO_2 and then filtered. It will be used as cooling tower make-up and service water, and as feed to the DM plant. According to groundwater studies by an independent agency appointed by IFF, operating the three new back-up boreholes will not affect aquifer recharge. Demineralised water will come from the existing DM plants, and the IEPL and IFZ DM plants will be integrated to pool their spare capacity. A new condensate polishing system with mixed-bed polisher units will treat process and steam condensates from the ammonia plant, the urea plant and the steam turbine for reuse as boiler feed water. Exhausted resins will be regenerated with sulphuric acid and caustic soda.

Wastewater recovery and cooling. IFF Line 2 wastewater will be treated in the existing wastewater recovery plant, which treats 580 m³/hr and recovers 522 m³/hr (90%). Treatment by filtration, ion exchange and reverse osmosis produces water of cooling tower make-up and DM quality. The report finds the plant's capacity adequate for IFF Line 2, and the plant itself will not be modified or expanded. Two new cooling towers (26,000 m³/hr for ammonia and 16,000 m³/hr for urea) will receive make-up partly from the recovery plant and partly from the existing water treatment plant. Their continuous blowdown will be treated in the recovery plant and reused.

Natural gas supply. The complex currently receives gas from three suppliers through an existing underground pipeline and receiving station. Indorama has also secured gas from a further supplier (AGPC and Renaissance, Assa North – Ohaji South Project). A new underground 20-inch, 65 km natural gas pipeline from this supplier and a new gas receiving station, each with a capacity of 300 MMSCFD, will be built with IFF Line 2. This ESIA covers the on-site receiving station and the pipelines within the Indorama Free Zone and the IFF Line 2 footprint. The off-site transmission pipeline is subject to separate permitting. Its ESIA was approved by the Federal Ministry of Environment by letter reference FMEnv/EA/EIA/7236/Vol.I/289 dated 24 March 2025.

The main operational inputs and outputs given in the chapter are summarised in Table ES-11.

TABLE ES-11: KEY INPUTS AND OUTPUTS OF IFF LINE 2 (OPERATIONAL PHASE UNLESS STATED)

Category	Item	Quantity	Source / destination
Feedstock and fuel	Natural gas	200 MMSCFD (FCU capacity); new pipeline and receiving station 300 MMSCFD	New supplier via the 20-inch, 65 km pipeline and existing supply; feed and fuel for the ammonia plant
Water	Total water demand	~710 m³/hr (normal operation)	Existing boreholes plus three new back-up boreholes, supplemented by recovered water
Power	Electricity	+40 MW (site total rising from ~142 to ~182 MW of 264 MW installed)	Existing captive GTG plant plus GT-8

Category	Item	Quantity	Source / destination
Steam	MP steam	Not quantified in chapter	Existing common MP steam network plus HRSG-6; HP steam generated within the ammonia plant
Chemicals	MDEA; UF-85; sulphuric acid	3.0 kg/hr; 1,200 kg/hr; 80 kg/hr	Stored and handled under SOPs and MSDS
Products	Ammonia (intermediate)	2,300 MTPD, ≥99.90 wt%	To urea plant; to existing Train 1 storage tank when urea plant is down
Products	Granular urea	4,000 MTPD	120,000 t storage, then bulk trucks to MM FZE Port, Onne
Products	UFC-85	150 MTPD	Used internally as a granulation additive
By-products / recovered streams	C_2+ and stabilised condensate heavies; CO_2	Not quantified (C_2 recovery >98%)	C_2+ and heavies to IEPL; CO_2 recovered from the ammonia plant to the urea plant
Construction phase	Water; diesel; gasoline; power	~230,000 m³; ~4,000 KL; 500 t; ~2 MW	Existing treated water; existing refuelling facilities; existing generating units

Environmental and Safety Controls

The design prioritises process-water recovery and reuse, with no routine process wastewater discharge proposed. During recovery-system shutdowns, wastewater will pass through existing treatment and holding facilities, with controlled release subject to quality confirmation and retention-pond conditions.

The main wastewater streams and how they will be handled are:

- Boiler blowdown: routed to the cooling tower basin as make-up water.
- Turbine and steam condensates: polished and reused as boiler feed water; off-specification condensate goes to the wastewater treatment system.
- Ammonia process condensate: treated in a dedicated stripper. Urea process condensate: treated in a dedicated hydrolyser and stripper. Both are then polished for reuse as boiler feed water. Off-specification condensate shall be held in a tank within the plant and either treated gradually or transferred to the wastewater treatment system.
- Oily water: collected in dykes or oil traps at each source, skimmed, and passed through an oily water separator (such as a CPI separator) before going to the wastewater treatment system.
- FCU hydrocarbon condensate (from molecular-sieve regeneration): flashed to flare. The knock-out drum drain is treated in a CPI separator to below 10 ppm oil and grease before intermittent transfer to the wastewater treatment system.
- Chemical drains around the water treatment dosing facility: routed to an existing neutralisation pit.
- Floor-wash water: from the urea synthesis area, collected in a dedicated pit and treated in the hydrolyser and stripper; from the granulation area, recovered in a dissolving pit within the urea plant, with no discharge.
- Sewage from IFF Line 2 and the FCU: conveyed through the existing IFF Line 1 sewage network to the existing sewage treatment plant. On-specification treated sewage goes to the existing wastewater discharge network.

If the wastewater recovery plant is shut down, IFF Line 2 wastewater will be diverted to the existing equalisation and holding ponds of the Fertilizer Complex ETP. Once its quality has been confirmed, the treated water will be released in a controlled manner to the retention pond. There it mixes with rainwater runoff from the Indorama Manufacturing Complex before discharge to the Okulu River. Discharge from the retention pond shall take place only when the pond level is high (not daily), in line with applicable FMEnv effluent standards and Indorama's internal discharge protocols.

Clean stormwater will be separated from potentially contaminated runoff, supported by first-flush capture, oil-water separation and retention systems.

Stormwater shall be managed in line with the IFC General EHS Guidelines (2007) on Wastewater and Ambient Water Quality. Stormwater will be kept separate from process and sanitary wastewater, and runoff from process and storage areas will be kept separate from less contaminated runoff. Impermeable areas will be minimised, and peak discharge will be reduced through measures such as vegetated swales and retention ponds. Treatment will focus on the first flush. Each first-rain sump will have an oil skimmer, followed by a coalescing plate separator. Oil-water separators and grease traps will be installed at refuelling facilities, workshops, parking areas and fuel storage and containment areas. In normal operation, neutralised wastewater and de-oiled stormwater go to the existing retention pond. Sludge from stormwater systems shall be disposed of in line with local regulations. Organic sludge will be incinerated in the existing incinerators, and the ash will be tested by TCLP.

Air-emission controls include ammonia recovery, low-nitrogen-oxide burners, selective catalytic reduction, granulator scrubbing and catalytic treatment of UFC-85 tail gas. Fire detection, emergency shutdown systems, protective interlocks and flares provide process-safety controls.

The gaseous emission sources and their design controls are summarised in Table ES-12. Under normal operation, flares and process vents are not used for emissions. They are designed to burn hydrocarbons, and in the urea plant also ammonia, completely during upset, start-up and shutdown conditions. However, the urea plant also has a continuous flare for off-gases.

TABLE ES-12: MAIN GASEOUS EMISSION SOURCES AND CONTROLS

Plant	Source	Main pollutants	Controls
Ammonia	Primary reformer stack (natural gas, purge and flash gas firing)	NOx and combustion gases	Ammonia Recovery Unit removes ammonia from purge/flash gas; low-NOx burners; selective catalytic reactor (SCR)
Ammonia	Flare stack and process vents	Hydrocarbons and combustion products (upset only)	Designed for complete combustion at maximum upset discharge
Urea	Granulator and cooler exhaust	Urea dust, ammonia	Dust recovery/scrubbing system to <50 mg/Nm³; scrubber water recycled
Urea	Emergency and continuous flares; washing-column inerts	Ammonia, hydrocarbons, off-gases	Complete combustion, including during granulator washing
FCU	Regeneration gas heater (only continuous FCU flue gas source)	Combustion gases	Fired on flashed gas; no specific abatement stated

Plant	Source	Main pollutants	Controls
FCU	Flare	Hydrocarbons (intermittent)	Combustion of flashed vapours during regeneration and upset
UFC-85	Absorber tail gas	Methanol, formaldehyde, CO, dimethyl ether	Catalytic tail gas incineration to CO_2 and water vapour

Waste management will prioritise reduction, reuse and recycling, with hazardous materials handled through approved procedures, secure storage, secondary containment and spill-response arrangements.

Wastes are classed as non-hazardous or hazardous. Table ES-13 summarises the wastes estimated for the construction phase. In operation, IFF Line 2 waste will be managed through the existing IEPL and IFZ waste management system, and IFF shall update its Waste Management Plan to cover the Project. The 4R hierarchy applies: refuse single-use plastics, reduce non-recyclable products, reuse, and recycle.

TABLE ES-13: ESTIMATED CONSTRUCTION-PHASE WASTE TYPES AND QUANTITIES

Waste	Category	Quantity	Destination
Concrete debris and cement-contaminated soil	Non-hazardous	2,000–2,500 t/year	Landfill
Scrap metal and wire	Non-hazardous	400–500 t/year	Resale
Scrap plastic / PVC	Non-hazardous	20–25 t/year	Recycling
Mixed urban and cooking organic wastes (camps, kitchen, offices)	Non-hazardous	100–120 t/year and 10–12 t/year	Municipal / approved dump site
Used PPE	Hazardous	5 t/year	Existing incinerator or approved waste management facility
Lube and seal flushing oil (pre-commissioning)	Hazardous	1.5–2.0 t/year	Approved waste management facility
Paints and solvents; lamps and fluorescent fittings	Hazardous	0.2–0.4 t/year; 0.1 t/year	Approved waste management facility
Medical waste	Hazardous	0.05–0.10 t/year	Existing incinerator
Domestic wastewater	As stated in Table 45 (hazardous)	150 litres/day per worker	New STP

The hazardous materials to be used are: about 4,000 t of diesel and 500 t of gasoline during construction; and, in operation, MDEA (3.0 kg/hr), UF-85 (1,200 kg/hr) and sulphuric acid (80 kg/hr). Process catalysts are summarised in Table ES-14. They are replaced according to performance, typically once every 10–15 years. Any spent catalyst containing zinc sulphide shall be handled by a competent person in line with the MSDS and HSE procedures.

TABLE ES-14: PRINCIPAL PROCESS CATALYSTS

Service	Catalyst type	Approximate quantity	Replacement
Primary and secondary reformers and methanator	Nickel-based	250 t	Based on performance; typically once in 10–15 years

Service	Catalyst type	Approximate quantity	Replacement
High-temperature shift converter and ammonia converter	Iron-based	200 t	As above
Low-temperature shift converter	Copper-zinc-based	120 t	As above
Sulphur removal section	Zinc-based	80 t	As above

Hazardous materials shall be handled under material-specific SOPs, under proper supervision and following the MSDS. IFF shall ensure containers are properly labelled, MSDS are displayed, and secondary containment and spill-control equipment are available. A sulphuric acid spill will be washed down with enough water and the washings routed to the effluent treatment facility. Spilled MDEA and UF-85 will be collected and reused. During construction, minor diesel or gasoline spills will be caught in secondary containment and reused, and the existing refuelling facilities of IFZ, IFF and IEPL will be used.

Energy Management

The selected ammonia and urea technology is described as proven and as having the lowest specific energy requirement of the technologies available worldwide. Specific energy consumption for urea production will be 20.53 MMBTU/MT. Energy is also recovered through the waste heat boilers, high-pressure steam generation in the ammonia synthesis loop, electricity generation in the purifier expander, heat recovery in the UFC-85 plant and use of HRSG steam in place of an auxiliary boiler. IFF has taken account of the IFC General EHS Guidelines on Energy Conservation and the relevant Industry Specific Guidelines.

Operational Employment and Working Hours

Operations are expected to require approximately 160 additional employees, comprising 110 Nigerian personnel and 50 expatriates. Normal employee working hours are stated as 40 hours per week.

Normal working hours for IFF employees are 40 hours per week and 176 hours per month, in line with Nigerian labour law and International Labour Organization conventions. Nigerians shall be given priority in operational recruitment.

Decommissioning

Eventual decommissioning will involve dismantling, waste disposal, site clean-up and workforce demobilisation. A separate environmental and social assessment will be required to reflect conditions and requirements at that time.

The design operating life of the plant is about 30 years. At decommissioning, activities will include demolition, site clean-up, waste disposal, workforce demobilisation and a final site review. Baseline conditions are likely to have changed significantly by then, so decommissioning shall be the subject of separate environmental and social studies.

ES7.0 ESIA Methodology

ESIA Process and Applicable Standards

The ESIA has been undertaken in compliance with the Environmental Impact Assessment Act (Cap E12, LFN 2004) and S.I. No. 109, Environmental Impact Assessment Procedures and Charges Regulations, 2021, and in alignment with the IFC Performance Standards (2012), the AfDB Integrated Safeguards System (2023), the World Bank Group General and sector-specific EHS Guidelines and Indorama's environmental, health and safety policy commitments. The ESIA was prepared by ERM, an independent international environmental and social consultancy, in accordance with IFC PS1 and AfDB OS1. Specialist studies, including air quality modelling, biodiversity, socio-economic and community health and safety assessment, were undertaken by suitably qualified subject matter experts, and internal quality assurance and review were applied throughout to ensure consistency, accuracy and technical rigour across all specialist inputs.

The ESIA process was structured but iterative, with each stage informing the others as baseline data, specialist findings, design information and stakeholder inputs became available. The principal stages were: (i) screening for Project categorisation; (ii) scoping and review of the Terms of Reference (ToR); (iii) approval of the ToR by FMEnv; (iv) review of the proposed baseline methodologies and technical guide notes; (v) wet- and dry-season baseline data collection supervised by FMEnv and RSMEnv, with participation of an ERM Subject Matter Expert (SME) in the dry-season campaign; (vi) QA/QC review of the baseline data; (vii) impact assessment and development of mitigation measures; (viii) integration of mitigation and residual impact evaluation into the ESIA; (ix) development of the ESIA and ESMMP reporting framework; and (x) change management and continuing refinement of assumptions where new information became available.

Screening, Categorisation and Scoping

Following submission of the Project proposal and completion of site verification activities, FMEnv categorised the Project as a Category I development requiring a full ESIA in accordance with S.I. No. 109 of 2021 and the EIA Act (Cap E12), and advised that baseline data collection and stakeholder engagement should be undertaken in line with national requirements and international good practice. The scoping stage was used to identify the key environmental and social sensitivities and Project activities with the potential to cause significant impacts, to obtain stakeholder and regulator input, and to refine siting, layout and design considerations taking into account the existing industrial setting of the Indorama complex.

A Scoping Report and ESIA ToR were prepared in consultation with relevant stakeholders and regulatory authorities. The ToR defined the spatial and temporal boundaries of the assessment, the key impact pathways, the baseline data requirements and the approach to impact evaluation and mitigation. The ToR was submitted to and formally approved by FMEnv, authorising progression to the detailed ESIA phase.

Review of the ToR Baseline Methodologies

Following ToR approval, a structured review of the proposed baseline methodologies was undertaken to confirm that the baseline programme would support a scientifically robust, regulator-ready and lender-aligned ESIA. The review examined sampling design, media coverage, frequency, seasonality, equipment, QA/QC requirements and the respective roles of the local consultant (LC) and international consultant for air quality, terrestrial and aquatic biodiversity and ecosystem services, surface water quality, soils and fluvial sediments,

geology/hydrogeology, treated effluent, stack emissions, noise, traffic, and socio-economic and cultural heritage. The overall baseline framework was found to be appropriate, subject to the following topic-specific refinements:

- Air quality: strengthening of the receptor network and confirmation that meteorological inputs were adequate for robust dispersion modelling.
- Surface water: stronger integration of hydrology, discharge points, downstream receptor sensitivity and flow-related data.
- Soils, geology and groundwater: improved parameter and depth coverage, stronger QA/QC and use of existing complex-wide information only where justified.
- Traffic: seasonal representation, coverage of daytime and night-time conditions and like-for-like survey design across the affected road network.
- Social and cultural heritage: coverage of cumulative social pathways and community health and safety linkages, and a clearer methodology for cultural heritage survey, documentation and chance finds.

Cross-cutting recommendations addressed indicator selection, conceptual models, seasonality and ancillary data capture, QA/QC and chain-of-custody requirements, and cross-disciplinary integration to support impact and cumulative effects assessment. These recommendations were provided to the LC, the work plan was updated and the supplemented approach was approved by FMEnv. The baseline programme actually implemented was therefore strengthened beyond the original ToR where needed to produce sufficient, representative and auditable data.

Study Area and Area of Influence

The proposed development occupies approximately 80 hectares within the wider 250-hectare Indorama Free Zone, directly north of the existing IFF Line 1 facility.

The Area of Influence extends beyond the project footprint to surrounding communities, groundwater resources, drainage channels, the Okulu River and downstream estuarine system, and transport routes connecting the complex to Onne Port. Its extent varies by assessment topic, including a 4-kilometre biodiversity buffer and a 3-kilometre cultural heritage study area. This approach captures potential direct, indirect, and cumulative interactions with existing industrial activities.

Baseline Data Acquisition Methods

The baseline combines existing studies and regional information with field monitoring, laboratory analysis, ecological surveys, household surveys, interviews, focus group discussions, and traffic counts. Wet- and dry-season investigations undertaken during 2025 and 2026 capture seasonal differences where relevant.

The evidence provides a basis for impact assessment, although important limitations remain. These include short monitoring periods, incomplete reporting of some groundwater quality assurance procedures, uncertainty over connections between aquifers, and the absence of defined Okulu River flood extents for the proposed development

Wet- and Dry-Season Baseline Programme and Supervision

Baseline data collection was undertaken by an FMEnv-accredited LC under the supervision of FMEnv and RSMEnv, with ERM providing technical oversight, quality assurance and alignment

with lender requirements. One ERM SME participated in the dry-season fieldwork in February 2026 under an enhanced supervision model comprising on-site ERM specialist presence within the complex, review of method statements and Standard Operating Procedures (SOPs), verification of equipment and QA systems, end-of-day data reviews, chain-of-custody checks, and maintenance of QA/QC logs and corrective action records.

The wet- and dry-season programme covered meteorology and climate, ambient air quality, noise, geology and soils, hydrogeology and groundwater, surface water and sediments, biodiversity and ecosystem services, socio-economic conditions, traffic and transport, and cultural heritage. Field surveys, direct measurements and laboratory analyses were supplemented by desktop review, previous monitoring information, existing validated data from the wider industrial complex and published regulatory information. Meteorology was characterised from an on-site automated weather station and Port Harcourt International Airport data; air quality by passive sampling supplemented by particulate monitoring; and the socio-economic baseline by approximately 350 household surveys across seven AoI communities, focus group discussions and key informant interviews, with stakeholder engagement contributing directly to the social and cultural heritage baseline. The timing of the principal field campaigns is summarised in Table ES-15.

TABLE ES-15: PRINCIPAL WET- AND DRY-SEASON BASELINE FIELD CAMPAIGNS

Discipline	Wet season	Dry season	Key method notes
Noise	16–25 October 2025	20 February–5 March 2026	11 locations; unattended monitoring; daytime (07:00–22:00) and night-time (22:00–07:00) LAeq
Traffic	6–12 November 2025	8–14 February 2026	Daytime (07:00–22:00) and night-time (22:00–07:00) counts across the affected road network
Surface water	16–18 October 2025	17–19 February 2026	In situ measurements, sampling and laboratory analysis
Biodiversity	October 2025	January and February 2026	Habitat mapping, species recording and ecosystem services review
Geology, soils and groundwater	October 2025	February 2026	Two-phase investigation; groundwater levels recorded in both seasons at inventoried boreholes
Air quality	Wet-season monitoring	Dry-season monitoring	Passive sampling plus particulate monitoring; combined results used for assessment

QA/QC of Baseline Data

Before baseline data were accepted for use in the ESIA, ERM reviewed the LC's field and laboratory data for: (i) completeness and coverage, confirming that planned surveys, monitoring events, analyses and reporting had been completed and identifying any deviations; (ii) consistency and accuracy, cross-checking field observations, monitoring results and laboratory outputs against the known characteristics of the study area; (iii) laboratory and analytical quality assurance, verifying the use of accredited laboratories and of blanks, duplicates, standards and documented QA procedures; and (iv) documentation of limitations and assumptions. During the supervised dry-season campaign, QA/QC also included a daily technical interface with the LC, participation in daily safety briefings and task reviews, metadata checks, chain-of-custody verification, and formal QA/QC records, corrective action logs and oversight notes.

The review also verified alignment of the baseline data with the approved ToR and applicable international standards. Data gaps were addressed through clarification or additional information requests and, where longer-term actions were needed to achieve full alignment with lender expectations, these were carried forward as post-ESIA commitments in the ESMMP. QA/QC was therefore an iterative validation process in which outliers and anomalies were interrogated, methodological limitations were documented and residual uncertainty was carried transparently into the impact assessment.

Impact Assessment Method

Impacts were identified by reviewing the Project description, baseline conditions, source–pathway–receptor linkages and stakeholder concerns. For each impact the source, pathway, affected receptor/resource and consequence were defined, and direct, indirect, induced and cumulative effects, both adverse and beneficial, were considered for construction, operation and, where relevant, decommissioning. Pre-mitigation significance takes account of control measures already embedded in the Project design, so that significance is not assigned to a hypothetical Project without its committed design controls.

Impact magnitude describes the degree of change to a receptor and is derived from the impact characteristics of type (direct, indirect, induced), extent (local, regional, international), duration (temporary, short-term for the construction period, medium-term for 5–10 years after construction, long-term for the life of the Project or recovery within 10–20 years after construction, and permanent for changes enduring substantially beyond 20 years), scale and frequency (expressed numerically where appropriate) and, for unplanned events only, likelihood. Magnitude is designated as Positive, Negligible, Small, Medium or Large. The designations are universal, but their definitions are topic-specific; changes that are immeasurable, undetectable or within natural variation are assigned Negligible magnitude.

For unplanned events, such as accidental releases of hazardous materials, likelihood is factored into the magnitude designation using professional judgement, supported by quantitative data such as modelling where available. Likelihood is designated as Unlikely (may occur at some time during normal operating conditions), Possible (likely to occur at some time during normal operating conditions) or Likely (will occur during normal operating conditions, i.e. essentially inevitable), and is estimated from experience or evidence of previous occurrence. Likelihood refers to the probability of the event, not of the resulting effect; uncertainty about the effect is discussed contextually.

Receptor sensitivity/vulnerability/importance is designated Low, Medium or High. For physical and biological receptors this reflects conservation status and importance at local, national and international scale, vulnerability to disturbance and resilience. For human and cultural receptors it reflects value, vulnerability and resilience, including the ability to adapt or use alternatives. Legal protection, government policy, stakeholder views and economic value are also considered. Significance is then assigned by combining magnitude and sensitivity using the universal matrix in Table ES-16.

TABLE ES-16: IMPACT SIGNIFICANCE MATRIX (NEGATIVE IMPACTS)

Magnitude of impact	Low sensitivity	Medium sensitivity	High sensitivity
Negligible	Negligible	Negligible	Minor

Magnitude of impact	Low sensitivity	Medium sensitivity	High sensitivity
Small	Negligible	Minor	Moderate
Medium	Minor	Moderate	Major
Large	Moderate	Major	Critical

A Negligible impact is imperceptible or indistinguishable from natural background variation. A Minor impact is noticeable but well within applicable standards. A Moderate impact is within standards but ranges up to a level just short of a legal limit, and must be shown to have been reduced to as low as reasonably practicable (ALARP). A Major impact is one where an accepted limit or standard may be exceeded, or where large-magnitude impacts affect highly valued or sensitive receptors. A residual Critical impact warrants the highest level of concern and may be considered a potential fatal flaw, requiring regulators and stakeholders to weigh it against the Project's positive impacts.

Mitigation Hierarchy and Embedded Mitigation

The mitigation hierarchy of avoid, minimise, restore and compensate/offset was applied from the start of Project planning rather than as a post-design addition. Mitigation is first directed at the source of an impact, to avoid or reduce its magnitude, and then at the effect on the receptor through abatement, compensation or offsets. Additional mitigation is not declared for impacts rated not significant unless required for conformance with an end-of-pipe requirement. The objective is to reduce impacts to ALARP rather than necessarily to a not-significant level. Measures are designed to be specific, practical, measurable and capable of implementation through the Project's management system.

Examples of embedded mitigation built into Project planning and design are: use of operationally proven technology with the same production capacity and footprint; use of existing land, access roads, drainage network and laydown areas; shared utilities, identical structural layouts and compact plant configurations; selective catalytic reduction (SCR) on the reformer stack to reduce NOx emissions; enclosed conveyor systems; acoustic enclosures, low-noise equipment and turbines, and silencers; and processing of treated effluent in the wastewater recovery plant.

Residual Impacts, Cumulative Effects and Uncertainty

Residual significance is assigned by repeating the assessment on the assumption that the declared mitigation is effectively implemented. The method establishes a traceable sequence of baseline condition, impact pathway, significance assignment, mitigation measure, residual significance and monitoring requirement, which is carried through Chapters 8 and 9 and the ESMMP. Cumulative impacts, arising where Project impacts interact with those of other existing or planned developments, are identified and described qualitatively, depending on the information available on those other activities.

Where uncertainty, such as uncertainty arising from ongoing design development or seasonal and annual environmental variability, is material to the findings, it is stated explicitly and treated conservatively (the precautionary approach) to identify the broadest range of likely residual impacts and necessary mitigation. Assumptions and their associated uncertainties are documented, and some uncertainty in qualitative predictions is reduced through consultation. Through the ESMMP, monitoring is used to confirm compliance with standards and performance targets, to verify that mitigation is effective as predicted, and to identify any additional

mitigation or investigation required, forming the basis for adaptive management and corrective action.

Topic-Specific Assessment Methods

For air quality and noise, predicted levels are compared directly with adopted criteria that already reflect receptor type and land use. Physical climate risk, greenhouse gases (GHG) and cultural heritage are assessed using materiality, benchmarking and heritage-specific criteria respectively. These methods are summarised in Table ES-17.

Air quality. The assessment addressed NOx/NO2, PM10, PM2.5, SO2 and NH3 against the National Environmental (Air Quality Control) Regulations, S.I. No. 88, 2021 and IFC/WHO guidelines, with the most stringent applicable values adopted as Project standards. The study area extends 250 m from construction activities for dust, 50 m from construction access routes for traffic emissions and 10 km from the plant for operational stack emissions. Combined wet- and dry-season baseline concentrations were below 50% of the applicable standards, so the airshed is considered undegraded. Construction dust was assessed on the scale of earthworks, vehicle movements on unpaved roads and material volumes. Construction traffic exhaust was assessed with a semi-quantitative screening method based on the UK Design Manual for Roads and Bridges (DMRB) and IFC guidance, adapted to the Nigerian vehicle fleet and using an ADMS-Roads dispersion factor. Operational impacts were modelled with USEPA AERMOD 24142 over a 10 km × 10 km domain, including building effects but excluding terrain, using five years (2018–2022) of hourly WRF meteorological data and NOx-to-NO2 conversion of 35% (short-term) and 70% (long-term). Two scenarios were modelled: IFF Line 2 with SCR on the primary reformer, and the in-combination operation of IFF Line 1 and IFF Line 2.

Operational air quality magnitude is based on the Process Contribution (PC) as a percentage of the Air Quality Standard (AQS), with stricter bands where the Predicted Environmental Concentration (PEC = PC + baseline) exceeds the AQS. Where the PEC is below the AQS, the bands are Negligible (<10%), Small (10–25%), Medium (25–75%) and Large (>75%); where the PEC exceeds the AQS, they are Negligible (<5%), Small (5–10%), Medium (10–25%) and Large (>25%). Receptor sensitivity is High for hospitals and schools, Medium for residential areas, towns and villages, and Low for transient-use areas such as agricultural or fishing areas. The general population at modelled receptors is treated as Medium because the adopted standards already protect the most vulnerable. Air quality significance uses a modified matrix in which Large magnitude at a High-sensitivity receptor is rated Major, and Negligible magnitude is rated Negligible at all sensitivities. The cumulative assessment, using a monitored baseline that already includes surrounding industrial, traffic and regional sources together with the Line 1 and Line 2 in-combination contribution, found no exceedance of relevant limits and a low cumulative significance. No additional cumulative mitigation was identified beyond construction dust management and SCR on the reformer stack.

Noise. The Noise Impact Assessment (NIA) was undertaken with regard to the National Environmental (Noise Standards and Control) Regulations, 2009, the IFC General EHS Guidelines Section 1.7 and BS 5228-1:2009+A1:2014. Baseline noise was measured at 11 locations in the wet season (16–25 October 2025) and dry season (20 February–5 March 2026). Results were processed for daytime (07:00–22:00) and night-time (22:00–07:00) periods using LAeq, the metric referenced in both Nigerian regulations and IFC guidance, and data recorded during rainfall or at wind speeds above 5 m/s were excluded. Daytime LAeq was

below 55 dB at all locations, and night-time LAeq exceeded the 45 dB IFC criterion at location N9 only. Receptors N2, N3 and N4, approximately 200 m from the complex perimeter fence and nearest to the Project footprint, were used as assessment receptors; the other baseline locations are further away and were not considered relevant to Project-induced change. Vibration was scoped out because of the distances between the Project and the receptors. Construction and operational noise were predicted with iNoise V2026.1 (DGMR) using ISO 9613-2:2024, representing topography, ground conditions, buildings and receptor locations. Construction is planned for daytime only and is assessed against the more stringent of the Nigerian daytime construction criteria and the IFC daytime guideline value of 55 dB(A) at residential, institutional and educational receptors (Table 5-7A); operation is assessed against the more stringent IFC criteria (Table ES-17). Noise significance is derived from the degree of exceedance of the criterion, with receptor sensitivity embedded in the criteria. Operational noise, and construction noise at N2 and N4, were assessed as direct, negative and of negligible significance at the assessed receptors, which were treated as being of medium sensitivity; worst-case construction noise at N3 (59 dB(A)) exceeds the IFC daytime value by 4 dB and is of Moderate significance before targeted mitigation and Minor after. The NIA recommends periodic noise monitoring at representative noise-sensitive receptors (NSRs) during construction and operation, with any exceedances addressed through corrective actions under a Noise Management Plan.

TABLE ES-17: PROJECT NOISE CRITERIA AND SIGNIFICANCE BANDS

Phase	Receptor	Daytime LAeq dB(A)	Night-time LAeq dB(A)	Basis	Significance (exceedance of criterion)
Construction	Hospitals, schools, institutions of higher learning, homes for the disabled	60	50 (not applied; daytime works only)	Nigerian construction noise criteria	5 dB or more below: Negligible; more than 5 dB below up to criterion: Minor; up to 5 dB above: Moderate; more than 5 dB above: Major
Construction	Other buildings	75	65 (not applied; daytime works only)	Nigerian construction noise criteria	As above
Construction (adopted for assessment)	Residential, institutional and educational receptors (N2, N3, N4)	55	45 (no night works planned)	IFC General EHS Guidelines – more stringent, adopted following AfDB review (Table 5-7A)	As above

Phase	Receptor	Daytime LAeq dB(A)	Night-time LAeq dB(A)	Basis	Significance (exceedance of criterion)
Operation	Residential, institutional, educational	55 (07:00–22:00, one-hour LAeq)	45 (22:00–07:00, one-hour LAeq)	IFC EHS Guidelines	More than 5 dB below up to criterion: Negligible; up to 5 dB above: Minor; more than 5 to 10 dB above: Moderate; more than 10 dB above: Major

TABLE ES-18: SPECIALIST METHODS FOR PHYSICAL CLIMATE RISK, GHG AND CULTURAL HERITAGE

Topic	Method	Criteria / scenarios	Significance output
Physical climate change risk	Hazard-based screening and scenario analysis of acute and chronic climate hazards affecting the Project during construction and operation	SSP1-2.6 (+1.8°C by 2100) and SSP5-8.5 (+4.4°C by 2100); time horizons: baseline (present day), 2030 and 2050	Materiality rating: High, Moderate, Low or Unlikely material
Greenhouse gases	GHG accounting in tCO2e; Tier 1 for construction (indicative fuel and equipment); Tier 2 for operation (refined activity data)	Annual benchmarks: <10,000 Nominal/Negligible; 10,001–25,000 Low; 25,001–100,000 Medium-Low; 100,001–1,000,000 Medium-High; >1,000,001 High	Benchmark rating and proportional context; not the receptor matrix, because GHG effects are diffuse, cumulative and global
Cultural heritage	Value-based assessment of tangible and intangible heritage; precautionary approach; Chance Finds Procedure required	Sensitivity: Low (replicable, limited value), Medium (non-replicable, considerable value), High (critical, legally protected, substantial stakeholder value); magnitude from no discernible change (Negligible) to entire site lost (Large)	Significance reflecting legal protection, non-replicability and stakeholder value

ESIA and ESMMP Reporting

ERM prepared the ESIA in accordance with the ERM Impact Assessment Standard and the Applicable Project Standards. Reporting ran in parallel with design development so that environmental and social considerations could inform Project decisions as design information became available. The assessment drew on validated information for the wider industrial complex where appropriate, while remaining focused on the incremental impacts, interfaces and commitments of IFF Line 2. For each receptor, the ESIA reports in three linked stages: the potential impact and its pre-mitigation significance (Chapter 8), the mitigation and controls committed to (Chapters 8 and 9), and the residual impact and its significance (Chapter 8, with linked commitments in Chapter 9 and the ESMMP).

The ESMMP carries ESIA mitigation and monitoring commitments into pre-construction, construction and operation. Its functions are to convert mitigation measures into defined actions, identify monitoring parameters, indicators and performance requirements, support the allocation of responsibilities through the wider ESMS, provide for corrective action and adaptive management, and require contractors and subcontractors to align their procedures with the Management Plans. The Management Plans are to be refined as detailed design progresses and reflected in contractor method statements, procedures and work practices. The ESMMP forms

an integral part of the Project ESMS, consistent with IFC PS1 and AfDB OS1, which supports the prioritisation of significant impacts, compliance monitoring, inspection, auditing and reporting, and the management of unforeseen impacts or changes during construction and operation.

Review, Disclosure and Finalisation

The draft ESIA and draft ESMMP were issued for Client review, followed by incorporation of comments by ERM and issue of revised documents. The drafts are then to undergo public disclosure and review by national authorities and lenders, with a further review cycle for comments received from authorities and lenders and limited engagement with lenders to discuss comments on the draft report. Lender comments shall be addressed directly in the documents in tracked changes, and clean and tracked versions shall be shared electronically with the lenders. FMEnv comments shall be addressed, and the final ESIA, including a Comments–Response Matrix, shall be submitted to FMEnv in hard and soft copy for review and approval. Through this process, deferred actions, data gaps and follow-up measures are documented and carried forward into implementation requirements.

Monitoring and Performance Reporting to Lenders

The Project management framework includes internal reporting to identify and correct environmental, social and health and safety non-conformances, and external reporting on issues of interest or concern to communities, regulators and other stakeholders. Monitoring data generated under the ESMMP shall be reviewed by the Project, and annual performance reporting is envisaged to review performance and set targets and objectives for subsequent periods. The environmental and social performance monitoring report shall be submitted to the lenders at the frequency and in the format agreed in the loan agreement.

ES8.0 Stakeholder Engagement

Stakeholder engagement was undertaken throughout the ESIA process in accordance with AfDB Operational Safeguard 10 and national regulatory requirements. Consultations involved government institutions, host communities, traditional authorities, community-based organisations, women's groups, youth representatives, vulnerable groups and other interested stakeholders. Issues raised, including employment opportunities, environmental quality, community health and safety, infrastructure development and local procurement, were considered during Project design and incorporated into the mitigation measures, Stakeholder Engagement Plan and Grievance Redress Mechanism to support continued dialogue throughout Project implementation.

Basis for Engagement and the Stakeholder Engagement Plan

Stakeholder engagement was designed to meet Nigerian ESIA public participation requirements and good international industry practice, including the IFC PS1 and AfDB OS1 requirements for ongoing, meaningful, inclusive and culturally appropriate engagement. Chapter 6 summarises the Project Stakeholder Engagement Plan (SEP, Appendix B), which covers the life of the Project and sets out the engagement approach, the stakeholders identified, and the mechanisms for engagement through permitting, construction, operation and decommissioning. Because IFF Line 2 is an expansion within an existing complex, the SEP builds on relationships maintained by Indorama since 2007, on stakeholder records and lessons from earlier projects, and on the operations-wide stakeholder engagement strategy prepared by ERM for Indorama's operations in Eleme. This keeps stakeholder identification,

communication channels and grievance arrangements consistent across the complex while reflecting issues specific to IFF Line 2.

The objectives of engagement are to understand stakeholder interests, influence and concerns; maintain effective, transparent and timely two-way communication; address concerns through dialogue and corrective action; respect local traditions and cultural norms; manage expectations of socio-economic benefits; and identify the management mechanisms and capacity building needed to implement the SEP. Engagement is guided by the principles of transparency, accountability, trust, mutual respect, collaboration, responsiveness, proactiveness, fairness, accessibility and inclusivity, and shall be free from manipulation, interference, coercion and intimidation. In practice, this means providing understandable information in appropriate formats and languages, engaging early, ensuring that vulnerable groups are not excluded, and maintaining predictable information channels and accessible grievance pathways. These features matter in the Eleme context of socio-economic vulnerability, reliance on informal livelihoods and historic perceptions of industrial development.

Stakeholder Identification and Analysis

A stakeholder is any individual or group who may be affected by, or has an interest in, the Project. Stakeholders were identified from existing Indorama stakeholder databases and engagement records and from the operations-wide engagement strategy, and the stakeholder database shall be updated as new stakeholders emerge or relationships change. Stakeholders were identified across the Area of Direct Influence (ADI) and the Area of Indirect Influence (AII). They comprise:

- Government and regulators: FMEnv, RSMEnv, NESREA, the Rivers State Ministry of Chieftaincy and Community Affairs, the Nigerian Ports Authority (Onne Port Complex) and Eleme Local Government.
- Traditional and community leadership: the King of Eleme (Emere Nchia), the Eleme Council of Traditional Rulers, clan heads and Community Development Committees (CDCs).
- Directly impacted communities: Aleto, Okerewa, Agbonchia, Njuru, Akpajo, Elelenwo (Wakoahu Family) and Iriebe.
- Indirectly impacted communities in the AII and along transport routes: Onne, Alode, Ebubu, Ogale, Alesa, Umuebula, Rumukrushi, Woji, Okujagu and Abam Ama.
- Vulnerable groups: women, youth, widows and people with disabilities, represented through Eleme Women Leaders, the Eleme Youth Council and the Host Community Youth Forum.
- Civil society and interest groups: Eleme Fishing Association, Eleme Hunters Association and Eleme Graduate Forum.
- Employment and business associations: workers' unions, the Welders and Fitters Association and the Indigenous Suppliers Forum.
- Other stakeholders: academia and radio and print media.

The six host communities of Aleto, Okerewa, Agbonchia, Njuru, Akpajo and Elelenwo (Wakoahu Family) are represented through the Project Advisory Committee (PAC). The PAC was constituted by the Rivers State Government and its members are nominated by the host

communities. It is the principal formal interface with Indorama on ESIA consultation, MoU implementation, employment, contracts and community development commitments, including scholarships for youth, micro grants for women and skills development. Iriebe was also included in the ADI for the socio-economic baseline. The land was acquired by the Rivers State Government in 1984 and compensation was paid to the affected communities; the communities have carried out no socio-economic activities on the 250 hectares since then.

Stakeholders were prioritised by influence and level of support to determine engagement methods, frequency and effort, also taking account of their interest in the Project, the anticipated impact on them, their vulnerability and their relationships with high-influence stakeholders (Table ES-19). Under the Work Together approach, the Project shares information, consults and collaborates; under Keep Engaged it shares information and consults; and under Keep Informed it shares information. The high-priority stakeholders are environmental and permitting authorities, federal, state and local government, and traditional and community leaders. The stakeholder analysis shall be reviewed and updated periodically throughout the Project lifecycle.

TABLE ES-19: STAKEHOLDER INFLUENCE–SUPPORT ANALYSIS AND ENGAGEMENT APPROACH

Stakeholder cluster	Influence	Support	Engagement approach
Environmental and permitting authorities	High	High	Work Together
Regional government	High	High	Work Together
Local government; traditional leaders; community leaders	High	Medium	Keep Engaged
Directly affected communities	Medium	Medium	Keep Engaged
Youth	Medium	Medium	Keep Informed
Women; civil society groups	Low	Medium	Keep Informed
Existing natural resource users	Low	Low	Keep Informed

Previous Engagement

Indorama has engaged stakeholders continuously since 2007. For the IFF Line 1 (Train 3) Project, 11 engagement events were held between July 2021 and January 2023, with a combined recorded attendance of 785. They comprised a meeting with the FMEnv Environment Assessment Department on the draft ToR (14 July 2021, 10 attendees); an FMEnv/RSMEnv site verification for categorisation (26 July 2021, 7); an ESIA scoping workshop with regulators, Eleme LGA, communities, traditional leaders, vulnerable groups and civil society (20 August 2021, 89); community consultations in Akpajo, Aleto, Okerewa, Agbonchia, Njuru/Akpakpan and Elelenwo (Wakoahu Family) between 5 and 15 November 2021 (65–102 attendees each), attended by paramount rulers, CDC chairs, youth and women leaders, and fishermen and hunters; a PAC briefing (7 December 2021, 21); and a broader engagement on 13 January 2023 with FMEnv, RSMEnv, Eleme LGA, the King of Eleme and Council of Chiefs, women, youth, NGOs, farmers, traders, fishers and students (121). Engagement also continues through the PAC, monitoring of the host community MoU, the Community Relations & Development function and its Community Relations Officers, and the existing grievance management system. Engagement and feedback received during IFF Line 1 (Line 3 of the

complex) laid the foundation for IFF Line 2; for example, the wastewater recovery plant originated from ideas shared by participants.

Existing Stakeholder Concerns

The principal concerns recorded from engagement to date are: (i) increased traffic volumes leading to further deterioration of already poor roads and increased risk of road incidents; (ii) population influx of migrant workers and job seekers, with effects on housing, services, community stability, safety and security; (iii) environmental impacts on groundwater, surface water and biodiversity, poor air quality, and resulting public health effects; (iv) the distribution of employment, procurement and corporate social investment benefits between communities, effective implementation of the MoU and the perceived insufficiency of interventions relative to need; and (v) a perceived lack of sufficient ongoing engagement between Indorama and the host communities. These concerns reflect an underlying socio-economic profile of unemployment, low household income, reliance on informal livelihoods and pressure on infrastructure and services. Concerns about local hiring, contracting, women's access to benefits, youth expectations and cumulative environmental effects are therefore treated as expressions of this wider vulnerability rather than as stand-alone complaints.

ESIA-Phase Engagement

Engagement for the IFF Line 2 ESIA combined targeted stakeholder consultation with socio-economic fieldwork. Stakeholders were consulted in their communities at venues and times approved by community chiefs, in English and local dialects, with explanation of the Project briefing material and documentation of the issues raised. Twenty engagement events were held between September 2025 and May 2026, with a combined recorded attendance of 632 (Table ES-20). They comprised an institutional engagement with FMEnv in Abuja (11 September 2025); community engagements at the palaces and community halls of host and AoI communities in October and November 2025; a PAC session (19 February 2026); a public forum at Hotel Golden Tulip, Port Harcourt (26 February 2026, 188 participants); and a further stakeholder session at the same venue (29 May 2026, 30 participants). Vulnerable and interest groups were engaged through dedicated focus group discussions with youths (Alesa), hunters (Alode), the Eleme Graduate Forum (Aleto), widows (Agbonchia, 103 participants) and physically challenged persons (17 participants). The socio-economic baseline also included approximately 350 household surveys across seven AoI communities, focus group discussions with CDCs, youth, women's groups and the PAC, and key informant interviews with community leaders and institutional stakeholders.

TABLE ES-20: ESIA ENGAGEMENT UNDERTAKEN FOR IFF LINE 2

Date	Location / venue	Engagement type	Participants
11/09/2025	Conference Room, FMEnv EA Department, Abuja	Regulatory engagement	15
29/10/2025	Palace of HRH, Emere of Okerewa Community	Community engagement	57
30/10/2025	Palace of HRH, Emere of Njuru Community	Community engagement	26
30/10/2025	Palace of HRH, King of Agbonchia Clan	Community engagement	26

Date	Location / venue	Engagement type	Participants
01/11/2025	Palace of HRH Emere Olungwe Fineman, JP, King of Akpajo Clan	Community engagement	36
01/11/2025	Palace of HRH Emere Sunday Obo, King of Akpajo Clan	Community engagement	11
02/11/2025	Wakoahu Family, Elelenwo Community	Community engagement	14
02/11/2025	Ogale Community Hall	Community engagement	13
03/11/2025	Alesa Community, residence of Youth President, Eleme Kingdom	Focus group discussion – youths	14
06/11/2025	Palace of HRH, Emere of Ebubu Clan	Engagement with HRH	4
07/11/2025	Palace of HRH, Emere Aleto Community	Community engagement	11
11/11/2025	CDC Office, Iriebe Community	Community engagement	12
13/11/2025	Palace of HRH, Alode Community	Community engagement	18
19/02/2026	Project Advisory Committee (PAC), Indorama Complex	Stakeholder engagement	15
24/02/2026	Aleto community townhall – Eleme Graduate Forum	Stakeholder engagement	13
24/02/2026	Eleme Hunters Association Chairman's residence, Alode	Focus group discussion – hunters	9
26/02/2026	Hotel Golden Tulip, Port Harcourt	Public forum	188
12/03/2026	Agbonchia community townhall	Focus group discussion – widows	103
12/03/2026	Residence of Coordinator, Eleme Physically Challenged Association	Focus group discussion – physically challenged persons	17
29/05/2026	Hotel Golden Tulip, Port Harcourt	Stakeholder engagement	30

How Stakeholder Input Informed the ESIA and ESMMP

Stakeholder feedback has directly influenced Project design. The installation of SCR on the IFF Line 2 reformer stack responds to stakeholder feedback on air quality, and the wastewater recovery plant originated from ideas shared during earlier engagement. Table ES-21 summarises how the principal concerns have been addressed in the ESIA and ESMMP.

TABLE ES-21: SUMMARY OF CONSULTATION OUTCOMES

Issue raised	Stakeholder group	Project response	Where addressed
Traffic volumes, road deterioration and road incident risk	Consulted communities	Wet- and dry-season daytime and night-time traffic surveys on a like-for-like design; traffic impacts assessed and mitigation defined	Sections 5.3–5.4, 8.6 and 9.6; ESMMP
Influx of migrant workers and job seekers; housing, services, safety and security	Consulted communities	Influx assessed as a specific construction-phase impact, with socio-economic mitigation and monitoring	Sections 8.4.3, 9.4 and 9.4.3; ESMMP
Air quality and public health	Consulted communities	SCR on the reformer stack adopted in response to feedback; dispersion modelling of IFF Line 2 alone and in combination with IFF Line 1; construction dust management	Sections 5.6.3.1, 8.2.3, 8.4.6 and 9.2.4; ESMMP

Issue raised	Stakeholder group	Project response	Where addressed
Groundwater, surface water and biodiversity	Consulted communities	Wet- and dry-season water, sediment and biodiversity baseline; wastewater recovery plant (an outcome of earlier engagement) with recovery and reuse of treated effluent	Sections 8.2.6, 8.2.7, 8.3, 9.2.7, 9.2.8 and 9.3; ESMMP
Distribution of employment, procurement and CSI benefits; MoU implementation	Host communities and PAC; Eleme Youth Council; Indigenous Suppliers Forum	Monitoring of MoU implementation; engagement with the PAC employment sub-committee and sub-committees on community development projects, skills, scholarships and micro grants	Sections 8.4.1, 8.4.4, 8.4.5 and 9.4; SEP
Women's access to benefits and youth expectations	Women leaders; youth groups	Women leaders participate in the micro grant scheme; youth engaged every other month during construction; dedicated focus group discussions with youth, widows and physically challenged persons	Section 6.7; Section 9.4; SEP
Insufficient ongoing engagement	Host communities	Life-of-Project SEP; quarterly PAC engagement; quarterly (pre-construction) and monthly (construction) Project updates; PAC communiqués, public notices and grievance reporting	Section 6.8; SEP (Appendix B)

Grievance Mechanism

The SEP confirms that the grievance management procedure is a core element of ongoing engagement for IFF Line 2, building on Indorama's existing grievance management system for the complex. The mechanism provides accessible submission channels, systematic handling and recording of grievances, defined responsibilities, and periodic monitoring and reporting. It operates alongside the PAC, whose grievance management sub-committee is a standing forum for engagement, and the Community Relations & Development function and its Community Relations Officers. Indirectly impacted communities in the AII also have access to the Grievance Management Procedure. For workers, elected union representatives take part in the grievance management, disciplinary and dispute resolution processes during construction and operation, and the Indigenous Suppliers Forum represents its members on contract and supply grievances and disputes. Grievances shall be reviewed and tracked before construction and monitored during construction, operation and decommissioning, and Indorama shall report transparently on grievance categories, trends and corrective actions.

Disclosure and Post-ESIA Engagement

Under the SEP communication and disclosure framework, Indorama shall provide timely updates, particularly on environmental monitoring results, ESMP implementation and construction and operational performance. Updates shall be delivered through structured channels such as quarterly PAC communiqués, public notices and community briefings, with translation and inclusive formats for women, youth, low-literacy groups and elders. Post-ESIA engagement is planned for every Project phase (Table ES-22) and shall be updated if more intensive engagement with particular groups is needed or if the Project plan changes substantially. The engagement frequencies in Table ES-22, together with grievance tracking and reporting, provide the basis for monitoring SEP implementation.

TABLE ES-22: POST-ESIA STAKEHOLDER ENGAGEMENT BY PROJECT PHASE

Phase	Principal engagement activities and frequency
Pre-construction	Monitor implementation of the subsisting MoU (2023–2025); quarterly engagement with the PAC; quarterly Project updates; engagement with the employment sub-committee and the PAC sub-committees (employment, community development projects, grievance management, skill acquisition, scholarship, micro grant); review and tracking of grievances; briefing of local authorities, traditional rulers and community leaders on completion of the ESIA and start of construction
Construction	Monthly Project updates; quarterly engagement with the PAC; engagement with youth every other month; monitoring of grievances; engagement with the PAC sub-committees
Operation	Quarterly engagement with the PAC; broader Project updates as required; monitoring of grievances; engagement with the PAC sub-committees
Decommissioning	Announcement of intended decommissioning; quarterly engagement with the PAC; decommissioning updates as required; monitoring of grievances; engagement with the PAC sub-committees

ES9.0 Baseline Environmental and Social Conditions

The baseline establishes the environmental and social baseline for the proposed IFF Line 2 Fertilizer Project within the Indorama Free Zone in Eleme Local Government Area, Rivers State, Nigeria. It provides the reference conditions against which potential project impacts and future environmental changes will be assessed.

The project is located within an established industrial setting, alongside existing fertilizer and petrochemical operations. The principal sensitivities are extreme heat and flooding, groundwater protection and sustainable abstraction, existing pollution in receiving waters, ecological resources, vulnerable community livelihoods, cultural heritage, and traffic congestion.

Study Area, Area of Influence and Baseline Survey Effort

For the ESIA, the Project Area comprises the approximately 80-hectare development footprint, and the infrastructure directly associated with it, within the 250-hectare Indorama Free Zone, directly north of IFF Line 1. The Area of Influence (AoI) covers all areas likely to be affected directly or indirectly by construction, operation and decommissioning. This includes effects through environmental pathways, community use patterns, traffic routes and watercourses, and cumulative interaction with existing operations in the wider Indorama complex. The extent of the AoI varies by specialist discipline and is linked to the receptor or pathway concerned (Table ES-23).

TABLE ES-23: AREA OF INFLUENCE AND STUDY AREA BY SPECIALIST TOPIC

Topic	AoI / study area	Basis stated in Chapter 7
Meteorology and climate	Regional Port Harcourt / Eleme climatic setting and the Project site	Long-term regional records (Port Harcourt International Airport; NiMet) supplemented by an on-site Automatic Weather Station (AWS)
Climate risks	Full Project footprint and connected operational assets (Indorama North and Indorama South)	Asset-based physical climate change risk assessment

Topic	AoI / study area	Basis stated in Chapter 7
Air quality	Project footprint plus a 3 km study area; receptors within 250 m of construction works and 50 m of construction access routes; 10 km from the IFF Line 2 plant during operation	Direct impacts on sensitive receptors; 250 m is the precautionary maximum downwind travel distance for construction dust
Noise	Project site and nearest noise-sensitive receptors, within approximately 200 m of the perimeter fence	Receptor-based; 11 monitoring locations
Geology, soils and groundwater	Project footprint plus a 3 km study area, the monitoring borehole network and the wider hydrogeological context	Coverage of footprint, Indorama complex, surrounding communities and control points outside the zone of Project influence
Surface water and sediments	Okulu River, local drainage channels and tributaries: 2 km upstream and 5 km downstream of the existing outfall, plus control waterbodies. Direct influence extends about 1 km south to the first major confluence; indirect influence extends up to about 5 km downstream	Tidal flow reversal can carry contaminants both upstream and downstream
Biodiversity	Project footprint, immediate receiving habitat and a 4 km buffer	Buffer included to capture the wider receiving environment
Socio-economic and health	7 communities within 3 km of the complex perimeter fence; 10 communities within 5 km for engagement	Communities surveyed in 2025 / 2026
Cultural heritage	Project footprint plus a 3 km study area	Desk review, remote sensing, historic mapping and field survey
Traffic	Site access roads, East West Road, Onne Road and Federal Ocean Terminal Road	Public roads used during construction and operation

Baseline data were gathered in a wet-season campaign (October–November 2025) and a dry-season campaign (February–March 2026) wherever seasonality was relevant, particularly for air quality, groundwater, surface water and the hydrological setting. The field data were supplemented by long-term regional records and by complex-wide studies, notably the groundwater sustainability study and re-modelling (Mogaba, 2025 and 2026), the stormwater drainage design (Toyo Engineering, 2021), the hydraulic flood model (JBA Consulting, 2024) and the physical climate change risk assessment. The physical-environment survey effort is summarised in Table ES-24.

TABLE ES-24: PHYSICAL ENVIRONMENT BASELINE SAMPLING EFFORT

Topic	Wet season	Dry season	Network and effort
Meteorology	AWS, October–November 2025	AWS, February–March 2026	On-site AWS (short-term, less than one month); Port Harcourt International Airport 2018–2022; NiMet Port Harcourt rainfall 1990–2020
Ambient air (passive)	60 diffusion tubes at 10 locations	72 diffusion tubes at 12 locations	NH3, NO, NO2, NOx (derived), SO2, TVOC
Ambient air (active)	16–25 October 2025	28 February–3 March	28 stations (25 plus 3 controls), 8–20 hours per station with hourly readings; Miri Air monitors at 12 stations; one-month continuous PM monitoring at 3 on-site locations
Noise	16–25 October 2025	20 February–5 March 2026	11 long-term unattended locations; daytime 07:00–22:00, night-time 22:00–07:00
Soils	October 2025	February 2026	28 locations (including 3 controls) at 0–15 cm and 15–30 cm; 56 samples per campaign

Topic	Wet season	Dry season	Network and effort
Groundwater	October 2025	February 2026	20 boreholes sampled (3 Project Area, 2 Indorama complex, 12 community, 3 control); 31 boreholes reviewed for levels
Surface water and sediments	October 2025	February 2026	11 stations (SW1–SW7 on the Okulu River; SWC1–SWC4 controls) at high tide, low tide and non-tidal conditions
Treated effluent	October 2025	February 2026	14 points (Eff1–Eff14) from process units through the treatment train to the final discharge channel

Physical Environment

Meteorology and climate. The project area has a humid tropical monsoon climate, with annual rainfall exceeding 2,300 millimetres, consistently warm temperatures, and high humidity. Seasonal rainfall strongly influences drainage, groundwater recharge, erosion, and receiving-water conditions. Prevailing south-westerly winds generally transport emissions towards the north-east, while calm conditions can reduce pollutant dispersion.

The Project lies in the tropical monsoon (Am) climate zone. NiMet records for Port Harcourt (1990–2020) show a wet season from mid-March to November and a dry season from December to March, with mean annual rainfall above 2,300 mm. Monthly rainfall ranges from 17.2 mm in January to 374.5 mm in September. During the dry season, Harmattan winds bring dry air from the Sahara; during the rainy season, moist air arrives from the Atlantic. Long-term records from Port Harcourt International Airport (2018–2022) show annual mean temperatures of 27.7–28.1°C, extremes of 18.5°C to 38.6°C, and persistently high relative humidity (annual means of 88.5–89.6%). On-site AWS data show a warmer, slightly drier dry season (mean 28.8°C; 84.6% relative humidity) than wet season (mean 27.4°C; 87.1%). Cloud cover exceeds 6 oktas across the year.

Long-term mean wind speeds are low at 2.65–2.75 m/s, with maxima of 7.02–8.33 m/s and a prevailing direction of 221–228° (south-westerly). Emissions are therefore transported mainly towards receptors to the north-east of the Project. On-site AWS data recorded a mean wind speed of 2.3 m/s in the wet season and 0.5 m/s (range 0.0–12.9 m/s) in the dry season. This indicates that calm conditions (below 2 m/s) were predominant during the dry-season monitoring period, when they reduce atmospheric dispersion and can allow pollutants to accumulate locally.

TABLE ES-25: SUMMARY OF METEOROLOGICAL BASELINE DATA

Parameter	Port Harcourt International Airport (2018–2022)	On-site AWS, wet season (Oct–Nov 2025)	On-site AWS, dry season (Feb–Mar 2026)
Temperature min / max / mean (°C)	18.5–20.7 / 37.7–38.6 / 27.7–28.1	22.3 / 32.9 / 27.4	22.9 / 35.1 / 28.8
Relative humidity min / max / mean (%)	60.1–68.1 / 95.4–96.1 / 88.5–89.6	73 / 94 / 87.1	57 / 93 / 84.6
Wind speed min / max / mean (m/s)	0.25–0.28 / 7.02–8.33 / 2.65–2.75	1.6 / 11.3 / 2.3	0.0 / 12.9 / 0.5
Wind direction	221–228° (from the south-west)	Not reported	Not reported

Parameter	Port Harcourt International Airport (2018–2022)	On-site AWS, wet season (Oct–Nov 2025)	On-site AWS, dry season (Feb–Mar 2026)
Rainfall (NiMet, 1990–2020)	Mean annual above 2,300 mm; wettest month September (374.5 mm); driest month January (17.2 mm)	–	–

Climate risks. Extreme heat is rated as a high-materiality hazard, while extreme rainfall flooding is rated moderate to high. Wildfires and water stress or drought are rated moderate. Climate projections indicate increasing temperatures and longer warm spells, requiring consideration in worker protection, equipment performance, and operational planning. Cyclones, rainfall-induced landslides, and colder temperatures were screened out of the detailed assessment.

The physical climate change risk assessment covered Indorama North and Indorama South, which together are the main areas of the proposed IFF Line 2 development. It used IPCC AR6 scenarios SSP1-2.6 and SSP5-8.5 for a present-day baseline and for the 2030 and 2050 time horizons, chosen to match the construction and operational phases. Each hazard was rated as High, Moderate, Low or Unlikely material according to its potential effect on Project assets, access, operations and surrounding receptors.

Historical data show that Nigeria's average temperature rose by 0.8°C between 1960 and 2006 and that precipitation fell by approximately 3.5 mm per month per decade (USAID, 2019). Projections indicate warming of 1.1–2.5°C by 2060 (UNEP GRID, 2019) and 2.9–5.7°C by the end of the century (World Bank Group, 2021). Extreme heat days are projected to increase from 10 days in 1990 to 260 days by 2100, and mean sea level along the coast to rise by 0.4–1.0 m by 2100. World Bank Group risk mapping places the site in high-risk zones for both urban flooding and wildfire. WRI Aqueduct rates current overall water risk as High (3–4) but projects low water stress (below 10%) to 2040.

TABLE ES-26: CLIMATE HAZARD SCREENING AND MATERIALITY

Climate hazard	Materiality	Key evidence
Extreme heat	High	Projected increases in maximum daily temperature and a substantial increase in the Warm Spell Duration Index across Project assets by 2030 and 2050
Extreme rainfall flooding	Moderate to High	Flood-prone Port Harcourt setting; modelled inundation depth exceeding 1 m at Indorama North under baseline and future scenarios; Indorama South unaffected
Wildfires	Moderate	Historical burned-area evidence in the surrounding landscape; projected fire-weather conditions remain low
Water stress and drought	Moderate	Episodic historical dry anomalies; projected long-term water stress remains very low
Colder temperatures	Screened out	Cold Spell Duration Index falls from 4.90 days per year (baseline) to 0.00–1.40 days per year by 2050; minimum daily temperature rises from 18.51°C to 20.24–20.96°C by 2050
Rainfall-induced landslide	Screened out	0.00 triggering days at baseline and under all scenarios and horizons
Cyclones	Screened out	Maximum sustained tropical cyclone wind speed of 0.00 knots at baseline and under all scenarios and horizons

The drainage system has been designed for a worst-case rainfall intensity of 99 mm per hour, and this design basis is used in the impact assessment. Chapter 7 notes that downscaled climate datasets may under-represent short-duration, high-intensity convective rainfall. Model-based flood projections should therefore be interpreted with caution and, where necessary, supplemented at later design stages by more detailed local engineering and drainage analysis. The assessment is desk-based and relies on Global Climate Models and ERM's Global Climate Database. No local climate-monitoring data were collected for the Project footprint.

Project Contribution to Climate Change

During operation, the Project is expected to generate approximately 686,590 tCO2e per annum of Scope 1 and Scope 2 greenhouse gas emissions. This is approximately 0.20% of Nigeria's estimated national emissions of about 345 million tCO2e per annum (Boyle, 2024). Emissions are relatively high at facility level, reflecting the energy-intensive process, but the proportional contribution to the national inventory is relatively low. Because GHG emissions are cumulative and global in effect, the Project's absolute emissions warrant management, and IFF has committed to implementing GHG emission reduction initiatives.

Air quality. The report classifies the baseline airshed as undegraded. Annual mean concentrations adopted for the assessment include nitrogen dioxide at approximately 17.9 µg/m³ and PM10 at 26.4 µg/m³, below the respective project standards. Existing sources include industrial operations, road traffic, domestic activities, and dust. Cumulative emissions management remains important because communities and other sensitive receptors surround the complex.

The pollutants of interest are nitrogen dioxide (NO2) and oxides of nitrogen from combustion, particulate matter (PM10 and PM2.5), sulphur dioxide (SO2) and ammonia (NH3). Existing sources include domestic cooking and heating, agriculture, dust from paved and unpaved roads, Indorama's operating plants, oil and gas refining and storage, and urban traffic. At the monitoring sites, field teams also observed diesel and petrol generators, burning of tyres and waste, bush burning and livestock farming.

Passive diffusion-tube monitoring recorded the following results. NO2 was 11.8–22.6 µg/m³ in the wet season (average 17.9 µg/m³) and 13.6–24.3 µg/m³ in the dry season (average 17.8 µg/m³), against the 40 µg/m³ Nigerian and IFC annual limit. NH3 averaged 14.7 µg/m³ in the wet season (range 5.4–23.3 µg/m³) and 21.7 µg/m³ in the dry season (range 6.8–53.8 µg/m³), with the maximum recorded at AQ8 in the north of the facility; the limits are 200 µg/m³ (IFC) and 600 µg/m³ (Nigerian). SO2 was mostly below detection (below about 1.6 µg/m³) and was detected only at AQ5 (3.88 µg/m³) and AQ7 (2.22 µg/m³) in the wet season. Average TVOC was 93.6 µg/m³ in the wet season and 117.2 µg/m³ in the dry season.

Active monitoring at 28 stations (16–25 October 2025 and 28 February–3 March) recorded the following ranges in the wet and dry seasons respectively: NO2 11.91–30.71 and 15.81–30.57 µg/m³, with the highest values at AQ15 (Akpajo); SO2 1.95–5.45 and 1.09–8.73 µg/m³; NH3 11.55–34.75 and 8.69–40.54 µg/m³; ozone 6.92–23.82 and 11.96–32.23 µg/m³. All measured gaseous concentrations were below the NESREA and IFC limits. PM10 was 20.46–26.92 µg/m³ in the wet season and 20.71–61.91 µg/m³ in the dry season. PM2.5 was 11.46–24.04 µg/m³ in the wet season and 9.21–25.39 µg/m³ in the dry season. Dry-season PM10 was markedly higher at the Project-site and complex stations (AQ1–AQ9: 40.01–61.91 µg/m³)

than at the remaining stations (AQ10–AQ25 and the three controls: 20.71–26.38 µg/m³). These short-term (8–20 hour) values remain well below the 150 µg/m³ 24-hour guideline.

The assessment baseline (Table ES-27) uses an annual mean NO2 concentration of 17.9 µg/m³ (44% of the 40 µg/m³ standard) and an annual mean PM10 concentration of 26.4 µg/m³ (44% of 60 µg/m³). The PM10 figure comes from one month of continuous monitoring at three on-site locations (AQ8–AQ10; 22.4–30.9 µg/m³). The annual mean NH3 baseline is 18.2 µg/m³ (9.1% of 200 µg/m³). Short-term baselines were derived by doubling the long-term values in line with UK Defra TG(09), giving 61.2 µg/m³ for NO2 (24-hour and 1-hour; 30% and 18% of the respective standards) and 52.8 µg/m³ for 24-hour PM10 (35%). Because all baseline concentrations are below 50% of the applicable standards, the airshed is classified as undegraded.

TABLE ES-27: SUMMARY OF AMBIENT AIR QUALITY RESULTS (µG/M³)

Parameter	Wet season (Oct 2025)	Dry season (Feb–Mar 2026)	Baseline adopted	Standard
NO2, passive (average; range)	17.9; 11.8–22.6	17.8; 13.6–24.3	17.9 (annual)	40 annual (Nigerian and IFC)
NO2, active (range)	11.91–30.71	15.81–30.57	61.2 (24-hour and 1-hour)	120 (24-hour); 200 (1-hour)
SO2, active (range)	1.95–5.45	1.09–8.73	–	20 (IFC); 80 (Nigerian)
NH3, passive (average; range)	14.7; 5.4–23.3	21.7; 6.8–53.8	18.2 (annual)	200 (IFC); 600 (Nigerian)
NH3, active (range)	11.55–34.75	8.69–40.54	–	200 (IFC); 600 (Nigerian)
PM10, active (range)	20.46–26.92	20.71–61.91	26.4 (annual); 52.8 (24-hour)	60 (annual); 150 (24-hour)
PM2.5, active (range)	11.46–24.04	9.21–25.39	Not adopted	Not stated
Ozone, active (range)	6.92–23.82	11.96–32.23	–	Not stated

Noise. Daytime baseline noise levels were below the adopted 55 dB criterion at all monitored locations. One location, N9, recorded night-time noise of 46 dB, slightly above the 45 dB criterion. Predictive modelling reports negligible construction and operational noise impacts at the assessed receptors, including cumulative operation with IFF Line 1. Monitoring is recommended to confirm these predictions during actual activities.

The noise baseline was measured by long-term unattended monitoring at 11 locations during 16–25 October 2025 (wet season) and 20 February–5 March 2026 (dry season). Daytime was taken as 07:00–22:00 and night-time as 22:00–07:00. Data recorded during rainfall or at wind speeds above 5 m/s were excluded. LAeq was used as the assessment metric, consistent with the Nigerian noise regulations and IFC guidelines, against criteria of 55 dB (daytime) and 45 dB (night-time). Daytime LAeq ranged from 43 to 54 dB and night-time LAeq from 40 to 46 dB. Background (LA90) levels were 38–46 dB by day and 36–43 dB by night. The only exceedance was at N9 (mini-market environs), where night-time LAeq was 46 dB; N9 also recorded the highest daytime level (54 dB).

Noise was modelled using iNoise V2026.1 and ISO 9613-2:2024. The construction scenario assumed daytime-only works over approximately 33 months, with a combined sound power level of 131 dB(A) from earthworks and site-clearance equipment. The operational scenario

assumed 24-hour, seven-day operation and conservative building attenuation, and was run both for IFF Line 2 alone and for IFF Line 2 operating together with IFF Line 1. Only receptors N2, N3 and N4 were taken forward, because the other locations are further from the Project. Vibration was scoped out because of the separation distances involved. Periodic noise monitoring is recommended during construction and operation to confirm compliance.

TABLE ES-28: BASELINE NOISE MONITORING RESULTS (DB)

Location	Daytime LAeq	Night-time LAeq	Daytime / night-time LA90
N1 Project boundary towards Iriebe	43	43	41 / 39
N2 Secondary vegetation, north side	46	44	46 / 41
N3 Iriebe area	46	42	42 / 38
N4 New Akpajo area	46	44	41 / 39
N5 Akpajo area	50	42	43 / 38
N6 School opposite NNPC Housing Estate	43	40	38 / 36
N7 Front of Molam Hotels	46	42	42 / 39
N8 Residential area near complex gate	46	42	45 / 37
N9 Mini-market environs	54	46	44 / 43
N10 Life Camp (west of site)	49	44	44 / 39
N11 South of Project site	46	42	46 / 39
Criterion (IFC)	55	45	–

Geology and hydrogeology. The area is underlain predominantly by sandy deposits associated with the Benin Formation of the Niger Delta. No significant geological instability was identified. The groundwater system comprises shallow, intermediate, and deep aquifers, separated by discontinuous clay layers. These layers provide some protection but do not ensure complete hydraulic isolation.

The site lies on the dry deltaic plain of the eastern Niger Delta. Ground elevations across the Indorama complex fall from about 28.5 m above mean sea level (amsl) in the north to about 6 m amsl in the south, and this north-to-south gradient controls both surface drainage and shallow groundwater flow. Beneath the Quaternary deposits (about 40–150 m thick regionally), the regional sequence comprises the Benin, Agbada and Akata Formations. Site borehole logs show sandy clay to clayey sand from 0 to about 15 m below ground level (bgl), a sand-dominated sequence to about 30 m bgl, semi-continuous clay layers at intermediate depths, and a regionally extensive, highly productive sand unit below about 150 m bgl. Lateritic horizons reach up to about 12 m thick. The terrain is flat to gently undulating, with only localised seasonal waterlogging and no evidence of faulting, steep slopes, significant erosion or land instability.

Three aquifer systems are present: a shallow unconfined aquifer (0–30 m bgl), an intermediate aquifer (about 50–120 m bgl) and a deep semi-confined to confined aquifer (more than 150 m bgl). The deep aquifer supplies industrial water to the Indorama complex

through boreholes typically more than 200 m deep. Hydraulic conductivity is about 13 m/day in the shallow aquifer and 13.16–18.96 m/day in the deeper aquifers, against a regional range of about 3.3–77.8 m/day. Recharge is mainly from direct rainfall infiltration, estimated at 300–400 mm/year (about 8–12% of mean annual precipitation). The shallow aquifer responds rapidly to rainfall, while the deeper aquifers recharge more slowly by vertical percolation.

Soils. Soils are mainly loamy sands and sandy loams, with high permeability, weak cohesion, and limited nutrient retention. Testing generally indicates natural baseline conditions, with hydrocarbon indicators and several toxic metals below detection limits. Elevated iron and manganese are interpreted as largely reflecting natural geology. The main development sensitivities are erosion, nutrient leaching, and contaminant movement following disturbance or spills.

Soils were sampled at 28 locations (including 3 controls) at two depths in both seasons. They are coastal plain sands of loamy sand to sandy loam texture, with 78–85% sand in the topsoil and 78–83% in the subsoil, 9–17% silt and 2–9% clay. Bulk density is 1.2–1.5 g/cm³, porosity 40–55% and permeability about 0.12–0.48 cm/s, placing the soils in Hydrological Soil Group A (low stormflow potential). Moisture content is 7–36% in the topsoil and 5–27% in the subsoil, with higher values in the wet season and at low-lying locations.

Soil pH is slightly acidic to neutral (5.01–7.99 across all samples, depths and seasons). Nutrient concentrations are low, for example nitrate 1.22–2.16 mg/kg, phosphate up to 0.42 mg/kg and sulphate 0.25–1.19 mg/kg; sulphate is slightly higher in the wet season. Organic matter is 3.60–4.95% and total organic carbon 1.46–2.53%. Hydrocarbon indicators were below detection in every sample (THC below 0.01 mg/kg; TPH and PAHs below 0.001 mg/kg), as were mercury, arsenic, lead, vanadium and chromium. Nickel (0.10 mg/kg or less), copper (0.07–0.10 mg/kg) and zinc (1.65–3.23 mg/kg) are far below the NESREA limits of 70, 100 and 421 mg/kg. Manganese (about 90–149 mg/kg) and iron (about 1,879–3,554 mg/kg) are elevated, but at similar levels at all locations, depths and control sites, which indicates natural geogenic origin. Microbial populations are typical of natural soils, and the low numbers of hydrocarbon-utilising organisms are consistent with the absence of hydrocarbon contamination. Overall, the soils show no apparent anthropogenic contamination. However, their sandy texture and weak structure make them susceptible to erosion, nutrient leaching and contaminant migration if disturbed or affected by spills.

Groundwater. Groundwater is a highly sensitive resource supporting industrial operations and community water supplies. Samples generally show fresh, low-mineralisation water, slightly acidic conditions, and low concentrations of nutrients and hydrocarbon indicators. However, total and faecal coliforms were detected, indicating microbiological contamination and the need for treatment before potable use.

Groundwater was sampled at 20 boreholes in October 2025 and February 2026: three in the Project Area (GW3–GW5), two in the Indorama complex (GW1–GW2), twelve community boreholes (GW6–GW17) and three controls (GWC1–GWC3). Results were compared with NSDWQ, NESREA, WHO and IFC values (Table ES-29). The groundwater is fresh, soft and poorly mineralised, with salinity of 0.02–0.32 ppt and no evidence of saline intrusion. It is slightly acidic (pH 5.52–6.54), below the 6.5–8.5 guideline range, which reflects natural conditions in sandy deltaic aquifers. Nitrate (0.49–1.99 mg/L) and phosphate (0.10–0.16 mg/L) are low, and ammonia and urea were below detection (below 0.10 mg/L). The water is

moderately oxygenated (dissolved oxygen 3.9–4.5 mg/L) with low organic loading (BOD below 1.0–2.8 mg/L; COD 2.2–8.4 mg/L). Oil and grease, VOCs, TPH and PAHs were not detected, nor were chromium, lead, mercury, cadmium, nickel, arsenic or cobalt. Iron (0.08–0.23 mg/L) is below the WHO aesthetic value of 0.3 mg/L. Manganese reached 0.09 mg/L at some boreholes, marginally above the WHO value of 0.08 mg/L, which is attributed to natural processes.

The main quality concern is microbiological. Total coliforms (up to 6 MPN/100 mL) and faecal coliforms (up to 2 MPN/100 mL) were detected in both seasons, exceeding the WHO and NSDWQ values of zero for faecal coliforms in potable water. This reflects the high permeability and limited natural protection of the shallow aquifer. Chemical quality therefore presents a low risk, but microbiological quality presents a moderate risk if the water is used for drinking without treatment. Comprehensive laboratory QA/QC, such as systematic travel blanks and duplicates, was either not fully implemented or not adequately reported, and this limitation applies when interpreting the results.

TABLE ES-29: SUMMARY OF GROUNDWATER QUALITY RESULTS

Parameter	Wet season (Oct 2025)	Dry season (Feb 2026)	Guideline (NSDWQ / WHO)	Status
pH	5.75–6.52	5.52–6.54	6.5–8.5	Slightly acidic (natural)
Electrical conductivity (µS/cm)	43–594	52–604	1,000 / 1,500	Compliant
TDS (mg/L)	23–321	27–324	500 / ≤1,000	Compliant
Chloride (mg/L)	4.2–54.8	3.2–51.8	250 / 250	Compliant; no saline influence
Nitrate (mg/L)	0.49–1.95	0.54–1.99	50 / 50	Compliant
Iron (mg/L)	0.08–0.22	0.09–0.23	0.3 / 0.3	Compliant
Manganese (mg/L)	0.03–0.09	0.03–0.09	– / 0.08	Marginal exceedance at some boreholes
Hydrocarbons and toxic metals	Not detected	Not detected	–	Compliant
Total coliform (MPN/100 mL)	Nil–6	Nil–4	10 / 0	Exceeds WHO
Faecal coliform (MPN/100 mL)	Nil–2	Nil–2	0 / 0	Exceeds

Updated modelling indicates that the aquifer can sustain the confirmed operational abstraction regime of approximately 3,560 m³/hour, subject to the study assumptions. Existing localised drawdown, possible connections between aquifers, and proximity to brackish water reinforce the need for continued monitoring of groundwater levels, quality, and potential saline intrusion.

Static water levels are shallow and change little between seasons. In the shallow aquifer they are 4.9–6.2 m bgl in the wet season and 5.8–6.7 m bgl in the dry season; in the intermediate aquifer, 6.4–8.5 m bgl (wet) and 6.0–8.9 m bgl (dry); and in the deep aquifer, about 6.5–7.0 m bgl in both seasons. The highest hydraulic head is 18.41 m amsl (BH2, deep aquifer) and the lowest 12.45 m amsl (GW2, shallow aquifer). Groundwater flows south to south-west, following the topography, and is inferred to discharge to the Okulu River, which acts as a

hydraulic sink. Contour mapping shows a cone of depression centred on the Indorama production wellfield in the south-western part of the Project Area. A coincident shallow drawdown cone at GW2, about 25 m from deep borehole BH5, indicates vertical leakage through the discontinuous clay layers. Outside the wellfield, the regional flow pattern shows no apparent disturbance to groundwater–surface water connectivity. An additional 70 m investigation borehole, with paired monitoring, downhole geophysical logging and separate pumping tests of the shallow and intermediate units, is being considered to resolve the degree of connection between the aquifers.

Shallow and intermediate aquifers, tapped at 60–70 m depth, supply drinking, cooking and washing water to surrounding communities. Irrigation use is minimal. The Indorama complex has 16 deep abstraction boreholes (14 operational and 2 under construction), drilled to 226–311 m bgl, with individual maximum rates of 215–300 m³/hour. After IFF Line 2 is commissioned, 13 boreholes will operate at any one time at an average maximum abstraction rate of 3,560 m³/hour (85,440 m³/day), and three further back-up boreholes will be developed for emergency use.

A brackish, tidally influenced river lies about 2.4 km south of the existing wellfield and about 1.7 km from the proposed IFF Line 2 water-supply boreholes, and a connected creek extends into the development area. Earlier variable-density (SEAWAT) modelling assumed an extreme all-wells abstraction of about 6,010 m³/hour and showed limited landward movement of the freshwater–brackish interface, confined to the creek and river corridor. Re-modelling of the actual operating regime (3,560 m³/hour from 13 boreholes; Mogaba, 2026) predicts no inland encroachment of brackish water into any aquifer over one year. Over a continuous five-year simulation it predicts only a minor extension of the interface, confined to the Okulu creek inlet. In both cases the interface remains within Indorama-owned land and does not reach community supply boreholes. Groundwater is classified as highly sensitive because of high permeability, a shallow water table, strong connectivity with surface water, dependence by communities and industry, and existing microbiological vulnerability. Long-term monitoring of groundwater levels is therefore required to protect the groundwater–surface water relationship and community users.

Surface water, riverine sediments, and wastewater. The Okulu River is the main receiving watercourse and connects downstream to the Bonny estuarine system. Its conditions vary between upstream freshwater and downstream brackish waters, with tidal flow reversals affecting contaminant movement.

The Okulu River is the main local receiving watercourse for stormwater and runoff from the Indorama complex and neighbouring land uses. Its catchment of low-relief sub-catchments drains southwards to the Bonny estuarine system. In the non-tidal upstream reach, the river is a narrow channel (about 6.5 m wide at SW1) with discharge of about 0.17 m³/s. Downstream it becomes a wide tidal channel (up to 574 m at SW6) with depths of about 5–8 m and discharges above 490 m³/s. Flow reverses with the tide, running landward on the flood and seaward on the ebb, so contaminants can migrate upstream as well as downstream. The upstream stations SW1, SWC3 and SWC4 have unidirectional flow. Velocities were higher in the wet season (up to 0.72 m/s upstream) than in the dry season (0.02–0.16 m/s). At the existing outfall area (SW4), the channel is 54 m wide with velocities of 0.021–0.025 m/s and discharge of 1.7–2.5 m³/s. Sediment transport is mainly a wet-season, in-channel process dominated by bank erosion. Extensive sand mining and dredging rework the bed and banks,

whereas the treated-effluent discharge is small relative to river flows and causes only localised scour at the discharge point.

The river is already affected by cumulative pressures, including nutrient enrichment, organic loading, faecal contamination, sand mining, dredging, and runoff from surrounding land uses. Localised metal exceedances were also identified. These conditions cannot be attributed solely to the Indorama Complex.

Surface water quality varies strongly along the river (Table ES-30). Salinity rises from 0.08–0.43 ppt at the non-tidal upstream stations to 6.61–13.49 ppt in the tidal Okulu reach (SW2–SW7) and up to 21.58 ppt in the Bonny estuary (SWC2). Electrical conductivity ranges from 138 to 34,687 µS/cm, and chloride (up to 5,426 mg/L) and sulphate (up to 786 mg/L) confirm marine influence downstream. pH is stable at about 6.2–7.4. Nutrients indicate moderate enrichment. Nitrate is 4.32–5.83 mg/L in the tidal reach, compared with 1.85–3.24 mg/L upstream, and is below the NESREA value of 9.1 mg/L. Ammonium (0.40–1.70 mg/L) exceeds the NESREA value of 0.05 mg/L at all stations, and total nitrogen reaches 9.26 mg/L at SWC1. BOD (8.8–20.8 mg/L) exceeds the FMEnv aquatic-life value of 4 mg/L at every station. COD (26.8–60.6 mg/L) exceeds the FMEnv value of 40 mg/L throughout the tidal reach. Dissolved oxygen was 5.0–5.4 mg/L at all stations in both seasons, below the FMEnv (6.8 mg/L) and NESREA (6 mg/L) values tabulated in Chapter 7. Oil and grease, BTEX and phenols were below detection, and TPH (up to 0.745 mg/L) and PAHs (up to 0.095 mg/L) occur at low concentrations.

Cadmium is 0.019–0.082 mg/L in the tidal Okulu reach and reaches 0.095 mg/L at SWC1. This exceeds the NESREA value of 0.005 mg/L at all tidal stations, compared with 0.004–0.012 mg/L at the upstream freshwater stations. Chromium (up to 0.054 mg/L) and nickel show localised exceedances. Zinc, copper and iron exceed the conservative NESREA values at all stations, including controls, while lead, mercury and arsenic were below detection. Microbiological quality is poor. Total coliforms range from 160 to 2,400 or more MPN/100 mL, exceeding the IFC value of 100 MPN/100 mL at every station. Faecal coliforms range from 48 to 2,400 or more MPN/100 mL, with the highest counts at the tidal stream control SWC1. Concentrations at the existing outfall area (SW4) are generally lower than further downstream (SW7) and at the tidal controls; in the wet season, for example, cadmium is 0.019–0.022 mg/L at SW4, 0.042–0.059 mg/L at SW7 and 0.046–0.055 mg/L at SWC1–SWC2. Concentrations of cadmium, zinc, copper and chromium in the tidal reach were generally higher in the dry season than in the wet season.

TABLE ES-30: SUMMARY OF SURFACE WATER QUALITY RESULTS, OKULU RIVER SYSTEM (MG/L UNLESS STATED; W = WET SEASON OCT 2025, D = DRY SEASON FEB 2026)

Parameter	Benchmark (FMEnv aquatic life / NESREA / IFC)	Upstream non-tidal (SW1, SWC3, SWC4)	Okulu tidal reach (SW2–SW7)	Tidal controls (SWC1, SWC2)
Salinity (ppt)	–	W 0.08–0.14; D 0.09–0.43	W 6.61–12.36; D 7.86–13.49	W 9.32–20.89; D 11.68–21.58
pH	6.0–9.0 / 6.5–8.5 / 6.0–9.0	W 6.20–6.81; D 6.42–6.76	W 6.40–7.11; D 6.46–7.06	W 7.01–7.31; D 7.04–7.38

Parameter	Benchmark (FMEnv aquatic life / NESREA / IFC)	Upstream non-tidal (SW1, SWC3, SWC4)	Okulu tidal reach (SW2–SW7)	Tidal controls (SWC1, SWC2)
Dissolved oxygen	6.8 / 6 / –	W 5.00–5.20; D 5.10–5.20	W 5.00–5.40; D 5.20–5.40	W 5.10–5.20; D 5.20–5.40
BOD	4 / – / 30	W 9.8–14.6; D 8.8–16.4	W 11.4–19.4; D 11.6–18.3	W 16.0–20.8; D 12.6–19.6
COD	40 / – / 125	W 28.2–41.6; D 26.8–48.6	W 42.4–58.6; D 43.2–53.2	W 47.4–60.6; D 50.8–59.4
Nitrate	– / 9.1 / 50	W 1.85–3.24; D 1.98–2.82	W 4.45–5.39; D 4.32–5.83	W 5.51–5.85; D 5.89–6.18
Ammonium	– / 0.05 / 10	W 0.50–0.90; D 0.40–1.30	W 0.50–1.10; D 0.60–1.30	W 0.80–1.10; D 0.90–1.70
Total nitrogen	– / – / 10	W 4.45–6.87; D 3.98–7.55	W 5.81–7.85; D 6.14–7.85	W 7.28–9.26; D 7.05–8.69
Cadmium	0.0002–0.0018 / 0.005 / –	W 0.004–0.009; D 0.004–0.012	W 0.019–0.059; D 0.023–0.082	W 0.046–0.055; D 0.058–0.095
Total chromium	0.00002–0.002 / 0.001 / –	W <0.001–0.006; D <0.001–0.011	W <0.001–0.011; D 0.005–0.028	W 0.008–0.025; D 0.016–0.054
Zinc	0.03 / 0.01 / –	W 0.09–0.18; D 0.08–0.25	W 0.19–0.27; D 0.18–0.36	W 0.24–0.29; D 0.31–0.45
Total coliform (MPN/100 mL)	– / – / 100	W 260–460; D 160–720	W 240–960; D 280–920	W 400–≥2,400; D 520–≥2,400
Faecal coliform (MPN/100 mL)	–	W 72–106; D 48–220	W 48–180; D 56–240	W 148–≥2,400; D 180–≥2,400

Chapter 7 classifies the receiving environment as moderately impacted before the Project. Nutrient enrichment, organic loading and faecal contamination are already present, and they reflect several pressures: treated effluent from the existing Indorama Complex, which contributes nutrient and organic loading; domestic and sewage inputs from surrounding communities; extensive dredging and sand mining; and diffuse runoff from industrial, commercial and residential land in the catchment. The observed degradation therefore cannot be attributed solely to the Indorama Complex. The river remains functional, with natural assimilative capacity, and continues to support artisanal fisheries and informal water use. It is hydrologically connected to the Okrika mangrove and Bonny Estuary system downstream, so it remains sensitive to further pollutant loading.

Sediments generally show low petroleum contamination, although wet-season cadmium exceeded a sediment screening benchmark. Leachability testing indicates generally low contaminant mobility, with zinc requiring continued attention. Existing treated effluent is reported to comply generally with project and IFC discharge limits, although some parameters exceed the NESREA screening values used in the report.

Riverine sediments were sampled at the same 11 stations. They are predominantly sandy, with 74.5–90.4% sand in the wet season and 79.8–86.9% in the dry season; clay content rises to 15.2% in the dry season. Sediment pH ranges from 5.09 to 8.32, and sulphide is below

detection, which indicates oxic conditions. Nitrate reaches 8.70 mg/kg, phosphate 0.84 mg/kg and organic carbon 12.38% in the dry season. THC is 6.8–82.5 mg/kg, with the highest value at control SDC1, while TPH and PAHs were below detection in both seasons. In the wet season, cadmium was 0.15–0.95 mg/kg and exceeded the CCME Interim Sediment Quality Guideline of 0.6 mg/kg at five of the seven Okulu stations and at two of the four control stations. In the dry season it was below detection. This indicates a potential moderate ecological risk to benthic organisms. Other metals are well below CCME values; iron reaches 2,863 mg/kg in the dry season. Elevated sodium and potassium reflect saline estuarine conditions.

Toxicity Characteristic Leaching Procedure (TCLP) tests show that metals in the sediments have low mobility. Cadmium, chromium, lead, mercury, arsenic, cobalt and vanadium were below detection (below 0.001 mg/L) in all leachates. Iron remained below the FMEnv aquatic-life value of 1 mg/L, and nickel (0.009–0.044 mg/L) was generally within the FMEnv range. Zinc was the only parameter consistently above the FMEnv aquatic-life value of 0.03 mg/L, at 0.028–0.558 mg/L in the wet season and 0.073–0.745 mg/L in the dry season. The highest zinc values were at controls SDC1 and SDC2, which suggests local geochemical or historical influences rather than a recent source. The sediments are therefore unlikely to act as a significant secondary source of contamination, although zinc is to be retained in future monitoring.

TABLE ES-31: SUMMARY OF RIVERINE SEDIMENT RESULTS (MG/KG UNLESS STATED)

Parameter	CCME ISQG	Okulu stations SD1–SD7 (wet / dry)	Control stations SDC1–SDC4 (wet / dry)
Sand (%)	–	74.5–90.4 / 79.8–86.9	78.1–89.3 / 76.3–84.3
THC	–	14.5–49.3 / 9.75–51.80	17.4–69.7 / 6.80–82.50
Cadmium	0.6	0.15–0.95 / <0.001	0.12–0.79 / <0.001
Chromium	37.3	0.87–5.56 / <0.001	0.62–7.45 / <0.001
Lead	35	1.76–2.86 / 0.12–0.47	1.35–2.84 / 0.11–0.42
Zinc	123	1.06–3.50 / 0.87–2.71	0.95–3.53 / 0.83–1.85
Nickel	18	0.39–0.94 / 0.34–0.92	0.29–0.96 / 0.16–1.04
Iron	–	239.87–564.76 / 631–2,863	153.23–621.35 / 229–2,674

Effluent was sampled at 14 points across the existing Indorama treatment system. The final discharge (RPGV) and the downstream discharge channel had near-neutral pH (7.20–7.55), TDS of 930–1,089 mg/L, TSS of 4.8–8.7 mg/L, BOD of 8.8–9.8 mg/L, COD of 37.6–39.8 mg/L, total nitrogen of 5.85–7.15 mg/L and ammonium of 0.6–1.2 mg/L. Oil and grease were below 1 mg/L, and most trace metals were below detection (below 0.001 mg/L). Zinc (0.28–0.35 mg/L) and copper (0.06–0.08 mg/L) were the only metals detected. The effluent complies with the IFC/WBG EHS guideline values. TSS remains well below the Project Applicable Limit of 30 mg/L, which is based on FMEnv-approved project-specific limits (March 2018), and the IFC value of 50 mg/L. TSS, copper and zinc exceed the conservative NESREA values (0.75, 0.01 and 0.2 mg/L respectively), as do BOD and COD (NESREA values of 6 and 30 mg/L). Dissolved oxygen (5.0–5.4 mg/L) meets the NESREA minimum of 4 mg/L.

TABLE ES-32: TREATED EFFLUENT QUALITY AT FINAL DISCHARGE AND DISCHARGE CHANNEL (MG/L UNLESS STATED; WET OCT 2025 / DRY FEB 2026)

Parameter	NESREA	IFC (EHS/GIIP)	Final discharge (RPGV)	Discharge channel
pH	6.5–8.5	6.0–9.0	7.20 / 7.40	7.30 / 7.55
TSS	0.75	50	7.2 / 4.8	8.7 / 5.6
BOD	6	30	9.2 / 8.8	9.8 / 9.2
COD	30	125	38.0 / 37.6	39.8 / 39.0
Ammonium	2.0	10	0.60 / 1.0	0.70 / 1.2
Total nitrogen	–	10	5.85 / 6.74	6.02 / 7.15
Dissolved oxygen (minimum)	4	–	5.0 / 5.4	5.1 / 5.4
Zinc	0.2	–	0.28 / 0.32	0.30 / 0.35
Copper	0.01	–	0.06 / 0.08	0.07 / 0.08
Cr, Pb, Hg, Cd, Ni, As	0.005–0.5	–	<0.001	<0.001

Wastewater recovery and reuse are intended to reduce discharge. However, the water balance still identifies residual wastewater flows, and the assessment therefore assumes discharge as a precaution. Final discharge quantities and operating arrangements require clarification.

Chapter 7 states that the 580 m³/hour of treated effluent generated will be processed in the water recovery plant, which will recover 535 m³/hour of water for reuse. Residual process water and stormwater will be discharged, after multi-stage treatment, to an adjacent watercourse connected to the Bonny Estuary. The existing treated effluent is released at a single point (RPGV) into the discharge channel, which reaches the Okulu River in the outfall area (SW4). Future monitoring should use the same parameter suite and sampling locations as the baseline so that results can be compared directly.

Flooding and drainage. Effective stormwater management depends on engineered channels, culverts, retention capacity, and adequate outfall operation. Existing-site modelling demonstrates the importance of standby outfalls during extreme rainfall, but it did not directly model the proposed IFF Line 2 footprint. Formal Okulu River floodline delineation remains necessary to confirm the exposure of the development, hazardous installations, and discharge infrastructure.

Flood risk was assessed from the stormwater drainage design for the complex (Toyo Engineering, 2021) and a hydraulic flood model of the existing 360 ha Indorama development (JBA Consulting, 2024). Surface water is collected in lined open channels and culverts that drain by gravity to a retention pond in the south-east of the site, which attenuates flows before release to the existing canal. The network and pond are sized for intense local rainfall, with an allowance for fire-fighting water, and the drainage design basis is a worst-case rainfall intensity of 99 mm per hour. The model tested rainfall events up to and including the 1-in-1,000-year storm, for durations from 30 minutes to 24 hours. The network and pond have enough capacity for shorter and less severe events. With only the primary outfall operating, the pond would overtop in a 1-in-200-year (24-hour) event or larger. Bringing the two standby outfall pipes into service prevents overtopping even in the 1-in-1,000-year event. The model showed

some localised ponding in the western part of the site, which is considered overstated because of gaps in the drainage data. Separately, the climate risk assessment models persistent inundation depths exceeding 1 m at Indorama North.

No floodline delineation exists for the Okulu River. It therefore cannot yet be confirmed whether the IFF Line 2 footprint, its hazardous installations or the retention pond discharge point lie within the river's flood-prone area. Chapter 7 recommends formal floodline delineation that establishes, as a minimum, the 1-in-100-year flood extent with an allowance for climate change, for assessing the development platform, drainage and discharge point, and a more extreme extent (1-in-200-year or greater) for siting and protecting hazardous and critical infrastructure. The other development considerations are as follows: maintain setbacks from identified watercourses; rely on engineered drainage because natural gradients are low; design excavations and foundations for shallow saturated conditions; re-establish sheet flow with energy dissipation at outfalls; and size drainage for the wet-season peak while keeping it functional at dry-season low flows.

Physical Baseline Limitations

The main limitations of the physical baseline are as follows. On-site AWS records cover less than one month per season. Noise monitoring locations were selected before the Project design was finalised. Groundwater laboratory QA/QC was not fully reported, and the degree of connection between the shallow and intermediate aquifers remains unresolved. Hydrological sampling was short-duration rather than based on long-term gauging. The climate risk assessment is desk-based. Okulu River flood extents are not defined, and the IFF Line 2 footprint was not directly modelled. Operational monitoring is intended to extend the temporal coverage of the baseline.

Summary of Key Physical Sensitivities

TABLE ES-33: SUMMARY OF KEY PHYSICAL ENVIRONMENTAL SENSITIVITIES

Receptor / topic	Key baseline findings	Sensitivity for the Project
Meteorology and climate	Rainfall above 2,300 mm/year; mean temperature about 28°C; relative humidity 84.6–89.6%; prevailing south-westerly winds; frequent calm conditions	Influences runoff, recharge, flooding and dispersion towards receptors to the north-east
Climate risks	Extreme heat High; extreme rainfall flooding Moderate to High (more than 1 m modelled at Indorama North); wildfires and water stress / drought Moderate	Heat and flooding are the dominant long-term hazards for design and operation
Air quality	NO2 17.9, PM10 26.4 and NH3 18.2 µg/m³ adopted (below 50% of standards); dry-season PM10 up to 61.91 µg/m³ at site stations	Undegraded airshed, but in an active industrial and community setting where cumulative emissions management remains important
Noise	Daytime LAeq 43–54 dB (all below 55 dB); night-time LAeq 40–46 dB, with N9 above 45 dB	Existing night-time sensitivity at N9; predicted Project impacts are negligible
Geology and soils	Permeable loamy sand to sandy loam; no hydrocarbon or toxic-metal contamination; geogenic iron and manganese	Susceptible to erosion, nutrient leaching and contaminant migration if disturbed

Receptor / topic	Key baseline findings	Sensitivity for the Project
Groundwater	Shallow water table (about 4.9–6.7 m bgl); leaky multi-layer aquifer; coliforms present; 3,560 m³/hour abstraction from the deep aquifer; existing cone of depression	High sensitivity: community and industrial dependence, saline-intrusion pathway and microbiological vulnerability
Surface water and sediments	Tidal Okulu River; existing nutrient and organic loading, low dissolved oxygen, cadmium and faecal coliforms; wet-season sediment cadmium above CCME; zinc leachable	Moderately impacted, sensitive estuarine receptor connected to the Okrika mangrove and Bonny Estuary
Flooding and drainage	99 mm/hour drainage design basis; pond overtops at 1-in-200-year with the primary outfall alone; no Okulu floodline	Standby outfalls are needed for extreme events; floodline delineation is required to confirm the exposure of the footprint and hazardous installations

Biophysical Environment

The study area contains predominantly modified habitats, including farmlands, bush fallow, residential vegetation, landscaped areas, and open grasslands. Riparian forests, freshwater swamps, mangroves, and aquatic habitats remain important ecological receptors within the wider landscape.

Ecological Survey Scope and Effort

The ecological baseline was developed in line with IFC PS6, combining desktop review (IBAT, high-resolution aerial imagery, scientific literature and national aquatic databases) with field surveys by specialists engaged by IFF in three phases (October 2025, January 2026 and February 2026), covering the wet and dry seasons. The terrestrial study area comprised the Project footprint plus a 4 km buffer. Vegetation was sampled along 27 transects, each 100 m long, with four quadrats per transect at 20 m intervals (10 m × 10 m for trees, 5 m × 5 m for shrubs and 1 m × 1 m for herbs); unknown specimens were authenticated at the University of Port Harcourt Herbarium. Fauna were recorded through direct observation, indirect signs (tracks, calls, droppings, nests), opportunistic encounters and structured interviews with hunters, farmers and forest product collectors.

Aquatic biodiversity was sampled on 16–18 October 2025 (wet season) and 17–19 February 2026 (dry season) at the surface water and sediment stations: one non-tidal freshwater station on the Okulu River at Agbonchia (SW1), six tidal stations along the Aleto section to the NNPC housing (SW2–SW7), and four control stations outside the AoI (two freshwater: upstream of SW1 and the Imo River; two brackish: Woji/Elelenwo Creek and the Bonny Estuary at George/Kalo Ama). Samples were taken in triplicate, and tidal stations were sampled at both low and high tide.

Habitats of the Area of Influence

The AoI is dominated by modified habitats (bush fallow, homestead vegetation, farmland and open grassland), with remnant natural or semi-natural riverine habitats along the Okulu River and the upper Bonny Estuary. The proposed site itself lies within the existing perimeter fence and comprises open grassland of grasses, sedges and herbs, and landscaped green areas in which exotic species make up more than 50% of trees and shrubs. Table ES-34 summarises the habitats recorded.

TABLE ES-34: SUMMARY OF HABITATS RECORDED IN THE ECOLOGICAL STUDY AREA

Habitat	Location in AoI	Characteristic species	Condition noted in baseline
Open grassland within perimeter fence (proposed site)	Indorama Complex, proposed IFF Line 2 site	Megathyrsus maximus, Panicum laxum, Axonopus compressus, Cyperus rotundus, Chromolaena odorata	Mixture of native and opportunistic species; modified
Landscaped green areas	Within Indorama Complex	22 tree/shrub species (21 genera, 14 families); Mangifera indica, Azadirachta indica most abundant	Exotic species >50% of trees and shrubs; modified
Bush fallow	Outside perimeter fences, farmland and secondary forest fringes	Harungana madagascariensis, Elaeis guineensis, Alchornea cordifolia, Chromolaena odorata, regrowing crops	Regenerating former farmland; modified
Homestead / residential vegetation	Settlements across AoI	Plantain, banana, cassava, oil palm, fruit trees (pawpaw, African pear, mango)	Cultivated and ruderal; modified
Farmlands	Across AoI	Cassava, yam, fluted pumpkin, plantain/banana, oil palm	Cultivated; modified
Mangrove swamp	Woji, Okrika, Abuloma, Azubie, parts of Aleto and Akpajo (upper Bonny Estuary)	Rhizophora racemosa, R. harrisonii, R. mangle, Avicennia africana, Laguncularia racemosa; Nypa fruticans	Secondary and modified mangrove; invasion by Nypa
Freshwater swamp forest	Okulu River, Aleto and Agbonchia sections	Raphia sp., Pterocarpus spp., Elaeis guineensis, Alchornea cordifolia, Rauvolfia vomitoria	Hydromorphic riverine vegetation
Riparian / secondary forest relics	Agbonchia (Okulu River) and opposite NNPC Refinery	Raphia spp., tall Rhizophora, Anthocleista vogelii, emergent Ficus exasperata	Fringe or relics of relatively undisturbed forest
Aquatic macrophyte patches	Okulu River (Agbonchia), behind NNPC Residential Estate, Azuabie Creek, Imo River	Sacciolepis africana, Ipomoea aquatica, I. pes-caprae	Few species; mainly in un-dredged or recovering reaches

Seasonal surveys recorded diverse plant and animal communities. Most recorded species are classified as Least Concern, but the report also identifies species of conservation concern through direct observations, interviews, or previous studies. These evidence types differ, and historical or interview records should not be treated as confirmed observations during the current surveys.

Terrestrial Flora Results

A total of 169 plant species were recorded across the study area, of which 123 (72.8%) were native, 32 (18.9%) exotic and 14 (8.3%) invasive, with no seasonal difference in this composition. Aggressive invaders include Chromolaena odorata, Nypa fruticans and Leucaena leucocephala. Dredging and sand mining have caused bank collapse and saltwater intrusion along the Okulu River, favouring salt-tolerant or invasive species such as Acrostichum aureum, Ipomoea pes-caprae, Nypa fruticans and Sesuvium portulacastrum, which are progressively replacing native riverbank species.

Tree species richness was higher in the wet season, with Fabaceae dominant; in the dry season 67 tree species were recorded, led by Arecaceae (9 species, 13.4%), Moraceae (8 species, 11.9%) and Fabaceae (6 species, 9.0%). Five tree species of conservation concern were recorded: Cycas circinalis and Pterocarpus soyauxii (Endangered) and Khaya senegalensis, Terminalia ivorensis and Triplochiton scleroxylon (Vulnerable). Many tree species in the study area are planted within the Indorama facility as part of its green vegetation programme. The shrub layer comprised 25 species in 14 families, dominated by Apocynaceae and Euphorbiaceae (five species each), and the herb layer 78 species in 27 families in the wet season and 50 species in the dry season, led by Poaceae, Asteraceae, Fabaceae and Cyperaceae. Herbs made up 62.3% (wet) and 62.5% (dry) of the herbaceous species, grasses 20.3% and 27.5%, and sedges 17.4% and 10%. All shrub and herb species are Least Concern or Not Evaluated.

Terrestrial Fauna Results

Faunal richness was generally higher in the dry season, which the baseline attributes to greater detectability under reduced vegetation cover. The avifauna was the most species-rich group (65 wet-season and 68 dry-season species), dominated by raptors (Accipitridae) and herons and egrets (Ardeidae). Local breeding was confirmed by adults with chicks, and congregations of more than 400 waterbirds were recorded along the Okulu River and at the retention pond. Mammals were dominated by squirrels (Sciuridae) and rats and mice (Muridae), with duikers, bats and civets also present. Reed frogs (Hyperoliidae) dominated the amphibians, and reptiles included lizards, snakes, two crocodilians and tortoises. Insects were dominated by butterflies (Nymphalidae, Hesperiidae, Pieridae, Lycaenidae, Papilionidae). Table ES-35 summarises the survey results by group and the species of conservation concern, together with the type of evidence for each record.

TABLE ES-35: SUMMARY OF TERRESTRIAL FLORA AND FAUNA SURVEY RESULTS AND SPECIES OF CONSERVATION CONCERN

Group	Wet season (species / families)	Dry season (species / families)	Species of conservation concern (IUCN category; evidence)
Trees	Fabaceae dominant	67 / Arecaceae dominant	Cycas circinalis (EN), Pterocarpus soyauxii (EN), Khaya senegalensis (VU), Terminalia ivorensis (VU), Triplochiton scleroxylon (VU); recorded in vegetation survey, many planted in Indorama green areas
Shrubs	25 / 14 (both seasons)	–	None (LC or NE)
Herbs, grasses and sedges	78 / 27	50	None (LC or NE)
Mammals	27 / 13	36 / 16	Phataginus tetradactyla, pangolin (VU; hunters' report); Cercopithecus mona, mona monkey (NT; previous report, and direct observation at the outer fringe of the study area in the dry season)
Birds	65 / 30	68 / 33	Necrosyrtes monachus, hooded vulture (CR) and Psittacus erithacus, African grey parrot (EN); previous reports only, not observed during the surveys
Amphibians	11 / 6	14 / 9	None (LC or NE)

Group	Wet season (species / families)	Dry season (species / families)	Species of conservation concern (IUCN category; evidence)
Reptiles	27 / 13 (both seasons combined)	–	Osteolaemus tetraspis, dwarf crocodile (VU; hunters' report); Python sebae and Python regius (NT; hunters' report, outer fringe of study area)
Molluscs and crustaceans	6 / 3	15 / 8	None (LC or NE)
Insects	41 / 21	57 / 23	None (LC or NE)

Hunting pressure on reptiles is evident: hunters killed a royal python (Python regius) in the Ebubu–Agbonchia riparian forest two weeks before the dry-season survey. The baseline notes that species reported only by hunters or previous studies are generally associated with wetland and stream habitats, including seasonally flooded areas, and with denser forest and thicket vegetation.

The report concludes that the available dataset does not establish Critical Habitat under IFC Performance Standard 6. Nevertheless, potential triggering species and sensitive wetland, mangrove, and forest habitats warrant conservation attention.

Species of conservation concern listed in the baseline as potential Critical Habitat triggering species are Cycas circinalis (EN) and Terminalia ivorensis (VU) among plants; Phataginus tetradactyla (VU) among mammals; Osteolaemus tetraspis (VU) among reptiles; Psittacus erithacus (EN) and Necrosyrtes monachus (CR) among birds; and Sardinella maderensis (VU) among fish. The Okulu River at Aleto and Agbonchia does not fall within any nationally protected or internationally recognised area (Nigeria has 11 Ramsar sites, none in the study area). The baseline concludes that the study area is not a critical or sensitive aquatic fish habitat and that no endemic fish species occur.

Aquatic communities are already influenced by dredging, sand mining, altered salinity, and pollution. Further sedimentation, contaminated runoff, or effluent loading could reduce habitat quality. Invasive plants also place pressure on native vegetation.

Aquatic Biodiversity Results

Aquatic macrophytes were sparse. No floating macrophytes were seen along most of the brackish reach; relics of riparian forest occurred at SW2–SW6, mangroves with Nypa fruticans at the brackish control stations, and Sacciolepis africana, Nymphaea lotus and Ipomoea aquatica at the freshwater stations.

Plankton communities were dominated by diatoms and copepods. In the wet season, phytoplankton comprised nine genera (seven diatoms and two green algae), with diatoms making up 90–100% of phytoplankton at brackish stations and 80–85% at freshwater stations (Shannon–Wiener index 0.995–1.696). In the dry season there were twelve genera. In the wet season, zooplankton comprised thirteen genera (eleven copepods, one cladoceran and one polychaete larva), with copepods making up 90–100% at brackish stations and 75–80% at freshwater stations (Shannon–Wiener 1.040–1.871). No plankton was recovered at SW1 in the wet season because of high water velocity; plankton was present there in the dry season.

Benthic macroinvertebrates comprised 18 genera in five major taxa (Polychaeta 10, Oligochaeta 2, Mollusca 3, Crustacea 2, Insecta 1). Polychaetes such as Nereis and Nephtys dominated the brackish stations, and only oligochaetes and insects occurred at the freshwater

stations (Shannon–Wiener 0.641–1.837). No benthos was recorded at SW1 in either season, probably because the sediment was altered during reconstruction of the bridge crossing. None was found at the freshwater controls SWC3 and SWC4 in the dry season, which the baseline attributes to intensive sand dredging.

Fishing is minimal and at subsistence level, using dug-out canoes, cast nets, seine nets and hooks. No fishing was observed at the freshwater stations. Thirteen fish species were recorded in the wet season and eleven in the dry season, dominated in both seasons by the black-chin tilapia (Sarotherodon melanotheron) and the Madeiran sardinella (Sardinella maderensis). Most species are Least Concern or Data Deficient. Sardinella maderensis is globally Vulnerable, and the white grouper Epinephelus aeneus (Near Threatened) was caught only at control station SWC2 in the dry season. All species are Not Evaluated under CITES. Mean Fulton's condition factors were 1.76 (wet) and 1.73 (dry) for S. melanotheron and 0.80 (wet) and 0.87 (dry) for S. maderensis. All four means exceed the 0.56 well-being benchmark, indicating fish in good condition.

The Okulu River is already heavily modified. Sand mining and dredging have widened and deepened the channel and converted much of it into a tidal water body, and saltwater intrusion from the upper Bonny Estuary is changing the biological assemblages. The river also receives treated effluent from the Indorama complex, runoff from filling stations and an abattoir, domestic and commercial waste, and tidal inputs from the Trans-Amadi industrial area. A crude oil pipeline crossing the river also ruptured recently.

Ecosystem services support food production, subsistence fishing, medicinal resources, fuelwood, pollination, erosion control, and cultural practices. Project management should therefore address both biodiversity conservation and the community benefits derived from these resources.

TABLE ES-36: SUMMARY OF ECOSYSTEM SERVICES BY ECOSYSTEM TYPE

Ecosystem type	Provisioning	Regulating / supporting	Cultural
Bush fallow and secondary vegetation	Food crops, medicinal plants, fuelwood	Soil stabilisation, erosion control; habitat for insects, rodents and birds	Traditional and ethnobotanical knowledge
Homestead vegetation and farmlands	Fruits, vegetables, spices, crops (cassava, yam, plantain, maize)	Shade, dust suppression; pollination, pest control, nutrient cycling	Aesthetic value
Mangrove swamp forest	Fish and shellfish nursery support, fuelwood	Shoreline stabilisation, flood control, carbon sequestration; breeding habitat	–
Freshwater swamp and riparian forest	Non-timber forest products, medicinal plants	Water purification, flood attenuation, bank stabilisation; wildlife corridors and amphibian breeding	–
Aquatic macrophytes and rivers	Edible Ipomoea aquatica; subsistence fisheries	Water filtration, nutrient uptake; fish and amphibian breeding habitat	No recreational or culturally important fisheries identified

Ecosystem type	Provisioning	Regulating / supporting	Cultural
Faunal assemblages	Bushmeat (e.g. cane rat, brush-tailed porcupine, blue duiker), edible snails and African palm weevil; skins and shells	Pollination (honey bee, butterflies); pest control (raptors, snakes)	Civet, sitatunga and palm-nut vulture used in traditional ceremonies and coronation rituals

Summary of Ecological Sensitivities

- Terrestrial: although disturbed by human activity, the AoI retains plant and animal species that support community ecosystem services. Clearance for the Project could affect surrounding habitats through siltation, pollutants, introduction of invasive alien species and loss of ecological function.
- Aquatic: little to no direct impact is predicted, but effluent discharge could contaminate the Okulu River system and reduce aquatic biodiversity that is already under pressure from dredging, sand mining, salinity change and pollution. Among the fish recorded, only one species (Sardinella maderensis) is considered threatened.
- Ecosystem services: the services most likely to be affected are those lost through the direct removal of natural systems from the Project footprint and the associated loss of function.

Socio-economic Environment and Health

The assessment establishes the socio-economic and health baseline for communities within the proposed IFF Line 2 Fertilizer Project's Area of Influence (AoI). It combines a stated 400-respondent survey programme with interviews, focus groups, participatory methods, and secondary information to understand community conditions, livelihoods, services, and vulnerability.

Primary data collection by Safespace Resources Limited (household survey, Focus Group Discussions, Key Informant Interviews and participatory appraisal) took place in December 2025. Access was facilitated through local gatekeepers and Indorama's community liaison structures. Data were analysed using SPSS and triangulated with official national statistics and published sources. The baseline updates information collected for the IEFCL Train 3 ESIA (2023).

Study Area

The study covers seven communities within approximately 3 kilometres of the existing Indorama Fertilizer Complex: Akpajo, Aleto, Agbonchia, Okerewa, and Njuru in Eleme LGA, and Elelenwo and Iriebe in Obio/Akpor LGA. Industrial development and access to major transport corridors have encouraged migration, trade, settlement expansion, and changing land use. The assessment updates information collected for the earlier Train 3 ESIA.

Key Socio-economic and Health Indicators

TABLE ES-37: KEY SOCIO-ECONOMIC BASELINE INDICATORS FOR THE PROJECT AOI

Indicator	AoI result	Comparator / note
Population, five enumerated communities (1991 census; 2026 projection at 3.5% per year)	26,646 (1991); 118,889 (2026)	Agbonchia 35,970; Elelenwo 33,665; Aleto 24,566; Akpajo 20,018; Iriebe 4,670 (2026)
Household members enumerated	3,842 (1,941 male; 1,901 female)	Sex ratio approx. 102 males per 100 females
Working-age population (15–64 years)	approx. 71%	Nigeria approx. 55%
Population aged 65 and over	approx. 4.7%	Dependency ratio approx. 45:100 (Nigeria 86:100)
Religion	Christian 82%; Muslim 13%; traditional 5%	Islam practised mainly by migrants
Adult literacy (male / female / total)	72.0% / 75.1% / 73.5%	Nigeria 71.3% / 52.7% / 62.0% (2018)
Unemployment (male / female / overall)	33.2% / 24.3% / approx. 26.3%	Nigeria approx. 5.0% (NBS 2024)
Females who are full-time homemakers	44%	Employed household members: males 32%, females 17%
Mean monthly household income	₦51,374 (mode ₦50,000)	approx. USD 1.3 per day vs USD 2.15 extreme poverty line
Housing in good condition	76.9%	Remaining 23.1% fairly good; none bad
Mobile phone use	approx. 95%	All major networks present
Refuse to government-designated dumpsites	54.6%	Family dump sites 21.7%; burning 2.9%

Governance and Administration

Governance combines statutory institutions, traditional authorities, and community organisations. Local government councils oversee public administration and services, while traditional rulers, chiefs, and family heads retain substantial influence over customary land, cultural practices, and dispute resolution.

Community development committees, women's associations, youth groups, and age-grade organisations support development, security, and participation. Effective project engagement must involve these different structures because they influence consultation, land access, compensation, grievance resolution, and community acceptance.

In the Eleme communities, traditional authority is headed by the Oneh Eh Eleme (Paramount Ruler), a government-recognised first-class traditional ruler supported by a Council of Chiefs and Elders, chiefs (Emere) and family heads. In the Ikwerre communities of Elelenwo and Iriebe, authority rests with the Nye-we Eli (Paramount Chief, "Owner of the Land"); in Elelenwo, leadership rotates among three clans. Formal administration is through the Eleme LGA (headquarters Ogale) and Obio/Akpor LGA (headquarters Rumuodomaya) councils, which are responsible for primary health care and sanitation, primary and adult education, local planning, waste management and local roads. Social control relies on traditional titles, fines and youth-led vigilante groups.

Planning and Development

Development is shaped by industrial growth, national economic diversification priorities, and the Greater Port Harcourt City Development Plan. Petrochemical, fertilizer, oil and gas, and port activities support the regional economy, alongside local trading, fabrication, food processing, and sand mining.

Industrial expansion has increased business opportunities and attracted workers. However, population growth and urbanisation are increasing demand for housing, land, infrastructure, and natural resources faster than services are being provided.

The Greater Port Harcourt City Development Plan (introduced in 2017 and implemented from 2018) guides urban expansion around Old Port Harcourt City, Onne Seaport and Port Harcourt International Airport, reinforcing the AoI's role as an industrial and logistics corridor. Local small-scale industries include welding and fabrication, sand mining, fish smoking and cassava processing.

Human Rights

The section describes human rights conditions as influenced by uneven implementation of legal protections, socio-economic inequality, gender disparities, and environmental pressures. Pollution and declining access to natural resources have implications for community health and livelihoods.

Within the project area, access to employment, services, and participation varies between households and communities. Inclusive engagement, fair access to opportunities, environmental protection, and attention to vulnerable groups are therefore relevant project considerations.

Demographics

The population is young, growing, and strongly represented by working-age residents. Approximately 71% are reported to be aged 15–64, with a relatively balanced gender distribution of 50.5% male and 49.5% female. Population estimates rely on older census information and projections using an assumed annual growth rate of 3.5%.

Migration is mainly associated with employment, business, and family considerations. Eleme and Ikwerre are the principal indigenous ethnic groups, alongside migrant populations from other parts of Nigeria. Christianity is the predominant religion.

The age–sex distribution of the 3,842 household members enumerated is broad-based. The largest cohorts are aged 30–34 years (10.7%), 20–24 years (9.7%) and 35–39 years (8.2%), and the share of people aged 20–40 is higher than expected, which the baseline attributes to in-migration of working-age job seekers. People aged 65 and over make up about 4.7%, and the dependency ratio is estimated at about 45:100, against a national average of 86:100. The baseline cautions that this ratio may be distorted because dependants may live elsewhere. About 82% of residents are Christian, 13% Muslim and 5% follow traditional beliefs. In addition to the indigenous Eleme and Ikwerre, the population includes Igbo, Ibibio, Hausa and Yoruba residents, particularly in Akpajo, Elelenwo and Iriebe.

Continued population growth and migration increase labour availability but also place pressure on housing, services, and community resources.

Population figures are based on the 1991 census projected to 2026 at an assumed 3.5% annual growth rate. For the five communities with census data, the population was 26,646 in 1991 and is projected at 118,889 in 2026, with the highest concentrations in Agbonchia, Elelenwo and Akpajo. Figures for Njuru, Okerewa and Iriebe are estimates because historical data are limited.

Education and Literacy Rates

Overall adult literacy is reported at 73.5%, comprising 72.0% for males and 75.1% for females. Completed secondary education is the most common individual educational attainment category.

Scholarships, technical training, and skills programmes support educational opportunities. However, overcrowded public schools, inadequate facilities, limited teaching materials, shortages of trained teachers, and some children remaining out of school constrain educational outcomes.

The most common level of education reached was completed secondary education (19.8% of household members), followed by completed primary (17.8%) and completed tertiary education (15.2%); 4.7% had no formal education. Children typically enrol in nursery or primary school at about three years of age. The AoI has 172 nursery schools, 149 primary schools and 38 secondary schools, plus one polytechnic and one university (both in Agbonchia). There are no teacher training colleges or colleges of education. Public schools are cheaper and serve most children from poorer households, while more affluent households use private schools.

Socio-economic Characteristics

Employment opportunities are limited, with an estimated unemployment rate of approximately 26.3%. Reported employment participation is lower among women, and a substantial proportion are full-time homemakers.

The occupational structure is dominated by farming at 24.4%, trading at 20.5%, business activities at 19.8%, and artisan work at 11.7%. Formal salaried employment represents a smaller share. These conditions contribute to household dependence on informal livelihoods and create strong expectations regarding project employment and business opportunities.

Occupations differ by gender. Women outnumber men in farming (27.0% vs 22.0%) and trading (27.8% vs 13.9%), while men predominate in business (21.5% vs 17.9%) and artisan trades (16.0% vs 7.0%). Formal employment is limited: junior civil servants make up 9.3%, senior civil servants 6.1%, and junior and senior private-sector employees 3.6% and 3.3% respectively. No respondents reported fishing as an occupation, and 1.4% were hunters.

Income Levels and Household Economy

Mean monthly household income is reported at approximately ₦51,374, with most household heads reportedly earning below ₦71,000 per month. Household spending is concentrated on food, housing, education, transport, and energy.

Limited disposable income and savings reduce households' ability to manage economic shocks or invest in productive activities. Low earnings also constrain access to healthcare, education, and adequate nutrition, increasing financial vulnerability.

The income distribution is concentrated in the lower brackets. Of the 350 households reporting income, 23.7% earn ₦8,000–17,999 per month, 21.4% earn ₦38,000–47,999, and only 9.7% fall in the highest occupied bracket (₦98,000–107,999). At an exchange rate of ₦1,350 to USD 1, the mean household income is about USD 1.3 per day, below the international extreme poverty line of USD 2.15 per day, indicating that a substantial share of households are likely to be living in extreme poverty.

Livelihood Activities

Livelihoods are mainly small-scale, informal, and directed towards local consumption. Crop farming is the principal agricultural activity, with cassava, yam, cocoyam, maize, vegetables, plantain, and banana grown primarily for household use and local sale.

Agricultural productivity is constrained by small holdings, traditional tools, limited finance and inputs, declining fallow periods, and inadequate extension support. Other activities include livestock keeping, timber harvesting, subsistence fishing, hunting, palm oil processing, and gathering forest products.

Trading, tailoring, hairdressing, food services, welding, and carpentry provide additional income. Land conversion, habitat loss, dredging, and declining natural resources threaten several livelihood activities.

Farm holdings average about three plots per farmer. Fallow periods have fallen from about seven years to five years or less in Eleme, and to between two and four years in Ikwerre communities. Seasonal farm income is about ₦150,000–350,000 per harvest, which is generally not enough to sustain a household for the year. Palm oil extraction yields 22–35 bunches a week per operator in the rainy season and 120–310 in the dry season, earning about ₦6,000 per bunch from oil plus ₦1,000 from kernels. Produce is sold in local and periodic markets, including Eleme and Elelenwo markets. Hunting, which targets grasscutter, duiker, antelope and bush pig, is limited and declining as wildlife is lost.

Land Tenure and Land Use

Land ownership is primarily customary, with extended families, communities, and individuals acquiring rights through inheritance and family allocation. Sales and leases increasingly operate alongside these traditional arrangements.

Industrialisation and urban expansion are converting agricultural land into residential, commercial, and industrial uses. Reduced land availability has shortened fallow periods, potentially affecting soil fertility and farming productivity.

Rising land values benefit landowners but make access more difficult for low-income households and newcomers. Customary ownership and local authority structures remain important considerations for land-related engagement.

Land values have risen sharply over the past five years. A standard plot (30 m × 15 m) now costs about ₦7–30 million in Ikwerre communities (previously ₦7–15 million), ₦10–15 million in the Eleme axis (previously ₦5–7 million) and about ₦30 million in Elelenwo (previously ₦15 million). Rights to sell, lease or mortgage land in Ikwerre communities are generally restricted to indigenes, although non-indigenes may buy land through indigenous landowners.

Infrastructure and Public Services

The area benefits from major transport connections, including the East–West Road and Port Harcourt–Aba Expressway. Local roads are generally accessible, although conditions vary and some routes require improvement.

Schools, healthcare facilities, religious institutions, and established housing are present, but their distribution and capacity differ between communities. Housing is predominantly permanent, with 76.9% of surveyed houses classified as being in good condition.

Specialist healthcare, social welfare facilities, and formal recreation services are limited or absent. The assessment also reports gaps in institutional support, including banking, cooperatives, agricultural extension, and other formal services.

TABLE ES-38: SOCIAL INFRASTRUCTURE IN THE SEVEN STUDY COMMUNITIES

Category	Facility	Total	Distribution / note
Education	Nursery / primary / secondary schools	172 / 149 / 38	Highest numbers in Akpajo (53 / 51 / 8); one polytechnic and one university in Agbonchia
Health	Hospitals	4	Akpajo 1, Agbonchia 1, Iriebe 2; no teaching or specialist hospitals
Health	Maternity homes / clinics / health centres / dispensary	17 / 10 / 2 / 1	Maternity homes in five communities; dispensary in Aleto only
Health	Patent medicine stores	90	Present in all seven communities (Akpajo 22)
Health	Traditional healing centres / spiritual healing homes	28 / 11	Traditional healing centres in all seven communities
Religious	Churches / mosques	262 / 5	Mosques in Akpajo, Agbonchia and Iriebe
Institutional	Police stations	3	Akpajo, Elelenwo, Agbonchia; no banks, post offices, courts, extension services or cooperatives
Social welfare	Orphanages, daycare, homes for vulnerable groups	0	Absent across all communities

Most houses (45.4%) are bungalows, followed by rooming (courtyard) houses (31.4%) and storey buildings (23.1%). Walls are mostly cement block (92.3%), roofs are mostly corrugated iron sheets (65.1%), and all surveyed houses have strip foundations. Key roads include the East–West Road (Trunk A, under rehabilitation), the Port Harcourt–Aba Highway (Trunk A, good), the Agbonchia–Oyigbo and Agbonchia–East–West roads (Trunk B, good) and the graded Aleto–Agbonchia road (fair).

Utilities and Basic Services

Electricity connections are widespread, but unreliable supply has encouraged dependence on generators and supplementary solar systems. Water is obtained mainly from private or commercial boreholes and vendors because communal and piped systems are often unavailable or non-functional.

Telecommunications are relatively accessible, with mobile phone use reported at approximately 95%.

Waste management combines government-designated dumpsites with family disposal sites and some open burning. Water closets are the main sanitation method, although pour-flush

systems and open defecation persist. Uneven service provision creates environmental and public health concerns.

Grid electricity is supplied by the Port Harcourt Electricity Distribution Company (PHED), but outages are frequent and sometimes prolonged because of damaged transformers and fallen lines, and residents report overbilling and disconnection. In Akpajo and Elelenwo, the lack of functional piped water means residents rely almost entirely on private water sources. Of the 350 households surveyed, 54.6% dispose of refuse at government-designated temporary dumpsites, 21.7% at family dump sites and 2.9% by burning at designated sites.

Community Health Context

Primary health care, maternity homes and patent medicine stores are the main sources of health care in the AoI. The seven communities have 4 hospitals, 17 maternity homes, 10 clinics, 2 health centres, 1 dispensary and 90 patent medicine stores, together with 28 traditional healing centres and 11 spiritual healing homes. There are no teaching or specialist hospitals. Traditional healers still collect medicinal plants, although the baseline notes that modern medicine and Christianity have reduced reliance on them. The baseline rates health services as limited in capacity and resources, making communities sensitive to communicable disease and environmental health stressors, particularly during construction. Existing health risk factors identified include uneven access to improved sanitation (water closets are the main method, but pour-flush systems and open defecation persist in rural communities), informal refuse disposal, reliance on private boreholes and vendors for water, low household incomes that limit access to health care and nutrition, and occupational hazards in local livelihoods (snakebites, mosquito exposure and falls from palm trees). In-migration is identified as a potential route for communicable disease transmission.

Summary of Key Socio-economic Sensitivities

The AoI is characterised by **moderate to high socio-economic sensitivity**, driven by unemployment, low household income, dependence on informal livelihoods and natural resources, and constrained infrastructure.

The main project considerations are protecting livelihoods and community resources, managing workforce influx and additional service demand, addressing public health pressures, and maintaining social cohesion. Women, young people, and low-income households require particular attention to ensure access to benefits.

Gender and Vulnerable Groups

The baseline identifies women, youth and low-income households as structurally vulnerable. Women are less likely to be employed than men (17% vs 32% of household members), 44% are full-time homemakers, and they depend mainly on farming and petty trading, although female adult literacy (75.1%) is slightly higher than male (72.0%). Women's associations with elected leadership run self-help projects and advocate for women's interests. At national level, gender-based violence and gender disparities in access to education, health care and employment are reported. Youth unemployment is highlighted as a particular sensitivity. Elderly people (about 4.7% of the population) and households in extreme poverty are additional vulnerable groups.

Transparent recruitment and procurement, inclusive consultation, clear communication, and accessible grievance mechanisms are important for managing expectations and maintaining constructive community relationships.

Cultural Heritage

The assessment identified nine tangible cultural heritage resources within the wider 3-kilometre study area. Five shrine-related resources are classified as highly sensitive, three riverine or wetland cultural resources as moderately sensitive, and one modified river location as having low sensitivity.

The cultural heritage baseline draws on desk-based research, remote sensing, historic mapping and a field survey of the AoI carried out in March 2026. Each resource was ground-truthed during the field survey and given a sensitivity rating using criteria aligned with IFC PS8: Low for replicable heritage, Medium for non-replicable heritage, and High for critical cultural heritage. All shrines and resources associated with traditional belief systems were rated High as a precaution, whatever their state of physical disturbance, because their value derives mainly from continuing spiritual associations. Table ES-39 lists the nine tangible resources.

TABLE ES-39: TANGIBLE CULTURAL HERITAGE RESOURCES WITHIN THE 3 KM AOI

ID	Resource and location	Type	Condition / description	Sensitivity
IND_CH_001	Onura Shrine, Alesa	Shrine	Relic of sacred forest; vegetation impacted by commercial activity	High
IND_CH_002	Sirariokulu Shrine, Agbonchia	Shrine	Relic of sacred forest; residential and farming encroachment	High
IND_CH_003	Mukor Shrine, Agbonchia	Shrine	Relic of sacred forest; residential and farming encroachment	High
IND_CH_004	Okulu Creek, Agbonchia	Creek and agricultural site	Riparian forest and wetland; residential and agricultural use	Medium
IND_CH_005	Akoroka Shrine	Shrine and agricultural site	Relic of sacred forest; agricultural activity	High
IND_CH_006	Njuru Shrine	Relic and historic mining site	Relic of riparian forest and wetland; historic sand mining	High
IND_CH_007	Aleto (Okulu River)	River and mining site	Active construction and sand mining; low integrity	Low
IND_CH_008	Okulu River 1	Relic, historic mining and residential area	Relic riparian forest and wetland; historic sand mining	Medium
IND_CH_009	Okulu River 2	Relic, historic mining and residential area	Relic riparian forest and wetland; historic sand mining	Medium

Several sacred sites have already been lost or relocated because of development. The Okala/Ukala Nsin sacred waterbody in Okerewa has been lost to land-use change, and the Otalloboni shrine in Akpajo has been relocated for preservation. Other historic elements, such as trackways, farming sites, palm oil processing areas and former trade routes, are largely degraded or no longer visible. The archaeological record of the eastern Niger Delta indicates potential for previously unknown buried remains within the AoI.

No intact or significant tangible heritage resources were identified within the immediate project footprint. However, the wider area retains important spiritual and cultural associations, and previously unidentified buried remains may still occur.

Intangible heritage includes masquerades, the New Yam Festival, ancestral worship, shrine rituals, oral traditions, and customary governance. Development could affect these practices through changes to access, setting, or community participation. Engagement with custodians and protection of culturally important places and practices remain necessary.

Intangible heritage was also rated for sensitivity, with twelve resources rated in all. Four are rated High (critical cultural heritage): the Owu and Ekpo masquerade traditions, the New Yam Festival (Ori Ijii / Ogbo Nja, September–October) and other core seasonal festivals, traditional belief systems and ancestral worship, and rituals at shrines and sacred sites. Five are rated Medium: community festivals such as O'e Aka wrestling and end-of-farming celebrations, traditional governance systems, oral traditions, music and dance, and cultural practices linked to land and water use. Three are rated Low: generalised cultural expressions, common daily social practices, and language-use trends. Indigenous language use is declining among younger people as English and Nigerian Pidgin become more widely used.

Traffic

The project will use the East–West Road, Indorama access roads, Agbonchia New Road, Onne Road, and the Federal Ocean Terminal Road.

Near the Indorama entrance, the East–West Road is a four-lane asphalt road about 24 m wide with an intermittent low median, no drainage or sidewalks, and degraded pavement; reconstruction in concrete is under way. The Indorama Complex access road is about 1.3 km long, with two concrete truck lanes (15 m wide, with 2 m walkways) and a separate two-lane personnel road. Its junction with the East–West Road is gated but unsignalised. Onne Road (about 4.7 km) and its junction with the East–West Road are also unsignalised, and Onne Road meets the Federal Ocean Terminal Roadway at a roundabout. Agbonchia New Road is a 10 m wide paved link from the eastern corner of the site to the East–West Road, about 800 m south-east of Onne Road.

Existing traffic is substantial, with approximately 41,500 vehicles recorded during the average daytime counting period at Akpajo Junction on the East–West Road. Congestion and road safety concerns are concentrated at major intersections, the Indorama access junction, and routes serving Onne Port.

Traffic was counted at twelve locations, with vehicles classified as motorcycles and tricycles, cars and light vans, lorries and trucks, and buses and coaches. The daytime survey (06:00–20:00) ran from 6 to 12 November 2025. Across all daytime counts, motorcycles made up 30% of traffic, cars and light vans 38%, and medium and heavy vehicles 32%. Sunday was the lowest-traffic day at every location. At Akpajo Junction, daily volumes ranged from 33,214 (Sunday) to 45,995 (Monday), with peaks at 09:00–10:00 and 16:00–18:00 and average hourly flows of 2,749–3,362 vehicles. South of the Okulu Bridge, volumes ranged from 17,595 to 35,690 vehicles per day, with hourly flows of 1,606–2,227. On the Indorama Complex access road, weekday volumes ranged from 9,788 to 12,956 vehicles. The road peaked at 1,024 vehicles between 07:00 and 08:00, within a three-hour morning peak (06:00–09:00) of more than 900 vehicles per hour, and at 688 vehicles between 16:00 and 17:00. About half of

the access-road traffic was motorcycles. On Agbonchia New Road, medium and heavy vehicles made up 49.4% of traffic, reflecting its role carrying trucks between the Indorama Complex and Onne Port.

TABLE ES-40: AVERAGE DAYTIME AND NIGHT-TIME TRAFFIC VOLUMES AT SURVEY LOCATIONS

Count location	Daytime total, 06:00–20:00 (vehicles)	Night-time total, 20:00–06:00 (vehicles)	Of which lorries, trucks, buses and coaches (day / night)
T6: East–West Road, Akpajo Junction	41,528	7,659	12,878 / 3,194
T7: East–West Road, south of Okulu Bridge	27,898	8,556	10,854 / 4,131
2: East–West Road Refinery Junction	15,076	3,618	5,284 / 1,290
1: Eleme Junction	13,078	2,926	3,637 / 1,093
3: Trailer Park to Onne Port Road	10,991	3,004	3,793 / 2,001
5: Agbonchia New Road Junction	9,380	3,342	3,375 / 1,579
T5: Indorama Complex Road	9,221	575	1,285 / 246
T2: Agbonchia–Oyigbo Road (Agbonchia end)	934	139	274 / 63
T3: Agbonchia New Road–East–West Road	802	268	313 / 117
4: Agbonchia New Road	694	333	450 / 264
T4: Indorama North East Gate Road	303	109	157 / 12
T1: Agbonchia–Oyigbo Road (Oyigbo end)	132	No data	60 / –

Motorcycles form a substantial share of access-road traffic, while goods vehicles contribute to congestion along logistics routes. Limited pedestrian facilities and unsignalised intersections increase the importance of managing interactions between heavy vehicles and other road users.

Night-time volumes are much lower than daytime volumes, but the share of heavy vehicles is higher: motorcycles make up about 24% of night-time traffic, cars and light vans about 31%, and medium and heavy vehicles about 46%. For road safety, the baseline relies on national data. The WHO estimated 17.2 road traffic fatalities per 100,000 population in Nigeria in 2021, equivalent to nearly 40,000 deaths a year (down from 21.4 per 100,000 in 2016), compared with about 19 per 100,000 across Africa. WHO rates Nigeria's enforcement of traffic regulations at between 3 and 9 on a 10-point scale.

Existing controls include routing construction and export traffic through the Northeast Gate and Agbonchia New Road, supported by signs, traffic marshals, and enhanced police controls. Continued routing, scheduling, and junction management will be important as project transport demand increases.

ES10.0 Environmental and Social Risks and Impacts

The ESIA identified and assessed potential positive and adverse environmental and social impacts associated with the construction and operation phases of the Project

(decommissioning will be subject to a separate assessment). Positive impacts assessed in Chapter 8 are increased employment, increased income and spending, and socio-economic development benefits within the Area of Influence; at national level the Project will also enhance fertilizer availability and support agricultural productivity (ES4.0). Potential adverse impacts include atmospheric emissions, noise, wastewater generation, hazardous materials management, traffic, occupational and community health and safety risks, labour influx, pressure on community infrastructure, biodiversity disturbance, cumulative impacts and climate-related risks. Following implementation of the proposed mitigation measures, the majority of impacts are predicted to be of low to moderate significance.

Assessment Approach

Chapter 8 of the ESIA presents the predicted impacts of the IFF Line 2 Fertilizer Project on the physical, biological and socio-economic environment, together with the residual impacts expected to remain once the mitigation and management measures in Chapter 9 and the ESMMP (Chapter 10) are implemented. For each topic the assessment defines the impact, describes the relevant baseline, the Project activities giving rise to the impact and the receptors likely to be affected, rates significance before mitigation using defined criteria (magnitude, based on extent, duration, scale, frequency and likelihood, combined with receptor sensitivity), and then re-rates the impact after mitigation. Two topics use topic-specific methods: physical climate risks are expressed as hazard materiality ratings, and greenhouse gas (GHG) emissions are evaluated against sector, national and European Bank for Reconstruction and Development (EBRD) benchmark thresholds rather than the generic significance matrix. Impacts were assessed for the construction phase (approximately 33 months) and the operational phase (anticipated 30-year lifespan); decommissioning is addressed qualitatively for GHG emissions and cumulative traffic only.

Overview of Predicted Impacts

Overall, the impact assessment identifies a mix of significant adverse and beneficial impacts across the physical, biophysical and socio-economic environments during construction and operation. Before mitigation, the most material adverse impacts relate to construction dust, groundwater abstraction from the new back-up boreholes and associated saline intrusion risk, malfunction and overflow of the effluent treatment plant (ETP) affecting the Okulu River, sediment-laden runoff and wastewater discharges from construction, biodiversity loss, labour influx, community frustration over unmet expectations, and public and worker health, safety and human rights risks. Beneficial impacts are concentrated in employment creation, increased income and spending, and broader socio-economic development benefits within the AoI.

Following implementation of the proposed mitigation and enhancement measures, most impacts reduce to minor, moderate or negligible significance, while the positive socio-economic impacts are enhanced and become Major Positive during both construction and operation. The residual adverse impacts that remain comparatively more material are ETP malfunction affecting the Okulu River (which remains Major Negative after mitigation), groundwater abstraction and spills or leaks reaching groundwater (Moderate Negative), construction-phase sediment-laden runoff and wastewater discharges to surface water (Moderate Negative), and traffic operations (Moderate Negative). Physical climate risks and GHG emissions are assessed using topic-specific materiality and benchmark methods; these remain material after mitigation (residual extreme heat risk Moderate to High; operational GHG emissions Medium-High) but are considered manageable within the proposed controls. The significance of each impact before and after mitigation is summarised in Table ES-41.

TABLE ES-41: SUMMARY OF PROJECT IMPACTS BEFORE AND AFTER MITIGATION

Impact	Significance / materiality before mitigation	Residual significance / materiality after mitigation
Physical environment		
Climate change risk – extreme heat	High materiality hazard	Moderate to High residual materiality
Climate change risk – extreme rainfall flooding	Moderate to High materiality hazard	Moderate residual materiality
Climate change risk – wildfires	Moderate materiality hazard	Low to Moderate residual materiality
Climate change risk – water stress and drought	Moderate materiality hazard	Low residual materiality
GHG emissions – construction phase	Nominal / Negligible to Low under benchmark approach (20,340 tCO_2e over 33 months)	Nominal / Negligible to Low
GHG emissions – operational phase	Medium-High under benchmark approach (686,590 tCO_2e/annum)	Medium-High
Air quality – construction dust	Major Negative	Negligible to Minor
Air quality – construction traffic exhaust emissions	Minor Negative	Not significant (negligible to minor)
Air quality – operation, IFF Line 2 alone (Scenario 1)	Negligible; no adopted air quality standard exceeded	Negligible
Air quality – operation, IFF Line 1 and IFF Line 2 in combination (Scenario 2)	Moderate for 24-hour PM_{10} (PEC 65% of standard); Negligible for all other pollutants; no exceedance	Acceptable; low cumulative significance, no exceedance at sensitive receptors
Noise – construction activities	Negligible at N2 and N4; Moderate at N3 against the IFC 55 dB(A) daytime value (worst case 59 dB(A))	Negligible at N2 and N4; Minor at N3 (targeted barriers, scheduling and monitoring)
Noise – operation activities	Negligible Negative	Negligible Negative (with monitoring)
Soils and geology – soil erosion / loss of topsoil / sediment mobilisation	Moderate Negative	Minor Negative
Soils and geology – soil compaction	Minor Negative	Minor Negative
Soils and geology – soil contamination from hydrocarbon / chemical / wastewater spills and leaks	Moderate Negative	Minor Negative
Soils and geology – changes to the soil-water balance	Minor Negative	Minor Negative
Soils and geology – subsurface disturbance, cuttings and drilling-fluid handling from borehole installation	Minor Negative	Minor Negative
Groundwater – hydrocarbon, chemical and wastewater spills and leaks	Moderate Negative	Moderate Negative
Groundwater – overflow of the ETP retention pond and release of solid waste	Moderate Negative	Minor Negative
Groundwater – abstraction from new back-up water-supply boreholes	Major Negative	Moderate Negative

Impact	Significance / materiality before mitigation	Residual significance / materiality after mitigation
Groundwater – saline-water intrusion induced by abstraction	Moderate Negative	Minor Negative
Groundwater – excavation, dewatering and earthworks	Moderate Negative	Minor Negative
Groundwater – vertical preferential flow between aquifers from borehole installation	Moderate Negative	Minor Negative
Surface water – hydrocarbon spills during construction and operation	Minor Negative	Negligible Negative
Surface water – effluent treatment plant malfunction during operation	Critical Negative	Major Negative
Surface water – effluent treatment plant overflow during operation	Moderate Negative	Minor Negative
Surface water – hard surfacing and effluent discharge increasing flow in the Okulu River	Moderate Negative	Negligible to Minor Negative
Surface water – sediment-laden runoff and turbidity from construction earthworks	Major Negative	Moderate Negative
Surface water – construction-phase wastewater discharges	Major Negative	Moderate Negative
Surface water – contaminated stormwater runoff from operational process and storage areas	Moderate Negative	Moderate Negative
Biophysical environment		
Biodiversity loss during construction	Major Negative	Minor Negative
Biodiversity loss during operation	Major Negative	Minor Negative
Aquatic biodiversity loss through effluent treatment plant malfunction during operation	Major Negative	Minor Negative
Cultural heritage		
Cultural heritage resources	No impact identified for any of the 21 cultural heritage resources (9 mapped tangible and 12 intangible) during construction and operation	No Impact
Socio-economic environment		
Increased employment within the area of influence	Construction: Major Positive; Operation: Moderate Positive	Construction: Major Positive (Enhanced); Operation: Major Positive (Improved from Moderate Positive)
Increased income and spending within the area of influence	Construction: Major Positive; Operation: Moderate Positive	Construction: Major Positive (Enhanced); Operation: Major Positive (Improved from Moderate Positive)
Socio-economic development benefits	Construction: Major Positive; Operation: Moderate Positive	Construction: Major Positive (Enhanced); Operation: Major Positive (Improved from Moderate Positive)
Influx of migrant workers and job seekers	Construction: Major Negative; Operation: Moderate Negative	Construction: Moderate Negative; Operation: Minor Negative

Impact	Significance / materiality before mitigation	Residual significance / materiality after mitigation
Community frustration over unmet expectations	Construction: Major Negative; Operation: Moderate Negative	Construction: Moderate Negative; Operation: Minor Negative
Public and worker health, safety and human rights impacts	Construction: Major Negative; Operation: Moderate Negative	Construction: Minor Negative; Operation: Minor Negative
Traffic operations	Moderate Negative	Moderate Negative
Transportation infrastructure	Minor Negative	Minor Negative
Transportation safety	Minor Negative	Minor Negative

Climate Change Risk and Greenhouse Gas Emissions

Four physical climate hazards were taken forward for detailed assessment: extreme heat (High materiality), extreme rainfall flooding (Moderate to High), wildfires (Moderate) and water stress and drought (Moderate). The Project's operational Scope 1 emissions of approximately 686,590 tCO_2e/annum fall within the EBRD 100,001–1,000,000 tCO_2e/annum band and are rated Medium-High, while construction emissions total approximately 20,340 tCO_2e over 33 months. Both tracks of the climate assessment (risks to the Project and the Project's contribution to climate change) are summarised in ES11.0.

Air Quality

The air quality impact assessment (AQIA) considered oxides of nitrogen (NO_x/NO_2), particulate matter (PM_{10} and $PM_{2.5}$), sulphur dioxide (SO_2) and ammonia (NH_3) against Project-adopted standards based on the most stringent of the National Environmental (Air Quality Control) Regulations, 2021 and the IFC/WHO guidelines (for example, NO_2 annual mean 40 µg/m³ and 1-hour 200 µg/m³; PM_{10} 24-hour 150 µg/m³ and annual 60 µg/m³; NH_3 annual 200 µg/m³). Combined wet- and dry-season monitoring shows baseline concentrations below 50% of the standards, so the airshed is considered undegraded (NO_2 annual mean 17.9 µg/m³; PM_{10} annual mean 26.4 µg/m³ and 24-hour maximum 52.8 µg/m³; NH_3 annual mean 18.1 µg/m³). The construction study area extends 250 m from works for dust and 50 m from access routes for traffic, and the operational study area extends 10 km. Operational emissions were modelled with USEPA AERMOD 24142 over a 10 km × 10 km domain, including building effects and five years (2018–2022) of hour-sequential meteorological data, for Scenario 1 (IFF Line 2 alone, with selective catalytic reduction (SCR) on the primary reformer stack) and Scenario 2 (IFF Line 1 and IFF Line 2 operating in combination).

During construction, dust and particulate generation from site preparation, construction works and vehicle movement over unpaved surfaces is of high magnitude and Major significance before mitigation, reducing to negligible, or at worst minor, with the recommended dust controls. Construction traffic (approximately 25 trucks or containers and up to 100 buses per day at peak manpower) is not expected to exceed the screening thresholds derived from the UK Design Manual for Roads and Bridges and is rated Minor. During operation, the Project alone is not predicted to exceed any adopted standard and all Scenario 1 impacts are negligible. Under Scenario 2 the highest effect is 24-hour PM_{10}, with a maximum process contribution (PC) of 44.2 µg/m³ (29.5% of the standard) and a predicted environmental concentration (PEC) of 97 µg/m³ (65% of the standard), a medium magnitude and Moderate significance outcome at the worst-case receptor; all other pollutants remain negligible.

Because the PEC remains below the standard and the Project adds only a limited increment to an industrialised baseline, the AQIA concludes that there are no significant adverse cumulative air quality impacts. Key modelling results are given in Table ES-42.

TABLE ES-42: KEY OPERATIONAL AND IN-COMBINATION AIR QUALITY MODELLING RESULTS (µG/M³)

Scenario, pollutant and averaging period	Standard	PC	PC / standard	PEC (PEC / standard)	Significance
Scenario 1 – NO_2 annual mean	40 (IFC)	0.193	0.5%	18.1 (45%)	Negligible
Scenario 1 – NO_2 1-hour maximum	200	1.69	0.84%	37 (19%)	Negligible
Scenario 1 – NH_3 annual mean	200	4.46	2.2%	22.7 (11%)	Negligible
Scenario 1 – PM_{10} 24-hour maximum	150	11.8	7.8%	64.5 (43%)	Negligible
Scenario 2 – NO_2 annual mean	40 (IFC)	1.85	5%	19.7 (49%)	Negligible
Scenario 2 – NO_2 1-hour maximum	200	20.4	10%	56 (28%)	Negligible (small magnitude)
Scenario 2 – NH_3 annual mean	200	11.5	5.7%	29.7 (15%)	Negligible
Scenario 2 – PM_{10} annual mean	60 (Nigeria)	4.69	8%	31.1 (52%)	Negligible
Scenario 2 – PM_{10} 24-hour maximum	150	44.2	29.5%	97 (65%)	Moderate

Noise

Baseline noise surveys were undertaken in the wet season (16 to 25 October 2025) and dry season (20 February to 5 March 2026) at 11 locations, of which the three nearest noise-sensitive receptors (N2, N3 and N4) were taken forward for assessment. Baseline daytime LAeq is 46 dB at each of these receptors and night-time LAeq is 44 dB (N2), 42 dB (N3) and 44 dB (N4), below the 55 dB daytime and 45 dB night-time IFC criteria. Predicted construction noise is 48 dB at N2, 59 dB at N3 and 48 dB at N4, below the Nigerian construction criteria; against the more stringent IFC daytime value of 55 dB(A) adopted at the Bank's request, N2 and N4 comply but N3 exceeds it by 4 dB under the worst-case scenario, giving a Moderate pre-mitigation impact at N3 that reduces to Minor with targeted barriers, scheduling and monitoring (Section 8.2.4, Table 827A). Predicted operational noise from IFF Line 2 alone is 26 dB, 43 dB and 32 dB respectively, rising to 28 dB, 44 dB and 36 dB with IFF Line 1 and IFF Line 2 operating together, all within the 55 dB daytime and 45 dB night-time criteria. Operational noise impacts are therefore rated Negligible before and after mitigation; vibration was scoped out because of the distance between the Project and surrounding receptors. Noise monitoring shall nevertheless be undertaken at the receptors nearest the plant.

Soils and Geology

Soils in the Project footprint are Coastal Plain Sands of the Niger Delta Basin (loamy sand to sandy loam, typically more than 75% sand), well drained and highly permeable (0.12–0.48

cm/s), slightly acidic to neutral (pH approximately 5.0–7.9), and free of detectable hydrocarbons and toxic metals. They are physically fragile and hydrologically sensitive, support groundwater recharge and surrounding agricultural use, and are treated as a single receptor of medium sensitivity; no significant faulting or geological hazard is present. Before mitigation, soil erosion, loss of topsoil and sediment mobilisation across the cleared footprint (assessed at the 250 ha Project Area scale) and soil contamination from hydrocarbon, chemical and wastewater spills and leaks are rated Moderate Negative, while soil compaction, changes to the soil-water balance and subsurface disturbance from drilling three new water-supply boreholes (less than 1 ha in total) are rated Minor Negative. With an erosion and sediment control plan, staged clearance limiting bare ground to less than 25 ha at any one time, containment and spill response, all five impacts are reduced to Minor Negative. Cumulatively with existing industrial development, erosion, compaction, contamination and soil-water balance effects are each rated Moderate Negative before mitigation and Minor Negative after mitigation, with no material cumulative effect on geology.

Groundwater

The Project is underlain by a multi-layered Benin Formation aquifer system comprising shallow (approximately 0–30 m bgl), intermediate (to approximately 60–70 m bgl) and deep (more than 150 m bgl) aquifers, with a static water level of 5–7 m bgl and flow towards the south to south-west, discharging to the Okulu River. Because the clay horizons are laterally discontinuous, the three aquifers are treated as a single, highly sensitive receptor. Local communities depend on shallow and intermediate boreholes for potable supply, and the Indorama Manufacturing Complex operates 16 deep boreholes, each abstracting up to 300 m^3/hr. Groundwater is generally fresh and free of hydrocarbons and heavy metals, but total and faecal coliforms indicate existing microbiological vulnerability. Before mitigation, abstraction from the three new back-up boreholes is rated Major Negative; spills and leaks, ETP retention pond overflow and solid waste, saline-water intrusion, excavation and dewatering, and vertical preferential flow between aquifers are each rated Moderate Negative.

Under normal operation, 13 of the 16 existing boreholes will be operated after IFF Line 2 is commissioned at a maximum combined rate of 3,560 m^3/hr, with the three new IFF Line 2 boreholes held as back-up for short-duration emergency supply (demand under 72 hours). The modelled drawdown cone remains of the order of a few hundred metres under intermittent operation, extending towards kilometre scale only under sustained continuous pumping; communities lie more than 1 km from the Project Area. Variable-density (SEAWAT) re-modelling of the 3,560 m^3/hr regime predicts no inland saline encroachment into any aquifer over one year and only very minor, creek-confined interface extension over five years; a short-duration emergency scenario (4,290 m^3/hr from 19 boreholes) also predicts no inland encroachment. An earlier all-wells scenario (approximately 6,010 m^3/hr, including future expansion) indicated migration confined to the creek and river corridor (approximately 1,200 m in the shallow, 450 m in the intermediate and 360 m in the deep aquifer) with a marginal interface salinity change from 7.8 to 7.9 ppt. With pump testing, capped sustainable yield, metering, trigger-level monitoring and full annular grouting, residual abstraction impacts reduce to Moderate Negative and saline intrusion, ETP pond overflow, dewatering and vertical flow reduce to Minor Negative; spills and leaks remain Moderate Negative because releases to the high-permeability shallow aquifer remain credible. Cumulatively with the existing wellfield, reduced availability and drawdown are rated Major Negative before and Moderate Negative

after mitigation, groundwater quality Moderate Negative before and after, groundwater–surface water interaction Moderate to Minor–Moderate, and vertical flow Moderate to Minor.

Surface Water

The principal receiving water is the Okulu River, a tidally influenced river within the Bonny Estuary system with bidirectional flow (velocities 0.0166–0.384 m/s; depths approximately 1.8 m to more than 7.9 m), a freshwater-to-saline gradient (electrical conductivity 138–34,687 µS/cm; salinity up to 21.58 ppt), moderate nutrient enrichment, elevated biochemical oxygen demand (8.8–20.8 mg/L) and coliform counts above guideline values. Although already modified by sand mining and industrial discharges, it is rated highly sensitive because it is hydrologically connected to the downstream Okrika mangrove system of high conservation value and its assimilative capacity is reduced. The cooling system is closed loop with no thermal discharge, and process wastewater is recovered through the existing wastewater recovery plant, with controlled discharge to the Okulu River via the existing IFZ1/IFZ2 holding and retention ponds during recovery plant shutdowns; the hydrological assessment assumes an effluent discharge of about 385 m^3/h (approximately 106.94 L/s), about 6% of the average natural river flow.

Before mitigation, ETP malfunction during operation is rated Critical Negative, because large volumes of nitrogen-rich effluent could be released that would exceed NESREA limits and IFC EHS Guideline values for fertilizer manufacturing (un-ionised ammonia is acutely toxic to fish at 0.1–2 mg/L). Sediment-laden runoff from construction earthworks (annual rainfall exceeding 2,000 mm) and construction-phase wastewater discharges (including highly alkaline concrete washings above pH 12 and sanitary effluent) are rated Major Negative; ETP overflow, increased river flow from hard surfacing and effluent discharge, and contaminated stormwater runoff from process and storage areas are rated Moderate Negative; and hydrocarbon spills are rated Minor Negative. After mitigation, ETP malfunction remains Major Negative despite redundant treatment trains, online ammonia and nitrate analysers and preventive maintenance, because of evidence of environmental impact from releases at the existing plant. Construction runoff, construction wastewater and contaminated operational stormwater remain Moderate Negative; ETP overflow reduces to Minor Negative with retention and polishing ponds sized for at least a 1-in-100-year storm, high-level alarms and emergency holding capacity; hydrocarbon spills reduce to Negligible with bunding sized to 110% of the largest container; and flow change reduces to Negligible to Minor. Flood risk to the retention pond and controlled discharge point cannot yet be quantified because no floodline assessment is available for the Okulu River. Cumulatively, surface water quality deterioration and sediment disturbance are rated Major Negative before and Moderate Negative after mitigation, flow and runoff change Moderate to Minor, and thermal and nutrient loading Moderate to Major before and Moderate after mitigation.

Biodiversity and Ecosystem Services

Terrestrial and aquatic biodiversity in the Project Area has been altered by human activity, but the area still contains biodiversity of value and provides ecosystem services to surrounding communities. Most of the threatened species recorded, including migratory waterbirds, fish and reptiles, and species that may trigger critical habitat considerations, are closely linked to aquatic habitats. Before mitigation, biodiversity loss during construction and during operation (through clearance, accidental spills, erosion and disturbance) is rated Major Negative, as is

loss of aquatic biodiversity through ETP malfunction, reflecting the potential release of large volumes of untreated effluent. No loss of unique habitats or species is expected. With mitigation, all three impacts reduce to Minor Negative. Cumulatively, settlement expansion, agriculture and the conversion of greenfield sites to industry continue to reduce natural habitat, increase invasive species and stormwater runoff; however, the Project lies within predominantly modified habitat that does not support critical or unique biodiversity features, is not expected to result in a net loss of biodiversity, and no offsets are required at this stage, subject to confirmation through ongoing ESMS monitoring.

Socio-economic Environment – Beneficial Impacts

The AoI has high unemployment (approximately 26.3%), a young and economically active population (approximately 71% of working age) and low household incomes (mean approximately ₦51,374 per month, with most households earning below ₦71,000). Construction is expected to last approximately 33–35 months and require a peak workforce of approximately 5,250 (around 4,500 national workers and 750 expatriates), with approximately 89% of workers expected to be sourced from the Niger Delta region. Operation will create approximately 160 permanent positions (around 110 national employees and 50 expatriates) over the 30-year operational lifespan. Increased employment, increased income and spending, and wider socio-economic development benefits (through local procurement and demand for accommodation, food, transport and services) are each rated Major Positive during construction and Moderate Positive during operation before enhancement. With local hiring prioritisation, skills development, inclusive recruitment, local procurement and support to small and medium enterprises, all three are rated Major Positive during both construction and operation.

Socio-economic Environment – Adverse Impacts

The construction workforce is expected to draw migrant workers and job seekers into an AoI where water supply, electricity, sanitation, waste management and healthcare are already constrained in capacity and reliability. Labour influx is rated Major Negative during construction and Moderate Negative during operation, reducing to Moderate and Minor Negative respectively through a labour influx management plan, local hiring prioritisation and provision of worker accommodation. Community frustration over unmet expectations for jobs, procurement and wider benefits, particularly where skilled roles are filled by non-local workers and as the workforce falls from about 5,250 to about 160 at operation, is rated Major Negative (construction) and Moderate Negative (operation), reducing to Moderate and Minor Negative through transparent recruitment, clear communication of employment limitations, engagement with community leadership and a grievance mechanism. The cumulative social assessment, covering the AoI in Eleme and Obio/Akpor LGAs, identifies interacting pressures from continued industrial expansion in the Indorama Free Zone, the Greater Port Harcourt City Development Plan, in-migration and urban growth, resulting in population influx, pressure on infrastructure and public services, elevated community expectations, competition for jobs and resources, increased traffic and road safety risk, and increased demand for housing and land.

Public and Worker Health, Safety and Human Rights

Healthcare in the AoI is limited and unevenly distributed, water supply relies largely on boreholes and vendors, sanitation and waste management are mixed, and about 65% of mobility depends on road transport. During construction the large workforce may increase

communicable disease transmission and pressure on health services; heavy vehicles on the East–West Road and Port Harcourt–Aba Expressway increase road safety risk; and workers face typical construction hazards such as machinery and working at height. Human rights considerations relate to fair access to employment, non-discrimination in recruitment and the conduct of security arrangements. These impacts are rated Major Negative during construction and Moderate Negative during operation before mitigation, and Minor Negative in both phases after implementation of occupational health and safety systems, transport management, public health interventions, transparent recruitment, non-discrimination policies and accessible grievance mechanisms.

Cultural Heritage

The assessment considered direct impacts (ground disturbance), indirect impacts (changes to setting through visual, noise or dust intrusion, or restricted access) and cumulative impacts on tangible and intangible cultural heritage. All 21 identified cultural heritage resources (nine of high, eight of medium and four of low sensitivity) lie outside the construction corridor, and no direct or indirect impacts are predicted during construction or operation. Cultural heritage was therefore rated No Impact and screened out of the cumulative assessment; management measures, including for previously unidentified resources, are set out in ES13.0.

Traffic and Transport

Urea trucks and over-dimensional cargo (ODC) loads will travel between the Project and Onne Port via the Agbonchia New Road, East–West Road, Onne Road and Federal Ocean Terminal Road (27.3 km), while other traffic will use the East–West Road and Indorama Complex Road (21.5 km to the port). Construction will generate an average of 241 daily trips (200 contractor bus trips, 39 standard delivery trips and 2 ODC trips, from 460 ODC and super ODC deliveries), less than a 1% increase in existing traffic volumes, although the 100 one-way employee bus trips could add up to 3% to existing peak-hour traffic. Operation will generate an average of 410 one-way trips per day, including 200 urea truck movements, equivalent to approximately 8 to 9 additional truck trips per hour on the port route and about a 3% increase in peak-hour traffic on the East–West Road. Traffic operations are rated Moderate Negative, mainly because of left-turn movements across the East–West Road, and remain Moderate Negative after mitigation; impacts on road infrastructure and transportation safety (highest at the East–West Road intersections with Onne Road and the Agbonchia New Road) are rated Minor Negative before and after mitigation. Before ODC convoys depart the port area, roads shall be cleared and traffic control provided at narrow areas, cross-junctions and bridge crossings by the Federal Road Safety Corporation and Government Security, with obstructing power cables disconnected where required in coordination with the Port Harcourt Electricity Distribution Company. Cumulative traffic impacts are assigned Medium priority.

Rapid Cumulative Impact Assessment

A rapid cumulative impact assessment (RCIA) was prepared as a desk-based synthesis of the thematic assessments, applying the six-step logic of the IFC Good Practice Handbook on Cumulative Impact Assessment and Management. It is centred on Valued Environmental and Social Components (VECs) rather than on the Project alone, and serves as a screening and structured synthesis tool for cumulative risk management rather than a full regional cumulative impact assessment with agreed thresholds and multi-party governance.

The Project is a new urea production line within the Indorama Free Zone in Eleme, Port Harcourt, occupying an approximately 80 ha plot within the wider 250 ha industrial precinct and adjacent to the existing IFZ Line 1, IFZ Line 2 and IFF Line 1 facilities. It relies on or interfaces with shared internal roads, utilities, water and wastewater systems and logistics connections, and its finished product will be transported to MM FZE Port in the Onne Port Complex, approximately 20 km away. The spatial context covers the wider industrial complex, connected groundwater and surface water systems, associated public roads and the surrounding socio-economic AoI; the temporal context covers construction, operation and longer-term residual effects. Other activities and drivers considered are the existing Indorama fertilizer and petrochemical operations and captive power plant, the adjacent IFF Line 1 development, existing industrial and urban emission, traffic and wastewater sources, port-related logistics, industrial discharge and sand mining in the Okulu River, existing groundwater abstraction, and external drivers including extreme heat, flooding, seasonal hydrological variability, population influx, urbanisation, unemployment and service-delivery constraints.

Seven VECs were screened in for the RCIA; noise and cultural heritage were screened out because impacts are negligible or absent, and GHG emissions are addressed through the dedicated GHG assessment (ES11.0). The VEC screening and cumulative priority ratings are summarised in Table ES-43.

TABLE ES-43: RAPID CUMULATIVE IMPACT ASSESSMENT – VEC SCREENING AND PRIORITY

VEC	Screening outcome	RCIA priority	Principal cumulative issue
Climate resilience of Project assets, shared infrastructure and exposed receptors	Included	High	Concurrent extreme heat (cooling demand, electrical load, worker heat stress) and flooding, particularly at the northern part of the site and along shared drainage and access systems
Groundwater quantity and quality	Included	High (availability / drawdown); Moderate to High (quality)	New back-up abstraction superimposed on the existing wellfield drawdown; possible vertical leakage at one location; contaminant pathways in permeable sands
Surface water quality, hydrology, sediments and connected aquatic receiving environment	Included	High	Okulu River already affected by industrial discharge and sand mining; Project adds runoff, discharge and hydrological pathways through shared drainage
Aquatic biodiversity and connected ecosystem services	Included	Moderate to High	Dependence on the integrity of an already stressed aquatic system
Community infrastructure, services, livelihoods and social stability	Included	High (infrastructure / services and expectations); Moderate to High (livelihood competition and housing)	Population influx, service pressure, rising expectations, job competition, housing and land demand
Traffic operations, road condition and road safety	Included	Moderate	Combined heavy vehicle flows on shared roads and intersections; heavy rain and flooding as external drivers
Ambient air quality and human health	Included (monitored)	Low to Moderate	Incremental contribution with IFF Line 1 to an industrial baseline; no exceedance of air quality limits

VEC	Screening outcome	RCIA priority	Principal cumulative issue
Noise at nearby sensitive receptors	Screened out	Not applicable	Negligible magnitude; criteria met at all assessed locations, including combined IFF Line 1 and IFF Line 2 modelling
Cultural heritage resources	Screened out	Not applicable	No direct or indirect impacts identified
Project GHG emissions	Addressed separately	Not applicable	Covered by the dedicated GHG assessment and reduction initiatives (ES11.0)

The RCIA concludes that the most important cumulative VECs are climate resilience of shared infrastructure and exposed receptors; groundwater availability and quality; surface water quality, hydrology, sediments and the connected aquatic environment; community infrastructure, services, livelihoods and social stability; and traffic operations, road condition and road safety. Air quality is retained as a monitored cumulative VEC with low cumulative significance under the planned controls (dust management and SCR on the reformer stack).

In line with the IFC handbook, IFF shall apply the mitigation hierarchy to its own incremental contribution and use best efforts to engage other parties where cumulative issues extend beyond its control. The priority cumulative management actions are:

- Establishment of a site-wide cumulative management forum or coordination mechanism for the Indorama Free Zone to review groundwater abstraction, surface water discharge, emergency preparedness, traffic and logistics, and climate resilience across all relevant units.
- Shared or interoperable, trigger-based monitoring of groundwater abstraction, levels and community-well response; surface water and effluent quality upstream and downstream of discharge points; stormwater and drainage performance; traffic volumes, road safety incidents and road condition; community complaints, expectations and service-pressure indicators; and climate-related disruption such as heat stress, flood events and shared-infrastructure downtime.
- Integrated responses by VEC, including completion of a cumulative drawdown assessment before commissioning and capping abstraction within sustainable yield; operation of drainage, retention and treatment systems as designed with monitoring of the Okulu River; integration of climate adaptation into drainage, equipment siting, heat management, emergency response and business continuity planning; maintenance of dust controls and SCR performance; logistics, routing, driver and speed controls; and coordinated management of labour influx, recruitment communications, grievances and service pressure.
- Engagement with regulators, local authorities, other operators and affected communities on regional road safety, urban-service pressures, river-system management and wider catchment pollution sources.

The main uncertainties relate to the absence of agreed regional thresholds for several VECs, the future pace and form of industrial and urban growth, variability in flooding, rainfall and heat, reliance on specialist studies rather than a formal site-wide cumulative governance process, and the dependence of some outcomes on actions beyond the Project's control. The RCIA shall be updated over time using operational monitoring results and any broader Indorama-wide cumulative assessment or shared monitoring initiatives.

ES11.0 Climate Change Risk Assessment

The ESIA evaluated both the Project's contribution to greenhouse gas emissions and its vulnerability to current and future climate change. Climate-related risks, including increased rainfall intensity, flooding and extreme weather events, were assessed, and appropriate adaptation measures, such as resilient drainage systems, stormwater management, infrastructure design improvements and emergency preparedness measures, have been incorporated into the Project. Opportunities to improve energy efficiency and reduce greenhouse gas emissions were also considered during Project design.

Assessment Approach (Twin-Track)

Consistent with the twin-track approach, the ESIA addresses (i) the physical climate risks to the Project, through the Physical Climate Change Risk Assessment (Section 8.2.1), and (ii) the Project's contribution to climate change, through a quantified GHG assessment (Section 8.2.2) and a qualitative review of climate-related transition risks (Section 8.2.1.5). Physical hazards were screened using baseline climate conditions, published literature and future climate projections, and their materiality was rated according to the scale of potential disruption, the range of receptors affected and the potential for knock-on effects. GHG emissions were quantified using the GHG Protocol Corporate Accounting and Reporting Standard and the 2006 IPCC Guidelines and evaluated against sector, national and EBRD benchmarks.

Physical Climate Risks to the Project

Both acute hazards (extreme precipitation, extreme heat, cyclones and hurricanes, landslides, drought and wildfires) and chronic hazards (higher average temperatures, sea level rise and coastal flooding, changing precipitation patterns, ocean acidification and colder average temperatures) were screened. Four hazards were taken forward: extreme heat, extreme rainfall flooding, wildfires, and water stress and drought. Colder temperatures, rainfall-induced landslides and cyclones were screened out because Port Harcourt remains warm throughout the year with cold extremes projected to decline, the terrain and rainfall conditions do not favour landslides (the indicator remains zero across all scenarios), and tropical cyclone activity is not characteristic of the area.

Extreme heat is the most material long-term hazard. Warm-spell duration is projected to increase from a baseline of 22.80 days to 111.00–122.40 days by 2030 and up to 233.90 days by 2050 under the higher-emissions scenario. Potential effects include reduced equipment efficiency, overheating of substations, transformers, inverters and generators, thermal stress on structural steel, damage to roads and infrastructure, increased cooling demand, heat-induced opening of pressure valves with potential natural gas leakage, and heat-related illness, fatigue and lost working hours.

Extreme rainfall flooding is rated Moderate to High. Port Harcourt is highly susceptible to recurrent urban flooding, and site modelling shows flood risk concentrated at Indorama North, where inundation depths remain above 1 m under baseline and future scenarios, reaching 1.13 m by 2050 under SSP5-8.5; Indorama South is unaffected in the model outputs. Potential effects include restricted site access, damage to equipment, switchyards, transformers, generators, substations, power lines and the raw water pipeline, ground instability, injury from flowing water, reduced surface water quality and the spread of waterborne disease.

Wildfires are rated Moderate: the wider area has historical exposure (maximum burned area of 7.31 km² within a 30 km radius of Indorama North and Indorama South), although projected

fire-conducive days remain low in absolute terms. Potential effects include damage to structures, substations, power lines and equipment, possible damage to urea and ammonia storage that may result in explosions, restricted access, evacuations and respiratory and burn injuries to staff and communities. Water stress and drought are also rated Moderate: the Port Harcourt area experiences episodic dry anomalies, but Project-specific water stress remains very low (0.00 at baseline, rising to 0.01 under future scenarios), so the principal risk is short-term seasonal variability (competition for water, reduced surface and groundwater availability during long dry spells, and dust) rather than structural scarcity.

Because the Project lies within the wider IFZ, adjacent to existing fertilizer and petrochemical operations, shared infrastructure, transport corridors and communities, the same hazards may affect several facilities and receptors at once (for example, concurrent cooling and electrical demand during heat events, or simultaneous flooding of shared drainage and access roads). Cumulative climate risk is therefore rated High for extreme heat, Moderate to High for flooding and Moderate for wildfires and water stress and drought. The materiality of each hazard before and after adaptation is summarised in Table ES-44.

TABLE ES-44: PHYSICAL CLIMATE RISK MATERIALITY BEFORE AND AFTER ADAPTATION

Hazard	Key projected indicator	Project materiality before adaptation	Project residual materiality	Cumulative materiality	Residual cumulative materiality
Extreme heat	Warm-spell duration 22.80 days (baseline) to 111.00–122.40 days (2030) and up to 233.90 days (2050, higher-emissions scenario)	High	Moderate to High	High	Moderate to High
Extreme rainfall flooding	Inundation above 1 m at Indorama North, 1.13 m by 2050 (SSP5-8.5); Indorama South unaffected	Moderate to High	Moderate	Moderate to High	Moderate
Wildfires	Maximum burned area 7.31 km² within 30 km; low projected fire-conducive days	Moderate	Low to Moderate	Moderate	Low to Moderate
Water stress and drought	Project water stress 0.00 (baseline) to 0.01 (future scenarios)	Moderate	Low	Moderate	Low to Moderate

Adaptation and Resilience Measures

The residual ratings assume that adaptation is built into planning, design and operation. IFF shall implement flood defences and flood-resilient planning, integrate the Project drainage with the existing lined channels, culverts and retention pond system, apply conservative flood allowances in detailed engineering and site or elevate vulnerable equipment away from flood-prone areas, and maintain and desilt drainage to preserve design capacity. Retention and polishing ponds shall be sized to contain at least a 1-in-100-year storm event, consistent with the IFC EHS Guidelines, with high-level alarms and emergency holding capacity, and the siting and elevation of the retention pond outflow, discharge point and critical infrastructure shall be confirmed against the floodline study (1:50 and 1:100-year events). Further measures include heat-resilient specifications for electrical equipment and infrastructure, heat-stress management and work scheduling, vegetation and fuel-load control with fire detection and

suppression, a water management plan with storage and contingency supply, emergency evacuation and occupational health and safety procedures with drills, and coordination of these measures across the wider Indorama Manufacturing Complex. The identified risks shall be taken through a more detailed future physical climate risk review aligned with EP4 (2023), and climate-risk indicators shall be monitored under the ESMMP.

The existing site drainage network and retention pond were sized for intense local rainfall with an allowance for fire-fighting water. Hydraulic modelling of the wider Indorama site (JBA Consulting, 2024) for events up to the 1-in-1,000-year storm found that the pond would overtop in a 1-in-200-year (24-hour) or larger event if only the primary outfall operates, but that bringing the two standby outfall pipes into service prevents overtopping even in the 1-in-1,000-year event. This model covered the existing 360 ha development rather than IFF Line 2, and no floodline delineation yet exists for the Okulu River.

Residual Physical Climate Risk

After adaptation, residual physical climate risk is expected to reduce but not be eliminated, because the hazards remain present and are projected to intensify. Residual risk from extreme heat remains Moderate to High, particularly during operation when fixed infrastructure and continuous processes are exposed over the Project life. Flooding reduces to Moderate, although disruption remains plausible at the northern part of the site where modelled depths exceed 1 m. Wildfire reduces to Low to Moderate and water stress and drought to Low (Low to Moderate cumulatively, where several facilities share water supply during dry periods). Extreme heat and flooding therefore remain the key residual hazards for detailed engineering, operational planning and emergency preparedness.

Project Contribution to Climate Change – GHG Emissions

The GHG inventory uses the operational control approach, under which Indorama Fertilizer FZE accounts for all facilities directly associated with IFF Line 2, including the Feed Conditioning Unit, ammonia, urea and UFC-85 units and supporting infrastructure, with emissions from shared steam and power systems in the Indorama Free Zone allocated in proportion to Project consumption. Only Scope 1 emissions are reported: Scope 2 does not apply because power is generated on site rather than purchased from the grid, and Scope 3 emissions (upstream gas production, materials, transport outside Project control, commuting and downstream product use) are excluded. The inventory is limited to CO_2 (methane and nitrous oxide are considered negligible and were not quantified), using a Tier 1 approach for construction and a Tier 2 approach, based on Project-specific activity data, for operation.

Construction emissions are estimated at 20,340 tCO_2e over the 33-month construction period, comprising about 10,640 tCO_2e from approximately 4,000 kilolitres of diesel and about 9,700 tCO_2e from construction-phase power drawn from the existing gas-fired plant. Operational emissions are continuous and substantially higher, estimated at 686,590 tCO_2e per annum, based on natural gas consumption of approximately 105 MMSCFD (used both as feedstock and fuel) and a power demand of approximately 40 MW supplied by on-site gas turbine generators. Power generation and reformer fuel are the largest sources. CO_2 generated in ammonia production is captured and used as feedstock for urea synthesis; this CO_2 is not permanently sequestered, as it is released during downstream use of the urea. Decommissioning emissions were not quantified but are expected to be temporary and much lower than operational emissions. Emissions by source are shown in Table ES-45.

TABLE ES-45: PROJECT GHG EMISSIONS BY PHASE AND SOURCE (SCOPE 1)

Phase	Source	Activity data	Emissions (tCO_2e)
Construction (33 months)	Diesel combustion – mobile and stationary equipment	4,000 kl (2.66 $kgCO_2e/l$)	10,640
Construction (33 months)	Construction-phase power from existing gas-fired plant	Natural gas (56.1 tCO_2/TJ)	9,700
Construction total	All sources	–	20,340 (over 33 months)
Operation (per annum)	Reformer fuel (natural gas)	3,753 TJ/year	210,524
Operation (per annum)	Process off-gas combustion	1,663 TJ/year	93,292
Operation (per annum)	Steam generation (boiler)	579 TJ/year	32,504
Operation (per annum)	Power generation (gas turbine generators)	6,096 TJ/year	341,756
Operation (per annum)	Flaring	313 TJ/year	8,514
Operation total	All sources	–	686,590 per annum

Three benchmarks were applied. The Project's net emissions intensity is approximately 0.49 tCO_2e per tonne of urea, below the 0.75–1.27 tCO_2e per tonne typically reported for integrated urea facilities, reflecting natural gas-based production, CO_2 use in urea synthesis and process efficiency; the chapter notes, however, that this net value is not directly comparable with benchmarks that represent gross ammonia emissions. Annual emissions represent approximately 0.20% of Nigeria's estimated national emissions of about 345 million tCO_2e per annum, which is Low in national terms. Against the EBRD thresholds, 686,590 tCO_2e/annum falls in the 100,001–1,000,000 tCO_2e band, rated Medium-High. The overall GHG impact is therefore rated Medium-High. Cumulatively, IFF Line 1 (approximately 688,156 tCO_2e/annum) and IFF Line 2 together would exceed 1,000,001 tCO_2e/annum, which falls in the High benchmark category before mitigation.

Climate-related Transition Risks

Although the Project's emissions are a small share of the national total, their absolute volume is significant at facility level and their effect on climate change is cumulative and global. The Project may also be exposed to transition risks from the shift to lower-carbon industrial development, including evolving environmental regulation, more stringent GHG reporting, potential future carbon pricing, rising energy-efficiency expectations and changing requirements from international financial institutions, investors and customers, which could affect long-term operating costs, financing conditions, competitiveness and commercial resilience. The ESIA identifies these risks qualitatively; they have not been rated and shall be assessed further as they arise.

GHG Mitigation and Residual Emissions

GHG mitigation measures include optimising combustion efficiency in the reformer, boilers and gas turbine generators, heat integration, reducing flaring, preventive and predictive maintenance, monitoring of fuel consumption and emissions, and optimising natural gas use as feedstock and fuel. Indorama has identified four reduction schemes (process optimisation, efficiency improvements and new equipment) to be implemented over three years with an estimated combined reduction of about 227,000 tCO_2e per annum, and a reduction of routine

flaring at a natural gas supplier's facility estimated at about 343,000 tCO_2e per annum, giving a combined potential of approximately 570,000 tCO_2e per annum, subject to implementation and verification. A feasibility study for a carbon capture and storage pilot project, with an indicative potential of approximately 1 million tonnes of CO_2 per annum, has been initiated with the Nigerian Upstream Petroleum Regulatory Commission.

After mitigation, construction-phase GHG emissions remain Nominal / Negligible (low significance). Operational emissions remain Medium-High: even if the full 570,000 tCO_2e per annum of reductions were implemented, verified and attributed to the Project, residual emissions would remain above the 100,000 tCO_2e/annum threshold. The residual cumulative impact with IFF Line 1 is expected to reduce from High to Medium-High, provided that the reduction initiatives are implemented, verified and demonstrably attributed to the Project. Construction fuel use and operational Scope 1 emissions, emissions intensity and the status of the reduction initiatives shall be tracked and reported under the ESMMP.

ES12.0 Residual Impacts

Residual impacts were evaluated following implementation of the proposed mitigation measures and environmental management commitments. The assessment indicates that most environmental and social impacts will be reduced to minor or moderate significance, the principal exception being malfunction of the effluent treatment plant affecting the Okulu River, which remains of Major significance after mitigation (Section 8.2.7, Table 862) and is therefore subject to stringent operational controls, monitoring and emergency containment (Section 9.2.8). No environmental or social fatal flaw has been identified under normal operating conditions. Residual risks associated with abnormal events and cumulative industrial development will be managed through continual monitoring, emergency preparedness and adaptive management.

The significance of each impact before and after mitigation is presented in Table ES-41 (ES10.0), which reproduces the impact summary table of Section 8.7 with the ratings reconciled to the topic assessments in Chapter 8. The key conclusions on residual impacts are:

Key Residual Impacts

The impacts that remain most material after mitigation, and therefore the focus of monitoring and adaptive management under the ESMMP, are:

- Malfunction of the effluent treatment plant affecting the Okulu River – Major Negative (reduced from Critical), retained because of evidence of environmental impact from releases at the existing plant.
- Groundwater abstraction from the new back-up boreholes – Moderate Negative (reduced from Major), pending site-specific pump testing and long-term monitoring; hydrocarbon, chemical and wastewater spills and leaks to groundwater – Moderate Negative.
- Sediment-laden runoff and turbidity from construction earthworks and construction-phase wastewater discharges to the Okulu River – Moderate Negative (reduced from Major); contaminated stormwater from operational process and storage areas – Moderate Negative.
- Traffic operations on the East–West Road – Moderate Negative, unchanged by mitigation because of frequent heavy-truck left-turn movements between the Project and Onne Port.

- Labour influx and community frustration over unmet expectations during construction – Moderate Negative (reduced from Major).
- Physical climate risk from extreme heat – Moderate to High residual materiality – and from extreme rainfall flooding – Moderate; operational GHG emissions – Medium-High.

All positive socio-economic impacts (employment, income and spending, and socio-economic development benefits) are enhanced to Major Positive in both construction and operation. All other adverse impacts are reduced to Minor, Negligible or No Impact, including construction dust, noise, soils, saline intrusion, biodiversity loss and public and worker health, safety and human rights.

Residual Cumulative Impacts

Cumulative impacts were assessed for each environmental topic in combination with the existing Indorama fertilizer and petrochemical complex, IFF Line 1 and other pressures in the AoI. Their significance before and after mitigation is summarised in Table ES-46. The most important residual cumulative impacts relate to extreme heat, groundwater availability, drawdown and quality, and surface water quality and sediment pressure in the already sensitive Okulu River system.

TABLE ES-46: SUMMARY OF CUMULATIVE IMPACTS BEFORE AND AFTER MITIGATION

Topic	Cumulative impact	Before mitigation	After mitigation
Climate change risk	Extreme heat / extreme rainfall flooding	High / Moderate to High materiality	Moderate to High / Moderate
Climate change risk	Wildfires / water stress and drought	Moderate / Moderate materiality	Low to Moderate / Low to Moderate
GHG emissions	Combined operational emissions of IFF Line 1 and IFF Line 2	High	Medium-High (if reduction initiatives are implemented, verified and attributed)
Air quality	In-combination operation of IFF Line 1 and IFF Line 2	Moderate at worst-case receptor (24-hour PM_{10}); no exceedance	No significant adverse cumulative impact
Soils and geology	Erosion and sediment mobilisation; compaction; contamination; soil-water balance	Moderate Negative (each)	Minor Negative (each)
Soils and geology	Geology	Negligible / not material	Negligible / not material
Groundwater	Reduced availability and sustainable yield; drawdown and wellfield interaction	Major Negative (each)	Moderate Negative (each)
Groundwater	Deterioration in groundwater quality	Moderate Negative	Moderate Negative
Groundwater	Groundwater–surface water interaction	Moderate Negative	Minor to Moderate Negative
Groundwater	Vertical preferential flow between aquifers	Moderate Negative	Minor Negative
Surface water	Surface water quality deterioration; sediment disturbance and turbidity	Major Negative (each)	Moderate Negative (each)

Topic	Cumulative impact	Before mitigation	After mitigation
Surface water	Changes to flow and runoff behaviour	Moderate Negative	Minor Negative
Surface water	Thermal and nutrient loading	Moderate to Major Negative	Moderate Negative
Biodiversity	Landscape-scale habitat loss and aquatic degradation	Not rated	Minor Negative; no net loss expected, no offsets required at this stage
Traffic and transport	Congestion, road deterioration and road safety	Medium priority	Unchanged by mitigation

Residual and cumulative impacts shall be tracked through the ESMMP monitoring programme and the shared, trigger-based monitoring arrangements recommended by the RCIA.

ES13.0 Mitigation Measures

Mitigation measures have been developed in accordance with the mitigation hierarchy of avoid, minimise, restore and offset, and are based on Good International Industry Practice (GIIP). Key measures include pollution prevention and control technologies, efficient resource utilisation, wastewater treatment, spill prevention and emergency response systems, biodiversity protection, occupational and community health and safety measures, labour management procedures, local content initiatives, stakeholder engagement, grievance management and comprehensive environmental and social monitoring programmes.

The proposed measures aim to prevent or minimise adverse environmental and social impacts while enhancing project benefits. Implementation will be coordinated through the Environmental and Social Management and Monitoring Plan and the wider Environmental and Social Management System.

Approach to Mitigation and the Mitigation Hierarchy

Mitigation has been developed in accordance with the mitigation hierarchy of avoid, minimise, restore and offset / compensate where relevant, with priority given first to measures applied at the source of an impact and only then to abatement, compensatory measures or offsets for the residual effect on the receptor. Embedded controls, being the physical and procedural controls already planned as part of the Project design or existing Indorama procedures, were taken into account before impact significance was assigned. Additional measures were then declared where impacts were significant, with the objective of reducing impacts to "as low as reasonably practicable" (ALARP) levels rather than declaring measures for impacts already rated not significant.

Each measure is designed to be specific, practical, measurable and capable of implementation through the Project's management system. The ESIA maintains a direct line of traceability from baseline condition, to impact pathway, to significance assignment, to mitigation measure, to residual significance and finally to the monitoring requirement, and this linkage is carried forward from Chapter 8 into Chapter 9 and the standalone ESMMP (Appendix C). Annex E of the ESMMP provides a consolidated set of operational compliance tools supporting IFC PS3 and AfDB OS3 requirements for air emissions, effluent management, resource efficiency and hazardous materials management.

Table ES-47 summarises, for each key impact, the embedded design mitigation, the additional construction and operational mitigation, any enhancement or offset measures, and the resulting residual significance. Topic-specific detail is provided in the sub-sections that follow.

TABLE ES-47: SUMMARY OF MITIGATION BY MITIGATION HIERARCHY CATEGORY AND RESIDUAL SIGNIFICANCE

Key impact	Embedded design mitigation	Additional construction / operational mitigation	Enhancement / offset	Residual significance
Climate risk – extreme heat (workers, electrical equipment, infrastructure)	Heat-resilient design specifications for substations, generators, transformers, inverters and other temperature-sensitive systems; thermal resilience of roads, paved areas and exposed infrastructure	Heat-stress procedures (work-rest cycles, shaded rest areas, drinking water for outdoor workers, hydration, medical response); work scheduling in extreme heat; weather-triggered preparedness; review of temperature-sensitive electrical equipment and cooling options; routine condition checks; complex-wide coordination of cooling demand and electrical load	Future physical CCRA risk review aligned to EP4 (2023); annual climate risk review	Moderate to High
Climate risk – extreme rainfall flooding	Drainage tied into existing lined channels, culverts and retention pond system; conservative flood allowances; siting / elevation of vulnerable equipment; retention pond outflow, discharge point and critical infrastructure confirmed against 1:50 and 1:100-year floodline study	Routine inspection and desilting of drains and culverts; flood-resilient protection of substations, generators, pipelines and access; Emergency Evacuation Policy, OHS Policy, flood drills; wet-season logistics planning; post-event runoff and sanitation checks	–	Moderate
Climate risk – wildfires	Fire detection, alarm and suppression systems	Vegetation and fuel-load control; power-line maintenance; housekeeping around urea and ammonia storage; Fire Policy and Emergency Evacuation Policy with training and drills; coordinated site-wide emergency response and access management	–	Low to Moderate

Key impact	Embedded design mitigation	Additional construction / operational mitigation	Enhancement / offset	Residual significance
Climate risk – water stress and drought	Water recovery and reuse within closed-loop process water system	Water Management Plan; contingency supply (back-up storage, rainwater harvesting, agreements with local authorities); trigger-based abstraction management; dry-period dust management planning	–	Low
GHG – construction (20,340 tCO_2e over 33 months)	–	Fuel-efficient, well-maintained equipment and vehicles; optimised logistics; minimised idling; efficient sizing of temporary diesel generators; monthly fuel and tCO_2e tracking	–	Nominal / Negligible to Low
GHG – operation (686,590 tCO_2e/annum)	Integrated ammonia–urea design using process CO_2 in urea synthesis; heat recovery (e.g. waste heat from reformer and gas turbines)	Combustion optimisation of reformer, boilers and gas turbines; heat integration and process control; flare minimisation; preventive and predictive maintenance; LDAR; energy management and benchmarking; four reduction schemes (~227,000 tCO_2e/annum) by 2027–2028	Supplier flare reduction programme (~343,000 tCO_2e/annum, under assessment), giving ~570,000 tCO_2e/annum combined; CCS pilot (~1 Mt CO_2/annum, feasibility stage, not counted); reductions counted only once verified and allocated to the Project	Medium-High (cumulative with IFF Line 1: High reducing to Medium-High if reductions achieved)
Air quality – construction dust	Existing 20 kph construction site speed limit; existing wetting procedure for exposed surfaces and use of wetting trucks	Dust management procedure with dust deposition, dust flux, PM10 and visual monitoring and action levels; layout away from receptors; enclosures; covered loads and enclosed cement delivery; wheel washing and water-assisted sweeping; progressive stabilisation; no burning of waste; complaint recording and response	–	Negligible to Minor

Key impact	Embedded design mitigation	Additional construction / operational mitigation	Enhancement / offset	Residual significance
Air quality – operation	Selective catalytic reduction (SCR) and low-NOx burners at the primary reformer; ammonia recovery from purge and flash gas; granulator dust recovery limiting urea dust and ammonia to < 50 mg/Nm³	No further mitigation required as no air quality standard exceedance is predicted; ongoing monitoring and good operational practice	–	Minor (cumulative: Low)
Noise – construction and operation	Low-noise design specifications for compressors, blowers and pumps; permanent enclosures, silencers and acoustic barriers	Silenced, well-maintained plant; lower sound power equipment; traffic management near receptors; temporary barriers; contractor noise training; investigation of abnormal noise; attended monitoring (LAeq, LAmax) at NSRs and post-commissioning verification; at N3, temporary barriers, siting of stationary plant, low-noise piling and restricted hours for high-noise works	–	Negligible (Minor at N3 during the noisiest construction works)
Soils – erosion, compaction, contamination, soil-water balance	Secondary containment of 110% of total tank / vessel capacity; designated workshops with oil and grease traps; integration with existing stormwater system	Restricted clearance and footprint; topsoil stripping and stockpiling; Erosion and Sediment Control Plan; Spill Prevention, Control and Containment Plan; excavation of contamination to depth; ripping and reinstatement of compacted soils; Stormwater Management Plan; soil quality monitoring	Progressive re-vegetation using local species	Minor

Key impact	Embedded design mitigation	Additional construction / operational mitigation	Enhancement / offset	Residual significance
Groundwater – spills, abstraction, saline intrusion, dewatering, inter-aquifer flow	Three new boreholes as back-up supply only, sited away from community wells and screened ≥ 15 m below static water level; bunding to 110% of largest vessel; impermeable hardstanding to oil/water separators; retention ponds with freeboard and high-level alarm	Pump testing before commissioning; quantitative cumulative drawdown assessment; abstraction capped within sustainable yield and intermittent operation; metering and trigger-level monitoring; EC/TDS saline-intrusion early warning; model update at least every two years; full grout seals and cement-bond testing; controlled dewatering; Groundwater Management Plan; grievance route for water availability	–	Spills: Moderate; abstraction: Moderate (from Major); saline intrusion, dewatering, inter-aquifer flow, ETP overflow: Minor
Surface water – effluent, stormwater, thermal and nutrient loading	Closed-loop water management (condensate strippers, hydrolyser, polisher, blowdown to wastewater recovery plant); zero discharge under normal operation; closed-circuit cooling towers, engineered mixing zone and diffuser (ΔT ≤ 3 °C); sewage to existing IFF Line 1 treatment plant; stormwater segregation and first-flush capture	Erosion and Sediment Control Plan before ground disturbance; Emergency Spill Response Plan; CPI separators and oil skimmers; neutralisation pit; effluent verification against FMEnv and IFC EHS limits before any release; Okulu River upstream, downstream and reference monitoring with action thresholds; construction water from treated reuse water	–	Contaminated stormwater: Moderate; ETP malfunction / overflow: reduced but Moderate for some operational pathways
Biodiversity and ecosystem services	Location within modified brownfield habitat in the Indorama Free Zone; wildlife-sensitive lighting design; site drainage design	Demarcation of work areas; Biodiversity Management and Monitoring Plan (invasive plant control, threatened species monitoring, daily fauna checks, faunal incidence register); daytime works where possible; threatened trees spared; prohibition of plant / animal collection; waste and emergency plans aligned to biodiversity	Landscaping with indigenous species; no offsets required at this stage (no net loss expected, to be confirmed through ESMS monitoring)	Minor

Key impact	Embedded design mitigation	Additional construction / operational mitigation	Enhancement / offset	Residual significance
Employment, income and economic development (positive)	–	–	Local Content and Procurement Plan; priority hiring from host communities and Rivers State; skills and SME database; vocational training; inclusion of women, youth and vulnerable groups; SED / CSI programmes aligned with updated community MoUs	Construction: Major Positive (enhanced); Operation: Major Positive (from Moderate)
Labour influx and pressure on services	–	Labour Influx Management Plan; local hiring priority; worker accommodation where required; monitoring of pressure on services; coordination with local authorities; contractor workforce and community conduct requirements; monthly influx monitoring	Co-investment or partnership in infrastructure where feasible	Construction: Moderate; Operation: Minor
Community expectations and social conflict	–	Transparent recruitment; communication of employment limits and timelines; engagement with traditional leaders, CDCs and PAC; grievance mechanism; expectation management	Transparent, consistent benefit-sharing	Construction: Moderate; Operation: Minor
Community and worker health, safety and human rights	–	Traffic and transport management; Emergency Preparedness and Response Plan (EPRP); Hazardous Waste Management Plan (HWMP); public health and communicable disease awareness; contractor OHS compliance; coordination with authorities on health and emergency capacity; alignment with wider industrial emergency response	–	Minor (construction and operation)

Key impact	Embedded design mitigation	Additional construction / operational mitigation	Enhancement / offset	Residual significance
Cultural heritage – chance finds	Layout confirmed so that no known cultural heritage resource lies within the construction footprint (all 21 identified resources outside)	Chance Finds Procedure (stop work, demarcate, notify Project management and NCMM, specialist assessment, resume only after clearance); awareness training, toolbox talks and signage; continued engagement	–	No impact / Negligible
Traffic and transport	Established Indorama procedures including vehicle maintenance checklist; routing via the Northeast Gate and Agbonchia New Road	Comprehensive Transportation Management Plan: road maintenance, active traffic management for ODC / super ODC deliveries from Onne Port, driver qualification and training, rest standards, drug and alcohol testing, speed governors and GPS, daily vehicle checks, covered and non-overloaded loads, wetting trucks and cleaning station	–	Traffic operations: Moderate; infrastructure and safety: Minor

Climate Resilience

IFF shall protect workers, equipment and infrastructure from extreme heat, flooding, wildfire and water stress through resilient design, maintained drainage, fire protection and contingency water supplies. Apply heat-stress procedures, emergency training and evacuation drills, with coordinated planning across shared facilities and access routes.

In response to the extreme heat hazard, which retains a Moderate to High residual materiality, IFF shall implement workforce heat-stress management procedures covering work–rest cycles, shaded rest areas, provision of drinking water to outdoor workers, hydration and medical response arrangements, and shall schedule work during extreme heat periods to reduce the exposure of construction and operational personnel. IFF shall identify temperature-sensitive electrical infrastructure and equipment through a review of all major operating electrical equipment against its key specifications, evaluate air or water cooling options or alternatives where cooling is not feasible, and carry out regular condition checks so that early-stage heat stress or damage is identified and repaired. Weather-triggered preparedness measures shall ensure that extreme heat warnings lead to timely restrictions, adjustments or protective actions across adjacent facilities.

IFF shall maintain an Emergency Response Plan, Emergency Evacuation Plan, Fire Policy and Occupational Health and Safety Policy covering flooding, extreme temperature and fire events, with site personnel trained and drills practised. Climate-related mitigation shall be integrated with the wider site stormwater and flood management system, occupational health, safety and emergency response procedures, shared utility and water arrangements, transport and access management, and stakeholder communication and grievance mechanisms. The identified risks

shall be taken through a more detailed future physical climate change risk review and risk rating aligned to EP4 (2023), with the climate risk register reviewed annually and after major climate-related incidents or design / operational changes.

Greenhouse Gas Emissions

IFF shall reduce emissions through efficient fuel use, heat recovery, process optimisation, preventive maintenance, flare minimisation and leak detection and repair.

Planned efficiency improvements and supplier flare-reduction initiatives have a combined potential benefit of approximately 570,000 tonnes of CO_2 equivalent annually, subject to implementation, verification and attribution to the project. Carbon capture and storage remains a feasibility-stage opportunity.

Indorama has identified four GHG emission reduction schemes for implementation over a three-year period, comprising process optimisation, operational efficiency improvements and new hardware, with a combined estimated reduction of approximately 227,000 tCO_2e per annum. A further flare reduction programme at a natural gas supplier's facility has an estimated net reduction potential of approximately 343,000 tCO_2e per annum, giving a combined potential of approximately 570,000 tCO_2e per annum against the Project's estimated operational emissions of approximately 686,590 tCO_2e per annum. A Carbon Capture and Storage (CCS) pilot feasibility study is being undertaken with the Nigerian Upstream Petroleum Regulatory Commission (NUPRC), with an indicative sequestration potential of approximately 1 million tonnes of CO_2 per annum; this is prospective and is not included in the quantified reductions. The initiatives are summarised in Table ES-48.

TABLE ES-48: PLANNED GHG REDUCTION INITIATIVES

Initiative	Type	Estimated reduction (tCO_2e/annum)	Status	Target completion
GT6 Performance Improvement (PIP)	Operational improvement	14,000	Planned	2027
HRSG 5 installation	New hardware	79,000	Planned	2027
HP gas utilisation in reformer	Operational improvement	55,000	Planned	2027
HRSG 6 installation	New hardware	79,000	Planned	2028
Flare reduction programme (natural gas supplier facility)	New hardware	343,000	Under assessment	Ongoing
CCS pilot project (not counted in totals)	Carbon capture and storage	1,000,000	Feasibility stage	Ongoing

All GHG mitigation and reduction measures shall be integrated into the ESMMP. Any claimed reduction or offset, including the supplier flare reduction programme, shall be implemented, verified and allocated to the Project before it is counted against the Project emissions profile, and achieved reductions shall be formally tracked against the estimated annual values through quarterly implementation reviews and an annual verified GHG statement. If the reductions are achieved and attributed to the Project, the cumulative operational GHG impact of IFF Line 1 (approximately 688,156 tCO_2e/annum) and IFF Line 2 is expected to reduce from High to Medium-High under the adopted benchmark framework, but will remain material. The

measures are consistent with IFC PS3 and AfDB OS3 requirements to consider technically and financially feasible options for reducing project-related GHG emissions.

Air Quality

IFF shall control construction dust through surface wetting, covered loads, speed restrictions, wheel washing, protected stockpiles and progressive stabilisation of exposed ground. Maintain operational emission controls, including selective catalytic reduction at the reformer, and use monitoring and complaint investigations to trigger corrective action.

Noise

IFF shall use low-noise equipment, silencers, acoustic enclosures and appropriate barriers. Maintain machinery, manage vehicle movements near sensitive receptors and investigate abnormal noise. Undertake monitoring during construction, after commissioning and periodically during operation.

Soils and Geology

IFF shall restrict clearance and vehicle movements to designated areas, conserve topsoil and progressively rehabilitate disturbed ground. Prevent contamination through secure chemical storage, secondary containment, designated maintenance areas and prompt spill response. Coordinate erosion, drainage and contamination controls across the wider complex.

Groundwater Protection

IFF shall protect groundwater through impermeable handling areas, spill prevention, sound borehole construction and controlled dewatering. Before commissioning new boreholes, complete pumping tests and assess cumulative drawdown alongside existing abstraction.

Limit pumping to confirmed sustainable yields, operate backup wells intermittently and monitor groundwater levels, quality and salinity. Adjust abstraction where monitoring identifies pressure on aquifers or community supplies.

Production wells shall be screened and installed at least 15 m below the static water level, and no further boreholes shall be added without prior hydrogeological assessment and recalibration of the numerical groundwater model, which shall be updated at least every two years or following major operational changes. A saline-intrusion early-warning protocol shall monitor electrical conductivity and total dissolved solids in the boreholes nearest the river and creek, with abstraction scheduling adjusted to reduce pumping stress near the southern boundary should an inland salinity trend be detected. New boreholes shall be constructed with full grout annular seals isolating the shallow, intermediate and deep aquifers, with cement-bond integrity testing on completion and proper sealing of any redundant or test boreholes. These controls shall be implemented through a Groundwater Management Plan and a centralised groundwater monitoring and reporting framework across the wider Indorama complex.

Surface Water and Wastewater

IFF shall separate clean stormwater from potentially contaminated runoff, install erosion and sediment controls, and maintain drainage and retention capacity. Maximise wastewater treatment, recovery and reuse, with quality verification before any controlled release.

Monitor effluent, river water and sediments at appropriate upstream, downstream and reference locations. Maintain temperature and nutrient controls to protect the Okulu River and connected downstream ecosystems.

Under normal operation, wastewater from IFF Line 2 shall be processed, recovered and reused, with no routine discharge to surface water. Discharge to the Okulu River shall occur only during wastewater recovery plant shutdowns, via the existing IFZ1/IFZ2 holding and retention ponds, when the retention pond is full and after verification against FMEnv and IFC EHS Guideline limits for ammoniacal nitrogen, nitrate, BOD/COD, TSS, oil and grease, pH and temperature. Thermal discharge shall be controlled through closed-circuit cooling towers, an engineered mixing zone, diffuser design and continuous temperature monitoring, maintaining a temperature differential of no more than 3 °C above ambient at the edge of the mixing zone.

Biodiversity and Ecosystem Services

IFF shall implement a biodiversity management and monitoring plan covering threatened species, invasive plants, wildlife protection and habitat rehabilitation. Demarcate work areas, inspect for trapped fauna, minimise disruptive lighting and prohibit illegal wildlife collection. Integrate biodiversity safeguards into waste management and emergency response.

The Biodiversity Management and Monitoring Plan shall be carried over and adapted for the operational phase and reviewed at least every five years, with adaptive updates where required. Because the Project lies within predominantly modified habitat that does not support critical or unique biodiversity features, no biodiversity offsets are required at this stage; this conclusion is to be confirmed through ongoing ESMS monitoring.

Socio-Economic Management

IFF shall prioritise local recruitment, procurement, skills development and small-business participation, including opportunities for women, youth and vulnerable groups. Clearly communicate employment criteria and the temporary nature of construction jobs.

IFF shall manage labour influx, accommodation and pressure on services through contractor controls and coordination with authorities. Maintain community engagement, development commitments, public-health measures and accessible grievance procedures.

These commitments shall be delivered through a Local Content and Procurement Plan, a Labour Influx Management Plan, community investment programmes (SED / CSI) aligned with updated community MoUs, and continued engagement with traditional leadership, Community Development Committees (CDCs) and the Project Advisory Committee (PAC). To protect community health and safety, IFF shall implement traffic and transport management measures, an Emergency Preparedness and Response Plan (EPRP) and a Hazardous Waste Management Plan (HWMP), promote public health and communicable disease awareness, enforce contractor compliance with OHS requirements, and coordinate with local authorities on health and emergency response capacity. At the cumulative level, IFF shall coordinate local hiring, influx monitoring, infrastructure planning and emergency preparedness with other developments and with government.

Cultural Heritage

IFF shall avoid known heritage resources and train personnel to recognise potential discoveries. Where a chance find occurs, stop work, secure the area, notify the relevant authorities and obtain specialist assessment and clearance before resuming activities.

Traffic and Transport

IFF shall implement a transport management plan covering routing, oversized deliveries, road maintenance, driver competence, fatigue and speed control. Maintain project and contractor vehicles, conduct daily safety checks and provide reliable communications. Secure loads, prohibit overloading and use dust suppression and vehicle cleaning to protect public roads.

The Transportation Management Plan shall extend the plans developed for previous projects at the Indorama site and shall include active traffic management during ODC and super ODC deliveries along the route from Onne Port to the Project site, especially at intersections on the East West Road. Truck contracts shall avoid incentives for speeding or insufficient fatigue breaks, trucks shall be fitted with speed governors and on-board GPS, and, to the degree permissible by law, daily or periodic drug and alcohol testing shall apply to all drivers.

Monitoring and Coordination

IFF shall assign clear responsibilities, performance indicators and reporting requirements for environmental and social controls. Track emissions, water conditions, incidents, local participation, labour influx and grievances. Review cumulative trends across the complex and use monitoring results to update management measures and address emerging risks.

ES14.0 Major Accident Hazards, Process Safety and Emergency Preparedness

IFF Line 2 will handle and store significant inventories of hazardous substances, principally natural gas and hydrogen-rich synthesis gas (flammable), anhydrous ammonia (toxic and flammable) and, for the UFC-85 plant, methanol and formaldehyde. Consistent with AfDB OS4 (paras 25–31) and IFC PS4, process safety and emergency preparedness are managed through the inherent safety of the proven design replicated from IFF Line 1, engineered safeguards, a complex-wide Quantitative Risk Assessment (QRA) and an Emergency Preparedness and Response Plan (EPRP). The full assessment is presented in Section 8.4.8 of the ESIA.

Embedded Process Safety Design

IFF Line 2 replicates the process technology, equipment sizing, isolatable inventories and layout of IFF Line 1, which has been in safe operation since June 2026, and is designed to internationally recognised codes (ANSI, ASME, NACE, NFPA, IEC and IEEE). Key safeguards include an integrated Distributed Control System and Emergency Shutdown System (DCS/ESD), a Fire and Gas System (gas, ammonia and fire detectors, alarms, deluge systems, FM-200 suppression and hydrant network), relief valves and pressure-control devices sized for worst-case conditions and connected to dedicated flares, remotely operated isolation valves, and a 24-hour manned fire station serving the complex.

Quantitative Risk Assessment – Existing Complex

The risk profile of the Indorama complex has been assessed through successive QRAs undertaken by DNV using the Safeti software, the most recent being the IEFCL Line-3 QRA (DNV Report No. 10405953-002, Rev. 1, 11 December 2023), which covers the IEPL

petrochemical complex and fertilizer Lines 1–3. In the absence of Nigerian risk criteria, UK HSE tolerability criteria are applied: an upper individual risk limit of 10^{-4} per year for members of the public, an additional location-specific individual risk (LSIR) criterion of 10^{-5} per year for off-site residential populations, and an F-N criterion line through 2×10^{-4} per year for 50 fatalities. The principal findings are summarised in Table ES-49.

TABLE ES-49: SUMMARY OF THE COMPLEX QRA (DNV, DECEMBER 2023) RELEVANT TO IFF LINE 2

Aspect	Finding of the 2023 QRA	Relevance to IFF Line 2
Dominant hazard	Site risk is dominated by toxic ammonia releases from the ammonia trains; fire and explosion hazards are largely confined to the main plant area	IFF Line 2 adds a further ammonia train to the north of the complex
On-site risk	LSIR above 10^{-2} per year is localised to the ammonia lines; control rooms designed for blast and radiation loads at the 10^{-4} per year dimensioning frequency	Same design basis applied to IFF Line 2
Key recommendations	Confirm ammonia leak detection and isolation performance; update the Emergency Management Plan and emergency communication protocols; monitor residential development to the north/north-west; emergency announcement, CCTV and breathing apparatus in new line areas; preventive maintenance and emergency drills	Carried forward as IFF Line 2 commitments

QRA Update for IFF Line 2 (Line 4), FCU-3 and UF-85

IFF has engaged DNV to update the integrated complex QRA model (proposal OPP-00483666, October 2026) to incorporate IFF Line 2 (Line 4), a third Feed Conditioning Unit (FCU-3) and the UF-85 plant with its methanol storage and road-tanker operations, together with the ammonia storage and export road-tanker facilities. The update will quantify the risks of each development individually and cumulatively for on-site personnel, assets and off-site populations, evaluate them against the established criteria, and identify risk-reduction measures needed to demonstrate that risks are As Low As Reasonably Practicable (ALARP). The QRA is scheduled for completion by December 2026, before commissioning of IFF Line 2.

- IFF shall share the draft and final QRA reports with AfDB and the other lenders and incorporate all QRA recommendations into detailed design, the ESMMP and the EPRP before commissioning.
- IFF shall not commission IFF Line 2 until the QRA confirms that off-site individual and societal risks lie within the tolerable (ALARP) region, or until the additional risk-reduction measures identified by the QRA have been implemented.
- IFF shall continue to monitor land use and residential development within the off-site risk contours to the north and north-west of the complex and engage the Rivers State and Eleme Local Government planning authorities accordingly.

Emergency Preparedness and Response

A consolidated EPRP for IFF Line 2, combining the existing on-site Emergency Response Plan and off-site emergency plan of the complex is available. It covers ammonia and gas releases, fires and explosions, spills of hazardous materials, extreme weather and flooding, and medical emergencies, and defines emergency organisation and command, detection and alarm, notification of FMEnv, NESREA, RSMEnv, the State Emergency Management Agency, fire and police services and the lenders, community alert and evacuation procedures for the host

communities, mutual aid with neighbouring facilities, and training and drills. IFF shall review it at least every three years or after any significant change or incident.

ES15.0 Environmental and Social Management Framework

IFF's existing Environmental and Social Management System (ESMS), supported by the Project Environmental and Social Management and Monitoring Plan (ESMMP, Appendix C) and associated management plans, will guide implementation of mitigation measures throughout the Project life cycle. The framework establishes institutional responsibilities, environmental and social monitoring requirements, reporting procedures, performance indicators, audit mechanisms, corrective actions and adaptive management processes to ensure continual compliance with regulatory and lender requirements.

Institutional Arrangements and ESMS

The ESMMP forms an integral part of the wider ESMS for the Project. The ESIA defines the impacts and mitigation measures, while the ESMS provides the framework through which those measures are implemented, monitored, checked and continually improved, in alignment with IFC PS1 and AfDB OS1. The ESMS supports the prioritisation and management of significant impacts, implementation of the ESIA and ESMMP measures, compliance monitoring, inspection, auditing and reporting, integration of environmental, social and health considerations into decision-making, and management of unforeseen impacts or changes during construction or operation.

IFF, as the Project Implementing Entity, has overall responsibility for implementing the ESMMP, including provision of financial, human and technical resources, statutory approvals, contractor compliance, stakeholder engagement, grievance management, monitoring, incident reporting, corrective action and periodic review of ESMMP performance. IFF already operates an ESMS, HSE and Community Relations & Development functions and a grievance mechanism for the existing Lines 1, 2 and 3 and the wider Indorama complex. The roles of the Project Management Team, the HSE / Environmental and Social Management Team, Engineering / Operations, Procurement / Contract Management, contractors, regulators and host community structures are set out in Table ES-4. The monitoring frameworks further assign accountability to named functions, including the ESMS Manager, Site HSE Manager, Sustainability Lead, Utilities and Water Management Lead, Emergency Response Lead, Community Relations Team / Grievance Manager and IFF HR and Procurement.

ESMMP and Management Plans

A standalone ESMMP has been prepared for the Project and is included as Appendix C. It sets out the management, mitigation and monitoring measures for the pre-construction, construction and operational phases and serves as the operational bridge between the ESIA findings and Project implementation. Its main functions are to convert ESIA mitigation into defined actions, identify monitoring parameters and performance requirements, allocate responsibilities through the ESMS, provide the basis for corrective action and adaptive management, and require contractors and subcontractors to align their procedures with the Management Plans. The Management Plans are to be refined as detailed design progresses and reflected in contractor method statements, procedures and work practices. The management plans and procedures named in the ESIA are listed in Table ES-50.

TABLE ES-50: MANAGEMENT PLANS AND PROCEDURES NAMED IN THE ESIA

Theme	Plans and procedures	Source
Air, noise and pollution prevention	Dust / environmental management procedure with action levels; stakeholder communications procedure; Noise Management and Monitoring Plan (NMMP); ESMMP Annex E operational compliance tools (PS3 / OS3)	§9.1, §9.2.4.1.1, §9.2.5
Soils, water and spills	Erosion and Sediment Control Plan; Stormwater Management Plan; Spill Prevention, Control and Containment Plan; Emergency Spill Response Plan; Groundwater Management Plan; Surface Water Management framework; Water Management Plan	§9.2.1.1, §9.2.6.2, §9.2.7.2.6, §9.2.8
Waste and hazardous materials	Waste Management Plan / waste-control plan; Hazardous Waste Management Plan (HWMP)	§9.2.8.1.1, §9.3, §9.4.1.5
Biodiversity	Biodiversity Management and Monitoring Plan, incl. alien invasive plant control guidelines, faunal handling and release procedure, faunal incidence register, landscaping and rehabilitation guidelines	§9.3
Climate and GHG	Climate risk monitoring framework and risk register; GHG monitoring, reporting and verification framework; energy management and benchmarking system	§9.2.2, §9.2.2.1, §9.2.3.3
Social and stakeholder	Stakeholder Engagement Plan (SEP, Appendix B); Stakeholder / Community Grievance Management Procedure; Social Management Plan; Local Content and Procurement Plan; Labour Influx Management Plan; community investment (SED / CSI) aligned with MoUs	Ch 6; §9.4.1, §9.4.3; Ch 2 Table 15
Labour and workers	Labour Management Procedures; worker grievance mechanism; code of conduct and SEAH / GBV prevention and response protocol; IFZ labour, GBVH, anti-retaliation, confidential reporting and independent contractors' policies; Contractor ESMP	Ch 2 §2.7, P1168, compliance matrix (OS2, OS4)
Health, safety and emergency	Emergency Preparedness and Response Plan (EPRP); Emergency Evacuation Plan / Policy; Fire Policy; OHS Policy (incl. extreme heat); security management framework; Transportation Management Plan (TMP)	§9.2.1.1, §9.4.1.5, §9.6; Ch 2 compliance matrix (OS4)
Cultural heritage and change	Chance Finds Procedure (CFP); Management of Change process	§9.5.2.2, §11.2.2

Contractor Management

Environmental and social requirements, performance standards and regulatory obligations shall be written into tender documents, contracts and purchase orders, and contractors shall be prequalified on technical, financial, HSE and environmental capacity before mobilisation. Each major contractor shall designate competent HSE / E&S personnel, prepare a Contractor ESMP, method statements and task-specific plans, and implement the applicable ESMMP requirements within its area of responsibility. Contractors working with IFF are required to comply with the IFZ internal policies, including the Grievance Handling and Management Policy, Anonymous Grievance Handling Mechanism, Child Labour Prohibition, Human Rights, Non-discriminatory, Work Place Discipline, Security and Safety, and Employee Compensation policies. Contractor performance shall be verified through induction, routine inspections, audits, toolbox meetings, monitoring and corrective-action tracking, with an annual labour compliance review of suppliers and subcontractors (more frequently for high-risk contracts).

Capacity Building and Training

The HSE / E&S team shall be strengthened with additional competent personnel and specialists where required, particularly during peak construction, and qualified consultants shall be

engaged where specialist expertise is not available internally. Training commitments identified in the ESIA include: contractor training on noise awareness; training of contractors and staff on safe handling, transfer and transport of hazardous substances; trained spill response personnel; flood, fire and heat emergency drills; fauna and flora toolbox talks; cultural heritage awareness training and toolbox talks for all personnel involved in ground disturbance; driver training, defensive driving and testing; and health education for workers with an aim of 100% worker coverage. Community structures (CDCs, cluster heads and CLOs) require training in grievance handling and participatory environmental monitoring, and the Project shall support community skills development, vocational training and SME capacity building.

Grievance Redress Mechanism

A Stakeholder / Community Grievance Management Procedure (2018), applied across the existing site and updated for expansions, provides the structure for grievance submission, resolution and monitoring. The mechanism is designed to provide accessible submission channels, systematic handling and recording, defined responsibilities and periodic monitoring and reporting. Grievances are tracked through a grievance register, reviewed by PAC sub-committees on grievance management, and reported transparently by category, trend and corrective action. The mechanism also captures complaints on water availability, water quality, dust and climate-related concerns, and grievance performance (% resolved within the agreed timeframe) is reported monthly.

For workers, the IFZ policies extended to IFF Line 2 provide for a Grievance Handling and Management Policy and an Anonymous Grievance Handling Mechanism, an Anti-Retaliatory Policy that requires business partners to provide grievance access without fear of retaliation, and a Confidential Reporting Policy. The ESIA compliance crosswalk commits to a worker grievance channel separate from the community mechanism, with an anonymity option, and to a code of conduct, a SEAH / GBV prevention and response protocol and a confidential reporting route, to be implemented through the ESMMP and SEP. The IFZ Gender Based Violence and Harassment Policy, 2026 (Rev. 2) sets zero tolerance for GBVH and provides an integrated framework for grievance management with a focus on GBVH.

Reporting, Performance Indicators and Adaptive Management

The management framework includes internal reporting, to identify and correct environmental, social and health and safety non-conformances, and external reporting on issues of interest to communities, regulators and other stakeholders. Monitoring data generated under the ESMMP are reviewed by the Project, and annual performance reporting supports review of performance and the setting of targets for subsequent periods. Routine reporting includes monthly construction E&S, OHS, waste and traffic reports, quarterly ESMS / ESMMP, social performance, grievance and spill reports, and annual GHG inventory, verified GHG reduction statement and climate risk review reports. Key performance indicators include zero fatalities, zero gate hiring, the percentage of local employment and procurement, the percentage of grievances resolved within the agreed timeframe, erosion and sediment controls in place at 100% of active areas, and the proportion of the estimated 570,000 tCO_2e/annum reduction realised.

The environmental and social performance monitoring report shall be submitted to the lenders at the frequencies summarised in Section 5.7.5 (Table 5-18A), i.e. quarterly during construction and annually (Annual Monitoring Report) during operation, or as stipulated in the

Common Terms Agreement, and AfDB and other lenders will provide independent safeguard oversight through review of documentation and monitoring of ESMMP implementation. FMEnv provides regulatory oversight through approval conditions, inspections and review of compliance reports, supported by NESREA enforcement during operation, Rivers State Ministry of Environment monitoring and inspections, and NCMM engagement for any chance find. Lender comments on the ESIA are addressed in tracked and clean versions, and the final ESIA with a comments-response matrix is submitted to FMEnv for approval. IFF is responsible for incident reporting, with centralised incident reporting across the complex and event-based escalation reporting for climate-related events.

Monitoring results shall be used for adaptive management: where results or changing Project conditions indicate the need, corrective actions shall be implemented, and trigger-based responses apply to groundwater abstraction, salinity and water supply. The groundwater model shall be updated at least every two years, the Biodiversity Management and Monitoring Plan reviewed at least every five years, the climate risk register reviewed annually, and any future change in land requirements or access restrictions addressed through the Management of Change process. The SEP commits Indorama to timely disclosure of environmental monitoring results and ESMP implementation status through quarterly PAC communiqués, public notices and community briefings.

Audits and Review

The ESMS provides for compliance monitoring, inspection and auditing. The HSE / E&S team conducts inspections and audits and initiates corrective actions, contractor performance is subject to audits, waste contractor facilities are audited at the start of construction and regularly thereafter, HR audits verify local employment quarterly, and GHG reductions are subject to annual internal or third-party verification. Independent consultants support monitoring, audits and independent verification where required. During operation, periodic reviews of cumulative impacts and ESMS performance are required to support continuous improvement.

ES16.0 Environmental and Social Monitoring

A comprehensive environmental and social monitoring programme has been developed to evaluate compliance with regulatory standards, verify the effectiveness of mitigation measures and support continual improvement. The programme includes routine monitoring of air quality, greenhouse gas emissions, noise, surface water, groundwater, wastewater, biodiversity, waste management, occupational health and safety, community health and safety, stakeholder engagement, grievance management and overall environmental and social performance throughout all phases of the Project. The construction and operation phase monitoring programmes are summarised in Table ES-51 and Table ES-52 below.

TABLE ES-51: CONSTRUCTION MONITORING

Ref No.	Monitoring Topic	Monitoring Measure / Parameter	Timing and Frequency	Target / Performa Indicator
1	Air Quality	Undertake regular on-site and off-site inspection, where receptors (including roads) are nearby, to monitor dust and visible emissions. Carry out regular site inspections to verify compliance with the ESMMP dust and emissions	Throughout construction	Recommendations a corrective actions ta when dust generation combustion issues noted. Complai

Ref No.	Monitoring Topic	Monitoring Measure / Parameter	Timing and Frequency	Target / Performa Indicator
		controls. Increase the frequency of inspections during dry, windy, or high-dust activities.		managed through grievance mechanism.
2	Construction GHG Emissions	Track diesel and other fuel consumption associated with construction vehicles, generators, and major equipment. Estimate construction-phase GHG emissions using Project-approved accounting methodology.	Monthly during active construction	Construction fuel recorded and constructi phase tCO_2e estimated reviewed.
3	Groundwater Levels	Groundwater levels in the shallow borewells included in the monitoring network will be monitored on a quarterly basis.	Pre-construction and 1 year post-construction; quarterly	Yield and water levels private / community w not adversely affected.
4	Groundwater and Surface Water Quality	Monitoring of groundwater and surface water quality will take place at the agreed monitoring network locations, including the Okulu River and relevant boreholes. Surface and groundwater samples will be collected for parameters suitable to identify contaminants from Project activities.	Pre-construction and 1 year post-construction; frequency to follow approved monitoring schedule	Water quality resu compliant with performa criteria and no mate deterioration attributable construction.
5	Effluent / Discharge Quality	Water quality monitoring of all discharge and stormwater outlets to determine that discharge meets applicable effluent limits.	Monthly during construction	Water quality reports discharge point resu compliant with Proje adopted limits.
6	Biodiversity – Aquatic Ecology	Aquatic biomonitoring in habitats potentially affected by spills and discharge, using recognised best-practice aquatic monitoring protocols. Pre-construction baseline and post-construction comparison to be undertaken.	Prior to construction and post-construction	No deterioration in aqu ecological condit attributable to the Proje
7	Biodiversity – Site Control	Ensure the construction area is demarcated and no activities take place outside of these demarcations.	Monthly inspection	No unauthorised activ outside approved footpr any incidents recorded corrected.
8	Biodiversity – Awareness	Toolbox talks for all staff regarding fauna and flora, including prohibition on collection of plant or animal products.	Monthly during construction	Toolbox talk regist maintained.
9	Biodiversity – Invasive Species	Implement and inspect an alien invasive plant control programme within the Project site and adjacent buffer areas.	Quarterly during construction	Reports of species identif and control acti implemented.
10	Community Health & Safety – Health Surveillance	Maintain a confidential health surveillance and monitoring system for Project workers.	Throughout construction; reviewed quarterly	Cases communicable/vector-borne/STIs tracked; p employment screen records maintained.
11	Health Education and Training	Record details of health, education, and training provided to workers and relevant stakeholders.	Quarterly throughout construction	Records of training top and attendance; aim 100% worker coverage.

Ref No.	Monitoring Topic	Monitoring Measure / Parameter	Timing and Frequency	Target / Performa Indicator
12	Traffic and Driver Safety	Maintain a traffic database including driver training, incidents, non-compliances, and stakeholder road safety engagement.	Monthly during active construction; annual review	Number of drivers train number of incide roadworthiness iss tracked and addressed.
13	Grievance Mechanism	Maintain grievance register recording issues, actions, timelines, responsibilities, and closure status.	Quarterly throughout construction	Grievances tracked; resolved within agr timeframe.
14	Stakeholder Engagement	Maintain stakeholder engagement database with dates, attendance, actions, and follow-up.	Quarterly throughout construction	Stakeholder engagem records maintained actions closed in agr timeframes.
15	Recruitment and Procurement	Monitor local recruitment and procurement commitments using contractor and HR records.	Quarterly throughout construction	% of local skilled / se skilled / unskilled work and procurement track zero gate hiring.
16	Occupational Health and Safety	Monitor implementation of OHS induction, PPE, toolbox talks, incident records, and corrective actions.	Monthly throughout construction	OHS KPIs maintained; z fatalities; LTIs incidents tracked addressed.
17	Supplier and Subcontractor Labour Performance	Monitor suppliers and subcontractors for compliance with labour and working conditions requirements.	Annual throughout construction (or more frequently for high-risk contracts)	Contract clauses in pla non-conformances close agreed timeframes.
18	Cultural Heritage	Monitor implementation of the Chance Finds Procedure during ground-disturbing activities.	Continuous throughout construction	Chance find incide recorded and escala appropriately.
19	Waste Management	Audit waste contractors and inspect active work areas and waste storage areas for housekeeping and compliance.	At start of construction and regularly thereafter	Waste contractor facili licensed; work areas cl and free of litter.
20	Spill Monitoring	Weekly inspections of spill response equipment, quarterly review of preventative maintenance, biannual spill drills, and recording of all spills.	Weekly / quarterly / biannual / continuous	Spill response equipm available; d undertaken; spill maintained and correct actions closed out.
21	Soil – Erosion, Compaction and Contamination	Inspect erosion and sediment controls, exposed areas and stockpiles; record vehicle movements outside designated routes; check decompaction and reinstatement of temporary areas; sample soil after spills and at baseline locations (pH, TPH, heavy metals, nutrients) against baseline/control and EGASPIN target values.	Weekly and after rainfall > 25 mm/24 h (ESC); annually (soil quality); after each spill (confirmatory)	Indicators in Sect 7.2.4.4 met (ESC in place 100% of active areas; z off-route breaches; 10 of remediated ar confirmed clean)
22	Noise	Attended noise measurements (LAeq,1h for daytime 07:00–22:00 and night-time 22:00–07:00; LAmax) at receptors N2, N3 and N4 and at any location subject to a complaint.	Monthly throughout construction; weekly during piling and other high-noise works near the northern boundary	Compliance with Table 5 criteria (55 dB(A) day / dB(A) night at residen receptors, or no more t 3 dB above backgroun complaints closed out

TABLE ES-52: OPERATIONAL MONITORING

Ref No.	Monitoring Topic	Monitoring Measure / Parameter	Timing and Frequency	Target / Performance Indicator	Responsibility	Reporting
1	Grievance Management	Ongoing monitoring of the Project grievance mechanism to ensure that complaints are appropriately recorded, managed, and closed out.	Monthly	% grievances closed within agreed timeframe.	IFF Community Relations	Monthly dashboard
2	Water Treatment Systems	Monitor operation of water treatment systems to ensure operation within specified design parameters.	Continuous / monthly review	Systems operating within specified design parameters.	Utilities / Water Systems Manager	Monthly utilities report
3	Retention Ponds	Monitor retention ponds to ensure freeboard and design specifications are maintained.	Routine operational inspection; increased during wet season	Retention ponds functioning as designed.	Utilities / Infrastructure Manager	Monthly operations report
4	Groundwater Levels and Quality	Continue groundwater level and quality monitoring within the site monitoring network.	As per approved operational monitoring programme	Groundwater quality and levels remain within acceptable limits / no adverse trend attributable to operations.	IFF / Specialist support	Quarterly / annual groundwater report
5	Surface Water Quality	Continue surface water quality monitoring at designated upstream, downstream, and reference locations, including the Okulu River.	As per approved operational monitoring programme	Water quality results within applicable criteria and no adverse operational trend.	IFF / Specialist support	Quarterly / annual surface water report
6	Stormwater and	Monitor stormwater	Routine / monthly / as	Effluent quality and	IFF Operations / Water team	Monthly discharge

Ref No.	Monitoring Topic	Monitoring Measure / Parameter	Timing and Frequency	Target / Performance Indicator	Responsibility	Reporting
	Wastewater Discharges	and wastewater quality and volumes to verify compliance with applicable discharge standards.	required by permit	discharge volumes compliant with Project-adopted standards.		compliance report
7	Biodiversity Management Measures	Continue monitoring implementation of biodiversity controls and selected ecological indicators where relevant.	Periodic / annual review	No unacceptable deterioration in biodiversity condition attributable to operation.	IFF / Biodiversity specialist	Annual biodiversity report
8	Waste Handling, Storage, Transport, Disposal	Ongoing monitoring of waste handling practices, contractor performance, and waste records.	Monthly / periodic audit	Waste managed in accordance with legal and ESMMP requirements.	IFF / Waste contractor	Monthly waste report
9	Spill Monitoring and Response	Continue spill inspections, response readiness checks, and maintenance of spill log.	Continuous / quarterly review	Spill response readiness maintained; all spills recorded and corrective actions closed.	IFF HSE	Quarterly spill report
10	Operational Scope 1 GHG Emissions	Track operational Scope 1 emissions from process heating, reforming, utilities, and flaring using fuel and plant operating data.	Monthly internal tracking; annual consolidated inventory	Total operational tCO_2e tracked; emissions intensity per tonne of product reported.	Operations Manager / Project Engineer / Sustainability or Energy Lead	Monthly dashboard; annual GHG inventory report
11	Natural Gas Use Efficiency	Monitor natural gas consumption relative to production output and	Monthly	Natural gas consumption per tonne of ammonia / urea tracked and reviewed.	Operations Manager / Process Engineer	Monthly performance report

Ref No.	Monitoring Topic	Monitoring Measure / Parameter	Timing and Frequency	Target / Performance Indicator	Responsibility	Reporting
		process benchmarks.				
12	Fugitive GHG Emissions / LDAR	Implement LDAR inspection programme and track leaks, repair close-out, and repeat leak points.	Quarterly and during shutdowns / maintenance periods	Leaks identified and repaired; repeat leak points reduced.	Maintenance Manager / Integrity Engineer / HSE Manager	Quarterly LDAR summary
13	Energy Efficiency and Operational Performance	Monitor energy performance and benchmarking indicators across high-energy systems.	Monthly review; annual benchmark summary	Energy intensity trend reviewed and actions implemented.	Energy Manager / Project Engineer / Operations Manager	Monthly internal report; annual efficiency review
14	Planned GHG Reduction Initiatives	Track status and effectiveness of planned GHG reduction initiatives, including flare reduction, hardware upgrades, and efficiency improvements.	Quarterly implementation review; annual verification	Reduction initiatives implemented and annual reduction verified where applicable.	Project Head / Project Engineer / Sustainability Lead	Quarterly management update; annual climate / sustainability report
15	Climate Risk – Extreme Rainfall / Flooding	Inspect drainage, culverts, flood-control features, incident logs, and flood-response preparedness.	Monthly during wet season; after major storm events; annual drill review	Flood incidents, drainage blockages, and flood drills tracked.	Site HSE Manager / Utilities & Infrastructure Manager / Emergency Response Lead	Monthly internal HSE report; wet-season summary
16	Climate Risk – Extreme Heat	Review weather data, occupational incident records, and temperature-sensitive equipment performance during hot periods.	Daily during extreme heat periods; monthly seasonal summary	Heat-related incidents, exceedances, and response actions tracked.	Site HSE Manager / Operations Manager / Electrical & Maintenance Lead	Monthly HSE report; quarterly climate resilience review
17	Climate Risk – Wildfire	Inspect perimeter vegetation, fire	Monthly in dry season; after any fire event;	Wildfire / smoke incidents and	Fire & Emergency Response Lead	Seasonal dry-season report;

Ref No.	Monitoring Topic	Monitoring Measure / Parameter	Timing and Frequency	Target / Performance Indicator	Responsibility	Reporting
		readiness, incident records, and drill outcomes.	annual drill review	firebreak actions tracked.	/ Site HSE Manager / Facilities Manager	incident reporting
18	Climate Risk – Water Stress / Drought	Monitor water demand versus supply, storage status, and drought contingency activation.	Monthly; more often during prolonged dry periods	Water demand, supply triggers, and drought actions tracked.	Utilities / Water Management Lead / ESMS Manager	Monthly water resilience report; seasonal drought summary
19	Socio-economic Monitoring	Track local employment, training, local procurement, labour influx, infrastructure pressure, stakeholder engagement, community expectations, community health and safety incidents, and cumulative trends.	Monthly / quarterly depending on indicator	Indicators tracked in line with socio-economic monitoring framework.	IFF HR / Procurement / Community Relations / HSE / ESMS	Monthly dashboard; quarterly social performance report
20	Noise	Noise measurements at receptors N2, N3 and N4 and at the plant boundary; checks on dominant plant sources.	Once after commissioning at full load; annually thereafter and after any significant plant modification or noise complaint	Compliance with IFC criteria (55 dB(A) day / 45 dB(A) night) at receptors; no increase of more than 3 dB above background	IFF HSE / Operations	Annual environmental and social monitoring report

In addition to Table ES-51 and Table ES-52, Chapter 9 provides topic-specific monitoring frameworks for climate risk and cumulative climate impacts, GHG emissions and reduction initiatives, noise and socio-economic indicators, each defining KPIs, methods, frequencies, responsibilities and reporting lines for integration into the ESMMP and ESMS. Noise monitoring will include periodic attended measurements (LAeq, LAmax) at representative noise-sensitive receptors during construction and verification monitoring after commissioning to confirm consistency with modelling predictions. Monitoring outputs will be integrated with stakeholder engagement, grievance mechanisms and regulatory and lender reporting.

Monitoring results will be reviewed through the ESMS and reported internally and to regulators and lenders as described in ES15.0. Claimed GHG reductions will be subject to annual internal or third-party verification before being counted, surface water and groundwater results will be compared with baseline conditions and trigger levels, and host community representatives will

participate in participatory environmental monitoring. Where results show deviations from expected performance, corrective actions and adaptive updates to the ESMMP will be triggered.

ES17.0 Conclusion

The ESIA concludes that the proposed IFF Line 2 Fertilizer Project is environmentally and socially viable, subject to full implementation of its mitigation measures, management plans and monitoring commitments. Its location within the existing Indorama Free Zone limits additional land disturbance and avoids anticipated physical or economic displacement.

The assessment considers the project suitable for regulatory approval and international financing, conditional on meeting applicable Nigerian requirements and international lender standards.

The ESIA has been undertaken in alignment with Nigerian regulatory requirements, the IFC Performance Standards, AfDB's Integrated Safeguards System (Operational Safeguards) and the WBG EHS Guidelines. It concludes that the Project can achieve compliance with these standards provided the recommended mitigation measures, management systems and monitoring programmes are effectively implemented, with the ESMMP and ESMS providing the mechanism for implementation, monitoring and verification. No environmental or social fatal flaws have been identified. As no physical or economic displacement is expected and the land lies within the existing Indorama Free Zone under the Proponent's control, IFC PS5 and AfDB OS5 are not triggered; any future change shall be addressed through the Management of Change process and assessed against PS5 requirements.

Key Environmental and Social Findings

Expected benefits include increased fertilizer production, employment, local procurement, economic activity and efficient use of existing infrastructure.

These benefits include a contribution to national fertilizer production and food security, and are particularly important given the socio-economic context of the area, which is characterised by relatively high unemployment and limited income opportunities.

Principal environmental concerns include air emissions, wastewater and stormwater releases, groundwater abstraction, hazardous-material spills and indirect biodiversity effects. Social risks relate mainly to labour influx, pressure on services, employment expectations, community dissatisfaction and health and safety.

No significant cultural heritage resources were identified within the development footprint. Nevertheless, a chance finds procedure and continued community engagement are required.

Cumulative pressures on water resources, air quality, transport and community services require coordination with other operators and relevant authorities.

Residual Impacts and Uncertainties

Most impacts are predicted to reduce to minor or moderate significance following mitigation. The chapter identifies no critical residual impacts under normal operating conditions, while

recognising continuing risks from accidental releases, process failures, cumulative development and community expectations.

These conclusions depend on design assumptions, modelling and baseline information collected during defined periods. Further engineering, monitoring and periodic reassessment are necessary to address emerging information and changing conditions.

Certain elements of the Project design remain at a conceptual level and will be developed during detailed engineering, and future cumulative developments in the region may influence impact significance over time. In recognition of these uncertainties a precautionary approach has been adopted, and the ESMS provides for adaptive management to address emerging risks and new information.

Priority Actions and Recommendations

- Finalise detailed design, address outstanding baseline requirements and complete the lender Environmental and Social Action Plan.
- Fully implement the Environmental and Social Management and Monitoring Plan through contractor requirements and operating procedures.
- Maintain an effective Environmental and Social Management System with clear responsibilities, resources and reporting arrangements.
- Apply labour influx, traffic and community health and safety controls during construction.
- Monitor air emissions, water quality, groundwater abstraction and environmental performance throughout operation.
- Maintain transparent stakeholder engagement and an accessible grievance mechanism.
- Coordinate cumulative-impact management and regularly test emergency response arrangements.
    - Prior to construction, develop contractor management plans aligned with the ESIA commitments, and complete the ESAP with defined actions, timelines and accountability.
    - During construction, ensure that monitoring and reporting systems are operational to track performance and compliance.
    - During operation, undertake periodic reviews of cumulative impacts and ESMS performance to support continuous improvement.
    - Develop and regularly test emergency preparedness and response systems to manage unplanned events, which are the principal source of residual risk.

The project's anticipated benefits and environmental and social acceptability remain dependent on sustained implementation, monitoring and verification of these commitments.

1. INTRODUCTION

1.1 PROJECT OVERVIEW AND BACKGROUND

Environmental Resources Management Southern Africa (Pty) Ltd ('ERM') has been appointed by Indorama Fertilizer FZE ('Indorama' or the 'Proponent') to prepare the Environmental and Social Impact Assessment (ESIA) for the proposed IFF Line 2 Fertilizer Project in Eleme LGA, Port Harcourt, Rivers State, Nigeria (Figure 1-1). The Project involves the development of a new brownfield urea production line within the precincts of Indorama Free Zone of broader Indorama Manufacturing Complex in Eleme LGA, Rivers State, Nigeria The existing petrochemical complex of Indorama Manufacturing Complex hosts the operational petrochemicals production plants, power plant, utilities and other associated facilities. Indorama Free Zone hosts operational IFZ Line1 and Line 2. Indorama Free Zone also hosts IFF Line 1 which was recently commissioned in June 2026. The proposed IFF Line 2 fertilizer project is located adjacent to IFF Line 1. The ESIA makes use of relevant information established for IFF Line 1, supplemented by updated baseline data specific to IFF Line 2.

The proposed IFF Line 2 development comprises an Inside Battery Limits (IBL) configuration, including a Feed Conditioning Unit designed to process approximately 200 MMSCFD of natural gas, a 2,300 metric ton per day (MTPD) Ammonia Plant, a 4,000 MTPD Urea Plant, and a 150 MTPD UFC 85 unit. Outside Battery Limits (OBL) infrastructure includes natural gas receiving facilities, water treatment and cooling systems, effluent treatment and drainage systems, emergency flares, fire and gas protection systems, product evacuation infrastructure, and a 120,000-ton capacity urea storage building. Natural gas will be delivered via an underground pipeline and processed using established reforming, synthesis, and granulation technologies to produce granulated Urea fertilizer. Finished product will be transported to the MM FZE Port located within the Onne Port Complex, approximately 20 km from the manufacturing site, for storage and export.

The ESIA has been prepared in accordance with the Environmental Impact Assessment Act (CAP E12 LFN 2004) and the Environmental Impact Assessment Procedures and Charges Regulations (S.I. No. 109 of 2021). It also considers applicable international requirements, including the IFC Performance Standards (PSs), the World Bank Group General (WBG) and sector-specific Environmental, Health and Safety (EHS) Guidelines (notably the Nitrogenous Fertilizer Production guideline), the African Development Bank Integrated Safeguards System, and Indorama's internal Health, Safety, and Environment policies. These frameworks require assessment of environmental, social, and health risks across the full project lifecycle and the identification of appropriate control and enhancement measures.

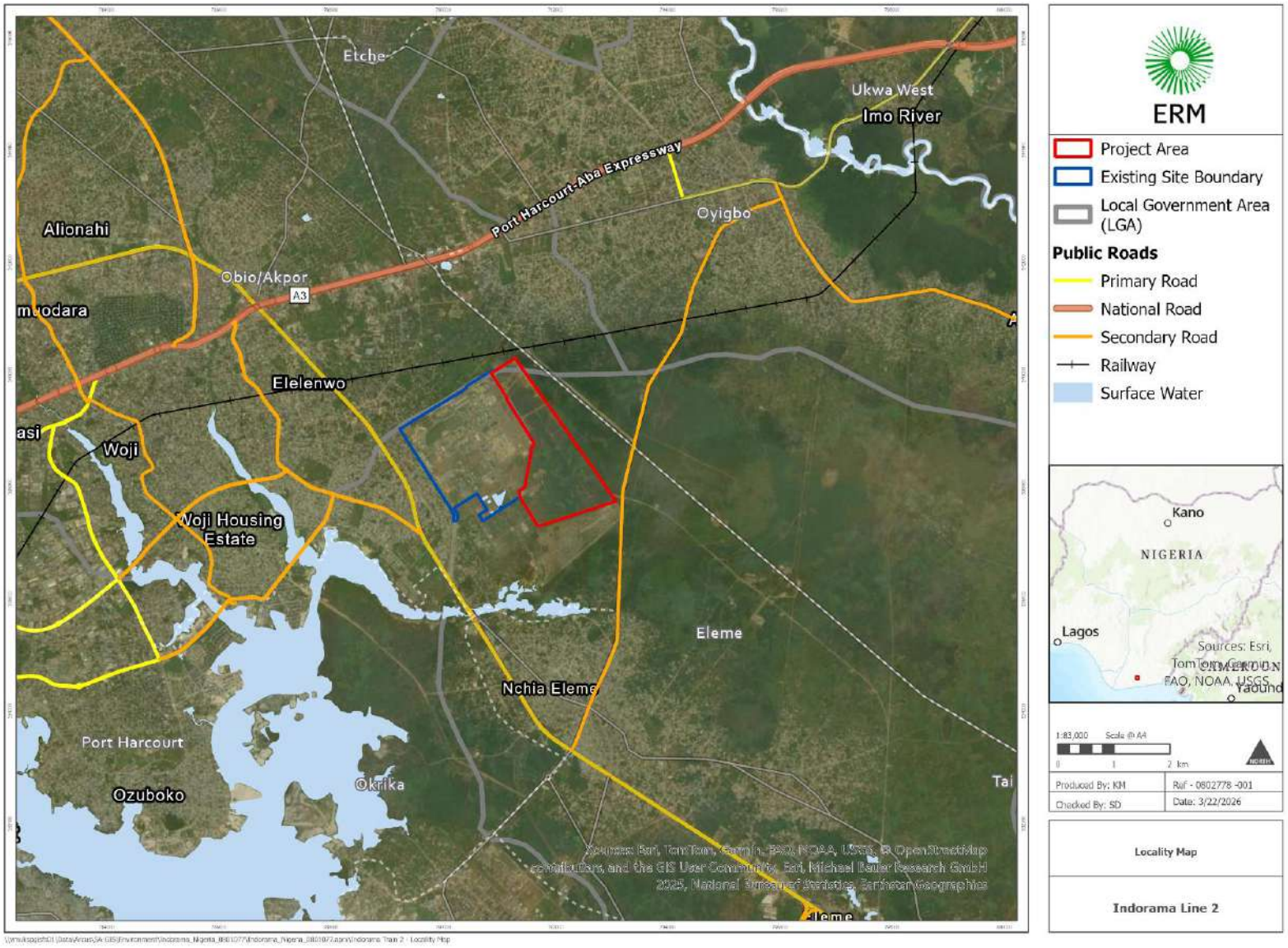


FIGURE 1-1: PROJECT LOCALITY MAP

Indorama has an established track record of undertaking ESIA processes for fertilizer expansion projects in Eleme. ERM's preparation of the ESIA for IFF Line 1 (previously referred to as the IEFCL-Train 3 Project) set the methodological foundation for current and future assessments, particularly in baseline data collection & review, modelling, and alignment with international best practice. For the IFF Line 2 Project, the Federal Ministry of Environment (FMEnv) serves as the regulatory authority responsible for screening, approval of the Terms of Reference (ToR), oversight of baseline data collection, and review of the full ESIA in line with applicable national procedures.

Baseline data collection for IFF Line 2 has been undertaken by Messrs Safespace Resources Limited (Local Consultant "LC"), an accredited Nigerian Consultant, under FMEnv supervision, with ERM providing technical oversight, quality assurance, and lender-standard alignment. This approach mirrors the structure applied for IFF Line 1, where ERM led the review, gap analysis, and integration of fieldwork into a comprehensive, lender-ready ESIA. For this ESIA however, one ERM Subject Matter Expert (SME) joined LC team during dry-season field data collection in February 2026. Existing air quality and noise models from IFF Line 1 have been expanded to evaluate combined operational conditions, thereby ensuring consistency across the broader Indorama expansion programme.

As part of its role, ERM has reviewed the baseline data submitted by the LC to verify alignment with the approved ToR and international standards. Any data gaps have been addressed through clarification or additional information requests. Where longer-term actions are required to achieve full compliance with the IFC Performance Standards, these will be documented as post-ESIA commitments within the Environmental and Social Management and Monitoring Plan (ESMMP).

1.2 DETAILS OF THE PROJECT TEAM

1.2.1 PROJECT PROPONENT

The Project proponent is Indorama Fertilizer FZE (IFF), Indorama Free Zone, Eleme, Rivers State, Nigeria. It is the proponent's intent to establish the IFF Line 2 Project, and required associated facilities, from pre-design to construction and subsequent commissioning & operation in line with the National Guidelines on manufacturing sector and in accordance with international best practice. The contact details for the applicant are as follows:

TABLE 1-1: PROPONENT DETAILS

Item	Description
Project Proponent Name	Indorama Fertilizer FZE
Registered Company Name	Indorama Fertilizer FZE
Company Registration Number	NEPZA FORM RCI/ 01419
Country of Registration	Republic of Nigeria
Operational Address	Indorama Free Zone, Eleme Local Government Area, Rivers State, Nigeria
Contact Person	Dr Jain Mahendra

Item	Description
Position / Title	Head of Environment
Telephone	+234 807 032 4523
Email Address	mahendra.jain@indorama.com

1.2.2 ESIA CONSULTANT

The ESIA has been prepared by ERM, appointed as the independent international ESIA consultant for the Project. ERM is responsible for leading the ESIA process, including the integration of specialist studies, quality assurance of baseline data, and ensuring alignment with applicable Nigerian regulatory requirements and international best practice standards, including the IFC PSs, AfDB's OSs and WBG EHS Guidelines. The details of the ESIA consultant and the project team are provided in Table 1-2 below.

TABLE 1-2: ESIA CONSULTANT DETAILS

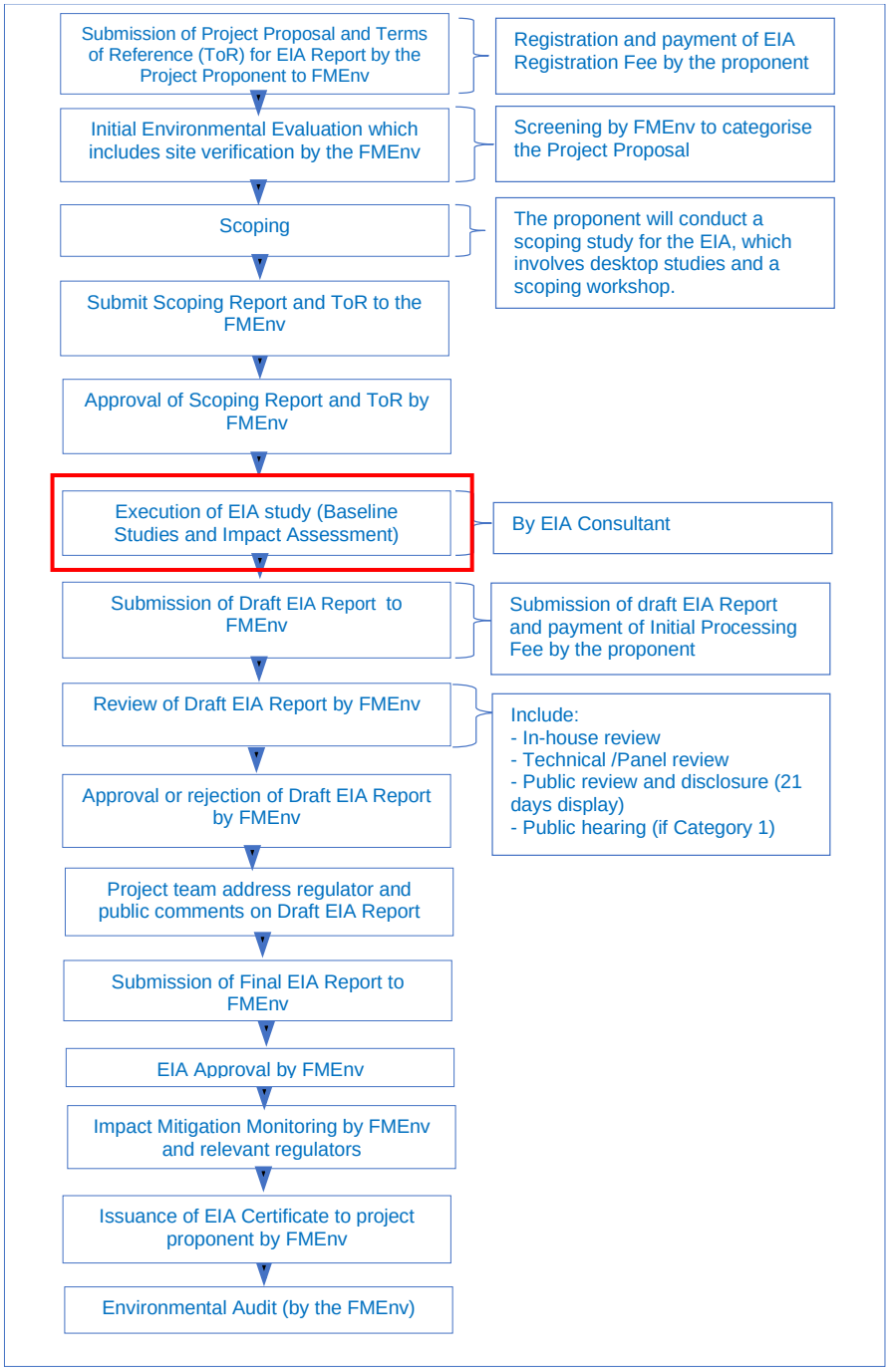
Item	Description
Consultant Name	Environmental Resources Management Southern Africa (Pty) Ltd (ERM)
Registered Company Name	Environmental Resources Management Southern Africa (Pty) Ltd
Consultant Role	International ESIA Consultant responsible for technical oversight, quality assurance, and alignment with international lender standards
Office Address	ERM Southern Africa, Building 27, 1st Floor, The Woodlands Office Park, Woodlands Drive, Woodmead, Johannesburg, 2148, South Africa
Telephone	+27 11 802 8263
Email Address	Sihle.dambuza@erm.com
Website	www.erm.com
Project Manager	Sihle Dambuza
Partner in Charge	Nigel Seed
Local Environmental Consultant (LC)	Messrs Safespace Resources Limited (accredited Nigerian Consultant)

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1.3 OBJECTIVES OF THE ESIA PROCESS

The Environmental and Social Impact Assessment (ESIA) for the proposed IFF Line 2 Fertilizer Project has been undertaken in accordance with the Environmental Impact Assessment Act (CAP E12 LFN 2004) and the Environmental Impact Assessment Procedures and Charges Regulations (S.I. No. 109 of 2021), together with relevant international standards and good practice guidelines, mainly the IFC PSs (International Finance Corporation Performance Standards on Environmental and Social Sustainability) and AfDB ISS (African Devlopment Bank Integrated Safeguard System). The FMEnv ESIA process followed for IFF Line 2 is summarised in Figure 1.2. The assessment has been carried out through a structured sequence of activities, including scoping, review of existing information, baseline data collection, stakeholder engagement, identification and evaluation of potential impacts, development of

mitigation measures, preparation of the ESMMP, and compilation of this ESIA Report. Each step is described in detail in the subsequent chapters.



Red box shows current stage

FIGURE 1-2: THE NIGERIAN ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

The specific objectives of the ESIA for the IFF Line 2 Project are to:

- Provide a detailed description of the proposed Project (including relevant alternatives) in terms of the planned activities and the expected environmental and social aspects associated with the activities.
- Establish the existing state of the environmental and socio-economic conditions and to identify any sensitive resources and receptors.

- Identify and assess the associated and potential environmental and socio-economic impacts and risks of the project, including potential secondary and cumulative impacts.
- Recommend appropriate mitigation measures (adopting the Mitigation Hierarchy, which is a set of guidelines that aim to achieve no overall negative impacts through the avoid, minimise, restore and offset sequential steps) to address the identified impacts of the project.
- Develop an appropriate ESMMP to detail how mitigation measures will be implemented and how environmental performance will be managed for the project throughout the Project's life cycle.
- Prepare and submit a detailed ESIA Report presenting clear and concise information on the findings of the ESIA study.

This ESIA has been prepared using a harmonised approach that meets both Nigerian regulatory requirements and international lender expectations. The assessment aligns with the Nigerian EIA Act as well as IFC PSs, AfDB OSs and the WBG EHS Guidelines, with the more stringent standard applied where national and international requirements differ. FMEnv allows the use of international benchmarks such as WHO air quality guidelines where they provide higher levels of protection, provided the justification is clearly documented in the ESIA.

Indorama Fertilizer FZE (IFZ), as the Project Proponent, is responsible for registering the Project with FMEnv, submitting the ESIA Report and facilitating all regulatory reviews required for approval. The accredited Nigerian Environmental Consultant manages all FMEnv-facing activities including baseline fieldwork, stakeholder engagement and data collection under FMEnv supervision, while the international ESIA Consultant provides technical oversight, quality assurance and ensures that the ESIA meets applicable international standards.

1.4 SCOPE OF THE ESIA STUDY AND REPORT

As outlined earlier, the IFF Line 2 ESIA builds on the methods applied for the IFF Line 1 (IEFCL-Train 3) ESIA, supplemented with updated baseline information specific to the new footprint and FMEnv's approved ToR.

- Review of applicable Nigerian and international frameworks, including the EIA Act (CAP E12 LFN 2004), Regulations S.I. No. 109 of 2021, IFC Performance Standards, and WBG General and Nitrogenous Fertilizer EHS Guidelines.
- Preparation, submission, and FMEnv approval of the ESIA ToR, confirming a Category 1 pathway and supervised baseline requirements.
- Literature and data review for the Project Area of Influence (AoI) and the wider Indorama complex to inform scoping and receptors.
- Consideration of feasible project alternatives, consistent with lender-aligned ESIA structure.
- Detailed description of ISBL/OSBL activities, utilities, and offsite infrastructure for assessment and modelling inputs.
- Wet and Dry -season baseline data collection by the FMEnv accredited Nigerian Consultant (LC) under FMEnv supervision, with ERM providing methodology guidance, QA/QC review, and gap closure to meet lender expectations.

- Identification and evaluation of environmental and socio-economic impacts, including secondary and cumulative effects from combined IFF Line 1 + IFF Line 2 scenarios using expanded models.
- Development of mitigation and management measures and preparation of the ESMMP, including any post-ESIA actions tied to lender readiness.
- Engagement with stakeholders, host communities, and authorities, aligned with an operations-wide SEP and a project-specific SEP for IFF Line 2.

1.5 REPORT STRUCTURE

In line with the FMEnv Procedural Guidelines, this ESIA Report has been organised into 12 Chapters (refer to Table 1-3).

TABLE 1-3: STRUCTURE OF THIS ESIA REPORT

Chapter	Description
Chapter 1: Introduction	Introduction containing an overview of the Project, the objectives and scope of the ESIA study
Chapter 2: Legal and Administrative Framework	Describes the legislative, policy and administrative requirements, as well as international good practice requirements applicable to the Project.
Chapter 3: Project Justification and Alternatives	Contains a rationale for the Project, as well as the analysis of Project alternatives.
Chapter 4: Project Description	A description of the Project containing the technical elements applicable to the ESIA.
Chapter 5: Environmental and Social Impact Assessment Process	Describes the ESIA process followed for the Project and the associated impact assessment methodology employed.
Chapter 6: Stakeholder Engagement	Summarises the stakeholder engagement activities associated with the Project and ESIA process.
Chapter 7: Description of the Environment	Provides a baseline assessment of the receiving physical, biophysical and socio-economic environments in the AoI and surrounds.
Chapter 8: Associated and Potential Environmental and Social Impacts	Assessment of all relevant environmental and socio-economic risks and impacts of the project, including associated and cumulative impacts.
Chapter 9: Mitigation Measures	Presents the mitigation measures for the identified environmental and socio-economic impacts and a discussion of residual impacts.
Chapter 10: Environmental and Social Management and Monitoring Plan	Presents the ESMMP for the Project, which will be attached to the report as an appendix.
Chapter 11: Conclusions and Recommendations	Summarises the key findings of the ESIA.
Chapter 12: References	Contains a list of references used in compiling this ESIA Report.

The ESIA report is supported by the following Appendices:

- Appendix A: ESIA ToR Approval by FMEnv
- Appendix B: Stakeholder Engagement Plan (SEP)
- Appendix C: ESMMP
- Appendix D: Quantitative Risk Assessment – IEFCL Line-3 QRA Report (DNV, 11 December 2023) and DNV proposal for the IFF Line 2 (Line 4), FCU-3 and UF-85 QRA update (October 2026), provided to the lenders on a confidential basis

1.6 IFC PERFORMANCE STANDARDS COMPLIANCE

The ESIA for the Indorama IFF Line 2 Fertilizer Project has been developed in alignment with the International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability (2012) (PS1–PS8), together with the applicable World Bank Group Environmental, Health and Safety (EHS) Guidelines.

These standards represent international good practice for the identification, assessment, and management of environmental and social risks and impacts associated with large-scale industrial developments and are expected by international lenders and development finance institutions (DFIs).

In addition to compliance with applicable Nigerian national and state regulatory requirements (as outlined in Chapter 2), the ESIA has been structured to ensure that the requirements of IFC PS1–PS8 are systematically addressed across all relevant technical disciplines, including environmental baseline characterisation, impact assessment, mitigation design, and management planning.

To support transparency and facilitate lender due diligence, Table 1.6 below provides a consolidated cross-reference between the IFC Performance Standards requirements and the sections of this ESIA where compliance is demonstrated. The table is derived from the project's internal IFC compliance checklist and has been refined for inclusion in the ESIA to provide a clear and auditable trail of how each requirement has been addressed.

This cross-referencing approach ensures that:

- IFC requirements are explicitly embedded within the ESIA structure;
- relevant evidence can be readily located within the report and associated appendices;
- alignment across specialist inputs is maintained; and
- potential gaps are identified and addressed during the ESIA development process rather than at lender review stage.

Detailed compliance evaluation, including status tracking, gap identification, and corrective actions, is maintained in the project's internal IFC Compliance Checklist and is reflected in the development of the ESMMP. See Table 1-4 below.

TABLE 1-4: IFC PERFORMANCE STANDARDS COMPLIANCE AND ESIA CROSS-REFERENCE

IFC PS / Topic	Requirement	Guidance / What good looks like	ESIA Section / Evidence
PS1 – Use of Existing Data (Para 11)	The client will use relevant available environmental and social data, including existing studies, where appropriate, as part of the identification of risks and impacts (IFC PS1, para 11)	Integrate prior ESIA/ESDD and baseline datasets	Ch 2; Ch 5
PS1 – Independent Experts (Para 7)	For projects with significant adverse impacts, the client will retain qualified and experienced external experts to assist in conducting the environmental and social assessment (IFC PS1, para 7)	Independent specialist review for high-risk industrial projects	Ch 5
PS1 – AoI & Impact Identification (Para 8–10)	The client will identify and evaluate environmental and social risks and impacts for the project within the area of influence, including direct, indirect, and cumulative impacts (IFC PS1, paras 8–10)	Include associated facilities, transport routes, cumulative impacts	Ch 5; Ch 8
PS1 – Alternatives Analysis (Para 11–12)	The client will examine technically and financially feasible alternatives, including the no-project alternative, and document the rationale for selecting the preferred option (IFC PS1, paras 11–12)	Comparative analysis across options	Ch 4
PS1 – Impact Assessment (Para 5–6)	The environmental and social assessment will be commensurate with the risks and impacts and will include an evaluation of the magnitude and significance of impacts (IFC PS1, paras 5–6)	Clear significance criteria	Ch 5; Ch 8
PS1 – Risk Prioritisation	The client will prioritise identified risks and impacts based on their significance (IFC PS1 intent)	Ranking matrix applied	Ch 8
PS1 – Cumulative Impacts (Para 8)	The client will assess cumulative impacts from the project in combination with other existing, planned or reasonably defined developments (IFC PS1, para 8)	Regional cumulative assessment	Ch 8
PS1 – Mitigation Hierarchy (Para 14)	The client will apply the mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimise and mitigate impacts, and where residual impacts remain, compensate/offset (IFC PS1, para 14)	Avoid → minimise → restore → offset	Ch 9
PS1 – Management Programmes (Para 16)	The client will establish management programs that describe mitigation and performance improvement measures and actions to address identified risks and impacts (IFC PS1, para 16)	Impact → mitigation → ESMP linkage	Ch 9; Ch 10
PS1 – ESMS (Para 15)	The client will establish and maintain an Environmental and Social Management System appropriate to the nature and scale of the project (IFC PS1, para 15)	ESMS with procedures and controls	Ch 10; ESMMP

IFC PS / Topic	Requirement	Guidance / What good looks like	ESIA Section / Evidence
PS1 – Organisational Capacity (Para 17–20)	The client will establish, maintain and strengthen the organisational structure that defines roles, responsibilities and authority to implement the ESMS (IFC PS1, paras 17–20)	Org chart, capacity	ESMMP
PS1 – Emergency Preparedness (Para 20–21)	The client will establish and maintain an emergency preparedness and response system to respond to accidental and emergency situations (IFC PS1, paras 20–21)	ERP incl. community	ESMMP
PS1 – Monitoring Programme (Para 24)	The client will establish procedures to monitor and measure the effectiveness of the management programme (IFC PS1, para 24)	KPIs and monitoring	ESMMP
PS1 – Reporting (Para 29–31)	The client will provide periodic reports on environmental and social performance to stakeholders (IFC PS1, paras 29–31)	Internal + external reporting	ESMMP
PS1 – Stakeholder Engagement (Para 25–27)	The client will establish and maintain a process for stakeholder engagement that is ongoing and appropriate to project risks (IFC PS1, paras 25–27)	SEP and disclosure	Ch 6
PS1 – Grievance Mechanism (Para 30)	The client will establish a grievance mechanism to receive and facilitate resolution of concerns (IFC PS1, para 30)	Accessible GM	Ch 6
PS2 – Labour Conditions (Para 8–10)	The client will provide workers with documented information regarding their rights under national law and labour practices (IFC PS2, paras 8–10)	Contracts and conditions	ESMMP
PS2 – Worker GM (Para 20)	The client will establish a grievance mechanism for workers (IFC PS2, para 20)	Separate GM	ESMMP
PS2 – OHS (Para 23–25)	The client will provide a safe and healthy work environment and take steps to prevent accidents, injury and disease (IFC PS2, paras 23–25)	Risk-based OHS	ESMMP
PS2 – Supply Chain (Para 27–29)	The client will identify risks of child or forced labour in the primary supply chain (IFC PS2, paras 27–29)	Supplier screening	ESMMP
PS3 – Air Emissions (Para 10)	The client will avoid or minimise adverse impacts on human health and the environment by avoiding or minimising pollution from project activities (IFC PS3, para 10)	IFC EHS limits comparison	Ch 7.4.3
PS3 – Effluent (Para 12)	The client will manage wastewater discharges to meet applicable standards (IFC PS3, para 12)	Effluent vs IFC limits	Ch 7

IFC PS / Topic	Requirement	Guidance / What good looks like	ESIA Section / Evidence
PS3 – Resource Efficiency (Para 7–9)	The client will implement technically and financially feasible measures for improving efficiency in consumption of energy, water and materials (IFC PS3, paras 7–9)	Efficiency measures	Ch 4
PS3 – GHG (Para 8)	The client will quantify direct and indirect greenhouse gas emissions for projects expected to produce significant emissions (IFC PS3, para 8)	CO2 estimate	Ch 8
PS4 – Community Health (Para 5)	The client will evaluate risks and impacts to the health and safety of affected communities during the project life-cycle (IFC PS4, para 5)	Health risk assessment	Ch 7.6
PS4 – Emergency Preparedness (Para 11)	The client will establish emergency preparedness measures to address accidental and emergency events (IFC PS4, para 11)	Community ERP	ESMMP
PS4 – Security (Para 12–13)	The client will assess and manage security risks in a manner that avoids or minimises risks to communities (IFC PS4, paras 12–13)	Security framework	ESMMP
PS6 – Biodiversity Baseline (Para 13–16)	The client will assess risks and impacts on biodiversity and ecosystem services (IFC PS6, paras 13–16)	Baseline surveys	Ch 7.5
PS6 – Critical Habitat (Para 16–19)	The client will determine whether critical habitat is present (IFC PS6, paras 16–19)	Screening	Ch 7.5.7
PS6 – Mitigation Hierarchy (Para 10)	The client will apply the mitigation hierarchy to biodiversity impacts (IFC PS6, para 10)	Avoid → offset	Ch 9
PS6 – No Net Loss (Para 15)	The client will achieve no net loss of biodiversity where feasible (IFC PS6, para 15)	Net loss statement	Ch 9
PS8 – Cultural Heritage (Para 8–11)	The client will identify and protect cultural heritage from adverse impacts of project activities (IFC PS8, paras 8–11)	Baseline and mitigation	Ch 7.7
PS8 – Chance Finds (Para 11)	The client will develop a chance finds procedure (IFC PS8, para 11)	Procedure	Ch 9

TABLE 1-5: AFDB INTEGRATED SAFEGUARDS SYSTEM (2023) COMPLIANCE AND ESIA CROSS-REFERENCE

AfDB Operational Safeguard / Topic	Requirement	Guidance / What good looks like	ESIA Section / Evidence
OS1 – Assess, Manage and Monitor (Paras 11–12)	The Borrower shall assess, manage and monitor the E&S risks and impacts of the project throughout the project life cycle, conduct an ESA, undertake stakeholder engagement and disclosure in accordance with OS10, develop and implement an ESMP, and monitor and report on E&S performance (AfDB ISS 2023, OS1, paras 11–12)	ESIA + ESMMP + monitoring and reporting cycle established as one integrated system	Ch 1; Ch 5; Ch 10; ESMMP
OS1 – Use of the Borrower's E&S Framework and Most Stringent Standard (Paras 15–17)	Where host country requirements differ from the levels and measures of the ISS and the EHSGs, the Borrower shall achieve whichever is more stringent, and gaps identified in the Borrower's E&S framework shall be addressed with the Bank (AfDB ISS 2023, OS1, paras 15–17)	Documented crosswalk of national vs. international limits with the governing value stated	Ch 2.3; Ch 2.6.4; Ch 2.7
OS1 – Use of Recent and Current Information (Para 20)	The ESA will be based on recent and current information, including an accurate description and delineation of the project and E&S baseline data at an appropriate level of detail, consistent with GIIP (AfDB ISS 2023, OS1, para 20)	Integration of prior ESIA/ESDD, site-wide operational data and wet/dry season baselines, with validation of vintage	Ch 1.7; Ch 5.4; Ch 5.5; Ch 7
OS1 – Qualified Preparers and Independent Experts (Paras 21, 29)	The ESA shall be an adequate, accurate and objective assessment prepared by qualified and experienced persons; for high-risk (Category 1) or contentious projects the Borrower may be required to engage independent experts (AfDB ISS 2023, OS1, paras 21, 29)	Named specialist team with disciplines and qualifications; independent review pathway identified	Ch 1.2.2; Ch 5; Ch 2.6.1 (independent review under EP4)
OS1 – Scope of Assessment, Area of Influence and Associated Facilities (Paras 8, 22, 24, 28)	The ESA shall take into account all relevant E&S risks and impacts of the project, including direct, indirect and cumulative impacts within the area of influence, and shall identify and assess the risks and impacts of associated facilities (AfDB ISS 2023, OS1, paras 8, 22, 24, 28)	Defined AoI, shared complex infrastructure and transport routes assessed, not only the plant footprint	Ch 7.2; Ch 8; Ch 8.8
OS1 – Mitigation Hierarchy (Para 23)	The ESA will always apply the mitigation hierarchy: anticipate and avoid; where avoidance is not possible minimise or reduce to acceptable levels; mitigate; and where significant residual impacts remain, compensate for or offset them where technically and financially feasible (AfDB ISS 2023, OS1, para 23)	Avoid → minimise → mitigate → compensate/offset, traceable from impact to residual rating	Ch 5.6.4; Ch 9

AfDB Operational Safeguard / Topic	Requirement	Guidance / What good looks like	ESIA Section / Evidence
OS1 – Climate Change in the Assessment (Paras 22, 24, 33)	The ESA and the ESMP shall take into account project-related risks and impacts associated with climate change vulnerability and gender inequality (AfDB ISS 2023, OS1, paras 22, 24, 33)	Physical climate risk screening, GHG assessment and gender-differentiated social analysis carried into the ESMMP	Ch 7.4.2; Ch 8.2.1; Ch 8.2.2; Ch 9.2.1; Ch 9.2.2
OS1 – Differentiated Measures for Vulnerable Groups (Paras 25–26)	Where the ESA identifies specific individuals or groups as vulnerable, the Borrower shall propose and implement differentiated measures so that adverse impacts do not fall disproportionately on them (AfDB ISS 2023, OS1, paras 25–26; see also OS7)	Vulnerable group identification carried through to targeted mitigation and benefit access	Ch 7.6; Ch 8.4; Ch 9.4
OS1 – Transboundary and Global Risks (Para 31)	The ESA shall consider potentially significant project-related transboundary and global risks and impacts, such as those from effluents and emissions and greenhouse gases (AfDB ISS 2023, OS1, para 31)	GHG quantification and regional air/water pathways addressed explicitly	Ch 8.2.2; Ch 8.2.3; Ch 8.2.7
OS1 – Cumulative Impact Assessment (Paras 24, 31; Annex 1)	The ESA shall assess cumulative impacts resulting from the incremental impact of the project when added to other existing, planned and reasonably foreseeable developments (AfDB ISS 2023, OS1, para 24 and Annex 1, cumulative impact assessment)	VEC-based rapid cumulative impact assessment at complex and regional scale	Ch 8.8; Ch 8.2 (per-topic cumulative sections)
OS1 – Environmental and Social Management Plan (Paras 32–33, 37)	The Borrower shall develop and implement an ESMP setting out the measures and actions required to achieve compliance with the OSs over a specified time frame, taking into account the findings of the ESA and the results of stakeholder engagement, and describing the management tools to be used (AfDB ISS 2023, OS1, paras 32–33, 37)	Impact → mitigation → ESMMP action, with responsibility, timing and cost	Ch 9; Ch 10; ESMMP
OS1 – Environmental and Social Management System and Capacity (Paras 18, 37; Annex on capacity)	The Borrower shall maintain its E&S framework, implementation practices and capacity, and the ESMP shall describe the management systems, organisational structure, roles, responsibilities and training required for implementation (AfDB ISS 2023, OS1, paras 18, 37 and Annex)	ESMS, organogram, competency and training plan	Ch 5.7.3; Ch 10; ESMMP
OS1 – Monitoring Programme (Paras 40–41, 43)	The Borrower shall monitor the E&S performance of the operation in accordance with the financing agreement, record information to track performance and verify compliance, and identify corrective and preventive actions based on monitoring results (AfDB ISS 2023, OS1, paras 40–41, 43)	Parameter, location, frequency, responsibility and trigger-based corrective action	Ch 9 (topic monitoring frameworks); Ch 10; ESMMP

AfDB Operational Safeguard / Topic	Requirement	Guidance / What good looks like	ESIA Section / Evidence
OS2 – Scope and Categories of Project Workers (Paras 4–9)	OS2 applies to direct workers, contracted workers, community workers and primary supply workers, with specified requirements applying to each category (AfDB ISS 2023, OS2, paras 4–9)	Worker categories mapped to the actual construction and operations workforce model	Ch 4.3.2; Ch 4.5; Ch 4.6; ESMMP
OS2 – Labour Management Procedures (Para 10)	The Borrower shall develop and implement written Labour Management Procedures applicable to the project, setting out how project workers will be managed in accordance with national law and this OS (AfDB ISS 2023, OS2, para 10)	Standalone LMP covering recruitment, terms, hours, grievance and contractor labour	Ch 2.7.3; Ch 10; ESMMP (Labour Management Procedures)
OS2 – Terms of Employment and Payment (Paras 11–13)	Project workers will be provided with clear and understandable information and documentation on their rights and terms of employment, will be paid regularly as required by national law and the LMPs, and will receive written notice of termination and severance details where required (AfDB ISS 2023, OS2, paras 11–13)	Written contracts, payslips and documented terms for all worker categories	Ch 2.7.3; Ch 10; ESMMP
OS2 – Non-Discrimination and Equal Opportunity (Paras 15–17)	Decisions relating to the employment or treatment of project workers will not be made on the basis of personal characteristics unrelated to inherent job requirements, and the Borrower shall provide protection and assistance to address the vulnerabilities of specific groups of workers (AfDB ISS 2023, OS2, paras 15–17)	Non-discrimination policy applied to recruitment, pay and promotion, with vulnerable-worker measures	Ch 2.7.1; Ch 2.7.3; ESMMP
OS2 – Child Labour (Paras 21–22)	A child under the minimum age established will not be employed or engaged in connection with the project, and a child over the minimum age and under 18 may only be employed under specified conditions following an appropriate risk assessment (AfDB ISS 2023, OS2, paras 21–22)	Age verification at gate and in contractor onboarding; hazardous work prohibition	Ch 2.7.2; Ch 10; ESMMP
OS2 – Forced Labour and Modern Slavery (Para 23)	Forced labour, consisting of any work or service not voluntarily performed that is exacted from an individual under threat of force or penalty, will not be used in connection with the project (AfDB ISS 2023, OS2, para 23)	Recruitment-fee, document-retention and freedom-of-movement checks in contractor audits	Ch 2.7.3; Ch 10; ESMMP
OS2 – Workers' Grievance Mechanism (Paras 24–26)	A grievance mechanism will be provided for all project workers to raise workplace concerns, proportionate to the nature and scale of the project, without impeding access to other judicial or administrative remedies (AfDB ISS 2023, OS2, paras 24–26)	Worker grievance channel separate from the community mechanism, with anonymity option	Ch 6.6; Ch 2.7.13; ESMMP, SEP

AfDB Operational Safeguard / Topic	Requirement	Guidance / What good looks like	ESIA Section / Evidence
OS2 – Occupational Health and Safety (Paras 27–33)	OHS measures will be applied to the project addressing hazard identification, preventive and protective measures, training, incident recording and reporting, emergency arrangements and remedy, with a system for regular review of OHS performance (AfDB ISS 2023, OS2, paras 27–33)	Risk-based OHS management system with leading and lagging indicators	Ch 8.4.6; Ch 9.4.1; Ch 2.7.9; ESMMP
OS2 – Third Parties and Contracted Workers (Paras 34–36)	The Borrower shall ascertain that third parties engaging contracted workers are legitimate and reliable entities with LMPs in place, establish procedures for managing and monitoring their performance, and ensure contracted workers have access to a grievance mechanism (AfDB ISS 2023, OS2, paras 34–36)	Contractor pre-qualification, labour audits and flow-down to sub-contractors	Ch 2.7.4; Ch 10; ESMMP
OS2 – Community Workers (Paras 37–40)	Requirements for community labour engaged by project-affected communities, including terms of engagement and monitoring responsibilities, set out in the LMPs (AfDB ISS 2023, OS2, paras 37–40)	Not applicable / not currently triggered: the Project workforce is engaged directly by IFF and its contractors; no community labour arrangements are proposed. To be re-screened if community-based works are introduced	Ch 4.3.2; Ch 4.5
OS3 – Cleaner Production and Resource Efficiency (Paras 7–9)	The Borrower shall include resource-efficiency and pollution-prevention principles in project activities in accordance with the principles of cleaner production, and implement technically and financially feasible measures to improve the efficient consumption of energy, water and raw materials (AfDB ISS 2023, OS3, paras 7–9)	Design-stage efficiency measures quantified against production output	Ch 4.3.1; Ch 4.4; Ch 4.4.11
OS3 – Energy Efficiency (Para 10)	Where the project is a potentially significant user of energy, the Borrower shall adopt the measures specified in the EHSGs and other GIIP to support the efficient use of energy (AfDB ISS 2023, OS3, para 10)	Heat and steam integration, energy intensity benchmarking against sector GIIP	Ch 4.4.1; Ch 4.4.4; Ch 4.4.11; Ch 9.2.2
OS3 – Water Use and Water Balance (Paras 11–12)	Where the project is a potentially significant user of water or may have significant impacts on water resources, a detailed water balance shall be developed, maintained, monitored and reported periodically, and opportunities for improvement in water use identified (AfDB ISS 2023, OS3, paras 11–12)	Documented water balance, abstraction limits and reuse/recovery measures	Ch 4.4.2; Ch 4.4.3; Ch 4.4.7; Ch 8.2.6
OS3 – Water Resources and Environmental Flows (Paras 13–16)	The Borrower shall avoid significantly altering flow regimes in ways that prevent water resources from fulfilling their functions for upstream and downstream ecosystems and communities, and shall assess and manage	Receiving water hydrology, discharge regime and downstream users assessed;	Ch 7.4.9; Ch 8.2.7; Ch 9.2.7

AfDB Operational Safeguard / Topic	Requirement	Guidance / What good looks like	ESIA Section / Evidence
	environmental flows using appropriate methodologies (AfDB ISS 2023, OS3, paras 13–16)	full environmental flow analysis reserved for water-infrastructure projects	
OS3 – Pollution Prevention and Applicable Standards (Paras 18–20)	The Borrower shall apply pollution prevention and control measures consistent with national legislation, applicable international conventions and internationally recognised good practice, particularly the EHSGs, achieving the more stringent where these differ, and shall avoid or otherwise minimise and control the release of pollutants (AfDB ISS 2023, OS3, paras 18–20)	Emission and effluent limits compared line-by-line against national and EHSG values	Ch 2.6.4; Ch 7.4.9; Ch 8.2.3; Ch 9.2.3
OS3 – Historical Pollution (Para 21)	Where the project involves historical pollution, the Borrower shall establish a process to identify the responsible party in accordance with national law and to determine the parties to be involved in and finance any necessary remediation (AfDB ISS 2023, OS3, para 21)	Baseline soil and groundwater screening used to establish pre-project condition and liability position	Ch 7.4.7; Ch 7.4.8; Ch 8.2.5; Ch 8.2.6
OS3 – Ambient Conditions and Assimilative Capacity (Paras 22–23)	To address potential adverse impacts on human health and the environment, the Borrower shall consider existing ambient conditions, remaining assimilative capacity in areas already impacted by pollution, and shall implement adequate measures where the project may constitute a significant source of emissions in an already degraded area (AfDB ISS 2023, OS3, paras 22–23)	Cumulative baseline plus project contribution compared against ambient criteria	Ch 7.4.3; Ch 8.2.3; Ch 8.8
OS3 – Air Emissions (Paras 24–25)	The Borrower shall consider project alternatives and implement feasible and cost-effective options to avoid or minimise air emissions during design, construction and operation, and shall characterise and estimate sources of air pollution as part of the ESA (AfDB ISS 2023, OS3, paras 24–25)	Source inventory, dispersion modelling and abatement selection documented	Ch 4.4.8; Ch 8.2.3; Ch 9.2.3
OS3 – Greenhouse Gas Emissions (Paras 26–27)	As part of the ESA the Borrower shall characterise and estimate sources of GHG emissions, including an estimate of gross emissions where technically and financially feasible, and shall consider alternatives and implement feasible options to avoid or minimise GHG emissions (AfDB ISS 2023, OS3, paras 26–27)	Scope 1 and 2 quantification by phase, intensity benchmarking and reduction initiatives	Ch 8.2.2; Ch 9.2.2
OS3 – Hazardous and Non-Hazardous Waste (Paras 28–31)	The Borrower shall identify potentially hazardous waste generated over the life cycle, avoid waste generation where possible and otherwise minimise, reuse, recycle and recover it, and comply with applicable requirements for the storage, transport and disposal of hazardous waste (AfDB ISS 2023, OS3, paras 28–31)	Waste hierarchy applied with characterisation, segregation and licensed disposal chain	Ch 4.4.9; Ch 9; ESMMP

AfDB Operational Safeguard / Topic	Requirement	Guidance / What good looks like	ESIA Section / Evidence
OS3 – Hazardous Materials and Chemicals (Paras 32–33)	The Borrower shall respect limitations on the production, trade or use of chemicals and hazardous materials subject to international bans, restrictions or phase-outs, and shall minimise and control the release and use of hazardous materials, with production, transport, handling, storage and use assessed through the ESA (AfDB ISS 2023, OS3, paras 32–33)	Chemical inventory, secondary containment and spill control assessed	Ch 4.4.10; Ch 8.2.5; Ch 8.2.6; Ch 9
OS3 – Pest and Vector Management (Paras 34–38)	Requirements for integrated pest and vector management and, where relevant, preparation of a Pest Management Plan (AfDB ISS 2023, OS3, paras 34–38)	Not applicable / limited: the Project does not involve agricultural production or significant pesticide procurement. Vector control associated with site drainage and standing water is managed as a community and occupational health measure	Ch 4.4.12; Ch 8.4.6; Ch 9.4.1
OS4 – Community Health and Safety Assessment (Paras 5–6)	The Borrower shall evaluate the risks and impacts of the project on the health and safety of affected communities during the project life cycle, including those who may be vulnerable, and shall develop and implement measures to address them (AfDB ISS 2023, OS4, paras 5–6)	Community health, safety and security assessment distinct from occupational risk	Ch 7.6; Ch 8.4.6; Ch 9.4.1; ESMMP
OS4 – Flow-Down to Contractors and Suppliers (Para 7)	The Borrower shall ensure that all relevant requirements are incorporated into procurement and bidding documents and contracts of primary suppliers, service providers, contractors and sub-contractors (AfDB ISS 2023, OS4, para 7)	Community H&S requirements written into contract documents, not only internal plans	Ch 2.7.4; Ch 10; ESMMP
OS4 – Structural Safety and High-Risk Locations (Paras 8–10)	The Borrower shall design, construct, operate and decommission the structural elements of the project in accordance with national legal requirements and the ISS Guidance Notes, taking into account safety risks to third parties and affected communities, and shall engage independent experts where structural elements in high-risk locations could threaten community safety (AfDB ISS 2023, OS4, paras 8–10)	Design codes stated; climate and natural hazard exposure factored into design basis	Ch 4.3.1; Ch 7.4.2; Ch 8.2.1; Ch 9.2.1
OS4 – Traffic and Road Safety (Paras 12–15)	The Borrower shall identify, evaluate and monitor traffic and road safety risks to workers, affected communities and road users throughout the operational life cycle, undertake road safety assessments for each project phase where appropriate, and implement driver and vehicle safety measures including training, monitoring and enforcement (AfDB ISS 2023, OS4, paras 12–15)	Baseline traffic counts, road safety assessment and a traffic management plan covering vulnerable road users	Ch 7.8; Ch 8.6; Ch 9.6; ESMMP

AfDB Operational Safeguard / Topic	Requirement	Guidance / What good looks like	ESIA Section / Evidence
OS4 – Ecosystem Services and Community Wellbeing (Para 16)	Where direct impacts on provisioning and regulating ecosystem services may result in adverse health and safety risks to affected communities, the Borrower shall identify and, where appropriate and feasible, address those risks (AfDB ISS 2023, OS4, para 16)	Ecosystem service dependencies of local users identified and linked to social mitigation	Ch 7.5.6; Ch 8.3; Ch 9.3
OS4 – Public Health and Disease (Paras 17–20)	Risks to public health and safety shall be identified during ESA scoping and addressed by competent experts, and the Borrower shall avoid or minimise the potential for community exposure to water-borne, water-based, water-related and vector-borne diseases, and to communicable and non-communicable diseases resulting from project activities (AfDB ISS 2023, OS4, paras 17–20)	Community health risk assessment with differentiated exposure considered	Ch 7.6; Ch 8.4.6; Ch 9.4.1
OS4 – Labour Influx and Project-Induced Migration (Paras 21, 23)	The Borrower shall take necessary measures to avoid, mitigate and manage risks and adverse impacts on public health and safety arising from the influx of workers, and shall prepare a Labour Influx Management Plan where project-induced migration risks are significant (AfDB ISS 2023, OS4, paras 21, 23)	Labour influx management plan with local hiring, accommodation and community interface controls	Ch 8.4.3; Ch 9.4.1; ESMMP
OS4 – SEAH, GBV and Communicable Disease (Para 22)	The Borrower shall ensure that women, girls, boys and men are protected from sexual exploitation, abuse and harassment and gender-based violence, and shall avoid and contain the spread of diseases associated with in-migration (AfDB ISS 2023, OS4, para 22)	Code of conduct, SEAH/GBV prevention and response protocol, and confidential reporting route	Ch 2.7.5; Ch 2.7.13; Ch 9.4.1; ESMMP
OS4 – Community Exposure to Hazardous Materials (Paras 25–26)	The Borrower shall avoid or minimise the potential for community exposure to hazardous materials and substances that may be released by the project, and shall control the safety of deliveries, storage, transportation and disposal of hazardous materials and wastes (AfDB ISS 2023, OS4, paras 25–26)	Process safety and transport controls for ammonia, urea, UFC-85 and feedstock handling	Ch 4.4.10; Ch 8.4.8; Ch 9.4.1; ESMMP; EPRP
OS4 – Emergency Preparedness and Response (Paras 27–31)	The Borrower shall conduct a risk and hazard assessment as part of the ESA and prepare an Emergency Preparedness and Response Plan, including engineering controls, emergency equipment, notification, response and evacuation procedures, and shall document, disclose and regularly review these arrangements with affected communities and relevant agencies (AfDB ISS 2023, OS4, paras 27–31)	EPRP covering off-site consequences, community notification and joint drills	Ch 8.4.8; Ch 9.4.1; Ch 10; ESMMP; EPRP (Emergency Preparedness and Response Plan)
OS4 – Security Personnel and Human Rights (Paras 32–37)	The Borrower shall assess risks and impacts on workers and communities arising from security arrangements, ensure compliance with the Voluntary Principles on Security and Human Rights and the UN Basic Principles on the	Security management framework and screening,	Ch 7.6.5; Ch 9.4.1; ESMMP

AfDB Operational Safeguard / Topic	Requirement	Guidance / What good looks like	ESIA Section / Evidence
	Use of Force, apply proportionality in hiring, conduct, training and monitoring of security personnel, verify that personnel are not implicated in past abuses, and review all allegations of unlawful or abusive acts (AfDB ISS 2023, OS4, paras 32–37)	with grievance route for security-related complaints	
OS4 – Dam Safety (Annex)	Dam safety requirements for new dams, existing dams and dams under construction, including independent panels of experts and instrumentation, operation and maintenance and emergency preparedness plans (AfDB ISS 2023, OS4, Annex – Dam Safety)	Not applicable: the Project does not include or rely on dams or reservoir infrastructure	Ch 4.3; Ch 4.4
OS5 – Land Acquisition, Restrictions on Access to Land and Land Use, and Involuntary Resettlement (Paras 4–10)	OS5 applies where a project results in physical or economic displacement, loss of assets or access to assets, or restrictions on land use, requiring a census, a resettlement or livelihood restoration plan, compensation at replacement cost and consultation with affected persons (AfDB ISS 2023, OS5, paras 4–10 and following)	Not triggered: Project land lies within the existing Indorama Free Zone under the control of the Proponent, and no physical or economic displacement has been identified. Land access restrictions and any future land requirements are to be managed under the Management of Change process and re-screened against OS5	Ch 4.2; Ch 7.6.11; Ch 11.2.2
OS6 – Assessment of Habitat and Biodiversity (Paras 8, 10)	The ESA shall consider direct, indirect and cumulative project-related impacts on habitats and the biodiversity they support, and shall identify the potential project-related risks to and impacts on them (AfDB ISS 2023, OS6, paras 8, 10)	Habitat mapping across the AoI with cumulative biodiversity considerations	Ch 7.5; Ch 8.3; Ch 8.3.8
OS6 – Baseline Characterisation (Para 11)	The Borrower's assessment will include characterisation of baseline conditions to a degree proportional and specific to the anticipated risk and significance of impacts (AfDB ISS 2023, OS6, para 11)	Season-appropriate terrestrial and aquatic surveys by qualified ecologists	Ch 7.5.2; Ch 7.5.3; Ch 7.5.4; Ch 7.5.5
OS6 – Mitigation Hierarchy, Offsets and Net Outcomes (Paras 9, 12, 15–18)	The Borrower shall aim to avoid adverse impacts on biodiversity and habitats and, where avoidance is not possible, apply the mitigation hierarchy; offsets shall only be considered after avoidance, minimisation and restoration measures have been applied, and shall be designed to achieve measurable,	Explicit residual-loss statement and justification of whether offsets are required	Ch 8.3.5; Ch 8.3.6; Ch 9.3

AfDB Operational Safeguard / Topic	Requirement	Guidance / What good looks like	ESIA Section / Evidence
	additional and long-term conservation outcomes (AfDB ISS 2023, OS6, paras 9, 12, 15–18)		
OS6 – Modified Habitat (Paras 19–20)	Where modified habitat includes significant biodiversity value as determined by the ESA, the Borrower shall avoid or minimise impacts and implement mitigation measures as appropriate (AfDB ISS 2023, OS6, paras 19–20)	Habitat classification stated and defended for the developed complex footprint	Ch 7.5.2; Ch 8.3.4
OS6 – Natural Habitat (Paras 21–22)	Where natural habitats are identified, the Borrower shall avoid adverse impacts in accordance with the mitigation hierarchy, and the concerns of affected communities identified through consultation should inform the design of mitigation measures (AfDB ISS 2023, OS6, paras 21–23)	Riverine, mangrove and swamp forest habitats assessed as natural habitat where applicable	Ch 7.5.2; Ch 8.3.4; Ch 9.3
OS6 – Critical Habitat (Paras 25–28)	The Borrower shall determine whether critical habitat is present, and in areas of critical habitat shall not implement project activities with potential adverse impacts unless all specified conditions are met, with the mitigation strategy described in a Biodiversity Management Plan (AfDB ISS 2023, OS6, paras 25–28)	Documented critical habitat screening against each qualifying criterion	Ch 7.5.7; Ch 8.3; Ch 9.3
OS6 – Legally Protected and Internationally Recognised Areas (Paras 29–31)	Where the project occurs within, or may adversely affect, a legally protected, designated or internationally recognised area, the Borrower shall meet additional requirements and shall not support the de-gazetting or downgrading of protected area status (AfDB ISS 2023, OS6, paras 29–31)	Proximity screening to protected and internationally recognised areas documented	Ch 7.5.7; Ch 8.3
OS6 – Invasive Alien Species (Paras 32–35)	The Borrower shall not intentionally introduce alien species other than in accordance with the existing regulatory framework, shall exercise diligence not to spread species already established, and shall assess the feasibility of eradicating or controlling invasive alien species over which it has management responsibility (AfDB ISS 2023, OS6, paras 32–35)	Invasive species recorded in baseline and controlled through site clearance and revegetation controls	Ch 7.5.3; Ch 9.3.1; Ch 9.3.2
OS6 – Living Natural Resources and Primary Suppliers (Paras 36–46)	Requirements for the sustainable management of primary production and harvesting of living natural resources, and for verification systems where natural resource commodities are purchased from areas of conversion risk (AfDB ISS 2023, OS6, paras 36–46)	Not applicable / limited: the Project does not involve primary production or harvesting of living natural resources. Feedstock is natural gas supplied by pipeline	Ch 4.3.3; Ch 4.4.6

AfDB Operational Safeguard / Topic	Requirement	Guidance / What good looks like	ESIA Section / Evidence
OS7 – Early Identification and Screening of Vulnerable Groups (Paras 17–18)	As early as possible the Borrower shall screen for and take the necessary measures to appropriately manage risks and adverse impacts of the project on vulnerable individuals and groups (AfDB ISS 2023, OS7, paras 17–18)	Vulnerability screening integrated into the socio-economic baseline and stakeholder mapping	Ch 6.3; Ch 7.6; Ch 7.6.14
OS7 – Social Assessment and Differentiated Mitigation (Paras 19–21)	Where screening determines that potential adverse impacts on vulnerable groups are present, a more in-depth social assessment shall be undertaken, and the Borrower and affected vulnerable groups shall identify mitigation measures aligned with the mitigation hierarchy as well as opportunities for shared benefits (AfDB ISS 2023, OS7, paras 19–21)	Vulnerable group analysis matrix with targeted measures and equitable benefit access	Ch 8.4; Ch 9.4.1; ESMMP
OS7 – Grievance Mechanism Accessible to Vulnerable Groups (Para 44)	The Borrower shall ensure that a grievance mechanism as described in OS10 is established for the project and is culturally appropriate and accessible to affected vulnerable groups (AfDB ISS 2023, OS7, para 44)	Multiple low-barrier grievance channels, including non-literate and remote access	Ch 6.6; SEP; ESMMP
OS8 – Cultural Heritage in the ESA	The ESA shall consider direct, indirect and cumulative project-specific risks to and impacts on cultural heritage; the Borrower shall aim to avoid impacts and, where not possible, identify and implement measures to address them, applying globally recognised practices for field-based studies, documentation and protection (AfDB ISS 2023, OS8, paras 9–11)	Tangible and intangible heritage assessed together, with avoidance considered first	Ch 7.7; Ch 8.5; Ch 9.5
OS8 – Chance Finds Procedure	A project-specific chance-finds procedure shall be followed if previously unknown cultural heritage is encountered during project activities (AfDB ISS 2023, OS8, para 12)	Stop-work, notification and clearance protocol with training and sign-off	Ch 9.5.2; ESMMP
OS8 – Legally Protected Cultural Heritage Areas	As part of the ESA the Borrower shall determine the presence of all listed legally protected cultural heritage areas affected by the project (AfDB ISS 2023, OS8, para 18)	Register check against national and state heritage listings	Ch 7.7.4; Ch 7.7.6
OS8 – Archaeological Sites	Where there is evidence or high probability of past human activity in the project area, the Borrower shall conduct desk-based research and field surveys to document and assess archaeological resources, and determine in consultation with experts and communities how they will be managed (AfDB ISS 2023, OS8, paras 19–21)	Desk study plus field walkover, with archaeological potential rated	Ch 7.7.3; Ch 7.7.4; Ch 8.5
OS8 – Movable Cultural Heritage	The Borrower, in consultation with relevant national cultural heritage authorities, shall identify movable cultural heritage objects that may be	Custody and curation arrangements agreed before ground disturbance	Ch 7.7.6; Ch 9.5.2

AfDB Operational Safeguard / Topic	Requirement	Guidance / What good looks like	ESIA Section / Evidence
	endangered by the project and agree measures for their protection (AfDB ISS 2023, OS8, paras 28–29)		
OS8 – Intangible Cultural Heritage and Commercial Use	The Borrower shall identify and assess the significance of affected intangible cultural heritage in consultation with communities and stakeholders, and shall not proceed with commercial use of cultural heritage without meaningful consultation and fair and equitable sharing of benefits (AfDB ISS 2023, OS8, paras 30–33)	Festivals, rites and traditional practices assessed alongside physical heritage	Ch 7.7.5; Ch 8.5.1; Ch 9.5.2
OS10 – Engagement Throughout the Project Life Cycle	The Borrower shall engage with stakeholders as an integral part of the project's ESA and design, throughout the project life cycle, commencing as early as possible in the project development process (AfDB ISS 2023, OS10, paras 6, 8)	Engagement from scoping onward, not a single disclosure event	Ch 6.1; Ch 6.4; Ch 6.5
OS10 – Stakeholder Identification and Analysis	The Borrower shall identify the different stakeholders, both project-affected parties and other interested parties, and shall identify project-affected parties who may be vulnerable due to their particular circumstances (AfDB ISS 2023, OS10, paras 12–13)	Stakeholder register differentiating affected, interested and vulnerable parties	Ch 6.3; Ch 7.6
OS10 – Meaningful Consultation	The Borrower shall facilitate meaningful consultation by providing timely, relevant, understandable and accessible information, in a two-way process that begins early, allows views to be expressed on risks, impacts and mitigation, and documents how those views have been considered (AfDB ISS 2023, OS10, paras 9, 23–24)	Documented feedback loop showing how comments changed the design or mitigation	Ch 6.4; Ch 6.6; Ch 6.7
OS10 – Stakeholder Engagement Plan	The Borrower shall develop and implement a Stakeholder Engagement Plan proportionate to the nature and scale of the project, describing the timing and methods of engagement across the life cycle, the measures to remove obstacles to participation, and how the views of differently affected groups will be captured (AfDB ISS 2023, OS10, paras 15–18, 20)	Standalone SEP referenced by, and consistent with, the ESIA	Ch 6.2; Ch 6.4; SEP
OS10 – Documented Record of Engagement	The Borrower shall maintain and publicly disclose, as part of the ESA, a documented record of stakeholder engagement, including a description of the stakeholders consulted (AfDB ISS 2023, OS10, para 11)	Attendance registers, issues log and responses appended to the ESIA	Ch 6.5; Ch 6.6; Ch 6.7; ESIA appendices (Vol 2)

AfDB Operational Safeguard / Topic	Requirement	Guidance / What good looks like	ESIA Section / Evidence
OS10 – Information Disclosure	The Borrower shall disclose project information to allow stakeholders to understand the risks, impacts and opportunities of the project, on an ongoing basis throughout the life cycle, in relevant local languages and in an accessible manner (AfDB ISS 2023, OS10, paras 21–22)	Disclosure locations, formats and languages specified for each phase	Ch 5.7.4; Ch 6.4; SEP
OS10 – Engagement During Implementation and Project Changes	The Borrower shall continue to engage with and provide information to project-affected and other interested parties throughout the life cycle in accordance with the SEP, and shall re-engage where significant changes result in additional risks and impacts (AfDB ISS 2023, OS10, paras 25–27)	Post-ESIA engagement programme with defined frequency and triggers	Ch 6.8; Ch 10; SEP
OS10 – Grievance Mechanism	The Borrower shall respond to concerns and grievances of project-affected parties in a timely manner through a grievance mechanism proportionate to the risks and impacts of the project, accessible and inclusive, handling grievances in a culturally appropriate, discreet and objective manner, and providing an appeals route without impeding access to judicial remedies (AfDB ISS 2023, OS10, paras 28–31 and Annex on grievance mechanisms)	Multi-channel mechanism with anonymous submission, timelines, register and appeal stage	Ch 6.6; SEP; ESMMP
OS10 – Organisational Capacity for Engagement	The Borrower shall define clear roles, responsibilities and authority and designate specific personnel with competency and experience in stakeholder engagement (AfDB ISS 2023, OS10, para 32)	Named community liaison function with reporting line and resourcing	Ch 10; ESMMP; SEP
OS10 – Reprisal Risk and Safe Consultation	Where reprisal risks are identified, the Borrower shall implement specific measures to prevent reprisals, including safe consultation practices, confidentiality for at-risk stakeholders, and cooperation with the Bank on how such risks are managed and resolved (AfDB ISS 2023, OS10, Annex on reprisals)	Anti-retaliation commitment linked to the grievance and whistle-blowing channels	Ch 2.7.6; Ch 2.7.13; Ch 6.6

1.7 USE OF EXISTING STUDIES, PROJECT-LEVEL DOCUMENTS AND AVAILABLE DATA

The ESIA has been informed by a combination of newly collected primary data and a range of pre-existing information sources, including:

- Previous project ESIA documentation (particularly the Train 3 ESIA);
- Site-wide and project-specific stakeholder engagement and social management documents (including the Stakeholder Engagement Plan (SEP), grievance procedures, and community agreements);
- Existing operational datasets and monitoring records from the wider Indorama Manufacturing Complex;
- Previous specialist studies undertaken at the complex level (e.g. groundwater sustainability assessments); and
- Published regional datasets, technical literature, and internal ERM databases, where appropriate.

In line with IFC PS 1 and AfDB OS 1 requirements, all available pre-existing information was reviewed for relevance, reliability, and applicability to the proposed Project. Where reliance was placed on historic or third-party datasets, the ESIA has identified key limitations and undertaken supplementary field surveys, updated modelling, or conservative assessment assumptions to ensure the robustness of conclusions.

Table 1-6 provides a consolidated register of the key previous ESIA documents, site-wide management instruments, historic studies, and operational datasets used in the assessment, together with their relevance, limitations, and application within the ESIA and ESMMP.

TABLE 1-6: USE OF EXISTING STUDIES, PROJECT DOCUMENTS, AND AVAILABLE DATA

Category	Document / Dataset	Year	Description / Source	How Used in ESIA	Key Limitation / Validation	ESIA / ESMMP Application
Previous ESIA	Environmental and Social Impact Assessment for *IEFCL Train 3 Project*	2023	Prior project ESIA for expansion of Indorama facility	Provides historical baseline context, ESIA methodology reference, and stakeholder engagement continuity	Used as contextual reference; updated through current surveys and data	Methodology alignment, stakeholder baseline, cumulative context
Social / Stakeholder	Stakeholder Engagement Plan (SEP) – site-wide / Train 2 SEP and updated SEP	2018–2026	Consolidated engagement system across projects	Used for stakeholder identification, engagement framework, and continuity of records	Updated to reflect current project scope and stakeholder landscape	Chapter 6, SEP, stakeholder engagement, ESMMP
Social / Stakeholder	Stakeholder / Community Grievance Management Procedure	2018	Formal grievance system applied across the site	Provides structure for grievance submission, resolution and monitoring	Updated and applied across expansions (not project-specific)	Grievance mechanism, monitoring, ESMMP indicators
Social / Stakeholder	Memorandum of Understanding (MoU) with host communities	2019	Community agreement defining commitments and benefits	Provides context for community expectations and existing commitments	Ongoing instrument requiring project-specific implementation	Social commitments, stakeholder engagement, PAC processes
Social / Stakeholder	Train 2 SIA and Stakeholder Engagement Plan	2018	Previous project social and engagement documentation	Provides historical engagement baseline and social context	Requires updating to reflect current conditions	Stakeholder mapping and engagement evolution
Social / Stakeholder	Train 3 Stakeholder Engagement Report	2023	Record of engagement activities during Train 3 ESIA	Used to identify historical stakeholder issues and engagement approach	Supplemented by current ESIA engagement activities	Stakeholder issue tracking and engagement continuity
Social / Stakeholder	Train 3 Local Hiring Plan	2023	Previous workforce and local content planning document	Used as reference for employment	Contextual reference only; updated for Line 2	Labour management and social planning

Category	Document / Dataset	Year	Description / Source	How Used in ESIA	Key Limitation / Validation	ESIA / ESMMP Application
				expectations and local participation		
Operational Data	Stakeholder database, engagement records, and grievance logs	Ongoing	Existing Indorama social systems and records	Used for stakeholder identification, mapping and tracking issues	Continuously updated; requires verification against current engagement	Stakeholder engagement, grievance tracking, ESMMP indicators
Operational Data	Borehole inventory and groundwater abstraction records	Ongoing	Existing groundwater monitoring system across the complex	Used to characterise groundwater use and cumulative abstraction	Requires continued monitoring and validation of new boreholes	Groundwater baseline, abstraction and monitoring
Operational Data	Existing production boreholes (Line 1 infrastructure)	2015	Infrastructure developed under IFZ Line 1 project	Used to understand existing abstraction and drawdown behaviour	Requires site-specific testing for new boreholes	Groundwater baseline and cumulative impact assessment
Operational Data	Wastewater treatment and effluent performance data	Ongoing	Existing treatment systems and monitoring records	Used to assess discharge quality and treatment performance	Supplemented with sampling and conservative assumptions	Surface water / wastewater impact assessment
Operational Data	Drainage, hydrology and site infrastructure data	Ongoing	Existing site-wide environmental and infrastructure information	Used to understand drainage patterns and flood risk context	Some uncertainty (e.g. flood extent) remains	Surface water baseline and infrastructure assessment
Operational Data	Shared utilities data (steam, power systems)	Ongoing	Integrated utility systems across Indorama complex	Used to define GHG boundary and allocate emissions	Allocation-based approach (not direct measurement)	Climate / GHG assessment
Specialist Study	Groundwater sustainability study and 2026 re-modelling (Mogaba) for Indorama Manufacturing Complex	2025; updated 2026	Complex-wide hydrogeological modelling and variable-density (SEAWAT) re-modelling for the confirmed operational abstraction regime	Used to assess aquifer behaviour, sustainable yield, drawdown and saline-water intrusion	Requires site-specific validation and continued monitoring	Groundwater baseline, impact assessment, monitoring

Category	Document / Dataset	Year	Description / Source	How Used in ESIA	Key Limitation / Validation	ESIA / ESMMP Application
Specialist Study	Train 3 Air Quality Impact Assessment	2023	Previous air quality assessment for expansion project	Used as baseline for updated AQIA and cumulative assessment	Updated with new baseline data and modelling	Air quality impact and cumulative assessment
Operational / Specialist (Combined)	Existing environmental monitoring data (surface water, groundwater, wastewater, sediment)	Ongoing	Combined operational datasets and previous studies	Used to supplement baseline and address data gaps	Requires validation through field surveys and updated sampling	Multiple baseline chapters and ESMMP monitoring
Secondary / Technical Data	ERM Global Climate Database and regional climate datasets	Various	Internal ERM database and public climate sources	Used to establish climate baseline and future projections	Desk-based; no new data collection for this study	Climate risk assessment (CCRA)
Secondary / Technical Data	IBAT, aerial imagery, and biodiversity literature	Various	Public datasets and spatial tools	Used to support biodiversity screening and contextual baseline	No named previous Indorama biodiversity study referenced	Biodiversity baseline and screening
Secondary / Technical Data	Archaeological, historical literature, mapping and remote sensing data	Various	Desk-based cultural heritage sources	Used to inform cultural heritage baseline and survey design	No specific previous project CH study identified	Cultural heritage baseline and management

1.7.1 USE OF PREVIOUS PROJECT ESIA DOCUMENTATION

The ESIA has drawn on prior Indorama ESIA documentation, particularly the ESIA for the Proposed IEFCL Train 3 Project.

The Train 3 ESIA provides an important reference point for:

- Historical baseline conditions;
- Established assessment approaches;
- Stakeholder identification and engagement frameworks; and
- The evolution of social and environmental management structures across the site.

The Train 3 stakeholder engagement process explicitly indicates that stakeholder identification for new developments builds on stakeholder databases developed for earlier projects (including Trains 1 and 2), demonstrating continuity of engagement across project phases and expansions.

Where relevant, the current ESIA uses the Train 3 ESIA as contextual information and a reference baseline, while updating baseline conditions through new surveys and current data collection.

1.7.2 USE OF SITE-WIDE SOCIAL MANAGEMENT AND STAKEHOLDER DOCUMENTS

The ESIA places significant reliance on existing Indorama stakeholder engagement systems and social management instruments, as consolidated in the project SEP and supporting documents.

These include:

- Existing stakeholder databases and engagement records;
- Previous Stakeholder Engagement Plans (including Train 2 SEP);
- Records of engagement activities and PAC processes;
- Memoranda of Understanding (MoUs) with host communities; and
- The Stakeholder / Community Grievance Management Procedure.

These materials were used to:

- Inform stakeholder identification and mapping for the Project;
- Provide continuity in stakeholder relationships;
- Identify historical issues, concerns, and engagement trends; and
- Design the current engagement and grievance mechanism in alignment with IFC PS1 requirements.

The grievance mechanism and stakeholder engagement system are also explicitly designed to apply across existing facilities and future expansions, ensuring integration of the Project into site-wide management systems.

In addition, previous project-specific social documentation; including the 2018 Train 2 SIA/SEP, 2023 Train 3 engagement report, and the Train 3 Local Hiring Plan; have been referenced to ensure alignment with existing commitments and community expectations.

1.7.3 USE OF EXISTING OPERATIONAL DATA AND SITE-WIDE ENVIRONMENTAL INFORMATION

A substantial portion of the baseline and impact assessment is informed by existing operational datasets from the Indorama Manufacturing Complex.

These include:

- Borehole inventories and groundwater abstraction records;
- Wastewater treatment system data and effluent performance records;
- Drainage, flood risk and site hydrology information; and
- Existing plant infrastructure and utility systems.

These datasets are explicitly used in the groundwater and surface water assessments to:

- Characterise baseline conditions;
- Understand cumulative effects from existing operations; and
- Inform the assessment of additional abstraction, discharge, and infrastructure integration.

Where uncertainties persist (e.g. flood extent, long-term groundwater behaviour), the ESIA applies precautionary assumptions and identifies monitoring and follow-up studies.

1.7.4 USE OF PREVIOUS SPECIALIST STUDIES AND COMPLEX-LEVEL ASSESSMENTS

The ESIA also draws on previous specialist work undertaken at the complex scale, most notably the groundwater sustainability study for the Indorama Manufacturing Complex, which provides a quantitative assessment of aquifer behaviour under sustained abstraction.

This study is used to:

- Interpret aquifer characteristics and connectivity;
- Assess cumulative abstraction effects;
- Evaluate sustainable yield and drawdown behaviour; and
- Inform groundwater management and monitoring commitments.

Similarly, the air quality assessment builds on prior train-specific studies (including the 2023 Train 3 AQIA), updating baseline conditions and explicitly considering cumulative operation of existing and proposed facilities.

1.7.5 USE OF SECONDARY PUBLISHED DATA AND INTERNAL DATABASES

For selected disciplines, including climate and biodiversity, the ESIA also uses:

- ERM internal databases (e.g. Global Climate Database);
- Desktop spatial tools (e.g. IBAT, aerial imagery); and
- Regional scientific literature and publicly available datasets.

These sources provide:

- Regional context and benchmarking;
- Screening-level inputs for baseline characterisation; and
- Inputs for climate risk and biodiversity sensitivity assessments.

1.7.6 INTEGRATION AND VALIDATION APPROACH

All pre-existing datasets were integrated into the ESIA using a structured approach:

- Verification through field surveys (wet and dry season sampling, where applicable);
- Cross-checking against current operational data;
- Conservative assumptions where data gaps or uncertainty persist; and
- Explicit identification of limitations and recommendations for additional monitoring or studies.

2. LEGAL AND ADMINISTRATIVE FRAMEWORK

2.1 INTRODUCTION

This Chapter details the legislative and international good practice environmental and social requirements for the proposed IFZ Line 2 Project. National (Nigerian) laws deemed relevant for the successful implementation of all environmental and social components of the Project are presented in this Chapter. Furthermore, the applicable standards of international lending organisations are provided, and their applicability discussed[1].

2.2 INSTITUTIONAL FRAMEWORK

A summary of National and State authorities with the mandate to implement aspects of Nigerian legislation over aspects relating to the Project are provided in this Section.

2.2.1 FEDERAL MINISTRY OF ENVIRONMENT (FMENV)

FMEnv is the principal authority for the regulation and enforcement of environmental laws in Nigeria. The EIA Act, established by the Ministry, which ensures that all development and industrial activities, operations and emissions are within the limits prescribed in the national guidelines and standards and comply with relevant regulations for environmental pollution management in Nigeria as and when these are released by the Ministry. Further to the Mandate, FMEnv developed laws/ guidelines on various sectors of the national economy including the Environmental Impact Assessment (EIA Act CAP E12, LFN 2004) Act and procedures for evaluating EIA reports. Furthermore, in September 2021, through Official Gazette No. 105, Vol 108, the Federal Republic of Nigeria published S.I. No. 109, Environment Impact Assessment Procedures and Charges Regulations. This ESIA has considered these regulations, which outlines the EIA procedure from project conception to commissioning and describes the requisite follow up activities. FMEnv consults with State Ministries of Environment during the EIA permitting process.

In addition, other regulatory agencies/authorities with oversight over specific industries have also issued guidelines to regulate the impact of such industries on the environment.

2.2.2 NATIONAL ENVIRONMENTAL STANDARDS AND REGULATION ENFORCEMENT AGENCY (NESREA)

The National Environmental Standards and Regulations Enforcement Agency (NESREA) was established in 2007 by the Federal Government of Nigeria as an Agency of FMEnv. The Agency is charged with the responsibility of enforcing the environmental laws, guidelines, standards, and regulations in Nigeria, specifically during the operational phase of development projects.

[1] Whilst this Chapter has been prepared with all due care by ERM, it does not constitute legal advice and should not be construed as such. Furthermore, the Nigerian regulatory environment may be subject to changes to both regulatory instruments and authorities during the projected Project life cycle. It is therefore recommended that the regulatory framework is reviewed and assessed periodically. The sourcing of legislation was limited to a desktop survey (ERM's EHS database and other available online sources) and reliance on in-country contacts.

2.2.3 NIGERIAN MIDSTREAM AND DOWNSTREAM PETROLEUM REGULATORY AUTHORITY (NMDPRA)

The Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA) is the federal regulator responsible for overseeing Nigeria's midstream and downstream petroleum operations under the Petroleum Industry Act, 2021. The Authority regulates activities relating to natural gas processing, transportation, storage, distribution, and related infrastructure, as well as petroleum refining, importation, exportation, and product distribution. In the context of industrial projects such as the IFF Line 2 Fertilizer Project, NMDPRA plays a key role in regulating gas supply systems, gas processing facilities, pipelines, and associated installations, and in issuing permits, licences, and approvals relevant to gas handling, safety, and operational integrity. The Authority is also responsible for enforcing applicable technical standards, safety requirements, and environmental protection provisions across the midstream and downstream petroleum value chain, working in coordination with the Federal Ministry of Environment and other competent authorities.

The effective implementation of the IFF Line 2 Project will depend on the capacity of the Project Proponent, contractors, government agencies, regulators and host communities to fulfil their respective environmental and social responsibilities. Consequently, the table below outlines the roles and responsibilities of each group, including their institutional and administrative capacity.

TABLE 2-1A: ROLES, RESPONSIBILITIES AND INSTITUTIONAL CAPACITY OF PROJECT IMPLEMENTATION STAKEHOLDERS

Institution/Entity	Principal Roles and Responsibilities	Institutional and Administrative Capacity
Indorama Fertilizer FZE (IFF)	Overall responsibility for implementation of the ESMP; provision of financial, human and technical resources; obtaining and maintaining statutory approvals; integrating E&S requirements into project design, procurement and contracts; ensuring contractor compliance; stakeholder engagement; grievance management; environmental and social monitoring; incident reporting; corrective actions; and periodic review of ESMP performance.	Indorama has an established organisational structure, experienced management and technical personnel, and an operational **Environmental and Social Management System (ESMS)** supported by HSE procedures. The existing facility has established systems for environmental monitoring, regulatory compliance, incident management, emergency response, contractor management, stakeholder

		engagement and reporting. These existing systems provide the institutional foundation for implementing and maintaining the ESMP for the proposed Project. Additional resources will be provided as required during construction and operation.
Project Management Team	Incorporate ESMP requirements into project planning, engineering, procurement, construction and commissioning; coordinate contractors and consultants; ensure that environmental and social commitments are incorporated into work packages and contractor obligations.	The Project Management Team will comprise experienced project, engineering, construction, HSE and environmental/social personnel. The team will have defined reporting lines and authority to incorporate E&S requirements into project decisions, approve work plans, coordinate contractors and track ESMP performance. Project-specific E&S responsibilities will be included in project implementation procedures and work packages.
HSE/Environmental and Social Management Team	Day-to-day implementation and supervision of ESMP measures; environmental monitoring; inspections and audits; waste management; pollution prevention; occupational and community health and safety; biodiversity and resource management; incident investigation; record keeping and regulatory reporting.	Indorama maintains an established HSE and environmental management function with personnel experienced in industrial environmental management, occupational health and safety, environmental monitoring, regulatory compliance and emergency response. The team will be strengthened with additional competent personnel and specialists where required, particularly during peak

		construction activities. It will have authority to conduct inspections, identify non-conformances, initiate corrective actions and escalate significant issues to management.
Engineering/Operations Department	Ensure that environmental and social controls are incorporated into engineering design, equipment selection, operation and maintenance; implement resource-efficiency, emission-control and pollution-prevention measures.	The Engineering and Operations teams possess technical and operational experience in the design, construction, commissioning and operation of large-scale ammonia–urea plants (IFZ Line 1, IFZ Line 2 and IFF Line 1). Their established maintenance, process-control and operational procedures provide capacity to integrate pollution prevention, energy efficiency, emission controls, waste minimisation and environmental safeguards into project design and operation. Specialist engineering support will be engaged where necessary.
Procurement/Contract Management	Incorporate E&S requirements, performance standards and applicable regulatory obligations into contractor and supplier agreements; monitor contractor performance and enforce contractual corrective actions.	Existing procurement and contract-management procedures provide a mechanism for incorporating HSE, environmental and social requirements into tender documents, contracts and purchase orders. Contractors will be prequalified based on relevant technical and HSE competence, and contractual performance requirements will include compliance with the ESMP, applicable legislation and Indorama's HSE requirements.

Contractors/Subcontractors	Implement all applicable ESMP, HSE and environmental requirements within their areas of responsibility; prepare method statements and task-specific plans; provide competent personnel and PPE; undertake monitoring and reporting; manage wastes and hazardous materials; report incidents and implement corrective actions.	Contractors will be required to demonstrate adequate technical, financial, HSE and environmental capacity before mobilisation. Each major contractor will designate competent HSE/environmental personnel and implement project-specific HSE and environmental plans. Contractor performance will be subject to induction, routine inspections, audits, toolbox meetings, monitoring and corrective-action tracking by Indorama.
Federal Ministry of Environment (FMEnv)	Regulatory oversight of the ESIA process and environmental compliance; review and approval of the ESIA/ESMP; monitoring of compliance with approval conditions; inspections and enforcement in accordance with applicable environmental legislation.	FMEnv has the statutory mandate, technical departments and established procedures for ESIA review, environmental compliance monitoring, inspection and enforcement. The Ministry will provide regulatory oversight through review of the ESIA/ESMP, approval conditions, inspections, monitoring and review of compliance reports.
Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA)	Regulatory oversight of applicable midstream/downstream petroleum and gas-related activities; review and enforcement of relevant technical, safety, environmental and operational requirements within its statutory mandate.	NMDPRA has specialised regulatory and technical capacity covering applicable gas and petroleum-sector activities, including technical, operational and safety oversight. Its established inspection, permitting, monitoring and enforcement mechanisms will support regulatory compliance for applicable gas-related aspects of the Project.

Rivers State Ministry of Environment / relevant State authorities	State-level environmental oversight, inspections, coordination and monitoring; participation in environmental compliance activities and community-related environmental matters.	The Rivers State environmental authorities provide state-level environmental oversight and have established personnel and administrative structures for environmental monitoring, inspection, stakeholder engagement and coordination with federal regulators. The Ministry will support implementation through periodic monitoring, participation in inspections and engagement on state and community-level environmental matters.
Relevant Local Government Authorities	Local administrative coordination, support for stakeholder engagement and community-level implementation of relevant project commitments.	The relevant Local Government Authorities provide an established administrative interface between the Project, host communities and state government. Their capacity will primarily support local coordination, communication, community mobilisation and participation in implementation of relevant community-level commitments.
Host Communities/Community Representatives/CDCs	Participate in consultation, disclosure, grievance management and participatory environmental monitoring; provide community feedback and assist in identifying emerging environmental and social concerns.	Existing community leadership structures, Community Development Committees (CDCs) and community representatives provide an established platform for stakeholder engagement and community participation. Their capacity will be strengthened through regular consultation, environmental

		awareness, grievance-management procedures and participation in **Participatory Environmental Monitoring (PEM)**.
Consultants/Independent Specialists	Provide specialist environmental and social expertise, baseline studies, monitoring, audits, capacity building and independent technical support where required.	Qualified and appropriately accredited consultants and specialists will be engaged where specialist expertise is not available internally. Consultants will support environmental and social monitoring, audits, technical studies, capacity building and independent verification. Their engagement will be subject to defined scopes of work, competency requirements and quality-control procedures.
Development Finance Institution/AfDB, IFC/WB where applicable	Oversight of applicable environmental and social requirements under the AfDB Integrated Safeguards System, including monitoring of implementation of relevant safeguard commitments.	Where applicable, AfDB, IFC/WB will provide independent safeguard oversight through review of environmental and social documentation, monitoring of ESMP implementation and engagement with the PIE and relevant stakeholders. The PIE will maintain appropriate documentation and reporting mechanisms to demonstrate compliance with applicable AfDB safeguard requirements.

Capacity assessment. In line with Section J and Annex 2 (item 3) of the AfDB Borrower Guidance Note on OS1, the review of the Nigerian environmental and social framework and of the implementing institutions concluded that: (i) the Federal and State regulators (FMEnv, NESREA, NMDPRA, NEPZA and RSMEnv) have clear statutory mandates and established EIA review, permitting and inspection procedures. (ii) IFF, as the Project

Implementing Entity (PIE), operates an existing ESMS, HSE and Community Relations & Development functions and a grievance mechanism for the existing IFZ Line 1, IFZ Line 2 and IFF Line 1 and the wider Indorama complex. (iii) contractors are required by contract to provide qualified HSE/E&S personnel and a Contractor ESMP; and (iv) community structures (CDCs, cluster heads and CLOs) need training in grievance handling and participatory monitoring.

2.3 NATIONAL REGULATORY FRAMEWORK

The national policies and regulations included in Table 2-1B below have E&S implications that pertain to the Project and associated ESIA study.

TABLE 2-1B: NATIONAL POLICIES AND REGULATIONS AND THE APPLICABILITY THEREOF

Governing Documents	Description	Applicability
	National Policies	
National Policy on the Environment, 1989	The National Policy on the Environment, 1989 (revised 1999 and 2017), provides a national mechanism for routine coordination and consultation among various tiers of local, state, and federal government to improve the development and implementation of environmental policy as well as establish effective relationships. In doing so, this Policy aims to achieve sustainable development through conserving the environment and natural resources, raising public awareness between environmental resources development, maintaining, and enhancing ecosystem processes, and co-operating with other countries, organisations, and agencies to reduce transboundary environmental degradation.	In line with the aims of the policy, this ESIA study includes an assessment of impacts to the physical, biological and socio-economical environments related with the different phases of the Project. Moreover, this ESIA includes mitigation measures and an associated ESMMP that aim to avoid /minimise /manage the severity of identified impacts. Once the ESIA is approved by the FMEnv, IFF will need to implement the commitments included and conduct periodic audits to ensure continuous improvement.
National Policy on Climate Change, 2013	The mission of the National Policy on Climate Change, 2013 is to strengthen national initiatives to adapt to and mitigate climate change and involve all sectors of society, including the poor and other vulnerable groups (e.g., women, elderly, youth etc.) within the overall context of advancing sustainable socio-economic development. Its main objectives are to: • Implement mitigation measures that will promote low carbon as well as sustainable and high economic growth; • Strengthen national capacity to adapt to climate change; • Raise climate change-related science, technology, and research and development to a new level that will enable the country to better participate in international scientific and technological co-operation on climate change; • Significantly increase public awareness and involve the private sector in addressing the challenges associated with climate change; and • Strengthen national institutions and mechanisms (policy, legislative and economic) to establish a suitable and functional framework for climate change governance.	In line with the National Policy on Climate Change, 2013 and the Climate Change Act, 2021, this ESIA has considered the climate change adaptation requirements for the Project and management relating to GHG emissions during all Project phases.

Governing Documents	Description	Applicability
Climate Change Act, 2021	The Climate Act 2021 provides a framework for achieving low greenhouse gas emission (GHG), inclusive green growth and sustainable economic development. The Act applies to the Ministries, Departments and Agencies (MDAs) of the Federal Government of Nigeria, and to public and private entities within boundaries of Nigeria for the development and implementation of mechanism geared towards fostering low carbon emission, environmentally sustainable and climate resilient society. Its main objectives are to: • Ensure that Nigeria formulates programmes for achieving its long-term goals on climate change mitigation and adaptation; • Facilitate the coordination of climate change action needed to achieve long-term climate objectives; • Mainstream climate change actions in line with national development priorities; • Facilitate the mobilization of finance, and other resources necessary to ensure effective action on climate change; • Ensure that climate change policies and actions are integrated with other related policies for promoting socio-economic development and environmental integrity; • Setting a target for year 2050-2070 for the attainment of a net zero GHG emission, in line with Nigeria's international climate change obligations; • Identify risks and vulnerabilities, building resilience and strengthening existing adaptive capacities to the impacts of climate change; • Implement mitigation measures that promote low carbon economy and sustainable livelihood; and • Ensure that private and public entities comply with stated climate strategies, targets, and National Climate Change Action Plan.	
The National Gender Policy, 2021	The National Gender Policy, 2021 presents a set of minimum standards to meet the mandate for gender equality, good governance, accountability, and being socially responsive to the needs of vulnerable groups. The policy builds on the revision of	This ESIA process has (and continues) to be undertaken to ensure effective, transparent, and timely stakeholder engagement. Moreover, it has been structured such that all stakeholder engagement activities will take into

Governing Documents	Description	Applicability
	the NGP, 2007 to respond to emerging issues across the sectors since 2006 and to incorporate current gender gaps to fulfil Nigeria's commitment to such global agenda as the SDGs. The strategic policy objectives are to bridge gender/social inclusion gaps, achieve parity in all spheres, to protect women's human rights, and mitigate sexual and gender-based violence through appropriate buffers and related services.	consideration in gender sensitivities, particularly when engaging with local communities. Moreover, the ESIA considers gender equality in recruitment and that no employee or job applicant discriminated against on the basis of his or her gender, marital status, nationality, ethnicity, age, religion or sexual orientation.
National Policy on Occupational Safety and Health, 2021	The Occupational Safety and Health policy strengthens the National Labour Policy and extant labour legislations, provisions Cap 126, the workmen's Compensation Act Cap 470, Trade Union Act Cap 126, Trade Dispute Act Cap 432, wages Board and Industrial Councils Act 466 and the Labour Act Cap 198, and other relevant Laws of the Federation of Nigeria. The goal of the policy is to facilitate improvement of occupational safety and health performance by providing the framework for participative occupational safety and health protection of workers including the most vulnerable groups in all sectors of economic activities.	The safety, health and welfare of all the workers associated with the Project will need to be addressed in line with all the provisions of this Policy throughout the Project lifecycle (construction, operational and decommissioning phases).
National Policy on Solid Waste Management, 2022	The National Policy on Waste Management 2022 provides a guidance for efficient and sustainable solid waste management in Nigeria. The policy objective is to provide a national direction on solid waste management for the Federal, States, Local governments, private sector, and all stakeholders. In doing so, the policy aims to promote a healthy and aesthetically satisfactory environment by ensuring effective, sustainable, safe, and sanitary solid waste management.	The Project, during the construction, operational and decommissioning phases, will generate wastes, which will need to be disposed of as per the guidelines in this Policy. The ESMMP has considered these regulations and includes a section on solid waste management.
National Environmental Sanitation Policy, 2005 (revised 2018)	This Policy serves as the instrument for securing sustainable quality environment for good health and social wellbeing of present and future generations.	This ESIA process has been undertaken to cover events that could impinge on sanitation, hygiene, and health.
The Agriculture Promotion Policy, 2016	The Agriculture Promotion policy builds on achievement of Agriculture Transformation Agenda (ATA), 2011-2015 and was readjusted to solve challenges faced by implementation of ATA and highlight Federal government (in partnership with State Government) priorities in the agricultural sector.	In line with this policy, IFF is required to abide to climate change and environmental sustainability in its operation and participation in agricultural promotion.
General Environmental		

Governing Documents	Description	Applicability
Environmental Impact Assessment Act 86 of 1992 (amended by EIA Act CAP E12 LFN 2004) and regulation 2021	This is the primary governing Act for EIA in Nigeria. The Act establishes a procedure and methodology to be followed to undertake an EIA study. Section 2 (2) of the Act requires that an EIA study must be undertaken in accordance with the Act when the extent, nature, or location of the proposed project or activities is likely to affect the environment significantly.	As the proposed Project will entail the construction of a fertilizer Plant for Ammonia and Urea production, an ESIA study in line with the provisions of the EIA Act is therefore required prior to the project commencing. Accordingly, an ESIA study is currently being carried out in line with the requirements of this Act and has further considered the Environment Impact Assessment Procedures and Charges Regulation, 2021, IFF shall be required to commit to implementing the commitments included in the ESMMP laid out in this ESIA Report and any other conditions as laid out by FMEnv, should an ESIA license be issued for the Project.
National Environmental Impact Assessment Procedural and Sectoral Guidelines, 1994	FMEnv developed the National EIA Procedural Guidelines in response to the establishment of the EIA Act. The Procedural Guidelines assists proponents in conducting detailed E&S assessments by providing an overview of the baseline information, key issues, impacts, mitigation, and management plans to be considered as part of the EIA study.	An ESIA study is currently being undertaken for the Project. This ESIA has been undertaken to comply with the requirements of these Guidelines. IFF shall be required to commit to implementing the ESMMP laid out in this ESIA and any other conditions stipulated by FMEnv.
The National Environmental (permitting & Licensing System) Regulation, 2009	The purpose of this regulation is to enable consistent application of Environmental Laws, Regulations and Standards in all sectors of the economy and geographical regions.	In line with these regulations, this ESIA has considered the Environmental Laws, guidelines, standards, and regulations in Nigeria during all Project phases.
Waste and Pollution		
National Environmental (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations, 1991, S.I.9	These Regulations impose restrictions on the release of toxic substances into the environment and stipulate requirements for pollution monitoring units, machinery for combating pollution, and contingency plans to be implemented by industries.	The Project, during the construction, operational and decommissioning phases, will generate wastes, which will need to be disposed of as per the guidelines in these Regulations. The ESMMP has considered these regulations and includes a section on the management of both non-hazardous and hazardous wastes.
National Environmental Protection	The National Effluent Limitation Regulation, S.1.8 of 1991 (No. 42, Vol. 78, August 1991) makes it mandatory for industries such as waste generating facilities (including research	The Project, during the construction, operational and decommissioning phases, will generate waste effluent, which will need to be managed per the guidelines in

Governing Documents	Description	Applicability
(Effluent Limitation) Regulation 1991, S.I.8	institutes, clinics, hotels etc.) to install pollution prevention and pollution abatement equipment on site. The regulation is specific for each category of a waste generating facility with respect to limitations of solid and liquid discharges or gaseous emissions into the ecosystem. Appropriate penalties for contraventions are also specified in the regulation.	these Regulations. This regulation requires the Project to install anti-pollution equipment for the detoxification of effluent and chemical discharges emanating from its activities and specify selected wastewater parameters for the industries in the First Schedule to the Regulations.
National Environmental (Management of Solid and Hazardous Wastes) Regulations, 1991, S.I.15	This instrument regulates the collection, treatment, and disposal of solid and hazardous waste streams from municipal and industrial sources. It gives a comprehensive list of chemicals and chemical waste by toxicity categories. The regulation requires the project proponent to practice waste segregation (at source) and engage the services of a government-approved waste management agents for appropriate waste disposal throughout the project's life cycle.	The Project, during the construction, operational and decommissioning phases, will generate wastes, which will need to be managed and disposed of as per the guidelines in these Regulations. The ESMMP has considered these regulations and includes a section on the management of both non-hazardous and hazardous wastes.
National Environmental (Sanitation and Wastes Control) Regulations, 2009, S.I.28	This Regulation aims to adopt sustainable and environment-friendly practices in environmental sanitation and waste management to minimise pollution.	The provisions included in this Regulation have been considered as part of the Project ESMMP.
Soils and Water		
National Environmental (Soil Erosion and Flood Control) Regulations, 2011, S.I.12	The overall objective of this Regulation is to ensure that projects developed on sites that are vulnerable to flooding, including facilities that serve such projects, are protected against flooding by appropriate design at the time of initial construction.	The provisions included in these Regulations will need to be considered by IFF as part of Project Engineering designs.
National Environmental (Surface and Groundwater Quality Control) Regulations, 2011, S.I.22	The purpose of these Regulations is to enhance and preserve the physical, chemical and biological integrity and to maintain existing use of groundwater and surface water resources. The standards contained herein provide for the protection of surface and ground water from pollutants so that the waters shall be protected, used, developed, conserved, managed, and controlled in ways that take into account: • Citizens' right of access to clean water and sanitation; • Protection of aquatic ecosystems and long term sustainability of water resources; and	The Project will be associated with waste generation, more specifically solid and effluent wastes, which should be managed and disposed of in an environmentally friendly manner to avoid any form of pollution, including water pollution. This ESIA and associated ESMMP has considered these regulations.

Governing Documents	Description	Applicability
	• Reduction and prevention of pollution and degradation of surface water resources and recognition of preventive, precautionary, and polluter-pays-principles.	
Water Resources Act, CAP W2 LFN, 2004	This Act is aimed at promoting the optimum planning, development, and use of Nigeria's water resources; ensuring the coordination of activities that are likely to influence the quality, quantity; distribution, use, and management of water; providing the application of appropriate standards and techniques for the investigation, use, control, protection, and management of water resources; and facilitating technical assistance and rehabilitation for water supplies.	In line with the requirements of this Act, IFF will need to safeguard the integrity water systems within and surrounding the Project area throughout the implementation of the Project. This includes implementing proper waste management to prevent water pollution during the construction, operational and decommissioning phases.
Climate Change		
Climate Change Act, 2021	The Climate Change Act provides a legal and institutional framework for reducing GHG emissions in Nigeria. The objective of the law is to establish a framework for reducing GHG emissions and to embed climate change actions into national plans and programmes. The Act establishes the National Council on Climate Change (NCCC), which has been delegated the authority to make policies and decisions on all matters relating to climate change in Nigeria. The NCCC is directed to collaborate with the Federal Inland Revenue Service (FIRS) to develop a carbon tax in Nigeria. The proceeds from the carbon tax will go to the Climate Change Fund established under the Act. The Fund is to be used for the administration and general operation of the NCCC, the funding of innovative climate change mitigation and adaptation projects, conducting assessments of climate change impacts on vulnerable communities, and incentivizing the transition to clean energy. The law is the first stand-alone comprehensive climate change legislation in West Africa. The Climate Change Act seeks to achieve net-zero GHG emissions in Nigeria between 2050 and 2070. It further provides a framework to help achieve Nigeria’s NDCs and mandates the Ministry of Environment, in consultation with the Federal Ministry for Budget and National Planning, to set a carbon budget to keep the average increase in global temperature to within 2°C, and to help keep to 1.5°C rise	In line with the requirements of this Act, this ESIA has considered the climate change adaptation requirements for the Project and management relating to GHG emissions during all Project phases.

Governing Documents	Description	Applicability
	above pre-industrial levels. The Act also requires the NCCC to collaborate with the FIRS to develop and implement a mechanism for carbon emission trading and empowers the Ministries to periodically revise the carbon budget, in line with Nigeria's NDCs with a view to complying with Nigeria's international obligations. The Climate Change Act also requires the preparation of a National Climate Change Action Plan (every five years) to ensure that the carbon budgets are being met, and that climate change mitigation actions are identified and are being actively applied.	
Air Quality		
National Environmental (Air Quality and Control) Regulations, 2021, S.I.88	The objective of the Regulations is for the prevention, control, and reduction of air pollution to ensure clean and healthy ambient air. It provides for the establishment of emission standards for various sources such as mobile sources (e.g. vessels, motor vehicles) and stationary sources (e.g. industries). Emission limits for different areas and facilities have been set. The regulations make provision for designating controlled areas and the setting of objectives of air quality management plans for these areas.	The Project, during the construction, operational and decommissioning phases, will generate air emissions. As part of this ESIA process, an air quality study has been undertaken. The primary objective of the air quality study is to consider and assess the potential impacts which the Project may have upon existing air quality, during both construction and operational phases. The assessment of construction impacts focuses on the potential effect of construction dust and construction-related combustion emissions (including vehicles) at existing sensitive receptor locations immediately adjacent to the Project. The assessment of operational impacts focuses on the potential negative effects of pollutants from a variety of sources. Impacts of emissions on air quality have been quantified by comparison of the predicted maximum concentrations with the Project applicable air quality standards (which have considered these Regulations). Moreover, the ESMMP includes specific controls to mitigate air quality emissions.
Noise		
National Environmental (Noise Standards and Control) Regulations, 2009, S.I.35	The Regulation highlights the permissible noise levels to which a person may be exposed, control and mitigate noise, permits for noise emissions above acceptable levels and enforcement maximum permissible noise levels a facility or activity to which a person may be exposed to.	The Project, during the construction, operational and decommissioning phases, will generate noise. As part of this ESIA process, a noise study has been undertaken. The study has considered noise emissions at the potentially most affected noise sensitive receiver (NSR) locations in proximity to the Project. The Project will be required to comply with these Regulations to promote a

Governing Documents	Description	Applicability
		healthy and safe working environment throughout all Project phases. Noise impacts have been quantified by comparison of the predicted maximum concentrations with the Project applicable noise standards (which have considered these Regulations). Moreover, the ESMMP includes specific controls to mitigate noise emissions.
Biodiversity		
National Environmental (Control of Alien and Invasive Species) Regulations, 2013, S.I.32	This regulation seeks to prevent the decline and minimise the modification and destruction of the ecosystem and human health caused by alien and invasive species.	This ESIA and associated ESMMP has considered a range of potential ecological impacts associated with the Project, including the control of invasive alien plants in the immediate Project area and surrounds.
Endangered Species Act CAP E9 LFN, 2004 as amended 2016	This Act prohibits, except under a valid license, the hunting, capture, or trade-in animal species, either presently or likely being in danger of extinction, and defines the liability of any offender under this Act. It also provides for regulations to be made necessary for environmental prevention and control regarding the purposes of this Act.	These regulations have been considered in the biodiversity study for the ESIA and associated ESMMP.
Health and Safety and Labour		
Employment Laws and Regulations Nigeria 2023	The Employment Laws and Regulation 2023 strengthens employment laws as stated in the constitution of the Federal Republic 1999, the Labour Act 2004, Federal and State laws that relate to labour and employment, and international conventions, treaties and protocols relating to labour and employment, industrial relations or matters connected therewith that have been ratified by Nigeria.	IFF will be bound to abide to Nigeria labour and employment laws and regulation during its Project lifecycle.
Factories Act, CAP F1 LFN 2004	The Factories Act 1990 (amended in 2004) is the primary law regulating the health, safety and welfare of workers in the country's factories. The Law holds management and staff personally responsible for violations of the provisions in the Act.	The safety, health, and welfare of all the workers associated with the Project will need to be addressed in line with all the provisions of this Act throughout the Project lifecycle.
Labour Act, CAP L1 LFN 2004	Nigeria has ratified all core International Labour Organisation Conventions. The Labour Act 1990 (amended in 2004) is the primary law protecting the employment rights of individual workers. The Act covers protection of wages, contracts, employment terms and conditions, and recruitment; and classifies types of workers and special workers.	IFF will be bound by this Act to abide to its stipulation on employee management and remuneration during its construction and operational phases.

Governing Documents	Description	Applicability
Trade Unions Act, 2005	This Act contains provisions with respect to the formation, registration, and organization of trade unions. It includes stipulation of 'equal pay for equal workers without discrimination on account of sex, or any other ground whatsoever'.	The Proponent will respect workers' rights to join (or not join) unions of their choice and to engage with those unions which workers are members of in relation to collective bargaining, disciplinary proceedings, and retrenchment of workers.
National Minimum Wage Act, 2019	The Act prescribes the national minimum wage and provides for a legal framework for a seamless review of the stated national wage.	IFF will abide to the stipulation of this Act on employee remuneration during the Project lifecycle.
Employee Compensation Act, 2010	This Act repeals the Workmen's Compensation Act W6 LFN 2004 and makes comprehensive provisions for payment of compensation to employees that suffer from occupational diseases or suffer injuries from accident at workplace or in the course of the employment.	The safety, health, and welfare of all the workers associated with the Project will need to be addressed in line with all the provisions of this Act throughout the Project lifecycle.
Pension Reform Act, 2014	This Act makes provision for the contributory pension scheme for public and private sectors in Nigeria.	IFF will be bound by this Act to abide to its stipulation on employee remuneration during all Project phases.
Violence against Persons (Prohibition) Act, 2005	The Violence against Persons (Prohibition) Act (VAPP) was passed into law in May 2015. The Act was necessitated as a result of agitations for the protection of persons against different forms of violence. The Act has strengthened advocacy against rape, female genital mutilation, partner battery, stalking, harmful widowhood practices while prohibiting all forms of violence, including physical, sexual, psychological, domestic, harmful traditional practices and discrimination against persons. It also provides maximum protection and effective remedies for victims and punishment of offenders.	The safety, health, and welfare of all the workers and communities associate with the Project will need to be addressed in line with all the provisions of this Act throughout the Project lifecycle.
Land		
Land Use Act CAP L5 LFN, 2004	Land Use Act No. 6 was enacted in 1978 (revised in 1990 and 2004). The Act vests all land in the territory of each State (except land vested in the Federal Government or its agencies) solely in the Governor of the State, who holds such land in trust for the people and is solely responsible for the allocation of land in all areas, to individual resident in the State and to organizations for residential, agricultural, and commercial purposes.	IFF have legally secured rights to the land associated with development of the Project.
Other		
National Environmental (Ozone Layer Protection)	This regulation prohibits the use, emission, storage, and disposal of stratospheric ozone-depleting substances (ODS) and articles which contain those substances.	IFF will need to ensure that equipment containing ODS's will either not be used on site or, if currently being used, will need to be phased out.

Governing Documents	Description	Applicability
Regulations, 2009, S.I.32		
National Environmental (Construction Sector) Regulations (S.I No. 19), 2011	The purpose of these Regulations is to prevent and minimize pollution from construction, decommissioning and demolition activities applicable to Nigerian projects. It stipulates that new projects in the construction sector shall apply cost-effective, up-to-date, efficient, use best available technology, to minimize pollution to the barest degree practicable.	This ESIA considers a variety of potential impacts that may result in pollution to the environment during the construction and decommissioning phases of the Project. IFF shall be required to commit to implementing the ESMMP laid out in this ESIA and any other conditions stipulated by FMEnv.
Harmful Waste (Special Criminal Provisions) Act CAP H1 LFN, 2004	The Harmful Waste (Special Criminal Provisions) Act CAP H1 LFN, 2004 prohibits and declares unlawful activities relating to the purchase, sale, importation, transit, transportation, deposit, and storage of harmful wastes. Appropriate penalties for infringement are prescribed.	The Project is not anticipated to generate any harmful waste, ESMMP has considered these regulations and includes a section on the management of both non-hazardous and hazardous wastes.
The Standards Organization of Nigeria (SON) ACT NO. 14, 2015	The Standards Organisation of Nigeria was established by Act. No.56 of 1971 which vested it with the authority for: Standards elaboration, Specifications, Quality assurance system of commodities, manufactured industrial and imported products and services generally. The Act No. 14 of 2015 amended the previous SON Act, 2004, and was enacted for the purpose of providing additional functions for the Standards Organisation of Nigeria, increasing penalty for violations; and for related matters.	IFF shall be required to commit the quality standards as certified by SON throughout its operation.
Criminal Code of 1990 (now CAP 38 LFN, 2004)	The Act contains the primary criminal law offences related to environmental damage, public health, and natural resources. Some environmental crimes include causing a public nuisance, fouling the water of any spring, stream, well, or reservoir of a place, and violating the atmosphere in any position to make it harmful to the health of persons.	IFF shall be required to commit to implementing the ESMMP laid out in this ESIA and any other conditions stipulated by FMEnv.
Nigeria Export Processing Zones Act 1992	This Act establishes the **Nigeria Export Processing Zones Authority (NEPZA)** and provides the legal framework for the designation, regulation, management, and supervision of Export Processing Zones (also referred to as Free Zones) in Nigeria. The Act defines approved activities within Free Zones, sets out licensing requirements for enterprises, and provides incentives including exemptions from customs duties, import and export controls, and certain taxes. It also grants NEPZA regulatory oversight over enterprises operating within designated Free Zones and allows for the issuance of subsidiary regulations governing Free Zone operations. Additionally, the	The proposed IFF Line 2 Project is located within the **Indorama Free Zone**, which is a designated Export Processing Zone regulated under this Act. Accordingly, the Project is required to be registered as an approved enterprise and to operate in accordance with NEPZA licensing, operational, and reporting requirements. While certain fiscal and customs incentives apply by virtue of Free Zone status, the Project remains subject to applicable Nigerian environmental legislation, including the EIA Act, and to all environmental, health, safety, and labour obligations not explicitly exempted under the Act.

Governing Documents	Description	Applicability
	Act outlines requirements relating to land use, security, movement of goods and persons, labour permits, and compliance with applicable laws not expressly excluded within Free Zones	Compliance with NEPZA approvals and conditions forms a prerequisite for Project development, construction, and operation.
Nigeria Export Processing Zones Authority (NEPZA), Investment procedures, Regulations and Operational Guidelines for Free Zones In Nigeria, 2004.	These Regulations, issued pursuant to Section 10(4) of the Nigeria Export Processing Zones Act, provide detailed procedural, regulatory, and operational guidance for the establishment, licensing, development, and operation of Free Zones and enterprises within them. The Guidelines set out requirements for enterprise registration, approved activities, land allocation and development, building permits, utilities, commencement of operations, incentives and concessions, movement of goods and persons, banking and customs procedures, environmental safety and pollution control, monitoring and reporting obligations, and enforcement mechanisms. They also clarify the application of environmental protection, health, safety, and security provisions within Free Zones.	The Project is required to comply with the procedural and operational requirements set out in these Guidelines, including registration as a Free Zone enterprise, adherence to approved activities, and compliance with environmental safety, pollution control, and reporting obligations. The Regulations reinforce the requirement for environmentally sound design, construction, and operation of facilities within the Free Zone and support the integration of ESIA commitments and ESMMP measures into Project implementation. Compliance with NEPZA monitoring, inspection, and reporting requirements will apply throughout the Project lifecycle.

2.3.1 KEY COMPLIANCE IMPLICATIONS FOR IFF

- **National Policy on the Environment:** General duty to assess and manage E and S impacts and implement mitigation.
- **National Climate Change Policy:** Integrate climate adaptation and GHG reduction actions.
- **Climate Change Act 2021:** Monitor emissions and align with national net zero targets.
- **National Gender Policy 2021:** Ensure gender responsive consultation and non-discrimination.
- **Occupational Safety and Health Policy 2021:** Maintain safe working conditions and worker protection systems.
- **National Solid Waste Management Policy 2022:** Apply proper waste segregation, safe handling and approved disposal.
- **Environmental Sanitation Policy:** Maintain site hygiene and protect public health.
- **Agriculture Promotion Policy:** Operate in an environmentally responsible manner that supports sustainable agriculture.
- **EIA Act (and 2021 Regulation):** Obtain FMEnv ESIA approval and comply with all licence conditions and the ESMMP.
- **EIA Procedural and Sectoral Guidelines:** Follow FMEnv methodology and reporting requirements.
- **Environmental Permitting and Licensing Regulation 2009:** Maintain applicable FMEnv environmental licences.
- **Pollution Abatement Regulations (S.I.9):** Install and maintain pollution control and response systems.
- **Effluent Limitation Regulations (S.I.8):** Meet effluent standards and operate compliant treatment units.
- **Solid and Hazardous Waste Regulations (S.I.15):** Segregate, store and dispose waste using licensed operators.
- **Sanitation and Waste Control Regulations (S.I.28):** Maintain clean work areas and prevent pollution.
- **Soil Erosion and Flood Control (S.I.12):** Incorporate flood and erosion controls in site design.
- **Surface and Groundwater Quality Control (S.I.22):** Prevent water pollution and meet water quality limits.
- **Water Resources Act:** Protect water resources and manage abstraction responsibly.
- **Climate Change Act 2021:** Integrate climate risk management and support national carbon budgeting.
- **Air Quality Regulations 2021:** Comply with emission limits and conduct air quality monitoring.

- **Noise Control Regulations (S.I.35):** Meet permissible noise levels at sensitive receptors.
- **Invasive Species Regulation (S.I.32):** Prevent introduction and spread of invasive species.
- **Endangered Species Act:** Avoid harm to protected species and comply with licensing rules if required.
- **Employment Laws:** Comply with national labour requirements.
- **Factories Act**: Maintain statutory workplace safety and welfare systems.
- **Labour Act:** Ensure lawful contracts, wages and employment conditions.
- **Trade Unions Act:** Respect workers' rights to organise.
- **National Minimum Wage Act:** Pay statutory minimum wages.
- **Employee Compensation Act:** Provide compensation for workplace injuries or disease.
- **Pension Reform Act:** Maintain contributory pension compliance.
- **VAPP (Violence Against Persons (Prohibition))Act:** Enforce zero tolerance for GBV and protect workers and communities.
- **Land Use Act:** Ensure lawful land allocation and secure tenure documentation.
- **Ozone Layer Protection (S.I.32):** Phase out ozone depleting substances and equipment.
- **Construction Sector Regulations (S.I.19):** Use best available techniques to minimise construction impacts.
- **Harmful Waste Act:** Prohibit creation or handling of harmful waste.
- **SON (Standards Organisation of Nigeria) Act:** Use materials and equipment certified to national standards.
- **Criminal Code:** Avoid actions that could constitute environmental or public health offences.

2.4 STATE LAWS AND ADMINISTRATIVE INSTITUTIONS ON ENVIRONMENTAL PROTECTION

Section 20 of the 1999 constitution of the Federal Republic of Nigeria, states that, "The State shall protect and improve the environment and safeguard the water, air and land, forest and wildlife of Nigeria". Furthermore, the EIA Act No. 86 of 1992 recommends the setting up of state environmental agencies to support the efforts of the FMEnv in regulating the consequences of project development on their environment.

2.4.1 RIVERS STATE MINISTRY OF ENVIRONMENT

Since the inauguration of the present democratic administration, Rivers State Government has established a full-fledged Ministry of Environment (RSMENV) headed by a commissioner. The Ministry was created from the Rivers State Environmental Protection Agency (RSEPA). RSMENV was empowered by the decree that set up the repealed FEPA (Decree 58 of 1988, as amended by Decree 59 of 1992), which encourages State governments to set up their own Environmental Protection Agencies.

Consequently, RSMENV is charged with the protection of the environment of Rivers State and operates with Edict No. 2 of 1994. In 2002, RSMENV published the Interim Guidelines and Standards on Environmental Pollution Control and Management in Rivers State which was revised in 2013. The guidelines seek to:

- Regulate the generation, handling, storage, disposal, and management of all wastes of whatever origin in Rivers State.
- Regulate physical development in compliance with the principle of sustainable development.
- Enhance and where possible, restore the quality of the environment and protect the biodiversity of the flora and fauna of Rivers State.

2.4.2 RIVERS STATE WASTE MANAGEMENT AGENCY (RIWAMA)

The Rivers State Waste Management Agency (RIWAMA) is responsible for the enhancement of the environment but is also mandated to positively change the living conditions and reduce diseases and health problems in the state. It was created in 2013 by the Rivers State House of Assembly and was assented by the state governor in July 2014. Prior to this, the agency functioned as the "Rivers State Environmental Sanitation Authority (RSESA)".

2.4.3 RIVERS STATE NOISE CONTROL EDICT, NO. 20, 1985

The law targets reducing occupational noise exposure of workers to noise from factories/industrial machines and exposure of the neighbouring population to noise from nearby factories. It also sets limits for other sources of noise including aircrafts, loud music and public address systems and recommends daily noise exposure limits for industry workers and communities.

2.4.4 RIVERS STATE ENVIRONMENTAL PROTECTION AND MANAGEMENT LAW, CAP A42, 2019

The objective of law is to exploit, develop and manage resources to achieve a higher quality of life by ensuring sustainable development. The law prescribing and listing activities that require environmental permits both in manufacturing and non-manufacturing sectors. The law also specifies terms for registration of environmental consultants in the state and conditions for issuance or renewal of the accreditation certificates / permits.

2.5 INTERNATIONAL CONVENTIONS, PROTOCOLS AND AGREEMENTS

Nigeria is a signatory to several international conventions and agreements targeted toward the conservation and protection of the environment to ensure sustainable development. The relevant international conventions and regulations most applicable to the project are highlighted below in Table 2-2.

TABLE 2-2: LIST OF RELEVANT INTERNATIONAL CONVENTIONS AND REGULATIONS

Conventions	Year Adopted	Overview	Project Applicability / Implication for IFZ
The Paris Accord	2015	The Paris Accord is a legally binding international treaty on climate change. It was adopted by 196 Parties at the United Nations Climate Change Conference, COP 21 in Paris, on 12 December 2015 and entered into force on 4 November 2016. The Paris Accord's long-term temperature goal is to keep the rise in mean global temperature to well below 2 °C (3.6 °F) above pre-industrial levels, and preferably limit the increase to 1.5 °C (2.7 °F), recognizing that this would substantially reduce the impacts of climate change. Emissions should be reduced as soon as possible and reach net-zero in the second half of the 21st century. It aims to increase the ability of parties to adapt to climate change impacts and mobilize sufficient finance. Under the Agreement, each country must determine, plan, and regularly report on its contributions.	Requires IFF to manage and reduce GHG emissions and align with Nigeria's national climate commitments reflected in the ESIA.
International Health Regulations (IHR)	2005	The IHR is an international legal instrument that is binding on 196 countries across the globe, including all the Member States of World Health Organisation (WHO). This binding instrument of international law was first adopted in 1969, revised in 2005 and entered into force on 15 June 2007. The purpose and scope are "to prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks and which avoid unnecessary interference with international traffic and trade".	Requires IFF to adopt internationally recognised public health measures, including disease prevention, emergency preparedness and worker health protocols.
International Labour Organization (ILO): ILO OSH 2001 Guidelines	2001	These guidelines call for coherent policies to protect workers from occupational hazards and risks while improving productivity. The guidelines present practical approaches and tools for assisting organisations, competent national institutions, employers, workers, and other social partners in establishing, implementing and improving occupational safety and health management systems, with the aim of reducing work-related injuries, ill health, diseases, incidents and deaths. At the organisational level, the guidelines encourage the integration of OSH management system elements as an important component of overall policy and management arrangements. Organizations, employers, owners, managerial staff, workers, and their representatives are motivated in applying appropriate OSH management principles and methods to improve OSH performance. Nigeria ratified the guidelines in 2001.	Requires IFF to maintain a structured OSH management system in line with international good practice and reduce workplace risks.
United Nations Convention on Biological Diversity	1994	The Convention was adopted in 1994. The objectives of the Convention include the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of benefits arising out of the utilization of genetic resources.	Requires IFF to protect biodiversity, avoid unnecessary habitat disturbance and integrate biodiversity mitigation measures into the ESIA.

Conventions	Year Adopted	Overview	Project Applicability / Implication for IFZ
Rio Declaration on Environment and Development	1992	The Declaration was made in 1992 in Rio de Janeiro, reaffirming the declaration of the United Nations Conference on Human Environment adopted at Stockholm in 1972. The principle works towards international agreement which respects the interest of all and protects the integrity of the global environment and development. The principles of the declaration relevant to the proposed project include: Principle 4: In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it. Principle 17: EIA as a national instrument shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority.	Reinforces the requirement to undertake the ESIA and integrate environmental considerations into project planning and decision making.
United Nations Framework Convention on Climate Change	1992	The Convention on Climate Change was adopted in 1992 during the Rio Earth Summit in Rio De Janeiro, Brazil and entered into force in 1994 to limit Greenhouse Gas (GHG) emissions which cause global warming.	Requires IFF to support national GHG reduction and climate adaptation actions and incorporate climate change considerations into project design.
International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC)	1990	Parties to the International Convention on OPRC are required to establish measures for dealing with pollution incidents, either nationally or in co-operation with other countries. Parties to the convention are required to provide assistance to others in the event of a pollution emergency and provision is made for the reimbursement of any assistance provided. Ships and operators are required to carry a shipboard oil pollution emergency plan, oil pollution emergency plans or similar arrangements which must be coordinated with national systems for responding promptly and effectively to oil pollution incidents.	Requires IFF to maintain emergency response plans, spill prevention systems and pollution control measures consistent with international expectations.
Montreal Protocol on Substances that Deplete the Ozone Layer	1987	The Protocol was adopted on 16 September 1987 as an international treaty to eliminate ozone depleting chemicals production and consumption.	Requires IFF to avoid and phase out ozone depleting substances in equipment, materials and operations.
Vienna Convention for the Protection of the Ozone Layer	1985	The Vienna Convention was adopted in 1985 and entered into force on 22 September 1988. It places general obligations on countries to make appropriate measures to protect the environment against adverse effects resulting from human activities which tend to modify the ozone layer.	Reinforces IFF's responsibility to avoid contributing to ozone depletion and adopt environmentally responsible technologies.
Protocol Concerning	1981	The objective of the protocol is to protect the marine environment, the coastal zones and the related internal waters falling within the jurisdiction of the States of the West and	Requires IFF to maintain pollution response capability and

Conventions	Year Adopted	Overview	Project Applicability / Implication for IFZ
Cooperation in Combating Pollution in Cases of Emergency in the West and Central African Region		Central African region against pollution in cases of emergency. The Parties undertake to cooperate in all matters relating to the protection of their respective coastline and related interests from the threat and effects of pollution resulting from marine emergencies, especially by exchanging relevant information (arts. 4, 5, 6, 7, 8 and 10). They agree to assist each other, on demand, in cases of marine emergencies (art. 8). Finally, they are to endeavour to maintain and promote marine emergency contingency plans (art. 9) and take appropriate measures to prevent, reduce, combat and control the effects of pollution (art. 10).	cooperate with national authorities in the event of any environmental emergency.
Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)	1979	This Convention, also known as the Bonn Convention, was adopted in 1979 and entered into force in 1983. It stipulates actions for the conservation and management of migratory species including habitat conservation.	Requires IFF to avoid harming migratory species, protect ecological corridors and apply protections in biodiversity-sensitive areas.
West African Aquatic Mammals MoU (2008)	2008	This MoU concerns the conservation of the manatee and small cetaceans of Western Africa and Macaronesia. It is a Multilateral Environmental MoU and entered into effect on 3 October 2008 under the auspices of the Convention on the Conservation of Migratory Species of Wild Animals. The MoU aims to protect these species at a national, regional, and global level.	Requires IFF to avoid impacts on aquatic mammals during any water related activities and comply with species protection expectations.
MoU concerning Conservation Measures for Marine Turtles of the Atlantic Coast (1999)	1999	This MoU requires signatories to endeavour to put in place measures for the conservation and, where necessary and appropriate, strict protection of marine turtles at all stages of their life cycle (including eggs, hatchlings, juveniles, sub-adults and adults. It came into effect in 1999 and is an agreement under Article IV, paragraph 4, of the Convention on the Conservation of Migratory Species of Wild Animals.	Requires IFF to avoid harming marine turtles and align any coastal or marine related project components with species protection expectations.
African Convention on the Conservation of Nature and Natural Resources	1968	The African Convention on the Conservation of Nature and Natural Resources was adopted in Algiers, Algeria, on 15 September 1968, and entered into force on 16 June 1969. The Convention stipulates that the contracting States shall undertake to adopt the measures necessary to ensure conservation, utilization and development of soil, water, flora and fauna resources in accordance with scientific principles and with due regard to the best interests of the people.	Requires IFF to conserve soil, water and biological resources and adopt environmentally responsible management practices throughout the project.

2.6 INTERNATIONAL BEST PRACTICE STANDARDS AND GUIDELINES

2.6.1 EQUATOR PRINCIPLES (EP4)

The Equator Principles provide a set of 10 principles of voluntary standards that present a credit risk management framework for determining, assessing and managing social and environmental risk in Project financing. The Equator Principles are based on the IFC Performance Standards on social and environmental sustainability and on the World Bank Group EHS Guidelines. The Project has committed to complying with this set of principles, which together with the IFC Performance Standards and the EHS Guidelines will be used as a benchmark for IBP.

Details of the applicability of the Equator principles to the Project ESIA process are provided in Table 2-3.

TABLE 2-3: APPLICABILITY OF THE EQUATOR PRINCIPLES TO THE PROJECT ESIA PROCESS

Principle	Relevance to Project
1: Review and Categorisation	Category A project per FMEnv.
2: Social and Environmental Assessment	IFF are currently undertaking an internationally compliant ESIA for the Project.
3: Applicable Social and Environmental Standards	The ESIA and associated ESMMP has been undertaken in accordance with standards and recommendations of IFC Performance Standards and EHS Guidelines.
4: Action Plan and Management System	At this stage, IFZ have a number of environmental, social, occupational health and safety and human resource plans, policies and procedures. These plans, policies and procedures relate to all IFZ's operations in Port Harcourt will be extended to IFF. Over the life of all of IFF's operations, the vehicle by which the commitments set out in the ESMMP related to this ESIA and other plans, policies and procedures should be developed into specific actions which can be implemented through an overarching Environmental and Social Management System (ESMS).
5: Consultation and Disclosure	On-going stakeholder engagement, community consultation and disclosure are being undertaken (refer to Chapter 6 and SEP).
6. Grievance Mechanism	A Project's Grievance Mechanism has been developed and is being implemented (refer to Chapter 6 and SEP).
7. Independent Review	The Project lenders will need to appoint an independent review panel to review all Project documentation.
8. Covenants	Relevant Nigerian legislation is being complied with. IFF employees and activities will need to comply with commitments included in the ESMMP. Annual reports will need to be prepared documenting actions and activities demonstrating these commitments.

Principle	Relevance to Project
9. Independent Monitoring and Reporting	The Project lenders will need to appoint an independent review panel to review all Project documentation.
10. Equator Principle Founding Institute (EPFI) Reporting	Not IFF's responsibility.

2.6.2 AFRICAN DEVELOPMENT BANK (AFDB) INTEGRATED SAFEGUARDS SYSTEM (ISS)

African Development Bank (AfDB) Integrated Safeguards System (ISS) 2023 provides the environmental and social risk management framework applicable to projects financed by the Bank. The ISS comprises a series of Operational Safeguards (OSs) that establish requirements for the identification, assessment, management, monitoring, and reporting of environmental and social risks and impacts throughout the project lifecycle. The ISS is designed to promote environmentally sound, socially inclusive, climate-resilient, and sustainable development outcomes while ensuring that affected communities, workers, vulnerable groups, biodiversity, and cultural heritage are appropriately protected. Given the anticipated participation of the AfDB in the lender consortium, the Project has been reviewed against the applicable Operational Safeguards, and the relevance of each safeguard to the IFF Line 2 Fertilizer Project is summarised in Table 2-4 below. The implementation of the ESIA, ESMMP, Environmental and Social Management System (ESMS), and associated management plans will support alignment with the requirements of the AfDB ISS.

TABLE 2-4: AFDB INTEGRATED SAFEGUARDS SYSTEM (ISS) AND RELEVANCE TO THE PROJECT

AfDB Operational Safeguard	Key Requirement	Relevance to the Project
OS1: Assessment and Management of Environmental and Social Risks and Impacts	Requires identification, assessment, management and monitoring of environmental and social risks through an ESMS, stakeholder engagement process, grievance mechanisms and adaptive management.	The Project is subject to a comprehensive ESIA and ESMMP. Indorama will implement an ESMS, stakeholder engagement programme, monitoring framework and grievance mechanisms consistent with OS1 requirements.
OS2: Labour and Working Conditions	Protects workers' rights, promotes fair treatment, non-discrimination, freedom of association, occupational health and safety, and prevention of child and forced labour.	The Project will employ a substantial construction and operational workforce. Labour and working conditions, contractor management, worker grievance mechanisms and OHS provisions are addressed through the ESMMP and company policies.
OS3: Resource Efficiency and Pollution Prevention and Management	Requires efficient use of resources, pollution prevention, GHG management, waste minimisation and application of good international industry practice.	The Project involves ammonia and urea production with associated emissions, effluent generation, waste streams, water consumption and energy use. Resource efficiency and pollution prevention measures are incorporated throughout the ESMMP.
OS4: Community Health, Safety and Security	Requires protection of affected communities from project-related risks including traffic,	Construction and operation may result in traffic, air quality, noise, emergency response and community safety risks.

AfDB Operational Safeguard	Key Requirement	Relevance to the Project
	hazardous materials, emergency events, workforce influx and security arrangements.	Dedicated Community Health and Safety, Traffic and Security Management Plans have been developed.
OS5: Land Acquisition, Restrictions on Access to Land and Land Use, and Involuntary Resettlement	Applies where projects result in physical or economic displacement, loss of assets, loss of access to resources or resettlement impacts.	The Project is located within the existing Indorama Free Zone on land already under the control of the Proponent. No Land Acquisition, Restrictions on Access to Land and Land Use, and Involuntary Resettlement, physical or economic displacement has been identified. Any future land requirements will be managed in accordance with OS5 principles.
OS6: Habitat and Biodiversity Conservation, and Sustainable Management of Living Natural Resources	Requires avoidance and minimisation of impacts on biodiversity, ecosystems and ecosystem services, with additional requirements for critical habitats.	Biodiversity impacts have been assessed through the ESIA. Biodiversity Management Measures have been included in the ESMMP to manage habitat disturbance, invasive species and impacts on ecosystem services.
OS7: Vulnerable Groups	Requires identification of vulnerable or disadvantaged individuals and groups and implementation of measures to avoid disproportionate adverse impacts and ensure equitable access to benefits.	The ESIA identified potentially vulnerable groups in surrounding communities. A Vulnerable Groups Analysis Matrix and targeted mitigation measures have been incorporated into the ESMMP.
OS8: Cultural Heritage	Requires protection of tangible and intangible cultural heritage and implementation of chance finds procedures where appropriate.	Potential cultural heritage sensitivities have been identified in the Project area. A Cultural Heritage Management Plan and Chance Finds Procedure have been included in the ESMMP.
OS9: Financial Intermediaries	Require financial intermediaries to establish and implement an **Environmental and Social Management System (ESMS)** to identify, assess, monitor, and manage environmental and social risks in their lending and investment portfolios	Not applicable to the IFF Line 2 (Line 4) Project, which is a direct investment and is not financed through a financial intermediary.
OS10: Stakeholder Engagement and Information Disclosure	Requires Stakeholder Identification, Engagement, Information Disclosure, and Grievance Mechanism provisions	As part of the ESIA process stakeholders at the State and Local Government and Community level have been consulted and engaged and will continue being engaged during the ESIA process and post-ESIA.

2.6.3 INTERNATIONAL FINANCE CORPORATION PERFORMANCE STANDARDS ON ENVIRONMENTAL AND SOCIAL SUSTAINABILITY, 2012 (IFC PSS)

IFC's Sustainability Framework (International Finance Corporation, World Bank Group) articulates the Corporation's strategic commitment to sustainable development and is an integral part of IFC's approach to risk management. The Sustainability Framework comprises

IFC's Policy and Performance Standards (PSs) on Environmental and Social Sustainability, and IFC's Access to Information Policy.

The Policy on Environmental and Social Sustainability describes IFC's commitments, roles, and responsibilities related to environmental and social sustainability. IFC's Access to Information Policy reflects IFC's commitment to transparency and good governance on its operations and outlines the Corporation's institutional disclosure obligations regarding its investment and advisory services.

The PSs are directed towards clients, providing guidance on how to identify risks and impacts, and are designed to help avoid, mitigate, and manage risks and impacts as a way of doing business in a sustainable way, including stakeholder engagement and disclosure obligations of the client in relation to project-level activities.

IFC requires its clients to apply the PSs to manage environmental and social risks and impacts so that development opportunities are enhanced.

The IFC PSs are outlined in Box 2.1.

BOX 2.1: INTERNATIONAL FINANCE CORPORATION PERFORMANCE STANDARDS

Performance Standards:

- PS 1: Assessment and Management of Environmental and Social Risks and Impacts.
- PS 2. Labour and Working Conditions
- PS 3. Resources Efficiency and Pollution Prevention
- PS 4. Community, Health, Safety and Security
- PS 5. Land Acquisition and Involuntary Resettlement
- PS 6. Biodiversity Conservation and Sustainable Management of Living Natural Resources
- PS 7. Indigenous Peoples
- PS 8. Cultural Heritage

The requirements of each of the eight IFC PSs, and their relevance to the Project, are presented in Table 2-5.

TABLE 2-5: IFC PSS AND THE RELEVANCE TO THE PROJECT

Performance Standards	Key Requirement	Relevance to the Project
IFC PS1: Assessment and Management of Environmental and Social Risks and Impacts	This PS relates to integrating and managing E&S performance throughout the life of a project in line with national regulations and international standards. The standard requires the development of an ESMS that entails a structured approach to managing environmental and social risks and impacts.	The Project poses a number of E&S risks and impacts, which will need to be appropriately managed. Appropriate management measures have been included in the ESMMP. Moreover, as part of the ESIA process stakeholders at the State and Local Government and Community level have been

Performance Standards	Key Requirement	Relevance to the Project
	Moreover, the PS describes how E&S issues are to be handled in project development and serves as the core around which the other standards are framed. This standard requires that nearby communities be appropriately engaged on issues that could potentially affect them. Key requirements include: • Conducting an informed consultation and participation process with affected communities; • Working in an inclusive and culturally appropriate manner; • Addressing the needs of disadvantaged or vulnerable groups; and • Making available an effective grievance management system.	consulted and engaged and will continue being engaged during the ESIA process and post-ESIA. At this stage, IFZ have a number of environmental, social, occupational health and safety and human resource plans, policies and procedures. These plans, policies and procedures relate to all IFZ's operations in Port Harcourt will be extended to IFF. Over the life of all of IFF's operations, the vehicle by which the commitments set out in the ESMMP related to this ESIA and other plans, policies and procedures should be developed into specific actions which can be implemented through an overarching ESMS.
IFC PS2: Labour and Working Conditions	This standard aims to ensure that the Proponent establishes, maintains and improves a worker-management relationship that promotes the fair treatment, non-discrimination and equal opportunity of workers, and compliance with national labour and employment laws and international standards (as defined by the International Labour Organisation (ILO). In particular, PS2 addresses child labour and forced labour, and promotes safe and healthy working conditions, and protecting and promoting the health of workers by recognising the role of employees.	Project workers (for all Project phases) will need to be provided with fair labour and working conditions. This will apply to all categories of workers irrespective of whether directly engaged by IFF or Contractor (direct workers), engaged through third parties (contracted workers), and workers engaged by the client's primary suppliers (supply chain).
IFC PS 3: Resource Efficiency and Pollution Preventions	This PS aims to abate pollution to air, water, and land that may threaten people and the environment at the local, regional, and global levels. This Performance Standard promotes the ability of private sector companies to adopt such technologies and practices where feasible.	Development of the Project will require a number of resources, which have the potential to cause some negative E&S impacts. All required resources will need to be used efficiently and all wastes needs to be managed in accordance with the waste management hierarchy, where avoidance of waste generation is the priority.
IFC PS 4: Community,	The role of this PS is to anticipate and avoid adverse impacts on the health and safety of the	Implementation of the Project will need to ensure that the health,

Performance Standards	Key Requirement	Relevance to the Project
Health, Safety and Security	affected communities throughout the life of the project as a result of routine and non-routine events. The PS also requires an assessment of how use of security by the project to safeguard personnel and property could impact on community security taking into account considerations of human rights.	safety and security of all Project affected communities are not compromised.
IFC PS5: Land Acquisition and Involuntary Resettlement	PS5 refers to the management of physical and economic displacement resulting from project-related land acquisition through resettlement and livelihood restoration processes. Objectives are to: • Avoid, and when avoidance is not possible, minimize displacement by exploring alternative project designs. • Avoid forced eviction. • Anticipate and avoid, or where avoidance is not possible, minimize adverse social and economic impacts from land acquisition or restrictions on land use by: – Providing compensation for loss of assets at replacement cost; and – Ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected. • Improve, or restore, the livelihoods and standards of living of displaced persons. • Improve living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites.	IFF have legally secured rights to the land associated with development of the Project. The securing of land and access restrictions to surrounding communities will need to be in line with the requirements of PS5.
IFC PS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	This PS aims to protect and conserve biodiversity based on the Convention on Biological Diversity. It divides habitat into three categories, modified, natural, and critical. For projects in natural habitat, mitigation measures should be designed to achieve no net loss of biodiversity where feasible. For projects in critical habitats, the project's mitigation strategy should be described in a Biodiversity Action Plan and be designed to achieve net gains of those biodiversity values for which the critical habitat was designated.	Assessment of the proposed Project's impacts on biodiversity has been carried out in line with the requirements of this PS.

Performance Standards	Key Requirement	Relevance to the Project
IFC PS7: Indigenous Peoples	This PS deals with safeguarding Indigenous Peoples. The aim of this PS is to protect the interests of Indigenous Peoples (IPs) during project implementation. On a broader scale, it requires project implementation to avoid adverse impacts on Indigenous Peoples as well as ensuring their participation and consent.	No recognized IPs are impacted by this Project, hence PS7 is not triggered.
IFC PS8: Cultural Heritage	Cultural heritage, according to this PS, refers to tangible forms of cultural heritage, such as tangible movable or immovable objects, property, sites, structures, or groups of structures, having archaeological (prehistoric), paleontological, historical, cultural, artistic, and religious values; unique natural features or tangible objects that embody cultural values, such as sacred groves, rocks, lakes, and waterfalls; and certain instances of intangible forms of culture that are proposed to be used for commercial purposes, such as cultural knowledge, innovations, and practices of communities embodying traditional lifestyles.	As part of this ESIA process a cultural heritage impact assessment (considering both tangible and intangible forms of cultural heritage) have been undertaken.

2.6.4 ENVIRONMENTAL QUALITY STANDARDS CROSSWALK (AMBIENT AIR, NOISE AND TREATED EFFLUENT DISCHARGE)

This section consolidates all numeric environmental quality standards relevant to the Project across three principal sources:

- Nigeria's statutory environmental standards,
- the IFC/WBG General Environmental, Health and Safety (EHS) Guidelines, and
- the IFC Sector-Specific EHS Guidelines for Nitrogenous Fertilizer Production.

The purpose the tables in this section is to provide a single, transparent reference point that shows how multiple standards may apply to the same environmental parameter; whether ambient air quality, ambient noise, or wastewater quality, and to clearly identify the Project-Adopted Standard for each parameter.

Because Nigeria's regulatory requirements and the IFC/WBG guidelines both apply to the Project, it is necessary to establish a clear and consistent method for determining which limit governs. The following logic is applied throughout the tables:

- **Legal compliance is the minimum requirement**: all Nigerian standards are mandatory and form the regulatory baseline.
- **International good practice applies concurrently**: where IFC/WBG guidelines include numeric limits for the same parameter, these are considered alongside Nigerian requirements.

- **Most stringent value prevails**: where different standards apply to the same parameter and averaging period, the Project adopts the more stringent limit to ensure compliance with both national expectations and lender requirements.
- **Completeness rule**: where one framework does not specify a numeric limit for a parameter, the Project adopts the applicable value from the other framework or a recognised international benchmark referenced in the ESIA.
- **Clarity and traceability**: the final column of the table ("Project-Adopted Standard") sets out the enforced benchmark used for impact assessment, modelling, and future monitoring.

2.6.4.1 HOW THE ADOPTED STANDARDS ARE USED IN THIS ESIA

The Project-Adopted Standards identified in Table 2-6 and Table 2-7 below are applied consistently throughout the ESIA as: (i) the benchmark for air dispersion and noise modelling and impact evaluation at sensitive receptors; (ii) the compliance criteria used to determine significance and residual impact ratings; and (iii) the performance thresholds referenced in mitigation measures, operational controls, and monitoring commitments in the ESMMP. Where standards are expressed using different averaging periods, receptor definitions, or measurement metrics, the ESIA applies like-for-like comparisons and documents any necessary assumptions to ensure the adopted standard remains conservative and defensible.

TABLE 2-6: AMBIENT AIR QUALITY STANDARDS

Parameter	Nigeria Standard	IFC/WHO Ambient Guideline	Other International Benchmark	Project-Adopted Standard	Adoption Basis
NO_2 (annual)	80 µg/m³	40 µg/m³	—	40 µg/m³	IFC is more stringent
NO_2 (1-hour)	200 µg/m³	200 µg/m³	—	200 µg/m³	Equivalent; IFC adopted
PM_{10} (annual)	60 µg/m³	70 µg/m³ (IT-1)	—	60 µg/m³	Nigeria more stringent
PM_{10} (24-hour)	150 µg/m³	150 µg/m³ (IT-1)	—	150 µg/m³	Equivalent
$PM_{2.5}$ (annual)	20 µg/m³	35 µg/m³ (IT-1)	—	20 µg/m³	Nigeria more stringent
$PM_{2.5}$ (24-hour)	40 µg/m³	75 µg/m³ (IT-1)	—	40 µg/m³	Nigeria more stringent
NH_3 (annual)	200 µg/m³	No IFC/WHO value	180 µg/m³ (UK EA)	180 µg/m³	IFC silent; adopt recognised benchmark
NH_3 (1-hour)	600 µg/m³	No IFC/WHO value	2,500 µg/m³ (UK EA)	600 µg/m³	Nigeria more stringent

TABLE 2-7: NOISE – AMBIENT RECEPTOR STANDARDS

Parameter / Receptor	Nigeria Standard (Day/Night)	IFC General EHS (Day/Night)	IFC Additional Rule	Project-Adopted Standard	Adoption Basis
Operational Noise – Residential / Institutional / Educational	50 / 35 dB(A)	55 / 45 dB(A)	+3 dB above background allowed	55 / 45 dB(A) + 3 dB rule	IFC more stringent for receptor class
Construction Noise – Sensitive Receptors	60 / 50 dB(A)	No IFC construction limits	—	60 dB(A) daytime	IFC silent; Nigeria standard adopted
Mixed Residential / Industry	55 / 45 dB(A)	70 / 70 dB(A)	—	55 / 45 dB(A)	Nigeria more stringent

2.6.4.2 INDUSTRIAL / PROCESS EMISSION STANDARDS CROSSWALK (ATMOSPHERIC, EFFLUENT, OTHER)

This section consolidates the numeric industrial and process-related emission standards applicable to the Project, focusing on point-source stack emissions and process effluent quality associated with ammonia and urea production. It integrates requirements from Nigerian environmental regulations, the IFC/WBG General EHS Guidelines, and the Sector-Specific EHS Guidelines for Nitrogenous Fertilizer Production.

Because multiple frameworks apply simultaneously, the table identifies all relevant standards for each pollutant or parameter and then determines the Project-Adopted Standard using the same logic applied in Table:

- Nigerian emission and effluent limits form the regulatory baseline.
- IFC/WBG guidelines are applied concurrently as international good practice.
- Where both Nigerian and IFC/WBG limits apply to the same parameter, the more stringent value is selected as the adopted project standard.
- Where one framework is silent, the Project applies the relevant limit from the available framework or the applicable sector-specific guideline.

TABLE 2-7, TABLE 2-8,

Table 2-9 and Table 2-10 serve as the definitive reference for engineering design criteria, stack and process emission modelling, operational compliance, and monitoring commitment.

TABLE 2-8: POINT SOURCE AIR EMISSIONS (AMMONIA & UREA PLANTS)

Parameter / Emission Source	Nigeria Emission Standard	IFC General EHS Guideline (Air Emissions)	IFC Sector EHS – Nitrogenous Fertilizer	Project-Adopted Standard	Adoption Basis
NH_3 – Ammonia Plant Stack	Not specified	Not specified	50 mg/Nm³	50 mg/Nm³	Only sector guideline provides a value
NO_x – Ammonia Primary Reformer (flue gas)	National combustion standards may apply (varies by sector)	General combustion guidance (no numeric limit)	300 mg/Nm³	300 mg/Nm³	Sector guideline is the only defined numeric limit
Particulate Matter (PM) – Ammonia Plant	Not specified	Not specified	50 mg/Nm³	50 mg/Nm³	Only sector guideline provides a value
Urea Dust – Urea Granulation/Prilling	Not specified	Not specified	50 mg/Nm³	50 mg/Nm³	Sector guideline establishes limit
NH_3 – Urea Granulation	Not specified	Not specified	50 mg/Nm³	50 mg/Nm³	Sector guideline establishes limit
PM – Urea Plant	Not specified	Not specified	50 mg/Nm³	50 mg/Nm³	Sector guideline applies to urea production

TABLE 2-9: PROCESS WASTEWATER / EFFLUENT (AMMONIA & UREA PLANTS)

(Note: Only parameters with numeric limits are listed)

Parameter	Nigeria Effluent Limit	IFC General EHS (Wastewater)	IFC Sector EHS – Nitrogenous Fertilizer	Project-Adopted Standard	Adoption Basis
pH	6.5–8.5	6–9	6–9	6.5–8.5	Nigeria has narrower, more stringent range
Temperature Increase	Not specified	<3°C above ambient	<3°C	<3°C	IFC/Sector define numeric limit
TSS	30 mg/L	Approx. 50 mg/L (typical GIIP)	30 mg/L	30 mg/L	Nigeria = Sector → most stringent
NH_3 (Ammonia)	5 mg/L	Not specified	5 mg/L	5 mg/L	Nigeria = Sector
Total Nitrogen	Not specified	Not specified	15 mg/L	15 mg/L	Only sector guideline provides a value
Urea	Not specified	Not specified	1 mg/L	1 mg/L	Only sector guideline provides a value
COD	150 mg/L	Principle-based; no numeric value	No sector value	150 mg/L	Nigeria provides numeric limit
BOD	30 mg/L	Principle-based	No sector value	30 mg/L	Nigeria provides numeric limit
Oil & Grease	10 mg/L	Approx. 10 mg/L (typical GIIP)	No sector value	10 mg/L	Nigeria explicit limit
Heavy Metals (Pb, Cr, Ni, Cu, Zn, Hg, Cd, etc.)	Parameter-specific numeric limits	Non-numeric	None	Nigeria limits	Only Nigeria provides numeric values

TABLE 2-10: OTHER PROCESS RELATED INDUSTRIAL REQUIREMENTS

Area	Nigeria Standard	IFC General EHS	IFC Sector EHS	Project-Adopted Standard	Adoption Basis
Flaring – Operational Emissions	Must comply with national flaring rules	Good practice: minimise flaring, complete combustion	Addresses non-routine emissions qualitatively	Compliance with national rules + IFC GIIP	Combine legal compliance + lender expectation
Hazardous Materials	Controlled under hazardous	Specifies GIIP for hazmat and	Identifies typical wastes	Apply Nigeria rules + IFC GIIP	Nigerian legal framework + IFC GIIP

Area	Nigeria Standard	IFC General EHS	IFC Sector EHS	Project-Adopted Standard	Adoption Basis
(e.g., spent catalysts)	waste regulations	chemical handling	(e.g., catalysts)		
Oily Water / Drainage Systems	Discharge limits defined under effluent regs	Requires oil–water separation and GIIP controls	Not specified numerically	Use Nigeria numeric limit + IFC GIIP controls	Nigeria provides numeric limit; IFC provides method

2.7 PROJECT SPECIFIC EHS POLICIES AND STANDARDS

Below listed policies are implemented for Indorama Eleme Fertilizer & Chemicals FZE (IFZ) and the same policies will be extended to proposed IFF Line2 Fertilizer Project.

2.7.1 IFZ NON-DISCRIMINATORY POLICY, 2026 (REV. 2)

IFZ is an equal opportunity employer and as per the Non-Discriminatory Policy does not and shall not discriminate against any employee or any applicant for employment on the basis of race, colour, religion (creed), gender expression, age, disability, military status, sexual orientation, and national origin in any of its activities or operations. These activities include but are not limited to employment – recruitment, selection, hiring, compensation, termination, upgrading, promotions, and other conditions of employment.

2.7.2 IFZ CHILD LABOUR PROHIBITION POLICY, 2026 (REV. 2)

IFZ does not and shall not offer employment nor employ any person below the age of eighteen (18) years. The Company maintains zero tolerance towards the breach of this policy.

In line with the Policy, IFZ shall maintain appropriate documents of all relevant details of employees including their age and these documents shall be open for verification by authorized personnel or the relevant statutory body. The Human Resources Department is responsible for the implementation of this Policy.

2.7.3 IFZ HUMAN RIGHTS AND LABOUR POLICY, 2026 (REV. 2)

The IFZ Human Rights Policy is guided by the International Human Rights Principles as enshrined in the Universal Declaration of Human Rights, the ILO Declaration on fundamental Principles of Rights at Work, and the African charter on Human Rights on the constitution of the Federal Republic of Nigeria 1999, as amended. Specifically, IFZ employees shall have the following rights:

- Freedom of association
- Freedom of express
- Healthy work environment
- Safety at workplace
- Non-discrimination
- Freedom of worship
- Freedom from bullying, sexual harassment

- Right to fair hearing
- Any other such rights as necessary and recognized by the law of the Federal Republic of Nigeria.

2.7.4 IFZ INDEPENDENT CONTRACTORS' POLICY, 2026 (REV. 2)

For the purpose of this Policy, independent contractors are workers working for IFZ. IFZ directs all independent contractors working with the Company to strictly comply with the guidelines on the following internal policies: Employee Hand Book, Grievance Handling and Management Policy, Anonymous Grievance Handling Mechanism, Child Labour Prohibition Policy, Human Rights Policy, Non-discriminatory Policy, Retrenchment Planning (Redundancy) as stipulated in the National Labour Law, Work Place Discipline Policy, Security and Safety Policy, Employee Compensation Policy and any other policy necessary for the wellbeing of the independent contractors and their employees.

2.7.5 IFZ GENDER BASED VIOLENCE AND HARASSMENT POLICY, 2026 (REV. 2)

IFZ is committed to promote gender diversity in the organization and recognizes the potential risk of Gender Based Violence and Harassment (GBVH). IFZ has a zero tolerance for GBVH and on continual basis endeavours to identify the risk areas, upgrade preventive measures; create awareness amongst both internal & external stakeholders, enhance capability building and increase effectiveness of grievance management system. The objective this Policy is to define a policy framework and define strategies for addressing the issue of GBVH. This Document also aims to provide an integrated framework for stakeholder engagement and grievance management system with a focus on GBVH at all states of business cycle.

2.7.6 IFZ ANTI-RETALIATORY POLICY, 2026 (REV. 2)

IFZ is committed to providing access to effective grievance management systems for its employees, stakeholders, and local business partners. Further, IFZ also expects from its local business partners working with the company to provide access to effective grievance management systems for its employees and stakeholders for freedom of expression and grievance redressal without any fear of Retaliation or victimisation. The objective of this Policy is to provide a framework, establish organisational commitment, assess risk, build organisation capabilities for preventative and mitigation measures, as well as proffer an effective grievance management system for safeguarding the human rights values.

2.7.7 IFZ COMMUNITY AND STAKEHOLDER POLICY, 2026 (REV. 2)

IFZ is committed to respecting the rights, cultures, customs, and values of employees and communities affected by its activities and will manage its businesses in a fair and equitable manner to meet its social responsibilities. The objective of the Policy is to ensure proactive engagement with key stakeholders on sustainable development challenges and opportunities in an open and transparent manner and to ensure effective grievance mechanisms are in place.

2.7.8 IFZ ENVIRONMENTAL & CLIMATE CHANGE POLICY, 2026 (REV. 2)

IFZ is committed to effective environmental management. The aim of this Policy is to minimise impacts on the environment and reduce impacts on climate change throughout its operations. The objective of the Policy is to ensure the development and implementation of Environmental

Management Systems that are compliant with applicable national, regional, and local environmental regulations, and good international practice.

2.7.9 IFZ OCCUPATIONAL HEALTH, SAFETY & WELLBEING POLICY, 2026 (REV. 2)

The Policy aims to promote the health and safety of employees, service providers, and any other person who is impacted by IFZ operations. The goal of the Policy is zero harm as well as safe and healthy workplaces.

2.7.10 IFZ PRODUCT STEWARDSHIP POLICY, 2026 (REV. 2)

IFZ is committed to the highest standards of product safety, quality, and business integrity to meet customer expectations and achieve customer delight. The Policy goal is to minimise the health, safety, environmental, and social impacts of their products.

2.7.11 IFZ RESPONSIBLE BUSINESS POLICY, 2026 (REV. 2)

The Responsible Business Policy objective is to make positive contributions to the economic, environmental, and social progress at the locations where IFZ operates. IFZ is committed to promoting business practices that provide benefits to society, transparently and ethically, and address potential negative impacts associated with its operations.

2.7.12 IFZ SOCIAL MEDIA POLICY, 2026 (REV. 2)

The IFZ Social Media Policy provides a framework for use of social media for corporate or personal accounts to protect against damage to the organization. The policy objective is to provide practical ways to avoid issues that may arise from the improper use of social media.

2.7.13 IFZ CONFIDENTIAL REPORTING POLICY, 2026 (REV. 2)

IFZ is committed to high ethical standards and encourages reporting of any acts listed below by any employee irrespective of their position. The Policy prohibits anyone from retaliating against any person who in good faith raises or helps to resolve any of the acts below or any other ethical concern. Confidential reporting applies to:

- Any violation of Indorama’s Code of Conduct.
- Any act that adversely affects the business interest of IFZ.
- Any act that is illegal under local or international law.
- Any abuse of authority.

3. PROJECT JUSTIFICATION AND ALTERNATIVES

3.1 INTRODUCTION

This Chapter presents the rationale for the Project. It also presents the alternatives (including locality, technology and no-go alternative considerations) considered for the Project.

3.2 NEED FOR THE PROJECT AND ASSOCIATED BENEFITS

Presently, Indorama has two operating lines (IFZ Line 1 and Line 2), which both independently produce 2,300 MTPD Ammonia and 4000 MTPD urea fertilizers and a third line (IFF Line 1) recently commissioned in June 2026. All of the Ammonia produced is captively converted to approximately 2.8 million tonnes of Urea per year. Indorama is recognised as the largest fertilizer producer in Sub-Saharan Africa, with a combined installed capacity of approximately 2.8 million tonnes of granular urea per year from IFZ Line 1 and Line 2. Post commissioning of third line (IFF Line 1), the total combined installed capacity is 4.2 million tonnes of granular urea per year.

As such, the Urea produced by the proposed IFF Line 2 (Line 4) Project will be primarily for export to Latin America, Europe, USA and West Africa. Indorama is not currently selling ammonia as a standalone product; however, given the uses of ammonia as a hydrogen carrier, there could be opportunities in future to sell ammonia.

DEMAND FUNDAMENTALS REMAIN ROBUST. GLOBALLY, THE UREA MARKET CONTINUES TO EXPAND ON THE BACK OF RISING FOOD DEMAND AND BROADER INDUSTRIAL APPLICATIONS (E.G., RESINS, DEF), WITH RECENT ASSESSMENTS INDICATING MEDIUM-TERM GROWTH IN THE 3–4% CAGR RANGE THROUGH 2029–2034 AS SHOWN IN



Figure 3-1. IFF Line 2's incremental output will therefore integrate into a growing market, while allowing Indorama to flexibly serve domestic offtake and export opportunities[2].

At the national level, IFF Line 2 supports Nigeria's agri-inputs availability and value-chain resilience goals. While domestic urea production capacity has risen, farm-level fertilizer use remains low by international standards, and government programmes (including PFI 3.0) are focused on stabilising supply to blending plants and farmers[3]. Additional, reliable upstream production from IFF Line 2 will help underpin these supply chains.

IFF Line 2 is also consistent with Nigeria's gas-based industrialisation and flare-reduction ambitions. The project's feedstock strategy utilises domestic natural gas and established ammonia–urea synthesis, aligning with Nigeria's position as a major gas-reserve holder and policy moves to capture and monetise gas that might otherwise be wasted. While global flaring increased again in 2024, national regulators continue to target flare

[2] Urea Market Size, Share & Growth Analysis | Report [2034]
[3] Presidential Fertilizer Initiative Strengthens Nigeria's Supply Chain - Voice of Nigeria Broadcasting Service

reduction by 2030; additional gas-based industry such as IFF Line 2 supports utilisation pathways complementary to these policies[4].



FIGURE 3-1: GLOBAL UREA MARKET SIZE AND OUTLOOK (2025–2034)
Source: Fortune Business Insights, 2025

The above being said**,** Sub-Saharan Africa (SSA) has the lowest nitrogen fertilizer usage in the world as outlined in Figure 3-2. Nigeria's national fertilizer consumption is only 4.2 kilograms (kgs) / hectare (ha) as of 2023.[5][6] against the global average of approx. 120 kgs/ha. The targeted fertiliser consumption in SSA is 50kg/ha. As such there is a substantial need for investment in the fertilizer sector to meet this consumption target.

Farming and livestock rearing is the main livelihood for approximately 70% of households in Nigeria. Agriculture remains predominately subsistence on small family owned plots in rural areas. The heavy reliance of subsistence crops as a source of food for majority of the population coupled with ever increasing population growth[7] and effects of climate change has exacerbated the food security crisis in Nigeria.

In the third quarter of 2021, agriculture contributed 29.94% to the nominal Gross Domestic Product (GDP) of Nigeria. The country is a global leader in various types of agricultural production, including (amongst others) for cocoa beans, sorghum, palm oils, etc. This being said, Nigeria's agricultural potential is far from being realised. Low fertiliser use is one of the major contributing factor for poor utilization of agricultural potential. The proposed Project therefore has the potential to significantly contribute to the provision of fertilizer for the local domestic market and other markets in West Africa. The projection that the use of nitrogen fertilizer per ha should increase from the current levels of 20 kg/ha to 50 kg/ha provides a robust justification for the Project.

[4] Nigeria's Natural Gas Reserves Hit Historic High Of 210.54 Trillion Cubic Feet - Majorwaves Energy Report
[5] https://ifdc.org/2021/06/24/changing-the-data-landscape-the-vifaa-nigeria-dashboard
[6] Fertilizer consumption (kilograms per hectare of arable land) - Nigeria | Data
[7] The Nigerian population projected to rise to 262 million by 2030 and 398 million by 2050.

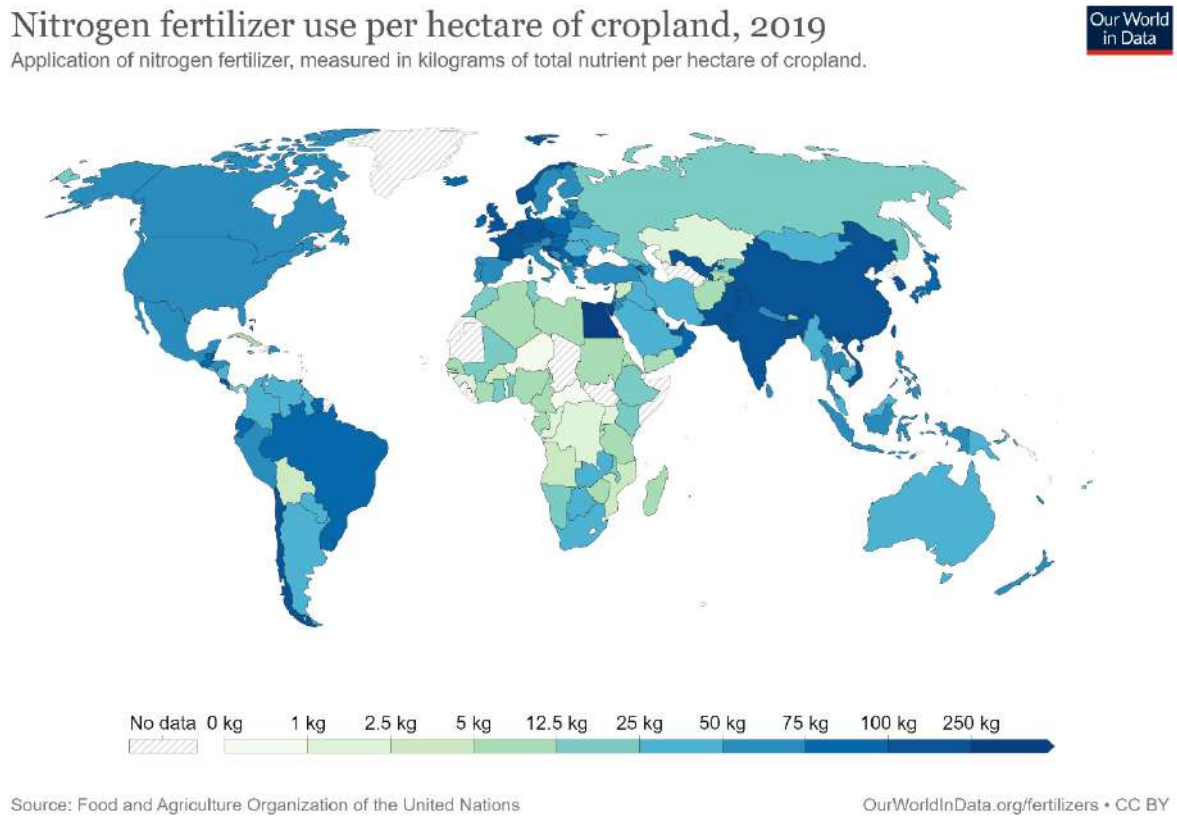


FIGURE 3-2: NITROGEN FERTILIZER USE PER HA OF CROPLAND

Indorama is currently using natural gas as a feedstock for ammonia and urea fertilizers production in IFZ Line 1 and Line 2 and will be used in IFF Line 1. Natural gas will also be used for the proposed IFF Line 2 Project. During the process, 80% of the natural gas is used as feedstock for fertilizer, while the remaining 20% is used for fuel and for Power generation.

The Petroleum Industry Act 2021, focused on increasing domestic gas supply and the reduction of gas flaring, while diversifying national revenues. The domestic gas market is gradually developing, with Gas Based Industries and Power Sector being the main drivers of gas demand. To date, out of total gas production of 7.5 BCF/day, approximately 1.4 BCF/day is supplied to the domestic market, with 3.5 BCF/day for exports, 2.0 BCF/day for reinjection and 0.6 BCF/day being flared.

According to the Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA), as of March 2022, Nigeria's gas reserve was estimated at approximately 209 trillion cubic feet, the highest in all of Africa. Although Nigeria has abundant gas resources, not much of it has been harnessed, with the nation's primary focus being on crude oil production. The domestic gas market is generally underdeveloped, with only 664 and 930 million cubic feet consumed and exported respectively in 2015[8].

[8] Yahya, B. and Nkwatoh, L. S. (2021). Testing the Long Run Relationship between Natural Gas Utilisation and Economic Activities in Nigeria. *Journal of Economics and Allied Research.* Vol. 6 (2). ISSN: 2536-7447. Available on https://jearecons.com/index.php/jearecons/article/download/163/161

While the proposed Project targets efficient use of natural gas, it is to be noted that a significant volume of natural gas is still being flared in Nigeria. According to World Bank data obtained from the Global Gas Flaring Tracker Report (2022), approximately 600 million standard cubic feet (MMSCF) gas was flared daily on average in 2021. In comparison, a new fertilizer plant consumes about 90 MMSCF per day and hence the project have potential to reduce approx. 3.4 MMTPA CO_2 eq. greenhouse gas. As such, the proposed Project has the potential to reduce flaring by an equivalent amount or reasonable amount subjected to flaring in absence of other downstream users[9]. The equivalent CO_2 emissions resulting from the flaring contribute significantly to global warming (World Bank, 2023)[10]. On top of CO_2 emissions, black carbon (otherwise known as soot) is another air pollutant resulting from flaring. Black carbon is produced through incomplete combustion of fossil fuels and despite remaining in the atmosphere for just a few days or weeks, it has the second-largest warming effect on the atmosphere, after carbon dioxide (World Bank, 2023). Flaring of natural gas is unproductive and the use of gas in the production of fertilizers (such as the proposed IFF Line 2 Project) is key in reducing overall greenhouse gas (GHG) emissions in Nigeria.

As of 2024, Nigeria ranks 7th in the world in terms of gas flaring (Figure 3-3) despite Nigeria making significant progress in reducing flaring[11]. Since 1996, flaring in Nigeria has been reduced by 68% (World Bank, 2022)[12].

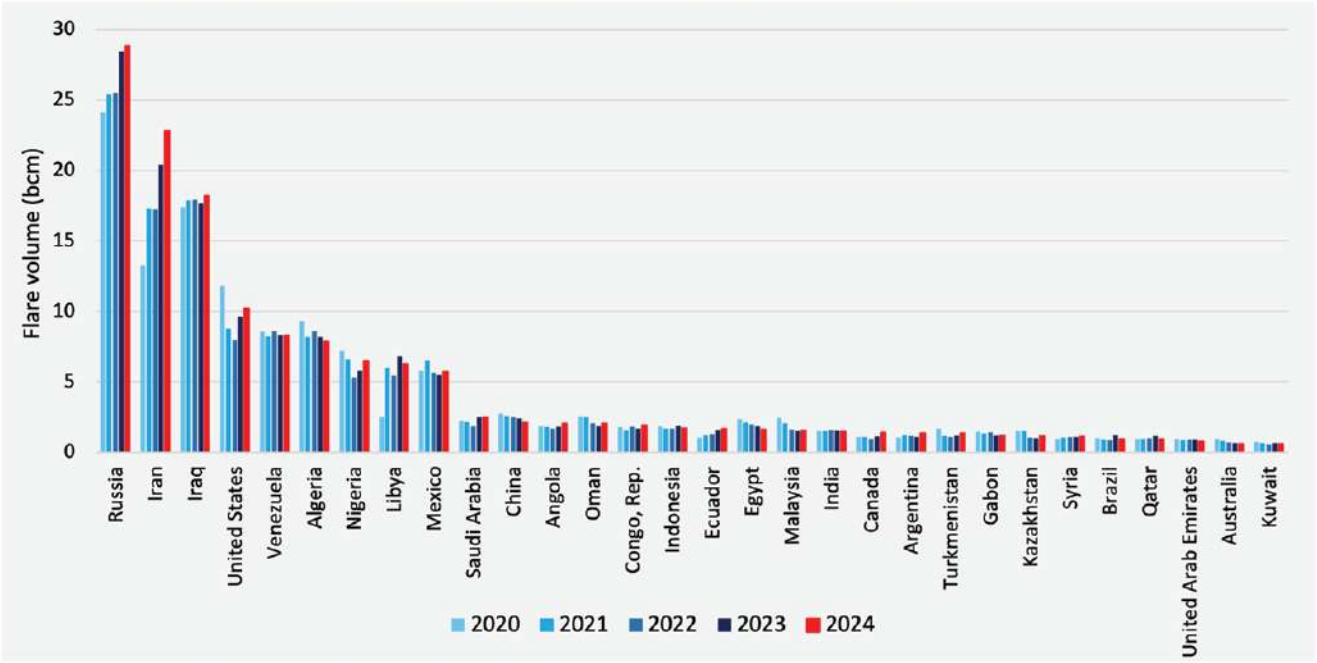
[9] The Project will receive gas from an upstream facility; therefore, it is not possible to conclude that it will result in an equivalent reduction in flaring. However, the Project will provide an additional downstream use for natural gas, potentially supporting the beneficial utilisation of gas resources that may otherwise be flared, subject to upstream operational conditions and gas management practices.

[10] https://www.worldbank.org/en/programs/gasflaringreduction/gas-flaring-explained#:~:text=Assuming%20a%20'typical'%20associated%20gas,of%20CO2%20equivalent%20emissions%20annually.

[11] Global-Gas-Flaring-Tracker-Report-July-2025.pdf

[12] chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://thedocs.worldbank.org/en/doc/1692f2ba2bd6408db82db9eb3894a789-0400072022/original/2022-Global-Gas-Flaring-Tracker-Report.pdf

Figure 7. Flare volumes in the top 30 flaring countries (in order of 2024 flare volume)



Source: NOAA, Payne Institute and Colorado School of Mines, and World Bank.

FIGURE 3-3: FLARE VOLUMES FOR TOP 30 FLARING COUNTRIES FROM 2012 TO 2021 (SORTED BY 2021 VOLUME, SHOWN IN RED)

As part of the effort to curb gas flaring in the country, in December 2016, the Federal Government launched the Nigerian Gas Flare Commercialization Program (NGFCP). The NGFCP was designed to implement the Policy objectives of the Government for the elimination of gas flares through technically and commercially sustainable gas utilization projects. The proposed IFF Line 2 Project has the potential to significantly contribute to the strategic investment program to increase the use of natural gas and reduce flaring while simultaneously ensuring the availability of fertilizer to enable the Green Revolution in Nigeria to usher in food security for the long term.

3.3 VALUE OF THE PROJECT

Previously, Indorama commissioned two lines of ammonia and urea productions, specifically IFZ Line 1 in 2016, IFZ Line 2 in 2021 respectively, and third line (IFF Line 1) was commissioned recently in June 2026. Indorama Management further plans to set up a 4th Line in the same location for ammonia and urea production. The investment is aimed at: improving domestic production, promoting the setting up of downstream blending plants, enhancement of supply/distribution networks and the provision of new employment opportunities for the growing demand from the young Nigerian population. With all four Lines in operation, Indorama will be able to produce ~5.6 million tonnes of Urea annually. Overall, the Project will be able to help improve the share of agriculture in the Country's GDP and derive valuable foreign exchange from the Urea that may be exported, as well as improve the local economy in the immediate Project area.

3.3.1 TECHNICAL SUSTAINABILITY

The proposed Project is expected to be technically sustainable due to the following reasons:

- Natural gas has more hydrogen compared with other feedstocks. Additionally, heavier feedstocks such as coal and oil are more complex to process & increases the GHG emissions.
- Ammonia and urea will be manufactured in the same plant resulting in use of carbon dioxide byproduct from ammonia production being used to produce urea.
- Both the operational IFZ Line 1 and Line 2, and the recently commissioned IFF Line 1 project employ the same technologies and have demonstrated a high degree of operability and reliability, while setting a benchmark in process safety. As such, the IFF Line 2 Project will employ the same technology as IFZ Line1, IFZ Line2 and IFF Line 1.
- Engineering and construction of the Project will be undertaken by the same Contractors who engineered and constructed IFZ Line1, IFZ Line2 and IFF Line 1.
- The Project Proponent will design, construct and operate the Project in strict adherence to internationally accepted codes, standards and best practices for engineering design and construction such as (but not limited to):
  - American National Standards Institute (ANSI)
  - American Society of Mechanical Engineers (ASME)
  - National Association of Corrosion Engineers (NACE)
  - National Fire Protection Association (NFPA)
  - International Electrotechnical Commission (ICE)
  - Institute of Electrical and Electronics Engineers (IEEE)
  - Institute of Electrical and Electronics Engineers (ISA)
  - Network Information Service (NIS)

It is important to mention that the successful designing, construction and operation of IFZ Lines 1, IFZ Line 2, and IFF Line 1 are as a result of robust designs, safety, energy efficiencies and deployment of vigorous O&M Practices.

- The Project has secured the availability of natural gas for feed and fuel.
- Indorama has technically competent personnel required for effective operation of the Project. These staff were / are involved in the designing, construction, commissioning and operation activities of IFZ Lines 1, IFZ Line 2 and IFF Line1.

3.3.2 ENVIRONMENTAL SUSTAINABILITY

Provided that all the E&S mitigation / management measures provided in this ESIA and associated ESMMP are implemented, and provided that the suggested ways forward are a condition of authorisation, it is the opinion of ERM that there are no environmental or

social fatal flaws or red flags which inhibit authorisation of the Project. Moreover, the positive E&S benefits (refer to Section 3.2) of the Project also need to be considered in the authorisation decision.

The ESIA process does not stop with submission of the Project ESIA report to the FMEnv. Following submission of the ESIA, work will continue to address some of the acknowledged additional studies and detailed design of the Project will progress. As additional studies concluded, a greater level of certainty regarding the impacts of the Project will emerge. Additional studies and any further changes to Project scope should be re-evaluated in terms of their influence on impact significance, and if necessary, mitigation / management measures included in the ESMMP should be amended to ensure negative impacts are mitigated and positive impacts enhanced.

3.3.3 ECONOMIC SUSTAINABILITY

The strategy of the Federal Government to reduce the flaring of associated gas from the various oil fields provides the push to incentivize and make available the required natural gas for this Project, as well as for other similar industries. The Project contributes positively to the economic sustainability due to more than required gas supply contracts in place, sound technology, experienced contractors and operations staff, easy access to Port, and an established marketing and sales team.

In addition, the Project will help to correct the existing market imbalance in terms of supply and demand of urea fertilizer. Presently the per capita consumption of fertilizer is very low in Africa, and Nigeria in particular. The projection that the use of fertilizer per ha should increase from the current levels of 4 kg/ha[13] to 50 kg/ha provides a robust economic justification for the Project.

The Project will improve the following areas of the economy:

- The local economy and development of other downstream medium scale industries such as NPK blending.
- Valuable foreign exchange, if the product is exported.
- Direct and indirect employment of the local population.
- Substantial indirect employment for plant construction, transportation, and support services.

3.3.4 SOCIAL SUSTAINABILITY

Indorama is committed to meet the ever-increasing national level demand of fertilizer, which in turn is a key enabler to achieving food security in Nigeria. Moreover, the Project will provide employment opportunities during all phases (construction and operations).

The robust and all-inclusive engagement of the host communities by Indorama Management has ensured a positive relationship between the Proponent and host communities. A detailed stakeholder consultation process has been implemented throughout the ESIA process to assist in ensuring that all relevant stakeholders have had the opportunity to provide input into the project planning process. IFF will ensure that

[13] Fertilizer consumption (kilograms per hectare of arable land) - Nigeria | Data

the stakeholder consultation process is sustained throughout the life of the Project as set out in the SEP.

3.4 PROJECT ALTERNATIVES

3.4.1 INTRODUCTION

In accordance with the Nigeria EIA Act No 86 of 1992 (now codified as the EIA Act CAP E12 Law of the Federation of Nigeria, 2004), an ESIA study should consider technically and economically feasible alternatives for carrying out a project, including an assessment of the environmental effects of alternatives. Additionally, the Federal Republic of Nigeria through Official Gazette No. 105, Vol 108 published S.I No. 109, Environment Impact Assessment Procedures and Charges Regulations in September 2021. These Regulations require that the alternatives be considered based on technology, site, energy and water requirements. The Project has therefore considered:

- Location Alternatives, and
- Technology Alternatives.

3.4.2 LOCATION ALTERNATIVES

The proposed Project will be established within Indorama Free Zone which is located within existing Indorama manufacturing complex. The land earmarked for the Project is within the industrial zone with no existing settlements and is therefore preferable from a social perspective as no physical resettlement will be required. Given the location of the proposed Project site in relation to existing operations, the site has access to key utilities such as power, water supply and wastewater treatment. In addition to utilities, the existing complex also has well established infrastructure and facilities such as roads that may be leveraged by the Project. Other major advantages to locating the Project within existing complex includes:

- Good soil conditions similar to the existing Lines plots;
- Support of existing power plant, utilities and Environment, Safety, Occupational health, Social, Emergency & Security Management team
- E&S impacts can be adequately managed / controlled (i.e. – there are no fatal flaws or red flags);
  - The relations with the host and neighbouring communities is positive;
  - The existing Operations and Maintenance (O&M) support team associated with the existing operations are available during the construction and operations of the Project; and
  - Proximity to the Proponent’s Port at Onne with good marine conditions.

Consequently, although location alternatives are reasonable, it is not a financially feasible option. Moreover, from an E&S perspective, there are no environmental or social fatal flaws or red flags associated with the location of the Project. As such, location alternatives will not be considered any further in this ESIA.

3.4.3 TECHNOLOGY ALTERNATIVES

As mentioned in Section 3.4.1, availability of raw material (i.e. – natural gas) is critical to the overall feasibility of the Project. Natural gas is considered to be more advantageous over other materials (like coal) for the following reasons:

- Natural gas will be available at the plant's battery limit. A separate authorization is in place to assure the delivery of the raw material.
- The reserve of the natural gas will suffice well above the life cycle of the Project (including for IFZ Line1, IFZ Line2 and IFF Line1).
- The use of coal or biomass as a raw material for the Project would be capital intensive, as material would need to be transported to the proposed Project site via road. Transportation of raw material via road for the life of the Project is also not favourable from a community or occupational health and safety perspective.
- Hydrogen production from biomass is either biochemical (anaerobic digestion or fermentation) or thermochemical. Anaerobic digestion to produce biogas can only process sewage sludge, agricultural, food processing and household waste, and some energy crops. Fermentation can process the non-edible cellulosic part of some plants; nevertheless, the volume of biomass required would be significantly high and cost prohibitive. The estimated amount of biomass (equivalent to 90 MMSCFD NG) required would be approximately 6,000 TPD. Further, the fermentation process results in CO_2 emissions. Preliminary assessments indicate that it would not be feasible to source such high volumes of biomass.
- Although gasification could potentially convert all organic matters to syn gas, the process produces a significant amount of CO_2. The operational efficiency of the gasification technology is poor, which may result in non-availability of syn gas, and the ammonia process needs to operate on 24/7 basis. There is also a challenge of the formation of tars in the gasification process, which can cause catalyst poisoning.
- The use of coal as feed stock for production of urea fertilizer would have significant environmental implications. The quantity of coal needed would be 4,500 TPD (1,642,500 tons/year), which would need to be imported. The gasification of coal produces significant amounts of CO_2, and hence is not a feasible option from a climate change perspective. The carbon intensity of hydrogen from natural gas is roughly half that of coal. Without Carbon capture, the CO_2 emission vide Natural Gas route is just about 9 kg /kg of H_2 while that from coal generates approx. 20 kg / kg of H_2. In summary, the reforming of Natural Gas is a much cleaner technology.
- The option of using coal or biomass would also demand land take, which can bring loss of vegetation, biodiversity and other natural resources.
- If coal or biomass were used as an alternative feed stock, the cost in developing the site to accommodate the use of such a feedstock would be more significant.

- The Project would not be complementing Nigeria's NGFCP, which aims to eliminate flaring of natural gas and rather using gas for commercially sustainable gas utilization projects (like the proposed IFF Line 2 Project).

Moreover, as mentioned in Section 3.3.1, the proposed IFF Line2 Project will employ the same technology as operational IFZ Line 1, IFZ Line 2 and IFF Line 1 which is currently commissioned. IFZ Line 1 and Line 2 have demonstrated a high degree of operability and reliability, while setting a benchmark in process safety.

As such, although technology alternatives in terms of a feedstock and process are reasonable, it is not financially or environmentally reasonable. As such, technology alternatives will not be considered any further in this ESIA.

3.4.4 NO / DELAYED/ PROCEED AS PLANNED PROJECT ALTERNATIVES

No Project

As per ESIA good practice, any comparative assessment of project alternatives must include a "No Project Alternative". For the purposes of this report, the No Project Alternative will be that the proposed Project is not established within any time period.

The key potential disadvantages associated with the no-go alternative include:

- Lost opportunity to supply an ever-increasing global demand for fertilizer.
- The global population is projected at 8.23 billion in 2025 and 8.30 billion by mid-2026, with a 0.83% annual growth rate sustaining rising food and fertilizer demand. Africa continues to grow faster than the global average, with countries such as Nigeria (2.06%) and Ethiopia (2.53%) showing some of the highest 2026 rates[14]. This rapid demographic expansion, combined with persistently low fertilizer use (<20 kg/ha), heightens regional food-security risks.
- Consequently, the no-project alternative would exacerbate supply pressures and undermine both national and regional food-system resilience. Lost contribution to the provision of fertilizer to Nigeria and other West African countries, especially given the drive to increase Nigeria's fertilizer consumption from the current 4 kg/ha to 50 kg/ha.
- Long-terms loss of utilising natural gas in a commercially sustainable gas utilisation project and the associated environmental disadvantages of having to flare reasonable amount gas or the equivalent of approximately 90 MMSCF per day. This would in turn translate to approx. 3.4 MMTPA CO_2 eq. emissions at source and the release of unburnt CH_4 would have a greater impact on climate change.
- Loss of opportunity of additional employment and development in the local area.
- Loss of additional revenue stream in Nigeria, which in turn will affect local, regional and national government revenues.

[14] Socioeconomic statistics - Nigeria Data Portal

- Cumulative loss in fertilizer supply could potentially increase fertilizer prices locally (i.e. in Nigeria) and regionally (i.e. West Africa), therefore affecting future price stability for fertilizer and potentially agriculture food products[15].

The No Project Alternative is a feasible option; however, its selection would result in the above-mentioned disadvantages which will be detrimental to society at large. As such, this alternative is not considered reasonable and will not be considered any further in this ESIA.

Delayed Project

The ESIA good practices also suggest considering "Delayed Project Option" in project alternatives analysis. For the purposes of this report, the Delayed Project Alternative will be that the proposed Project is postponing the implementation to a future date.

The key potential disadvantages associated with the delayed project alternative include:

- Environmental Impact: Delaying the project typically defers immediate physical impacts associated with construction. However, it does not permanently eliminate these impacts; it merely shifts them to a later timeframe
- Social Impact**:** Postponing implementation defers the possible social disruptions caused by construction activities. However, it also delays critical community investments, corporate social responsibility (CSR) programs and benefits tied to project development.
- Economic and Financial Losses: Postponing project implementation introduces significant economic inefficiencies and potential financial losses, including Cost Escalation and Inflation, Deferred Revenue and Socio-Economic Benefits, Extended Administrative and Holding Costs, Market and Opportunity Risk. Conclusion and Assessment Recommendation

While the Delayed Project Option temporarily postpones immediate construction-related environmental and social disturbances, its selection would result in the above-mentioned disadvantages and overall negative effects to society at large. As such, this alternative is not considered reasonable and will not be considered any further in this ESIA.

Proceed as Planned Option

The Proceed as Planned Option involves implementing the Project at the proposed location using the design, technology and schedule assessed in this ESIA. Implementation would incorporate the identified environmental and social safeguards and remain subject to obtaining all required approvals.

This option would enable the anticipated benefits, including increased production, employment, local procurement and wider economic development. It would also utilise available infrastructure, utilities and operational expertise.

Proceeding would introduce environmental and social impacts associated with construction activities, resource consumption, emissions, waste generation, traffic and workforce influx. These impacts would require implementation of the Environmental and

[15] Mainstream demand for fertilizer is directly coupled with the demand for agricultural crops.

Social Management and Monitoring Plan, continued stakeholder engagement, effective grievance management and emergency preparedness.

Selection of this option is conditional on completing outstanding studies, incorporating their findings into detailed design and demonstrating that significant risks are adequately addressed. Monitoring results and changes in project conditions would inform corrective actions and updates to management measures throughout construction and operation.

3.5 CONCLUSION

The availability of reliable natural gas feedstock at the broader Indorama Manufacturing Complex, together with the efficiencies realised through shared infrastructure and personnel from previous developments (IFZ Line1, IFZ Line2 and IFF Line1), favours the selected Project location. In terms of technological alternatives, the evaluation of alternate raw materials for production (such as coal and biomass) concluded that such options would not be environmentally preferred or economically viable. In view of the above, the availability of natural gas, and the strategic location of the IFF Line 2 (Line 4) Project within the existing Indorama Manufacturing Complex/Indorama Free Zone operations, is critical to the overall feasibility of the Project and has therefore been selected as the preferred option for this ESIA.

Table 3-1 below summarises all options considered and the rationale for their selection or rejection.

TABLE 3-1: ALTERNATIVES ANALYSIS MATRIX

Category	Option Considered	Design Feasibility	Cost / Implementation Implications	Environmental & Social Implications
Site / Layout	Greenfield site outside existing complex	Technically feasible	High capital costs (land acquisition, infrastructure duplication)	Increased habitat disturbar take, community displacem
	Expansion within existing industrial footprint (brownfield)	Highly feasible	Lower capital cost due to shared infrastructure	Reduced land disturbance, of new receptors
	Compact plant layout with buffer zones	Feasible	Moderate design optimisation cost	Reduced noise, air, and safe exposure to receptors
Technology / Process	Conventional process systems	Proven	Lower capex but lower efficiency	Higher emissions intensity resource use
	Advanced high-efficiency process systems	Proven and widely applied in sector	Higher capex, lower opex over lifecycle	Lower emissions, reduced e consumption
Energy Efficiency	Standard energy consumption design	Feasible	Lower initially	Higher GHG emissions and costs
	Energy-efficient systems (heat recovery, optimisation)	Feasible	Moderate increase in capex, payback via opex savings	Reduced energy demand ar emissions

4. PROJECT DESCRIPTION

4.1 INTRODUCTION

This Chapter provides a description of the proposed IFF Line 2 Fertilizer Project, including all related activities and ancillary infrastructure. Where reference is made in this ESIA to existing Indorama infrastructure, utilities, or shared systems, the assessment focuses exclusively on the incremental demands, interfaces, and operational interactions attributable to the IFF Line 2 Project. No expansion, modification, or re-authorisation of existing facilities outside the defined IFF Line 2 project footprint is proposed or assessed, except where explicitly stated.

The Project Description forms the basis for the Terms of Reference for specialist studies associated with the ESIA. The proposed IFF Line 2 development is a brownfield urea fertilizer production line within the Indorama Free Zone, adjacent to the existing IFF Line 1 (Line 3) facility at Eleme LGA, Port Harcourt. The IFF Line 2 configuration replicates the proven design and technology used in the operational fertilizer production lines, with a Feed Conditioning Unit capable of processing approximately 200 MMSCFD (Million Standard Cubic Feet per Day) of natural gas, and production capacities of 2,300 MTPD of ammonia, 4,000 MTPD (Metric Tons Per Day) of urea, and 150 MTPD of UFC-85 (Urea Formaldehyde Concentrate 85%).

These facilities build on the established operational performance, engineering reliability, and process safety benchmarks demonstrated by existing Indorama units. Table 4-1 summarises the permanent and temporary components associated with the proposed development.

TABLE 4-1: PROJECT COMPONENTS

Component	Description
New Permanent Project Components	
Feed Conditioning Unit (FCU)	Conditioning of 200 MMSCFD raw natural gas including slug catcher, NG KOD, amine treating, dehydration, heavies' removal section along with flare system
Ammonia Plant	Single-train facility producing 2,300 MTPD ammonia including reforming, air compression, CO_2 removal, synthesis loop and refrigeration.
Urea Plant	4,000 MTPD granulation-based urea plant including synthesis, purification, concentration, granulation, scrubbing and product handling.
UFC-85 Plant	150 MTPD Urea Formaldehyde Concentrate unit to support granulation and urea product quality.
Cooling Towers	Circulating water cooling system with blowdown routed to wastewater recovery.
Urea Storage (120,000 t)	Enclosed warehouse with air-handling units, portal scraper reclaimer and conveyor systems.

Component	Description
Truck Loading Facilities	Bulk truck loading for product evacuation to MM FZE Port, Onne
Natural Gas Receiving Station	Underground pipeline receipt, metering and supply to FCU.
Water Treatment (Raw, DM, Polisher Units)	Borehole sourcing, filtration, DM water generation and condensate polishing.
Wastewater Recovery and Effluent Treatment Plant	Treatment of process condensates, urea hydrolyser effluent, amine-contaminated water, cooling tower blowdown.
Flares	Emergency and startup/shutdown flaring for all units.
Fire and Gas System	Detection, alarms, deluge systems, FM200, hydrants, and 24-hour maned fire station.
DCS / ESD Systems	Integrated control, shutdown and safety systems.
New Temporary Project Components (only required for the construction phase)	
Temporary Offices	Contractor and project management offices.
Laydown Areas	Material laydown, pre-fabrication yards and construction warehouse zones.

4.2 PROJECT LOCATION

The proposed IFF Line 2 Fertilizer Project will be located within the Indorama Free Zone, an established 250-hectare industrial precinct situated within broader Indorama Manufacturing Complex in the Eleme Local Government Area of Rivers State, Nigeria. It is proposed to be adjacent to the existing fertilizer and petrochemical operations (refer to Figure 4-2. Existing facilities shown outside the Line 2 footprint are presented for contextual purposes only and do not form part of the infrastructure being assessed or authorized under this ESIA). The IFF Line 2 development occupies an approximately 80-hectare plot positioned directly north of the existing IFF Line 1 (formerly IEFCL-Train 3) facility. The site is bound by the wider Indorama Manufacturing Complex to the south, with undeveloped land to the north, east, and west. The geographic extent of the Indorama Free Zone, including the IFF Line 2 plot, is shown on Figure 4-1 and ranges between approximately 4°49’33.64”N to 4°50’50.03”N and 7°06’16.72”E to 7°07’16.46”E as outlined in Table 4-2 below.

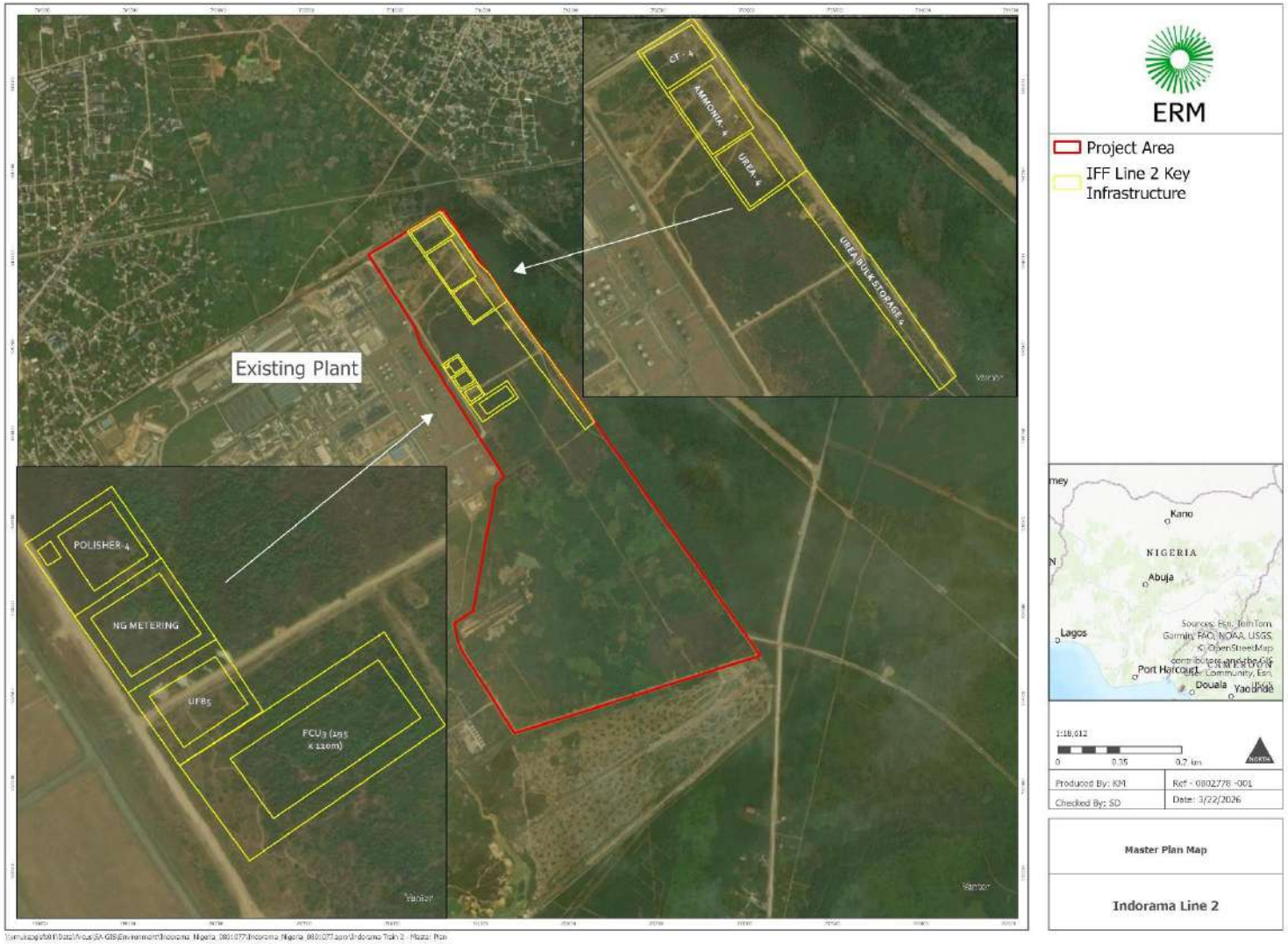
TABLE 4-2: INDORAMA FREE ZONE COORDINATES

Fertilizer Manufacturing		
S/no	Northing	Easting
A	4°50’50.03”N	7°06’29.97”E
B	4°49’44.76”N	7°07’16.46”E
C	4°49’33.64”N	7°06’58.97”E
D	4°50’41.79”N	7°06’16.72”E

FIGURE 4-1: GOOGLE MAP SHOWING INDORAMA FREE ZONE (PERSIAN BLUE COLOUR)



FIGURE 4-2: SITING AND LAYOUT OF KEY INFRASTRUCTURE ASSOCIATED WITH THE LINE 2 PROJECT



4.3 PROJECT PHASES

The proposed IFF-Line 2 Project will be developed in the following phases:

- Design Phase
- Construction Phase
- Operational Phase; and
- Decommissioning Phase.

Each of these four phases have a different combination of activities and the commencement of each phase is dependent on the outcome and success of its predecessor. It must be noted that the scope of the proposed Project, and the associated Project ESIA, relates to all four phases.

The above-mentioned Project phases are discussed in this Section.

At the end of the design phase, the proposed IFF-Lin2 Project will be dimensionally correct, such that all the main components of the Project can be fully described. It is during this phase that the outcomes of the ESIA will influence how the proposed Project develops.

Project planning, decision-making and refinement of the Project will continue throughout the design phase, as a result of continued engineering studies, as well as per the findings of this ESIA and associated ESMMP, and through further post-ESIA environmental and social studies.

4.3.1 DESIGN PHASE

The design Phase comprises of Engineering of entire project Scope and will involve Project planning, decision-making and refinement of the Project, continued engineering studies, Incorporation of findings of this ESIA and associated ESMMP, and refinement through further post-ESIA environmental and social studies.

4.3.1.1 CURRENT DESIGN

The Project will be identical to the IFF-Line1, as the equipment design, process flow sheets, layout, etc. will be duplicates of IFF-Line1. IFF has already engaged Engineering, Procurement and Construction (EPC) Contractors for the Project. For the purposes of this ESIA, the following regarding the Project is important to note:

- Project design is such that the Project will have an operational lifespan of 30 years, with a planned shutdown for maintenance purposes every 4 years.
- Design capacity is such that the Plant will operate 330 days/year.

The IFF-Line2 Project will comprise of the following main infrastructure:

- A Feed Conditioning Unit (with a capacity to process 200 MMSCFD Natural Gas)
- An Ammonia Plant (with a capacity of 2,300 MTPD). The key infrastructure associated with the Ammonia Plant includes
  - The Compressor Unit
  - Stacks associated with the Reforming
- A Urea Plant (with a capacity of 4,000 MTPD). Key infrastructure associated with the Urea Plant includes:
  - The Granulation Unit and associated stack

- A Urea Formaldehyde Concentrate (UFC-85) Plant with 150MTPD production capacity.
- Internal Road & Drain Network (with a width that varies between 8 to 10 meters)
- Urea Product Handling and Bulk Loading Area; and
- Bulk Urea Storage Facilities, Cooling Towers for ammonia & Urea plant each.

MOREOVER, ARCHITECTURAL PLANS FOR THE IFF LINE 2 MASTER PLOT (

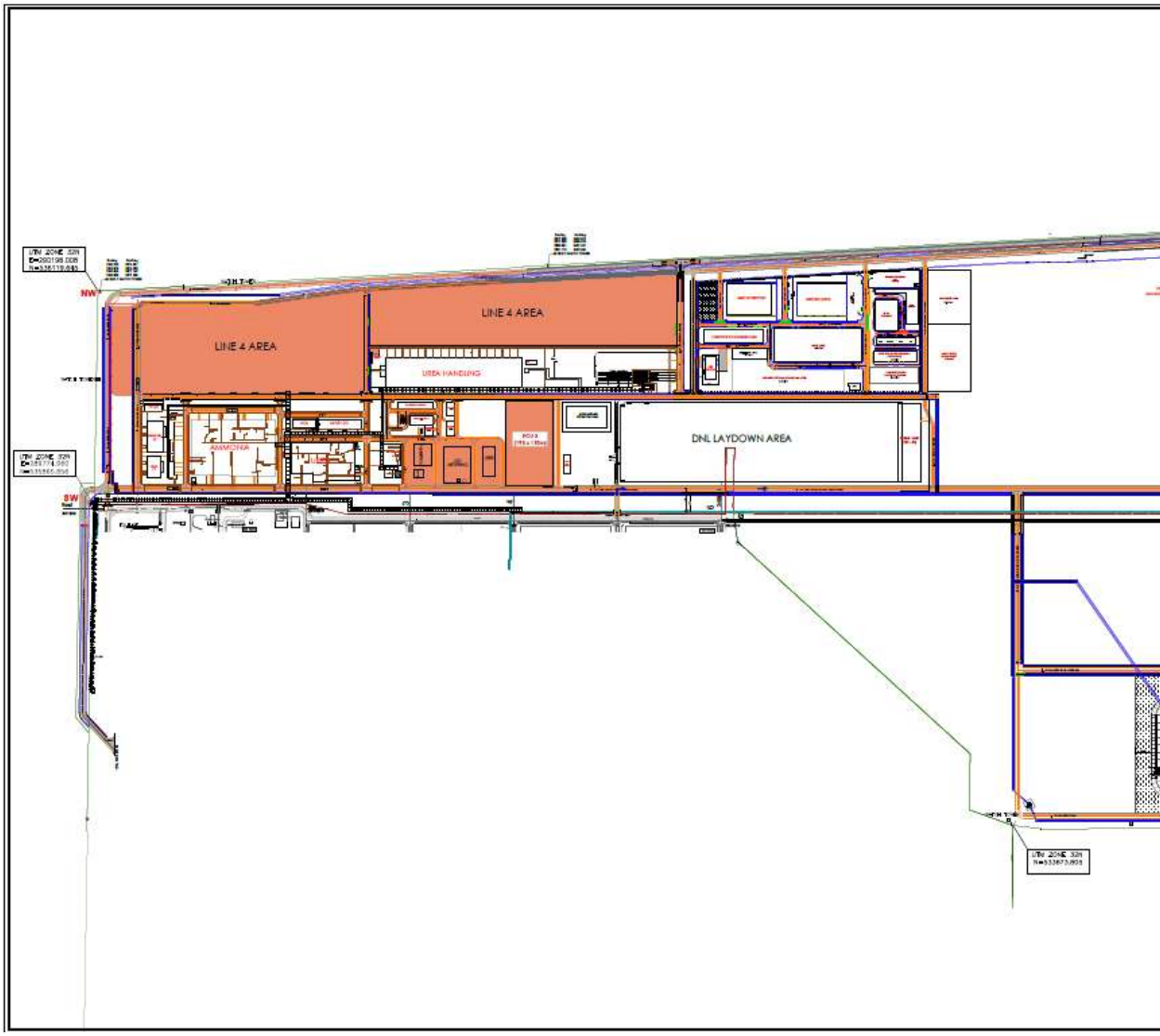


FIGURE 4-3 A

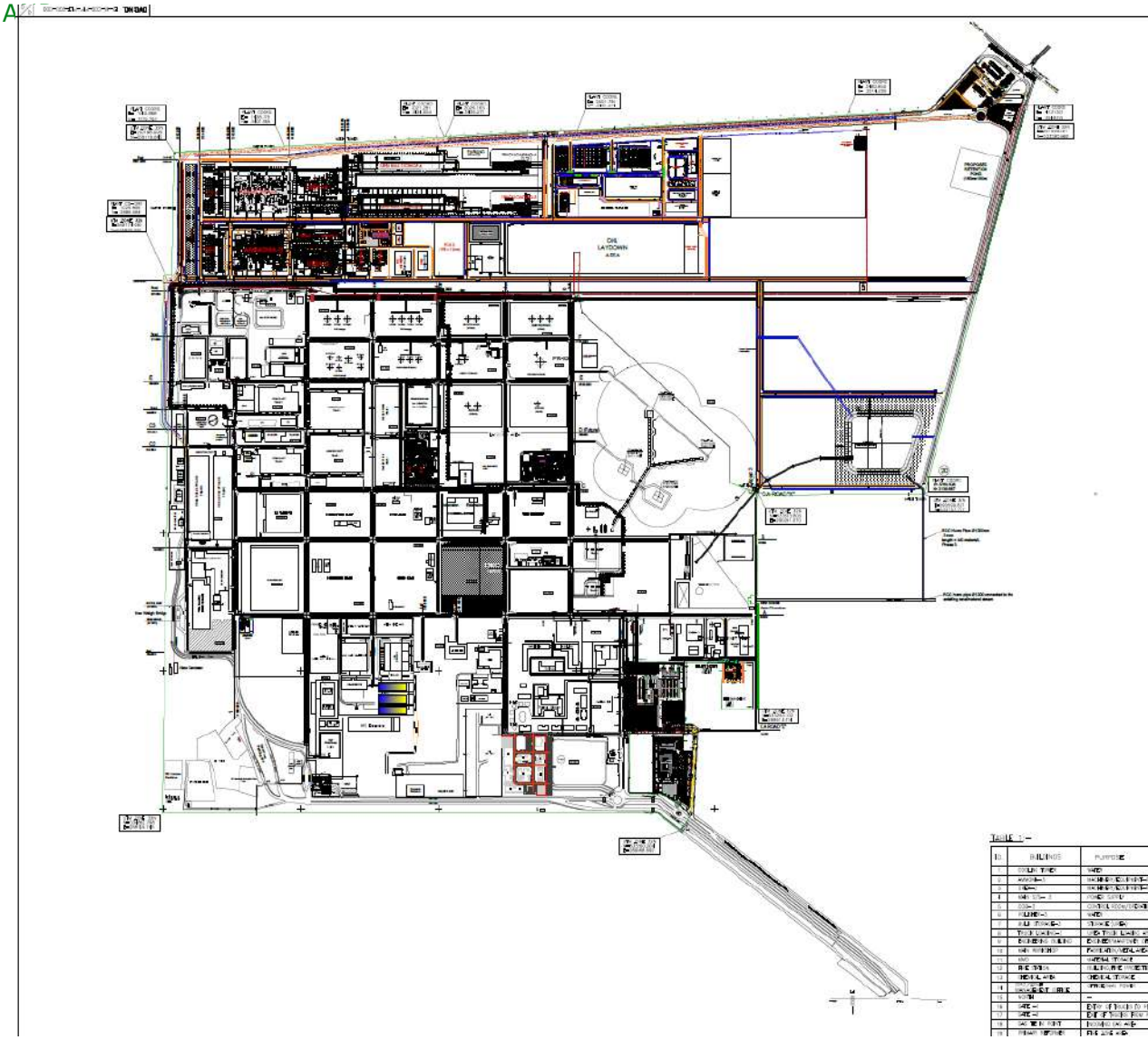


FIGURE 4-4) AND ITS COMPONENTS; THE COMPRESSOR HOUSE (

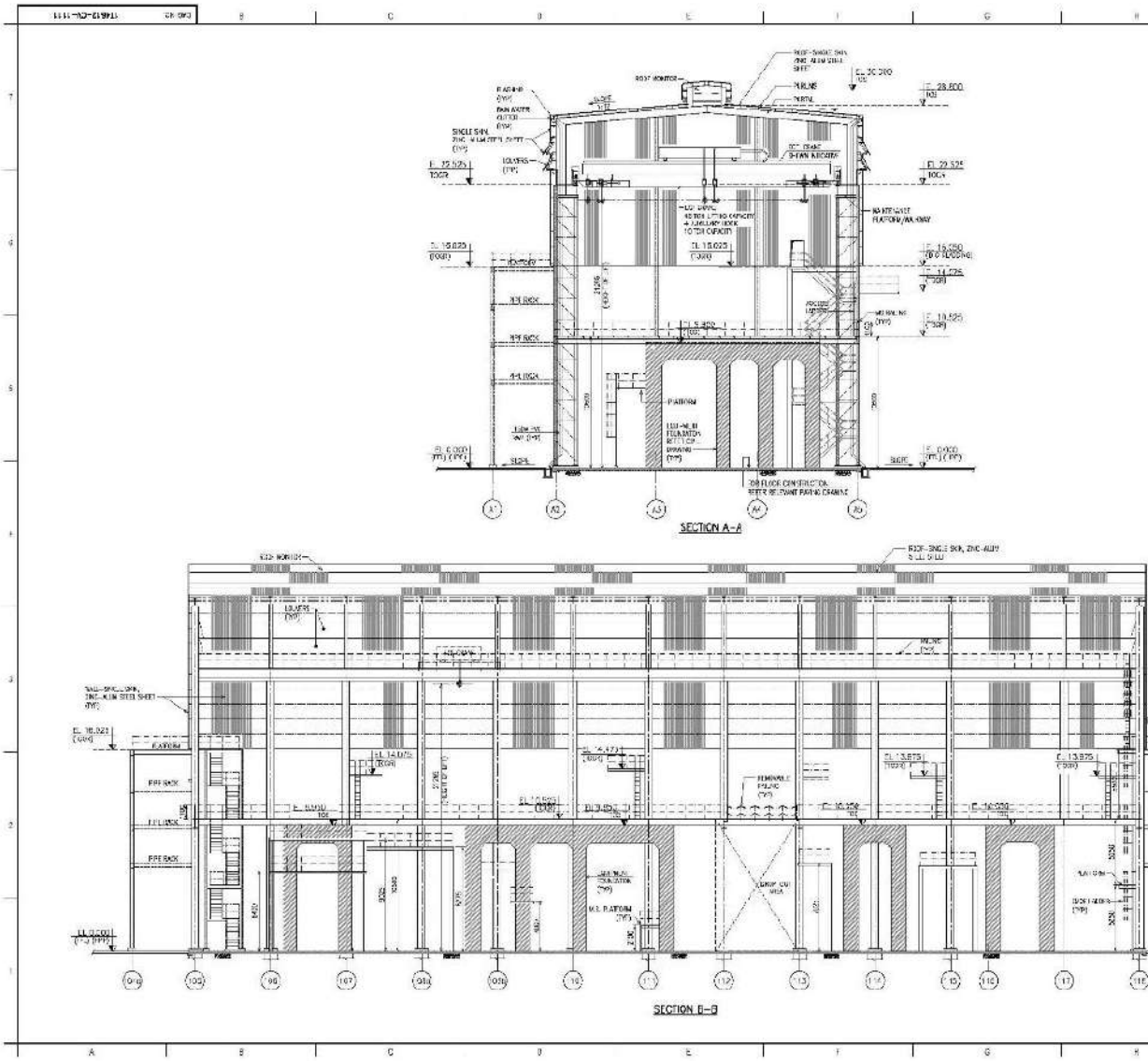


FIGURE 4-5),

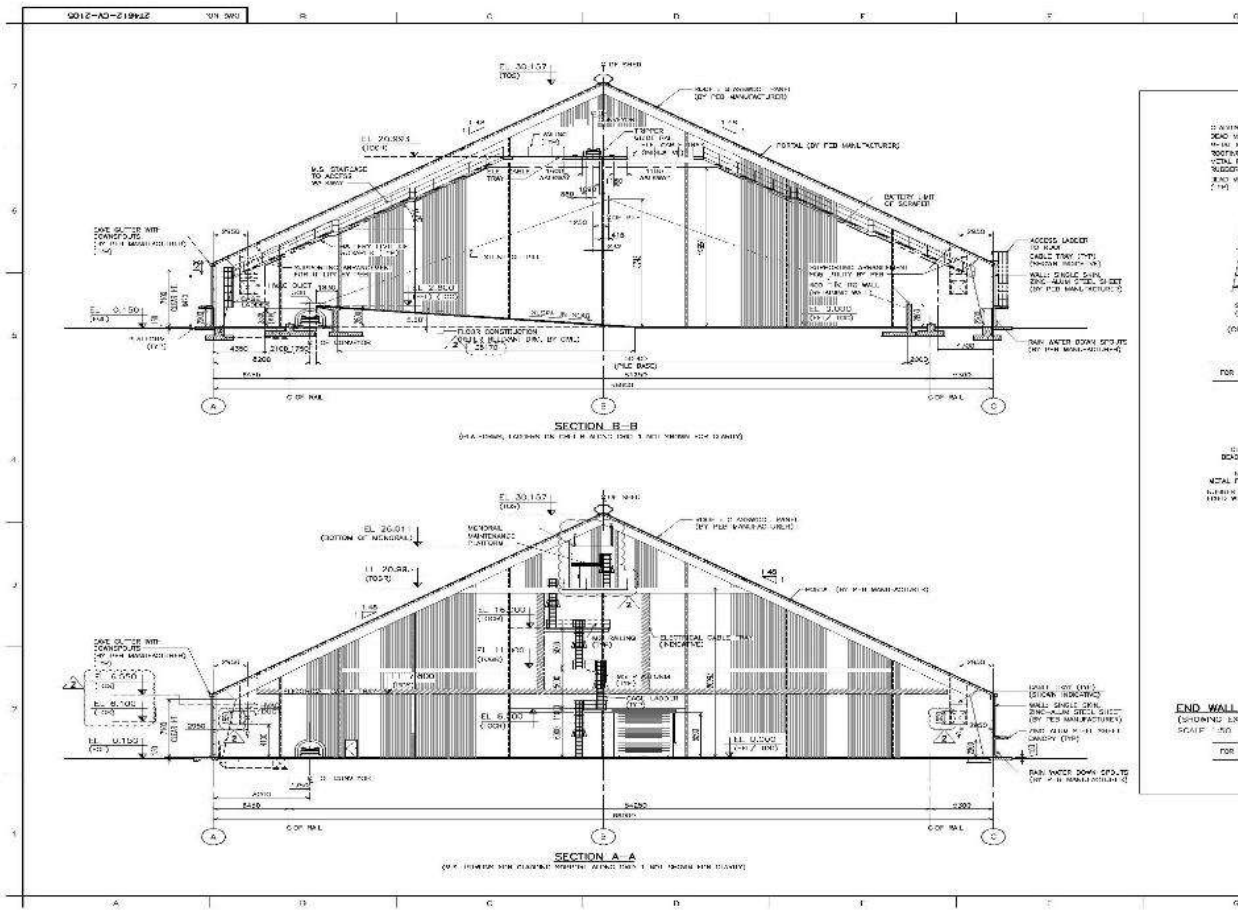


Figure 4-7) are presented below.

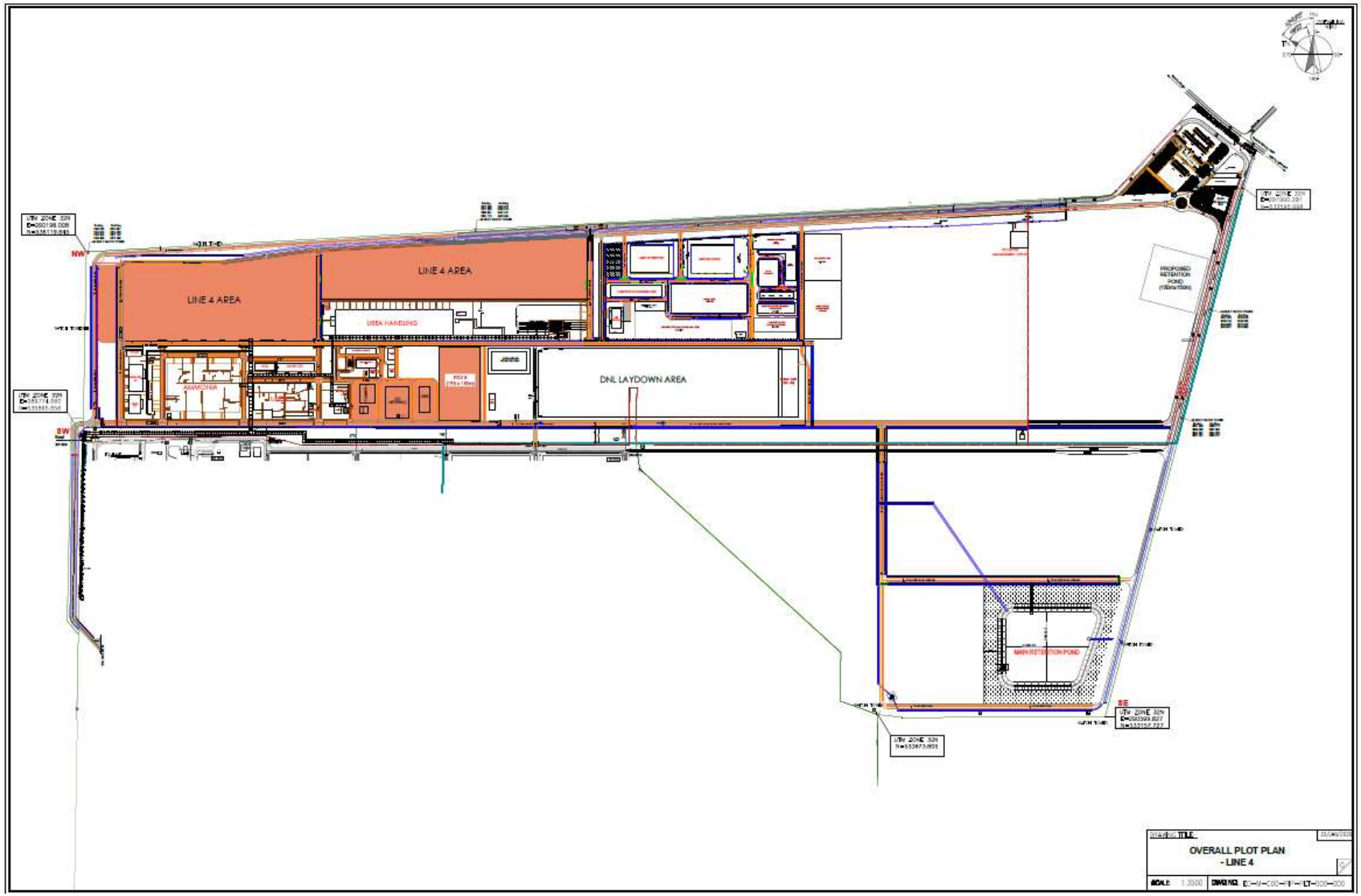


FIGURE 4-3: IFF LINE 2 (TRAIN 4) HIGHLIGHTED AREAS SCHEMATIC PLAN

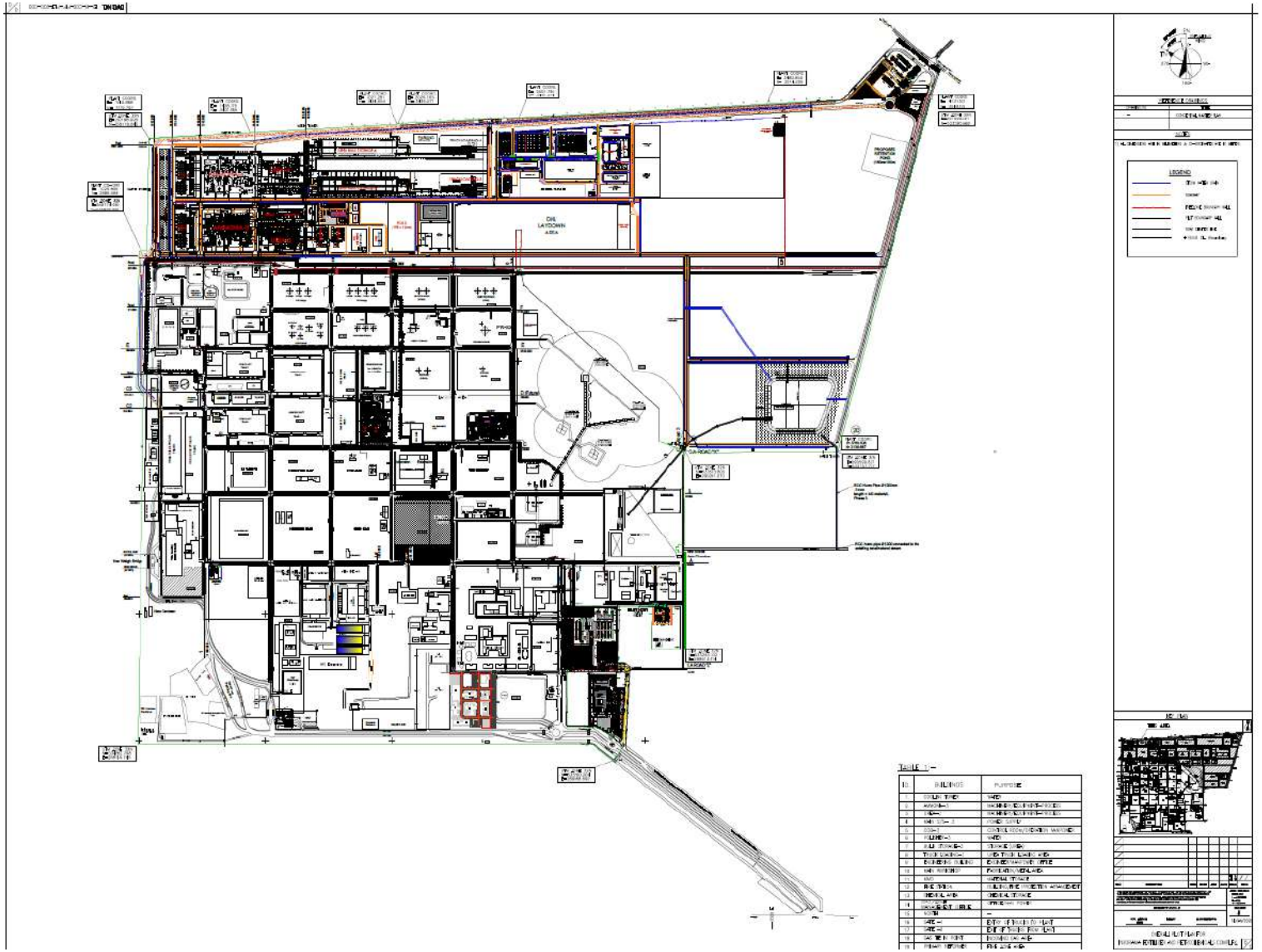


FIGURE 4-4: ARCHITECTURAL PLOT OF THE MASTER PLOT FOR IFF LINE 2 (LINE 4)

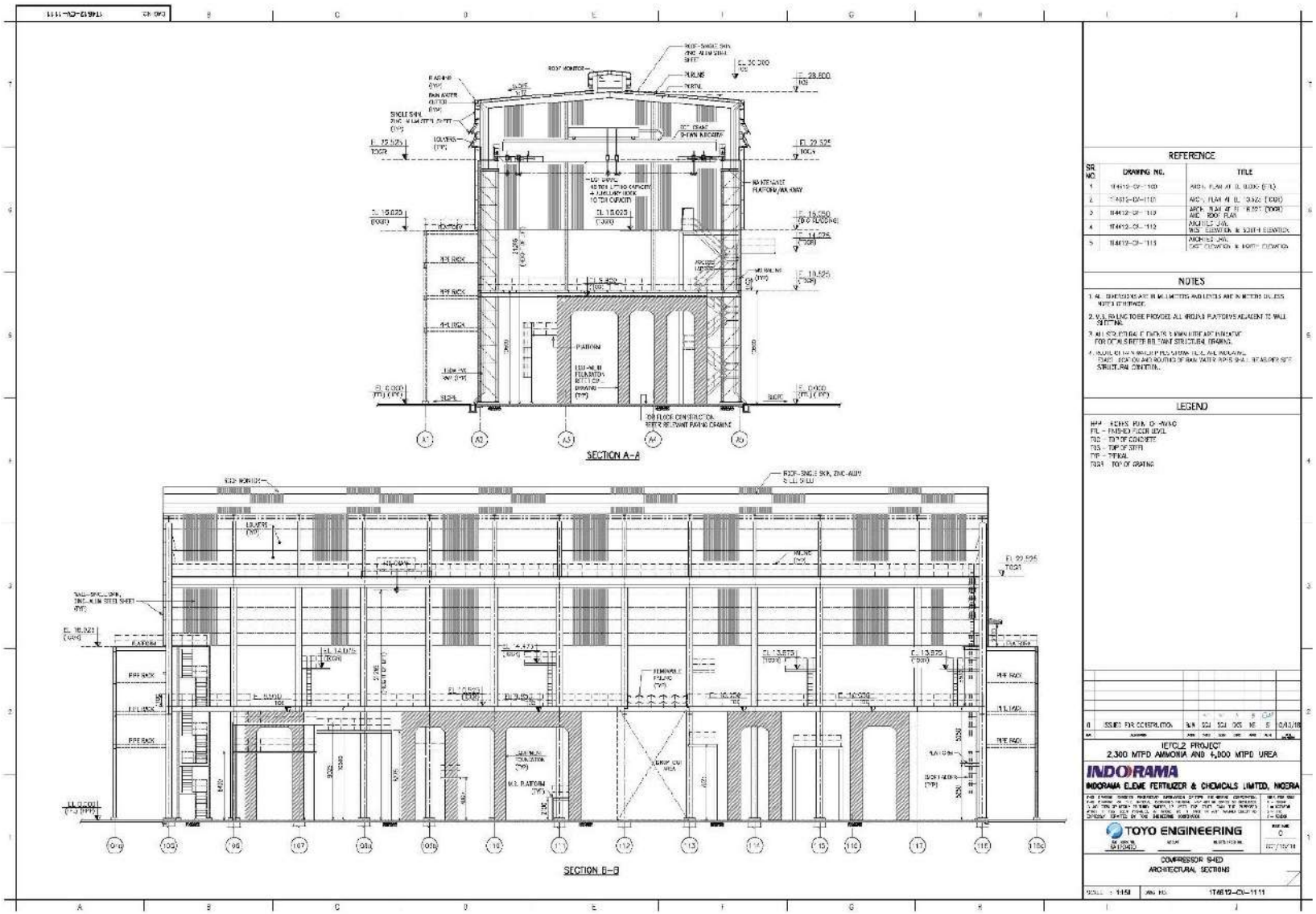


FIGURE 4-5: COMPRESSOR HOUSE ARCHITECTURAL PLAN

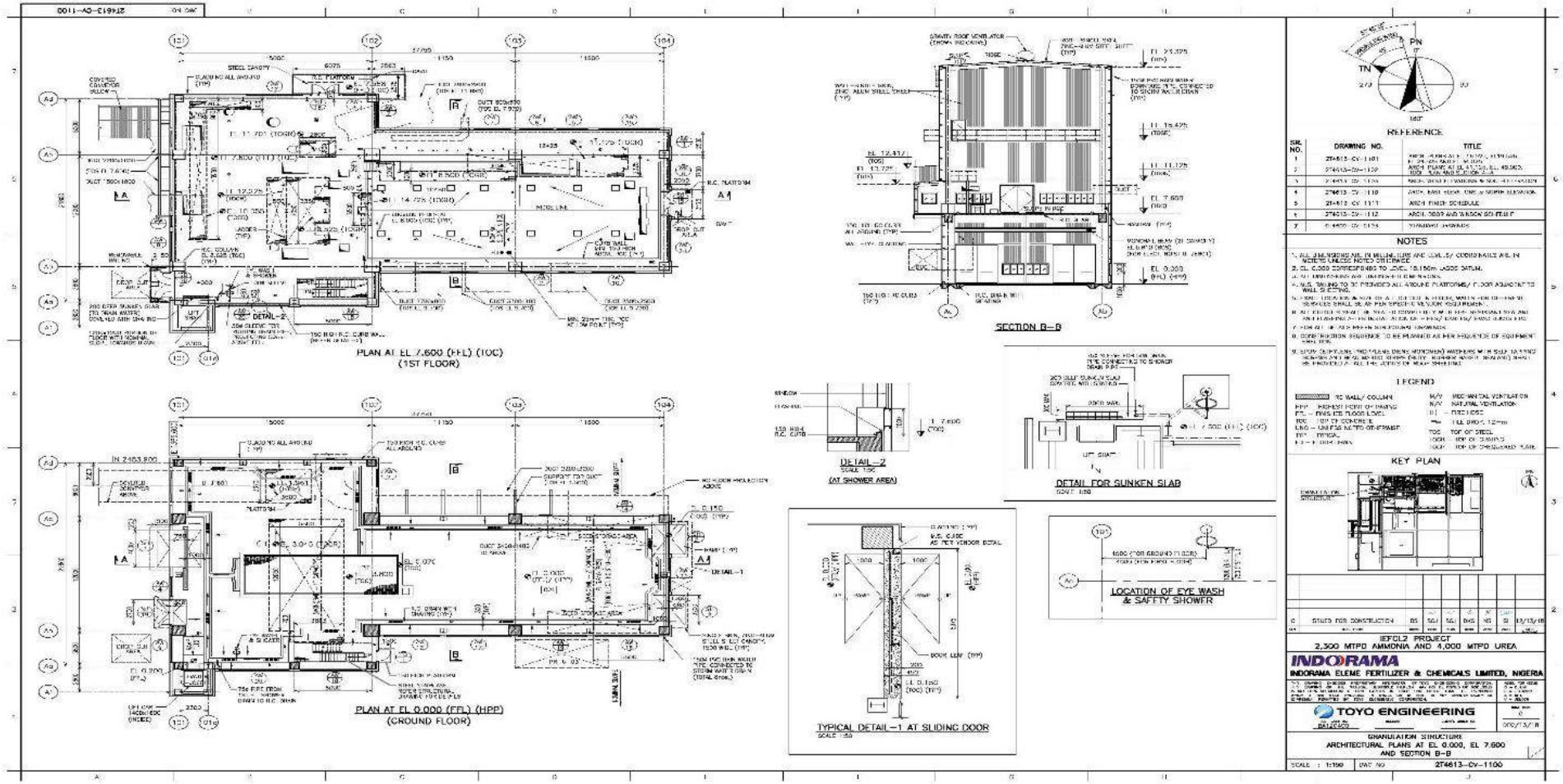


FIGURE 4-6: GRANULATOR BUILDING ARCHITECTURAL PLAN

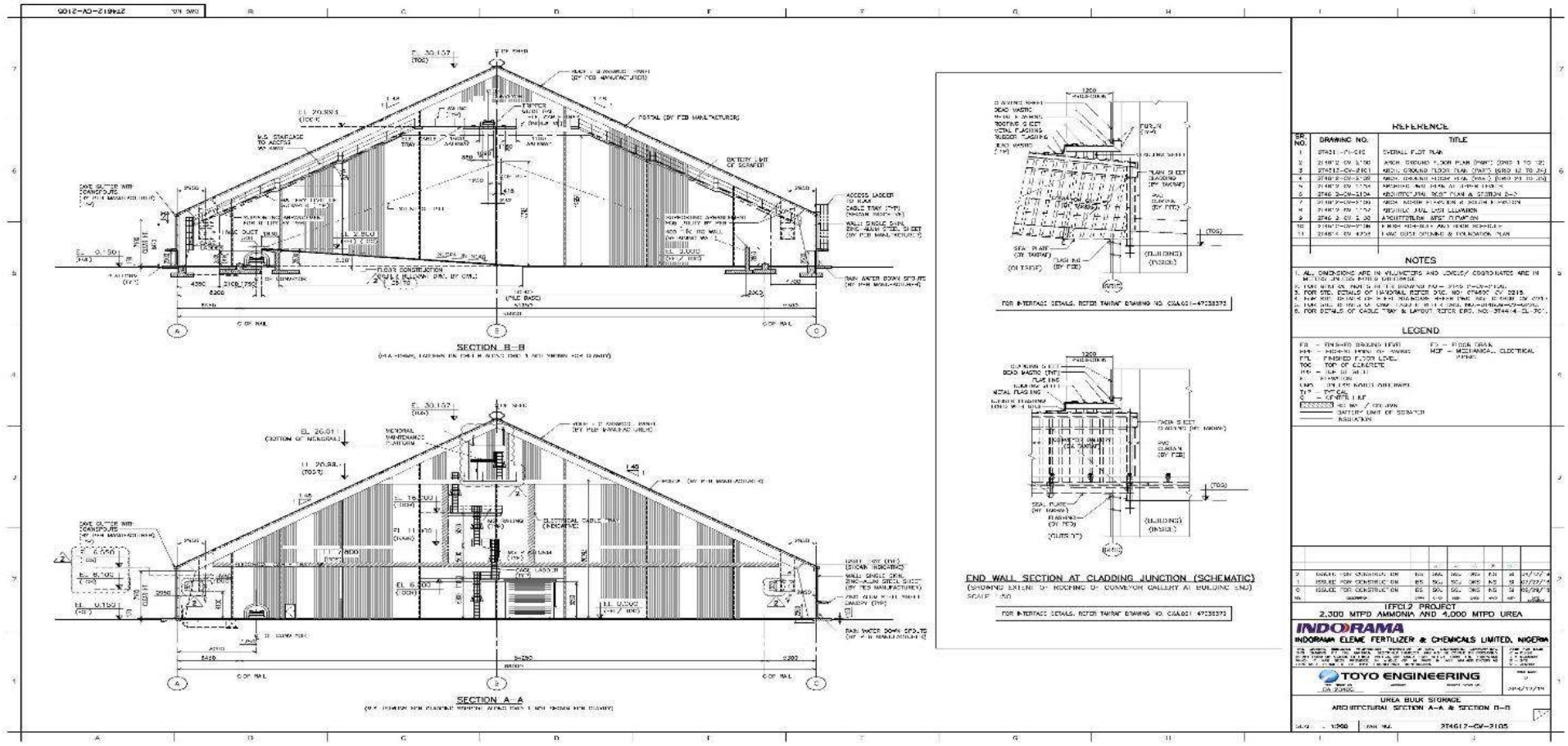


FIGURE 4-7: UREA BULK STORAGE ARCHITECTURAL PLAN

The following auxiliary infrastructure has been incorporated into the Project's current design:

- A raw water supply system fed by existing boreholes plus three new back-up boreholes, with decarbonation and filtration for use as service and cooling-tower make-up water.
- A demineralized water and condensate polishing system integrated with the existing DM plant and supported by mixed-bed polishers for ammonia, urea and turbine condensate streams.
- Steam supply from the existing medium-pressure network, supported by installation of HRSG-6 tied to GT-8 for additional steam generation.
- Two cooling towers, one each for the ammonia and urea plants, with blowdown routed to the wastewater recovery system.
- A new natural gas receiving station and underground pipeline with a total capacity of 300 MMSCFD.
- A wastewater recovery and effluent treatment system designed to treat and recycle all process effluent with no routine wastewater discharge.
- Sewage handling will be integrated into the existing IFF Line 1 network and treatment in existing sewage treatment plant, with treated sewage routed to the treated effluent discharge network.
- A stormwater and drainage system that segregates clean and contaminated runoff and includes oil-water separators and first-flush control.
- A Fire and Gas System including detectors, alarms, deluge systems, FM-200, hydrants and a 24-hour mend fire station.
- An integrated DCS/ESD system providing process control, emergency shutdown and safety interlocks.
- New flares designed for full combustion during emergency, start-up and shutdown conditions.

4.3.2 CONSTRUCTION PHASE

The construction phase shall commence after the approval of the associated ESIA study. It is assumed that construction will continue for a duration of approximately 33 months. Activities during the construction phase will typically involve establishment of the temporary fence of project site, clearance of secondary vegetation and grading of land, civil works (specifically piling work & equipment foundations), installation of equipment, piping erection and establishment of the infrastructure mentioned in subsequent section.

No construction activities will be undertaken during the night.

4.3.2.1 CONSTRUCTION EQUIPMENT

Construction activities will lead to increased traffic, due to movement of employees and construction equipment/materials. Vehicular movement during this phase will include trucks, buses, minibuses, and cars. Separate access and routes have been defined for movement of employees and materials. During construction period it is expected that additional average daily traffic of about 25 trucks/containers for the transport of equipment/ materials (logistics)

and 100 buses average per day during peak manpower leading to a deployment of about 4,300 people.

It is proposed that the equipment, machinery and vehicles included in Table 4-4 will be used during the construction phase. It must be noted that the equipment, machinery and vehicles will be used intermittently during the day, i.e., all equipment, machinery and vehicles will not be used simultaneously.

4.3.2.2 CONSTRUCTION UTILITIES

It is anticipated that the following utilities will be required during the construction phase of the Project:

- **Water** – total consumption will be approximately 230,000 cubic meters (m^3), which will consist of treated water from the existing operation.
- **Diesel Consumption** – total consumption will be approximately 4,000 Kilolitres (KL), with an average consumption of approximately 46 KL/month for first 7 months and, and approximately 112 KL/month subsequently during the construction period.
- **Construction Power** – approximately 2 MWH power will be required during the construction phase and will be supplied from the existing power generating units.
- **Compressed air** – during construction, the compressed air shall be generated from portable air compressor.

4.3.2.3 LABOUR REQUIREMENTS DURING CONSTRUCTION

The construction workforce will peak to 4,500 national staff and 750 expat staff. The 4,500 national staff will consist of skilled, semi-skilled and unskilled personnel. Employment of Nigerians will be prioritised, seeking local qualified and skilled Nigerian as a priority, The Project ambitions for recruitment of national staff during the construction phase is provided in Table 4-3 below.

TABLE 4-3: RECRUITMENT AMBITIONS DURING THE CONSTRUCTION PHASE

Region Band	Skilled	Semi-skilled	Unskilled	Total
Eleme N'Delta	270	837	216	1,323
Rivers N'Delta	540	1,116	144	1,800
Other States N'Delta	338	558	-	896
Sub Total N'Delta	**1,148**	**2,511**	**360**	**4,019**
Others	203	279	-	482
Total	1,350	2,790	360	4,500

TABLE 4-4: EQUIPMENT, MACHINERY AND VEHICLES REQUIREMENTS DURING THE CONSTRUCTION PHASE (MONTH 1 TO 35)

Equipment Description	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32	M33	M34	M35
AUXILIARY EQUIPMENT																																			
AIR COMPRESSOR (UPPER 100 CFM)	-	2	3	3	3	4	3	3	4	5	6	6	6	6	7	8	8	8	8	8	8	8	8	_	8	9	9	8	9	9	8	7	5	4	_
FUEL TRUCK	1	1	1	1	1	1	1	1	1	_	1	1	1	2	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	1	1	_
GENERATOR (HEAVY)	2	2	2	2	1	2	1	_	_	2	_	_	_	_	_	_	_	_	_	1	2	2	2	_	2	2	2	2	2	2	6	7	5	5	_
MAN LIFT, STRAIGHT	5	4	2	2	2	2	1	1	5	3	5	6	6	7	8	8	8	11	13	15	16	15	15	_	_	_	_	_	_	_	_	11	9	9	7
WATER TRUCK	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	_	1	2	2	2	2	2	2	3	1	1	_
SCISSORS LIFT	2	3	3	3	2	3	2	1	1	_	2	2	2	2	3	3	3	3	3	3	3	3	3	_	_	_	_	_	_	_	_	_	_	_	_
SEWEGE TRUCK	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	_	1	1	1	1	1	1	1	1	1	1	_
CIVIL EQUIPMENT																																			
BULL DOZER	1	1	_	_	_	_	1	_	_	2	1	1	1	1	1	1	1	1	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
CONCRETE PUMP CAR	1	1	1	1	2	2	2	2	2	_	2	3	3	3	3	3	3	3	3	3	3	3	3	_	_	1	2	2	2	2	2	2	_	_	_
DUMP TRUCK	3	4	4	4	4	5	5	6	6	6	6	10	11	11	11	9	9	9	9	9	11	10	9	_	_	2	4	6	7	7	5	3	2	1	_
EXCAVATOR	6	7	6	8	8	9	11	16	16	13	14	13	13	13	15	15	15	15	15	15	16	16	15	_	1	4	4	6	8	7	9	7	1	1	_
MIXER TRUCK	3	3	3	3	3	3	4	4	4	_	3	6	6	6	6	6	6	6	6	6	6	6	6	_	_	2	2	2	2	2	3	2	_	_	_
MOTOR GRADER	1	1	1	1	1	1	1	2	2	_	1	1	1	2	2	2	2	2	2	2	2	2	2	_	_	_	_	1	1	1	_	1	_	_	_
SELF LOAD MIXER	-	-	-	-	-	-	-	-	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	_	_	_	_	_	_	_	_	_	_	_	_
UNI LOADER	_	_	_	_	_	_	_	_	_	_	_	2	2	2	2	2	2	3	3	3	3	3	3	_	_	_	1	1	1	1	1	2	_	_	_
WHEEL LOADER	4	5	5	5	5	5	5	6	7	7	7	8	8	7	8	7	7	7	7	7	7	7	7	_	1	5	5	5	5	5	5	5	4	4	_
PILING																																			
PILING CRANE		3	3	3	4	5	5	4	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
PICKAWAY TRUCK		1	1	1	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	Chats _
WELDING MACHINE		2	2	2	4	5	5	5	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
CRAWLER CRANE																																			
CRAWLER CRANE		2	2	2	2	3	4	6	8	13	14	15	15	17	20	20	20	20	21	20	21	20	20	2	9	16	18	17	15	16	10	7	6	5	_
HYD' CRANE																																			
HYD' CRANE (RT)	3	4	2	2	2	3	3	4	5	5	7	9	9	11	11	12	14	14	14	14	14	13	13	_	2	8	10	10	10	11	12	11	9	8	_
LIFTING EQUIPMENT																																			
FORKLIFT	1	2	2	2	1	1	2	4	4	5	5	6	6	6	9	8	8	10	10	10	10	10	10	_	1	8	9	9	9	9	10	11	10	10	_
FORKLIFT, TELESCOPIC	-	-	-	-	-	-	-	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	_	_	1	1	1	1	1	1	1	1	1	_
PAVING EQUIPMENT																																			
VIB ROLLER	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	_	_	1	1	1	1	1	1	1	_	_	_
PICK AWAY																																			

Equipment Description	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32	M33	M34	M35
PICKAWAY TRUCK	2	2	2	2	2	3	4	5	5	5	6	7	7	7	7	7	8	9	9	9	9	9	9	_	2	8	9	9	9	9	9	9	7	7	_
PLANT																																			
BATCH PLANT	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	_	1	1	1	1	1	1	1	1	1	1	_
TRANSPORTATION																																			
CARGO TRUCK	3	3	3	3	3	3	3	3	3	2	3	3	3	3	4	4	4	4	4	4	4	4	4	_	_	2	3	3	3	3	3	3	3	3	_
MINI CARGO TRUCK (UNDER 4.0T)	6	7	6	8	7	7	6	6	8	8	8	7	8	7	8	8	8	8	8	8	8	8	8	6	7	9	10	10	10	10	9	10	10	10	_
TRAILER, HIGH BED	4	4	4	4	4	4	5	5	5	5	5	5	5	8	9	8	9	9	9	9	9	9	9	_	2	6	6	6	5	5	9	7	2	2	_
TRAILER, LOW BED	2	2	2	2	2	2	2	2	2	1	2	3	3	4	5	5	4	4	4	4	4	4	4	_	1	2	2	2	2	2	4	2	1	1	_
AUXILIARY M/C																																			
AIR COMPRESSOR (UNDER 100 CFM)/ENGINEERING WELDING MACHINE	_	_	_	_	_	-	9	5	6	13	15	26	26	25	26	26	26	26	27	26	26	26	26	9	26	28	28	27	28	29	33	29	32	27	8
CIVIL M/C																																			
CONCRETE CUTTER	2	2	1	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CONCRETE SCREED MACHINE	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DRUM COMPACTOR	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HYD' BREAKER	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MACHINE, DRILLING	2	2	1	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PLATE COMPACTOR	4	4	3	6	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WATER PUMP	2	2	1	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PLANT M/C																																			
MACHINE, LATHE	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SHOP M/C																																			
BAR BENDING M/C	1	2	1	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BAR CUTTER M/C	1	1	1	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CAR. LIFT	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WELDING M/C																																			
ARC WELDING MACHINE	1	_	_	_	_	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ENGINE WELDING M/C	5	5	3	7	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WELDER, ELECTRICAL DC, TIG/ARC	4	8	5	11	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUS																																			
BUS	6	6	4	9	8	9	10	14	13	12	15	18	22	22	24	24	24	24	24	24	24	23	24	19	22	23	23	23	24	24	24	25	26	27	1
MINI BUS	4	4	3	5	4	4	4	4	5	8	5	6	6	6	6	6	6	6	6	6	6	6	7	5	5	5	6	6	6	6	6	6	6	6	_
EMERGENCY BUS																																			
AMBULANCE	1	1	1	1	1	1	1	1	1	2	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	_
JEEP																																			

Equipment Description	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32	M33	M34	M35
JEEP	4	4	3	6	8	8	9	11	11	11	11	11	12	11	12	12	11	12	12	12	11	12	12	10	11	12	12	12	12	12	12	13	13	13	1
PICK UP																																			
PICK UP	6	7	5	10	8	9	12	14	14	24	21	21	21	23	26	25	26	26	27	26	25	26	26	17	23	25	25	25	25	25	25	28	29	29	1
TOTAL	**101**	**122**	**100**	**140**	**139**	**109**	**126**	**141**	**147**	**160**	**174**	**205**	**212**	**222**	**246**	**242**	**245**	**253**	**258**	**258**	**262**	**259**	**259**	**72**	**131**	**188**	**201**	**203**	**206**	**208**	**216**	**220**	**187**	**179**	**18**

4.3.3 OPERATIONAL PHASE

Early estimates indicate a potential life of the plant of approximately 30 years of operation. The Sections below provide a summary of the operational process flow:

4.3.3.1 FEED CONDITIONING UNIT (FCU)

THE FCU PROCESSES RAW NATURAL GAS TO PRODUCE A STABLE, METHANE -RICH FEED FOR THE FERTILIZER PLANTS. IT REMOVES LIQUIDS, HEAVIES, ACID GASES, MERCURY AND WATER BEFORE CRYOGENIC FRACTIONATION, ENSURING THE GAS MEETS THE 99.8% METHANE SPECIFICATION FOR THE DOWNSTREAM AMMONIA PLANT PRIMARY REFORMER. THE OVERALL PROCESS FLOW IS OUTLINED IN THIS SECTION, AND IT IS ILLUSTRATED IN

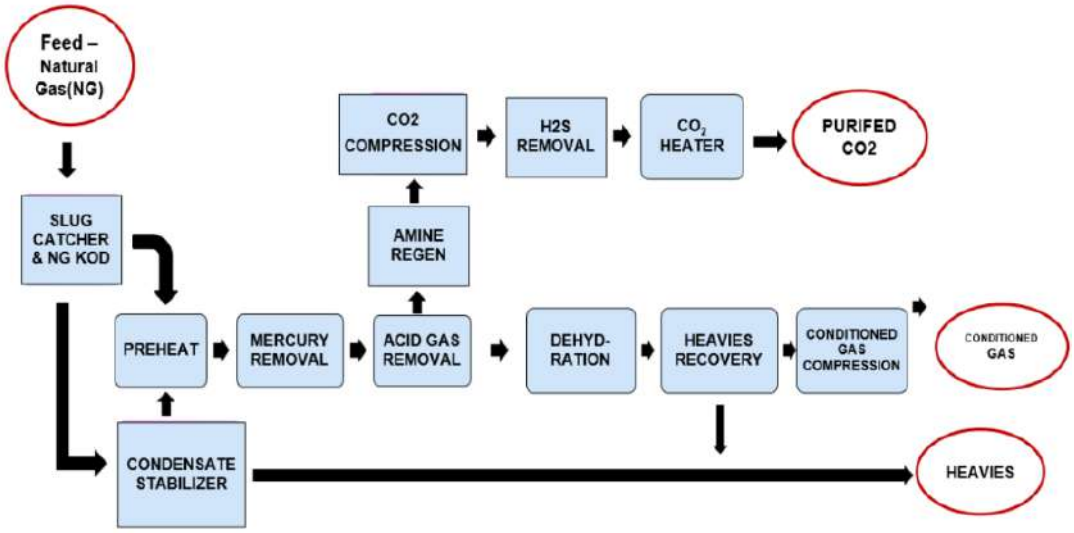


Figure 4-8 below.

- Front End Removal and Stabilisation
  - Slug catcher and NG KOD separate liquids and condensed heavies.
  - Condensate stabilizer flashes vapours and sends bottom heavies to IEPL.
  - Mercury bed captures trace mercury.
- Acid Gas Removal, Dehydration and Cryogenic Steps
  - Amine contactor removes CO_2, H_2S and mercaptans; amine regeneration restores lean amine.
  - Molecular sieves dry gas to 0.1 ppm water.
- Cryogenic section (exchangers, cold separator, expander, demethanizer) recovers methane and sends C_2+ to IEPL.
- C2 recovery above 98%.
- Final Compression and Supporting Systems
  - Lean gas compressor boosts conditioned gas to BL pressure.
- CO_2 is compressed and polished for the urea plant; acid gas treater removes residual H_2S.
  - Small condensate volumes are routed through knockout drum and CPI separator to the ETP (Effluent Treatment Plant).

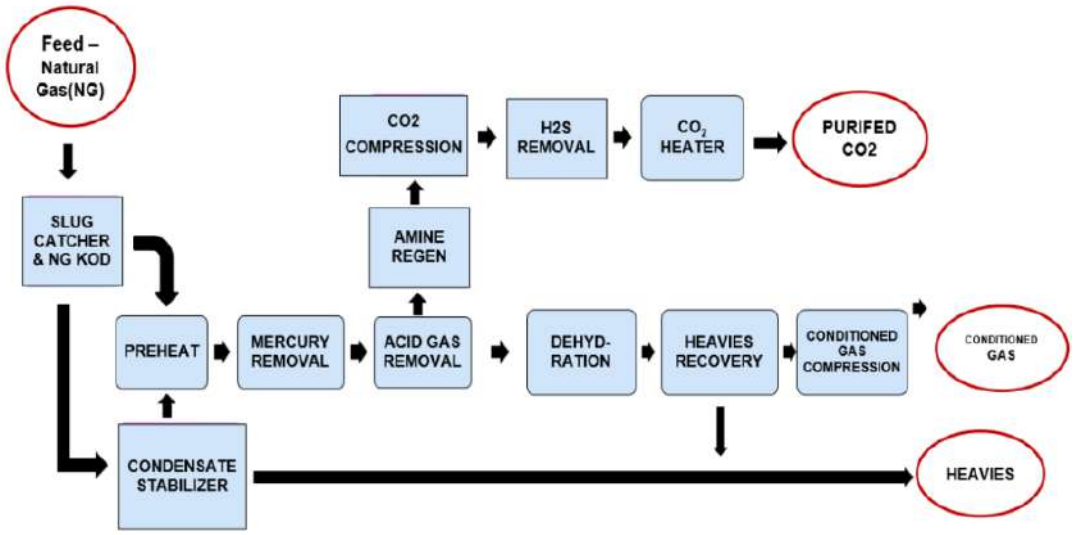


FIGURE 4-8: BLOCK DIAGRAM OF FEED CONDITIONING UNIT (FCU)

4.3.3.2 AMMONIA PLANT

Process Flow

The ammonia plant is designed to produce 2,300 MTPD of ammonia. Ammonia will be delivered to the urea plant in pipes. The plant will also deliver produced liquid ammonia to an atmospheric storage tank in the event that the urea plant be shutdown.

The ammonia plant is a single train plant consisting of the following main process stages:

- Feed and fuel gas supply
- Feed gas desulfurization
- Primary reforming
- Process Air compression
- Secondary reforming
- CO shift conversion, HTS and LTS (High and Low Temperature Shift conversion)
- CO_2 removal
- Methanation
- Syngas drying
- Cryogenic Purification
- Synthesis gas compression
- Ammonia synthesis
- Ammonia refrigeration system
- Loop Purge Ammonia Recovery
- Process condensate stripping

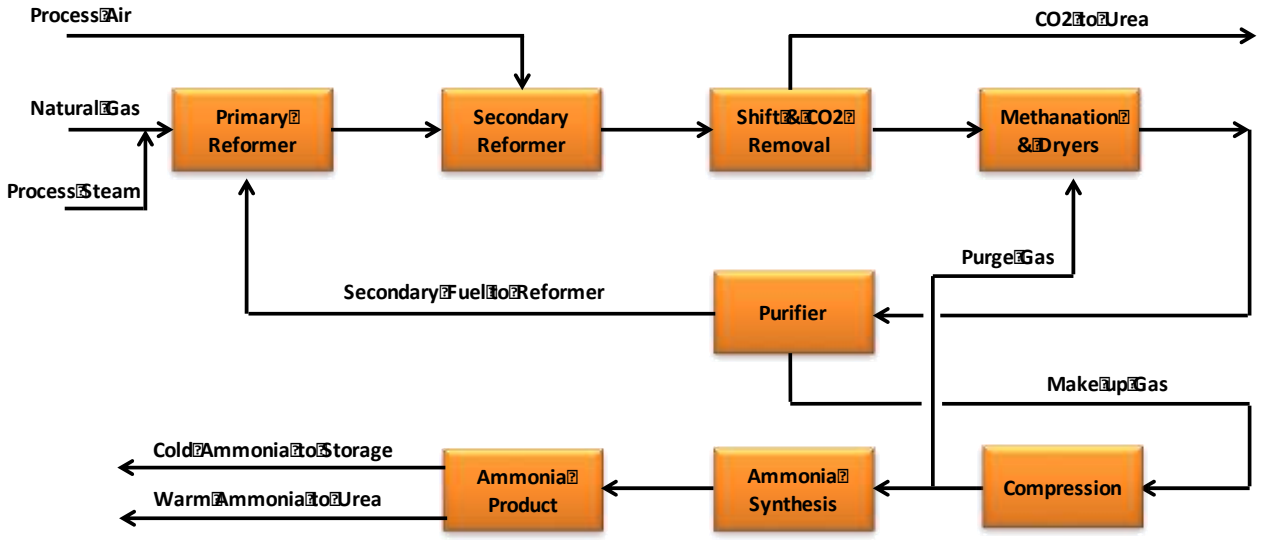


FIGURE 4-9: BLOCK DIAGRAM OF AMMONIA PLANT

Further details of the operational process of the ammonia plant are as follows:

Feed and Fuel - the ammonia plant feed is natural gas (NG), which will be available at the plant battery limit[16] at approximately 48-kilogram force per square centimetre (kg/cm^2) and at a temperature of approximately 15 degrees to 25 degrees Celsius (^{0}C). The fuel gas for the reforming and steam boiler will be part of the total natural gas delivered at the battery limit. The natural gas fuel for reforming will be supplemented by the waste gas generated within the ammonia plant.

Feed Gas Desulphurisation – feed gas supplied at the battery limit will be directed through a slug catcher to separate the liquids entrained in the natural gas and thereafter processed in a desulphurization section to remove Sulphur. A small amount of hydrogen will then be added to the feed gas, following which it will be heated in the convection area of the reforming section of the plant. The gas will then pass through a bed of cobalt-molybdenum catalyst, which converts organic sulphur into Hydrogen Sulphide (H_2S). H_2S will then be absorbed to zinc oxide bed. The desulphurised gas leaving the zinc-oxide bed contains less than 0.1 parts per million (ppm) of sulphur.

Primary Reforming - the gas leaving the zinc oxide bed will then be mixed with medium pressure steam to maintain a specific steam-to-carbon molar ratio. The gas is subsequently heated in the convection zone of primary reformer, following which it is directed to the reformer catalyst tubes where the gas and steam react in the presence of a nickel base catalyst to form hydrogen and carbon oxides. Here partial reforming of the Natural gas occurs.

Process Air Compression – the process air compressor provides process air for the secondary reforming. Process air is heated in the convection zone of the primary reformer and then fed to the secondary reformer along with partially reformed gas.

Secondary Reforming – the process gas leaving the secondary reformer has a temperature of approximately 890 - 900°C. The gas is cooled to about 360°C in the Waste Heat Boiler, where saturated steam is produced. After cooling, the gas flows to the High Temperature CO converter.

Saturated steam at 126 kg/cm^2 (g) will be superheated to 510°C in the coils of the waste heat section of the primary reformer. After superheating, the steam will be used in the high-pressure steam turbine that drives the air and other compressors.

Shift Conversion – the CO leaving the secondary reformer will be further reacted with water over a catalyst to produce CO_2 and H_2. This conversion is accomplished in the following two steps – 1) the High Temperature Shift conversion (HTS) followed by 2) the Low Temperature Shift (LTS) conversion. Here the CO content is further reduced to less than 0.30 % vol. (dry).

CO_2 Removal – the CO_2 removal is performed through preferential absorption in proprietary solvent. The rich solvent undergoes a two-stage regeneration process. The absorbent removes the CO_2 in the process gas. The recovered CO_2 is directed to the urea plant after compression.

Methanation – the gas leaving the CO_2 removal section is heated and fed through Methanator Catalyst Beds where the remaining carbon oxides are transformed into methane and water. A reaction process that is opposite to reforming is used to eliminate carbon oxides from the gas stream, as these are harmful to synthesis catalyst. The syngas leaving the Methanator (Methanator effluent gas) contains less than 5 parts per million by volume (ppmv) of carbon oxides (as CO + CO_2). The Methanator effluent gas is then cooled. The chilled gas is then directed to the Molecular Sieve Driers. The driers contain solid desiccant. Each drier is sized to remove water, Ammonia, and carbon dioxide to less than 1ppmv.

Cryogenic Purification – dried synthesis gas from the Molecular Sieve Drier is directed to the Purifier Expander, which is a turbo expander. At this stage of the process, pressure reduction energy from the gas is removed to develop the net refrigeration required for the Purifier. The removed energy is recovered as electricity in the Purifier Expander Generator. The effluent emanating from the expander is further cooled and partially condensed in the Purifier Feed / Effluent Exchanger. Process stream is then directed to the Purifier Rectifier, in which the molar ratio between hydrogen-to-nitrogen as needed for Ammonia synthesis is achieved.

Compression of Synthesis Gas – purified synthesis gas will then be compressed to the synthesis loop pressure in the Synthesis Gas Compressor, which is a two-casing centrifugal compressor. The compressor will be driven by Steam Turbine that uses High Pressure (HP) steam produced in the Ammonia Plant (see below).

Ammonia Synthesis – the syngas leaving the compressor is initially heated with the converter effluent, following which it will enter the syngas converter. Ammonia is produced in the three-bed converter, where the hydrogen and nitrogen react over an iron-based catalyst. The reaction is exothermic. Heat is recovered in the steam generator located in Synthesis loop to generate HP steam.

Ammonia Product – from the syngas converter, compressed ammonia is condensed in a Refrigerant Condenser, which is then directed to the Refrigerant Receiver. From the Refrigerant Receiver, either cold ammonia or warm ammonia can be produced. Warm ammonia product is routed to the Urea Plant and cold ammonia is directed to an existing Train 1 ammonia storage tank in the event that the urea plant is under shutdown.

The product ammonia (i.e. warm ammonia) has the following characteristics at the ammonia plant battery limits:

- Ammonia: 99.90 wt % (min)
- Water: 0.10 wt % (max)
- Oil: 5 ppm (max)

Process Condensate Treatment – process condensates produced in ammonia plant during process containing NH_3, CO_2 is treated in process condensate stripper to ensure that the condensate is free of all contaminants. Treated process condensate is sent to the Polisher Unit for further treatment and thereafter used as polished water.

Key Inputs and Outputs associated with Ammonia Production

The overall inputs / outputs associated with the ammonia plant are detailed below.

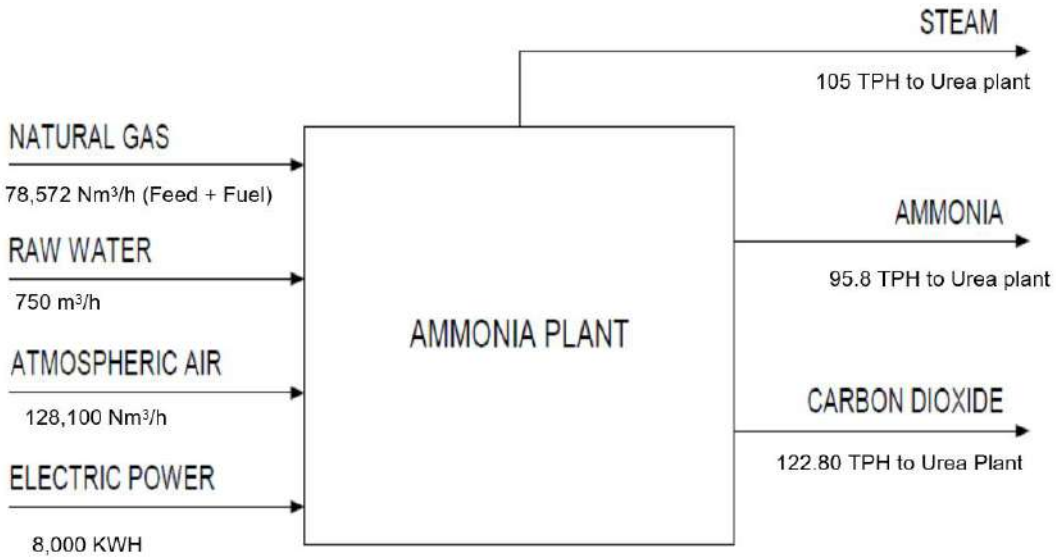


FIGURE 4-10: KEY INPUTS AND OUTPUTS ASSOCIATED WITH THE AMMONIA PLANT

4.3.3.3 UREA PLANT

Process Flow

The urea plant is designed to produce 4,000 MTPD of urea. The urea plant consists of the following main process stages:

- Urea synthesis, whereby ammonia and CO_2 react to produce a urea solution.
- Urea solution purification and recovery.
- Conversion of the urea solution to granules (employing spout bed fluid granulation technology).
- The urea granules produced will be sent to storage either for bagging or bulk shipment.

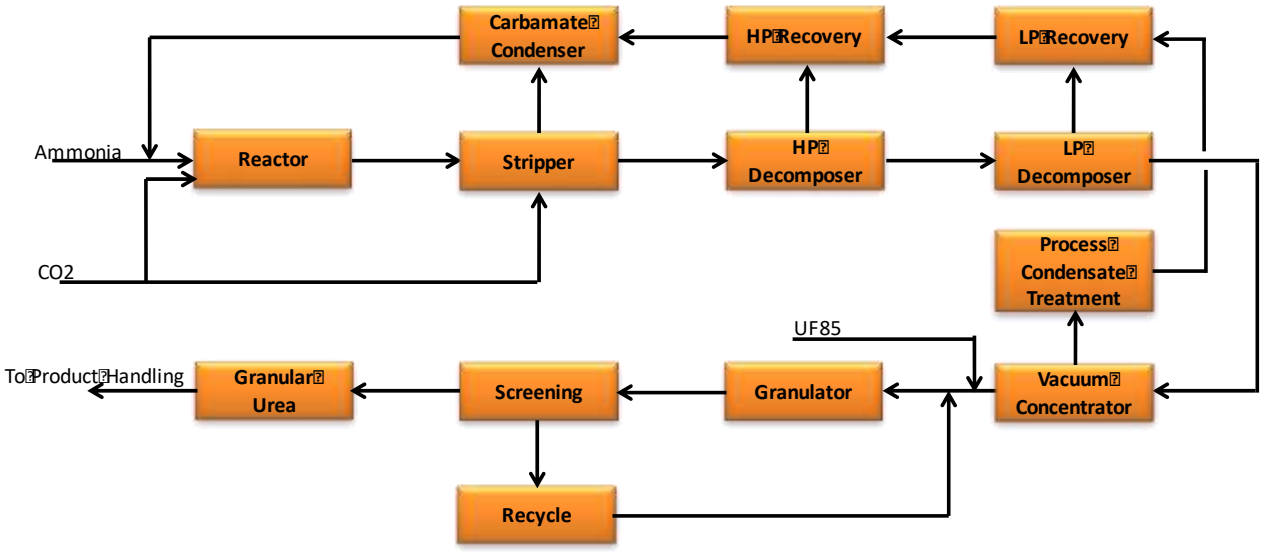


FIGURE 4-11: BLOCK DIAGRAM OF UREA PLANT

Further details of the operational process of the urea plant are as follows:

- **Synthesis of Ammonia and CO_2** – urea is produced through the synthesis of ammonia and CO_2. Ammonia and CO_2 react to form ammonium carbamate, a portion of which dehydrates to urea and water.
- The fraction of ammonium carbamate that dehydrates is determined by the ratios of various reagents, the operating temperature, pressure, and the residence time in the Reactor. The reaction products leaves the Reactor and is directed to a Stripper (a vertical in tube falling film stripper in which the liquid, distributed on the heating surface of tubes as a film, flows by gravity to the bottom of the tube).
- As the liquid film flows through the Stripper, it gets heated, resulting in the decomposition of carbamate Vapours (essentially ammonia and CO_2) are removed at the surface of the Stripper. The recovered vapor is condensed and recycled to the urea reactor by means of carbamate ejector.
- **Urea Purification** – urea purification and overhead vapours recovery takes place in two stages at decreasing pressures. The exchangers where urea purification occurs are called Decomposers. In this equipment, the residual carbamate decomposition takes place. The decomposed carbamate vapours are condensed and recycled back to the synthesis loop while the inerts are washed in the washing column before being sent to the flare stack. The urea solution exiting this section is purified to generate urea solution of 69-71 wt %.
- **Urea Concentration** – in order to granulate urea, concentrated urea solution is required. Urea concentration is achieved in the Vacuum Concentrator, whereby the concentrated urea solution (~97 % by wt.) is sent to the Granulator, after mixing with UF85 additive (Urea Formaldehyde Concentrate) as anti-caking agent.
- **Process Condensate Treatment** – process condensates containing NH_3, CO_2 and urea coming from the vacuum Concentrator is treated to ensure that the condensate is free of all contaminants. Treated process condensate is sent to the Polisher Unit for further treatment and thereafter used as polished water.

- **Granulation** - the concentrated urea solution is sprayed onto urea seeds in the Granulator through the use of multi spray nozzles. The water in the feed urea solution is evaporated in the Granulator. The enlarged granules are cooled to a suitable temperature by fluidizing air on the fluidized cooling beds in the granulator. Urea granules produced in the Granulator are screened to separate the product size granules from over and under size granules through the double deck screen. Smaller granules are recycled back to the Granulator as the seed and oversized granules are crushed and also recycled back to the Granulator. Exhaust air from the Granulator and cooler is scrubbed to recover urea dust and ammonia. Water used in the dust scrubber is also recycled back into the urea plant.
- **Urea Storage** – from the granulator, urea product will be transported by belt conveyor to new storage buildings. The new storage area will be capable of holding 120,000 metric tons of urea. Storage building will be equipped with air handling units to control ambient air temperature & humidity inside the storage building to avoid lump formation of the product. Portal scraper reclaimer will be used to reclaim the product onto a conveyor belt for export to bulk truck loading system.

Key Inputs and Outputs associated with Urea Production

The overall inputs / outputs associated with the urea plant are detailed below.

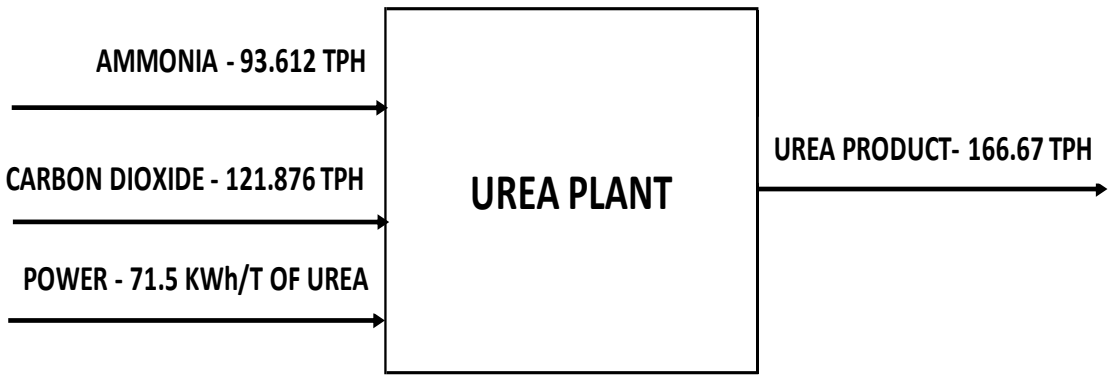


FIGURE 4-12: KEY INPUTS AND OUTPUTS ASSOCIATED WITH THE UREA PLANT

It must be noted that for safety purposes, all relief valves and pressure control devices associated with the ammonia and urea plant are designed for worst cases and connected to dedicated flare.

4.3.3.4 UFC-85 PLANT

Process flow

The proposed IFF Line 2 Project includes a dedicated Urea Formaldehyde Concentrate (UFC-85) plant, with a nominal production capacity of 150 metric tonnes per day. The UFC-85 unit is integrated with the urea granulation process and produces a concentrated urea–formaldehyde solution used as a conditioning additive to improve urea product quality, strength, and handling characteristics.

The UFC-85 process is based on the controlled oxidation of methanol to formaldehyde using excess air, followed by absorption of formaldehyde into demineralised water and urea solution. The process is designed to achieve high conversion efficiency, stable operation, effective heat recovery, and compliance with applicable environmental performance standards.

The UFC-85 plant comprises the following key process stages which are illustrated in Figure 4-13 below:

- Generation of formaldehyde via catalytic oxidation of methanol under excess air conditions.
- Controlled removal and recovery of reaction heat to stabilise process conditions and improve energy efficiency.
- Absorption of the formaldehyde-rich gas stream into urea solution and demineralised water to form UFC-85.
- Treatment of absorber tail gas via catalytic incineration prior to atmospheric discharge.

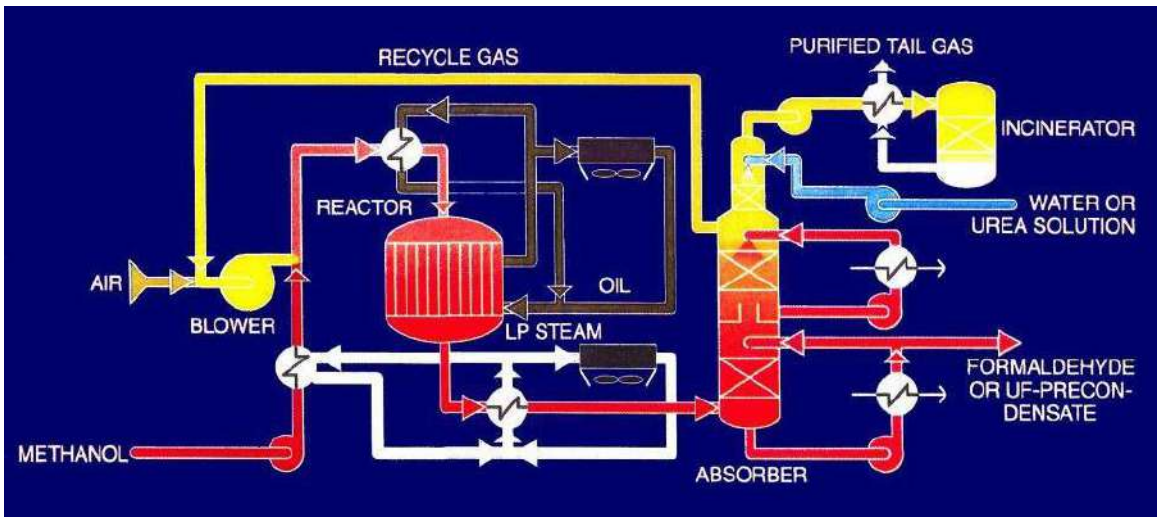


FIGURE 4-13: SCHEMATIC FLOW DIAGRAM OF "EXCESS AIR FORMALDEHYDE PROCESS"

Formaldehyde Generation

Formaldehyde is produced in a dedicated tubular fixed-bed reactor, where vaporised methanol reacts with oxygen in excess air over a metal oxide catalyst, typically based on iron and molybdenum oxides with trace promoters.

Key features of the formaldehyde generation step include:

- Operation within a controlled temperature range to achieve near-complete methanol conversion.
- A highly exothermic oxidation reaction requiring active temperature management.
- Catalyst loading schemes designed to flatten the axial temperature profile and minimise hot-spot formation.

- Dilution of catalyst with inert material in selected reactor sections to reduce pressure drop increase and extend catalyst life.

Temperature control within the reactor is achieved by circulating a heat transfer oil system on the shell side of the reactor tubes. This system removes excess heat and stabilises reactor operation.

Heat Recovery and Gas Cooling

The hot formaldehyde-rich process gas exiting the reactor is rapidly cooled in a waste heat recovery boiler. This step serves two main purposes:

- Recovery of reaction heat for beneficial use within the plant utility system, including process heating or steam generation.
- Rapid quenching of the gas stream to suppress the formation of secondary by-products such as formic acid.

Heat recovery from this stage contributes to the overall energy efficiency of the IFF Line 2 Project.

Absorption and UFC-85 Formation

Following heat recovery, the cooled gas stream is routed to an absorption system, where formaldehyde is absorbed into a controlled mixture of demineralised water and urea solution to produce UFC-85.

Key aspects of the absorption and product formation step include:

- High absorption efficiency to minimise formaldehyde losses.
- Control of UFC-85 product concentration by adjusting water and urea solution flow rates.
- Integration of the UFC-85 product stream with the downstream urea granulation process.

This step produces a consistent UFC-85 solution suitable for use as a granulation additive.

Tail Gas Handling and Emissions Control

The absorber tail gas contains low residual concentrations of methanol and formaldehyde, as well as non-condensable reaction by-products such as carbon monoxide and dimethyl ether. To ensure compliance with applicable air emission requirements, the tail gas is routed to a dedicated catalytic tail gas incineration unit.

The tail gas treatment system is characterised by:

- Catalytic oxidation of residual organic compounds.
- Operation without support fuel under normal operating conditions.
- Conversion of residual hydrocarbons to carbon dioxide and water vapour prior to discharge.

This system forms part of the Project’s integrated air emissions control strategy.

4.3.4 DECOMMISSIONING

Activities during the decommissioning phase will involve demolition and site clean-up, disposal of waste, demobilization of the workers, and a final site review. Decommissioning will take place years from now, and the baseline conditions associated with the Project and surrounds are likely to be significantly different to what it is today. When the IFF-Line2 Project reaches end of life and should decommissioning be required then this would need to be assessed under a separate Environmental and Social studies.

4.4 PROJECT UTILITIES AND RESOURCE REQUIREMENT

4.4.1 POWER GENERATION

Power for the construction and operational phases of the proposed IFF-Line2 Project will be provided by the existing captive power plant in the Indorama manufacturing complex situated adjacent to the proposed Project. The existing power plant consists of seven operating Gas Turbine Generators (GTG), One additional GTG (GT-8) shall be installed for redundancy. Each of the gas turbines can produce approximately 33 MWH of power. Hence total power generation capacity of 8 GTG's total. is 264 MWH and the existing power consumption is about 142 MW. The Project is expected to consume an additional 40 MWH; thus, total power consumption will be 182 MW. The Indorama power grid operates with no connection to the state grid. Therefore, in order to have stable and reliable power, Indorama operates the gas turbines on an N+1+1 operation philosophy. Therefore, if one turbine trips during the operations, there would not be any load shedding in the manufacturing complex. Thus, the installed capacity is more than sufficient to meet the power demand of the Project while ensuring high reliability.

In addition to the gas turbines, the existing Petrochemicals complex is equipped with five emergency diesel generators to supply emergency power in the event of power outages. The complex has 14 MW of emergency power capacity. The installed capacity of EDGs is adequate to meet the additional emergency power requirement of IFF Line-2.

The installation and permitting of GT-8 and associated HRSG facilities are addressed under separate approvals for the broader Indorama complex. This ESIA assesses only the utilisation of available power and steam capacity and the incremental operational demands associated with the IFF Line 2 Project.

4.4.2 RAW WATER TREATMENT

Water for the Project will be supplied by existing boreholes, and three additional new boreholes that will be developed as a back-up to ensure uninterrupted raw water supply. The location of the three new boreholes has been identified, and the relevant groundwater supply studies have been undertaken by an independent agency appointed by IFF. The groundwater studies were carried out by eminent Professors in hydrology. The study concluded that the aquifer recharge is unaffected with the operation of additional boreholes.

Under normal operating conditions, total water demand for the proposed IFF line-2 Project will be approximately 710 m^3/hr.

Raw water will be treated through de-carbonators to remove dissolved CO_2. The decarbonated water will be treated further through filtration devices (to remove suspended solids) and will be used as filtered water, for consumption in cooling tower as make up and also as service

water within the plant. Filtered water shall also be fed to the demineralized (DM) plant for producing DM Water.

4.4.3 DEMINERALIZED WATER & CONDENSATE POLISHING SYSTEM

4.4.3.1 DEMINERALIZED WATER SYSTEM

The DM plant will produce ultra-pure water, which will be further de-aerated to produce Boiler Feed Water (BFW) suitable for steam generation.

Demineralized water shall be supplied from the existing DM water plant to IFF Line-2. The existing IEPL & IFZ DM plants will be integrated to consolidate the spare capacity of each and improve operational reliability.

Condensate Polishing System

The Project will include a condensate polishing system, which will consist of mix bed polisher units. The system will be used to treat process and steam condensates from the ammonia plant, urea plant and the steam turbine. Return condensates from these plants will be received and stored in a condensate storage tank. The stored condensate will be passed through mixed bed polisher unit filled with resins. The resins will absorb the impurities in the water, converting it to ultra-pure quality. The resins inside the polisher units will be exhausted after the design through-put. Sulphuric acid and caustic soda are used for regeneration of exhausted resin beds.

Wastewater Recovery Plant

The wastewater generated from IFF line-2 will be treated in an existing wastewater recovery plant which treats 580 m^3/hr of wastewater with a recovery of 522 m^3/hr (90%). The wastewater will be converted to cooling tower make-up quality and DM water after passing through series of treatment processes comprises of filtration, ion exchange and reverse osmosis.

The design capacity of existing wastewater recovery plant is adequate to treat the quantity of wastewater generated from IFF line-2. The treatment and reuse of wastewater will reduce the ground water consumption and result in sustainable water consumption.

The ESIA evaluates the incremental hydraulic, pollutant load, and operational impacts of IFF Line 2 wastewater streams on the existing treatment and recovery systems. The existing wastewater recovery infrastructure itself is not being modified or expanded as part of the IFF Line 2 Project.

4.4.4 STEAM GENERATION

The medium pressure steam required in the IFF Line-2 ammonia and urea process will be supplied from the existing MP (medium pressure) steam common network of petrochemical and fertilizer plants.

The existing steam generators, i.e. fuel fired boilers and heat recovery steam generators (which utilizes the exhaust gasses from Gas turbines to produce steam), are connected to common MP. steam network.

A new HRSG no-6 will be installed integrated with new GT-8 and connected to common M.P steam network. The combine steam generation capacity of steam generators is adequate to

meet the steam demand of IFF line-2. Hence, a separate auxiliary boiler for IFF line-2 is not considered. The use of HRSGs for steam generation will not consume natural gas and hence will help in overall GHG reduction from IFF Line 2 project.

4.4.5 COOLING TOWER

Two new cooling towers, having circulation capacity of 26,000 and 16,000 m^3/hr, shall be installed to supply cooling water for ammonia and urea plants respectively. Make-up water associated with the cooling towers shall be supplied partly from the wastewater recovery plant and partly from existing water treatment plant.

A continuous blow-down from Ammonia & Urea circulating cooling water network is provided in order to maintain concentration of dissolved salts, turbidity and other key parameters of circulating water within acceptable to avoid deposition and corrosion in piping / equipment. The blow-down from cooling towers will be treated inside the wastewater recovery plant and reused as make-up to cooling towers

4.4.6 NATURAL GAS SYSTEM

The Project requires natural gas as a feed for ammonia production and as a fuel for heat /power generation. Indorama Fertilizer Complex receives natural gas from three suppliers through an existing underground pipeline. From these suppliers, natural gas is received in a station consisting of slug catcher, filters, ultrasonic gas flow measurement skid and distribution network. Indorama has also secured natural gas from one more supplier, i.e. AGPC and Renaissance (Assa North – Ohaji South Project Gas Processing Company (gas supplier).

A new underground 20” diameter, 65km long natural gas pipeline from new supplier to IFF Line 2 and a new gas receiving station will be constructed with development of IFF Line2 project. The capacity of new underground pipeline and gas receiving station will be 300 mmscfd. The ESIA scope covers the on-site natural gas receiving station and all pipelines located within the Indorama Free Zone and the defined IFF Line 2 project footprint. The gas transmission infrastructure, and off-site pipeline corridors are subject to separate permitting and regulatory approvals and are not assessed as part of this ESIA. The ESIA for Pipeline was approved by Federal Ministry of Environment vide letter reference number FMEnv/EA/EIA/7236/Vol.I/289 dated 24th March 2025.

4.4.7 WASTEWATER

Liquid waste is generated from the Ammonia boiler blow downs, air compressor intercoolers, turbine condensates, steam condensates, process condensate, and oily effluent from the various processing units of IFF line-2. Some waste streams will be individually treated in the ammonia and urea plants before being channelled into condensate polisher unit for reprocessing and reuse as boiler feed water. The various treatment approaches of wastewater / effluent streams are as follows:

- **Boiler Blow Down** – routed to the cooling tower basin as make-up water.
- **Turbine Condensate** – sent to the polishing unit and shall be reused as boiler feed water after polishing. If condensate is off specification it will be transferred to the wastewater treatment system.

- **Steam Condensate** - sent to the polishing unit and reused as boiler feed water after polishing. If condensate is off specification it will be transferred to the wastewater treatment system.
- **Ammonia Process Condensates** – process condensate generated in the ammonia plant is treated in a dedicated Stripper and treated condensate is sent to the polishing unit and reused as boiler feed water after polishing. In case the process condensate is off specification, condensate shall be stored in a tank in the ammonia plant and gradually treated in the process condensate Stripper or transferred to the wastewater treatment system.
- **Urea Process Condensates** – process condensate generated in the urea plant is treated in a dedicated urea hydrolyser and Stripper, and treated condensate is sent to the polishing unit and reused as boiler feed water after polishing. In case the process condensate is off specification, condensate shall be stored in a tank in the urea plant and gradually treated in the process condensate Stripper or transferred to the wastewater treatment system.
- **Oily Water** – collected in a dyke or an oil trap at each potential source of oily water. Oil is skimmed manually at each pit periodically and further removed in oily water separator (such as a CPI separator) prior to discharging to the to the wastewater treatment system.
- **Chemical Drain** – a chemical drain will be constructed around the water treatment chemical dosing facility to direct any effluent to an existing neutralization pit.
- **Floor-washing Water in the Urea Synthesis Area** – spilled process fluid on the surface of the paving or equipment is washed and collected in dedicated pit inside the urea plant. The collected water is treated in hydrolyser and stripper, and the treated stream is sent to the wastewater treatment system.
- **Floor-washing Water in the Granulation Area** – the granulation area is designed in such way that wash water containing urea is collected in a dissolving pit and recovered within urea plant. Any spilled process fluid on the surface of the paving or equipment is washed by steam condensate and sent to the dissolving pit. There is no discharge to wastewater system from granulation area.
- **Sewage** – sewage generated from the IFF Line 2 and FCU will be connected to IFF Line 1 existing sewage network and transferred to existing sewage treatment plant through existing sewage transfer lines and lift pumps. The on-spec treated sewage from the sewage treatment plant will be transferred to existing wastewater discharge network.
- **Hydrocarbon Condensate (FCU)-** Effluent from the FCU is limited to small condensate volumes generated during molecular-sieve regeneration. This condensate is flashed to remove entrained hydrocarbons for flaring, with the remaining liquid routed through the flare knockout drum. The knockout drum drain, which may contain trace oil and grease, is treated in a CPI separator that reduces contaminants to below 10 ppm before the stream is intermittently transferred to the wastewater treatment system.

Wastewater from the Project will be collected and sent to the wastewater recovery plant for further treatment and recovery. Hence, there will be no wastewater disposal from the proposed IFF line-2 Project during normal operation.

In times of shut-down of wastewater recovery plant, the wastewater from IFF Line 2 will be diverted to existing equalization and holding ponds of Fertilizer Complex ETP for treatment. The treated wastewater from the existing holding pond will be discharged to the retention pond in a controlled manner, once the quality has been confirmed. At the retention pond, the treated wastewater from holding pond will be mixed with rainwater runoff from the Indorama Manufacturing Complex and discharged to the Okulu River. Any intermittent controlled discharge to the Okulu River would occur only when Retention Pond level is high, subject to compliance with applicable FMEnv effluent standards and internal Indorama discharge protocols. No routine operational discharge to surface water is proposed for the IFF Line 2 Project. It is important to note that the discharge from the Retention Pond will only be carried out when the pond is full and not discharged daily.

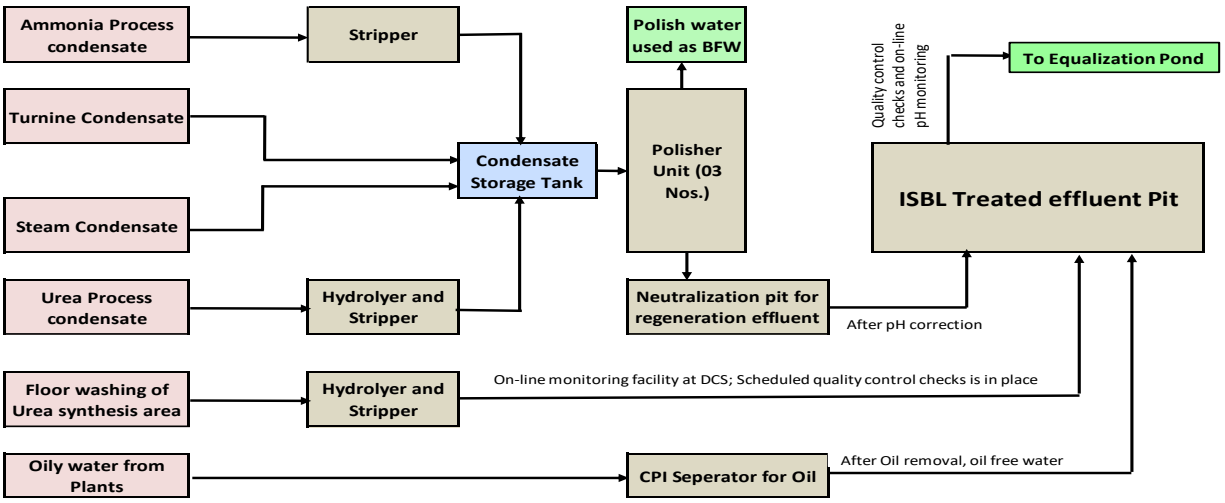


FIGURE 4-14: FLOW DIAGRAM OF EFFLUENT TREATMENT ASSOCIATED WITH THE PROJECT

4.4.8 GASEOUS EMISSIONS AND AIR QUALITY MANAGEMENT

4.4.8.1 SOURCES OF GASEOUS EMISSIONS FOR THE AMMONIA PLANT

The ammonia plant is designed to minimise gaseous emissions during normal and startup operations. Design features are as follows:

- **Process Heater (Primary Reformer)** – in the Primary Reformer, purge gas and flash gas are burned along with natural gas to supply the energy for the reforming reaction. Purge gas and flash gas contain ammonia, which is an emission source of nitrogen oxides. In order to reduce nitrogen oxides discharged from the Primary Reformer stack, the following inbuilt controls have been included:
  - Ammonia in the purge and flash gas is completely recovered in the Ammonia Recovery Unit. Treated gas is used as a fuel gas, which is sufficient to limit nitrogen oxide emission from the Primary Reformer.
  - The low nitrogen oxides gas burners have been selected.

- Selective catalytic reactor (SCR) to decompose NOx

- **Flare Stack and Venting** – flare stack and process vents can also be source of gaseous emissions in plant during upset conditions. Each flare stack is designed for complete burning of hydrocarbons even at the highest discharges in upset conditions. This is not carried out during normal operations of the plant, hence there is no emission and no flaring of gas.

4.4.8.2 SOURCES OF GASEOUS EMISSIONS FOR THE UREA PLANT

Major emissions from the urea plant are ammonia and urea. These emissions are caught and recycled back to process in an efficient manner, reducing emissions of pollutants to the atmosphere. The urea plant is designed to minimise such gaseous emissions during normal and startup operations. Design features are as follows:

- **Exhaust Air from the Granulator** – urea dust and ammonia contained in the exhaust air from the granulator can be a source of air pollution in urea plant. A unique dust recovery system proven in many commercial plants has been incorporated to reduce both urea dust and ammonia content in the exhaust to less than 50 mg/Nm^3-air.
- **Flare Stack and Venting** – flare stack and process vents can also be source of gaseous emissions in plant during upset conditions. Emergency flare stacks are designed for complete burning of hydrocarbons and ammonia even at the highest discharges in upset conditions and during granulator washing. This is not carried out during normal operations of the plant, hence there is no emission and no flaring of gas. A continuous flare is also provided for complete burning of off gases.

4.4.8.3 SOURCES OF GASEOUS EMISSIONS FOR THE FCU

Gaseous emissions from the FCU originate mainly from the regeneration gas heater, which serves as the unit's only continuous flue gas source and burns flashed gas as fuel to heat the regeneration stream for the molecular sieve dehydrators. Additional intermittent emissions occur through the flare system, which receives entrained hydrocarbons removed when hot conditioned gas condensate is flashed during regeneration; these vapours are safely combusted in the flare during non-regeneration and upset conditions.

4.4.9 SOLID WASTE MANAGEMENT

Wastes generated from Project activities can be categorised as non-hazardous or hazardous according to their types and associated risks. The definitions of waste categories are as follows:

- **Non-hazardous Wastes** – wastes that do not exhibit any hazardous properties and are relatively low risk to human health and the environment. This category would include a range of materials that may be recycled or can safely be disposed of in a landfill.
- **Hazardous Wastes** – wastes that exhibit one or more characteristics which mean that the wastes are potentially harmful to human health and/or can cause damage to the environment (air, land, and/or water) or natural ecosystems. For example, the waste may be corrosive, reactive, toxic, mutagenic, teratogenic, infectious, carcinogenic, ecotoxic, flammable, or explosive.

Waste types and estimated quantities during the construction phase are shown in Table 4-5 below. The duration of construction activities up to mechanical completion is estimated at about 35 months.

TABLE 4-5: WASTE TYPES AND ESTIMATED QUANTITIES DURING THE CONSTRUCTION PHASE

Activity	Description	Waste Category	Quantity	Destination
Site preparation / ton/year Foundations	Cement / concrete – concrete debris, soil containing cement	Non-hazardous	2000-2500 ton/year	Land fill
	Scrap metal / wire – strips of metal, metal supports, pieces of wire	Non-hazardous	400-500 ton/year	Resale
Construction activities	Scrap plastic / PVC	Non-hazardous	20-25 ton/year	Recycle
Maintenance operations	Paints and solvents – traces of paint, solvents, etc.	Hazardous	0.2-0.4 ton/year	Approved waste management facility
	Light bulbs, fluorescent light fittings; Equipment which can contain traces of neon and tungsten	Hazardous	0.1 ton/year	Approved waste management facility
Personal Protective Equipment (PPE) from work activities	Used PPE – goggles, gloves, etc.	Hazardous	5 ton/year	Existing Incinerator or Approved waste management facility
Lube oil and seal flushing of machinery skid (Pre-Commissioning phase)	Lube and seal oil – oil containing weld splatter, chips, welding flux deposits, powered metal oxides	Hazardous	1.5 - 2.0 ton/year	Approved waste management facility
Camps, kitchen, offices operations	Cooking organic wastes	Non-hazardous	10-12 ton/year	Municipal/Approved dump side
	Mixed urban wastes	Non-hazardous	100-120 ton/year	Municipal/Approved dump side
	Medical wastes	Hazardous	0.05-0.10 ton / year	Existing Incinerator
	Wastewaters (drinking, washing, shower, sanitary)	Hazardous	150 lt/day per worker	New STP

During the operational phase, waste contributed by the proposed IFF-Line2 Project will form part of the existing waste management system associated with the existing IEPL and IFZ operations. To this end, IFF will update their Waste Management Plan to accommodate operational aspects of the Project.

The Project will adopt the 4R principle for solid waste management, which includes (in order or priority) to:

- **Refuse** single use plastics as much as possible
- **Reduce** the use of non-recyclable products
- **Reuse** solid waste where possible to convert it into other useful products
- **Recycle** all waste where possible

4.4.10 HAZARDOUS SUBSTANCE

The hazardous substances used during all Project phases are provided in Table 4-6.

TABLE 4-6: HAZARDOUS MATERIALS TO BE USED ON SITE DURING CONSTRUCTION/OPERATIONS

Phase	Material	Quantity
Construction	Diesel fuel	4,000 ton during construction
	Gasoline	500 ton during construction
Operation	MDEA (Methyl diethanolamine)	3.0 Kg/hr
	UF-85	1,200 kg/hr
	Sulphuric acid	80 kg/hr
	Catalysts	Nickel, Copper, Zinc and Iron based catalyst in quantity in various reactors. Replacement based on performance and typically once in 10-15 years. Primary, secondary reformer and Methanator – Nickel base catalyst approximate quantity 250tons. High temperature shift converter and ammonia converter – Iron based catalyst approximate quantity 200tons Low temperature shift converter – Copper zinc base catalyst approximate quantity 120 tons Sulphur removal section zinc base catalyst approxmate quantity 80tons

The hazardous materials included in Table 4-6 will be handled as per SOP (Standard operating procedures) for that specific material and under proper supervision and the guidance as per MSDS (material safety data sheet).

Moreover, IFF will ensure the proper labelling of containers, display of MSDS and availability of secondary containment and provision of spill control equipment. In the event of sulphuric acid spill, the spill will be washed with sufficient quantities of water, following which water will be routed to effluent treatment facility.

Any spillage of MDEA and UF-85 will be collected and reused. During construction minor spills during transfer of diesel/gasoline will be collected in secondary containment and reused. It

should be noted that existing refuelling facilities in the operational IFZ, IFF and IEPL will be used.

4.4.11 ENERGY MANAGEMENT

The technology selected for the proposed IFF – Line2 Project is proven with respect to specific energy consumption and has the lowest energy requirements among the technologies available in the world for ammonia and urea production. The specific energy consumption for urea production will be 20.53 MMBTU/MT.

IFF have also considered the guidelines included in the IFC General EHS Guidelines (Energy Conservation) and Industry Specific Guidelines.

4.4.12 STORMWATER MANAGEMENT

Stormwater will be managed following recommendations indicated by "IFC General EHS Guidelines, Ed. April 30th, 2007 – Wastewater and Ambient Water Quality".

Stormwater includes any surface runoff and flows resulting from precipitation, drainage, or other sources. In order to reduce the need for stormwater treatment, the following principles, in compliance with IFC guidelines on Wastewater and Ambient water quality will be applied for the Project.

Stormwater will be separated from process and sanitary wastewater streams in order to reduce the volume of wastewater to be treated prior to discharge.

Surface runoff from process areas or potential sources of contamination will be prevented. Where this approach is not practical, runoff from process and storage areas will be segregated from potentially less contaminated runoff.

Runoff from areas without potential sources of contamination should be minimised (e.g., by minimising the area of impermeable surfaces) and the peak discharge rate should be reduced (e.g., by using vegetated swales and retention ponds).

Where stormwater treatment is deemed necessary to protect the quality of receiving water bodies, priority will be given to managing and treating the first flush of stormwater runoff where the majority of potential contaminants tend to be present. Normal case will consider the disposal of neutralized wastewater and of de-oiled storm water to the existing Retention pond.

Oil water separators and grease traps will be installed and maintained as appropriate at refuelling facilities, workshops, parking areas, fuel storage and containment areas. Oil Skimmer has been foreseen inside each first rain sump to remove the majority of the oil, while the remaining will be removed through a Coalescing Plate Separator.

Sludge from stormwater catchments or collection and treatment systems may contain elevated levels of pollutants and should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long-term sustainability of water and land resources. Organic sludge will be incinerated in existing incinerators following existing SOP and ash will be analysed for TCLP (Toxicity characteristics leaching procedure). Any spent catalyst containing zinc Sulphide will be handled by competent person as per the guidelines of MSDS HSE (Health safety and Environment) procedure.

The IFF Line 2 storm-water drainage system is designed for a worst-case rainfall intensity of 99 mm per hour, which is also the drainage design basis adopted in the climate risk and impact assessment of this ESIA (Sections 7.4.2.3 and 8.2.1).

4.5 EMPLOYMENT

In addition to the workforce required during the construction phase the Project is anticipated to require an additional 50 and 110 expat and national staff during the operational phase of the Project. Employment of Nigerians will be prioritised.

4.6 WORKING HOURS

The established normal working hours for IFF employees is 40 hours per week and 176 hours per month as stipulated in Nigerian Labour Laws and Internal Labour Organisation (ILO) conventions.

4.7 PROJECT IMPLEMENTATION SCHEDULE

IT IS ANTICIPATED THAT THE MECHANICAL COMPLETION WILL BE ACHIEVED IN 32 MONTHS AND OVERALL PROJECT COMPLETION IN ~35 MONTHS AS SHOWN IN



Figure 4-15 below.

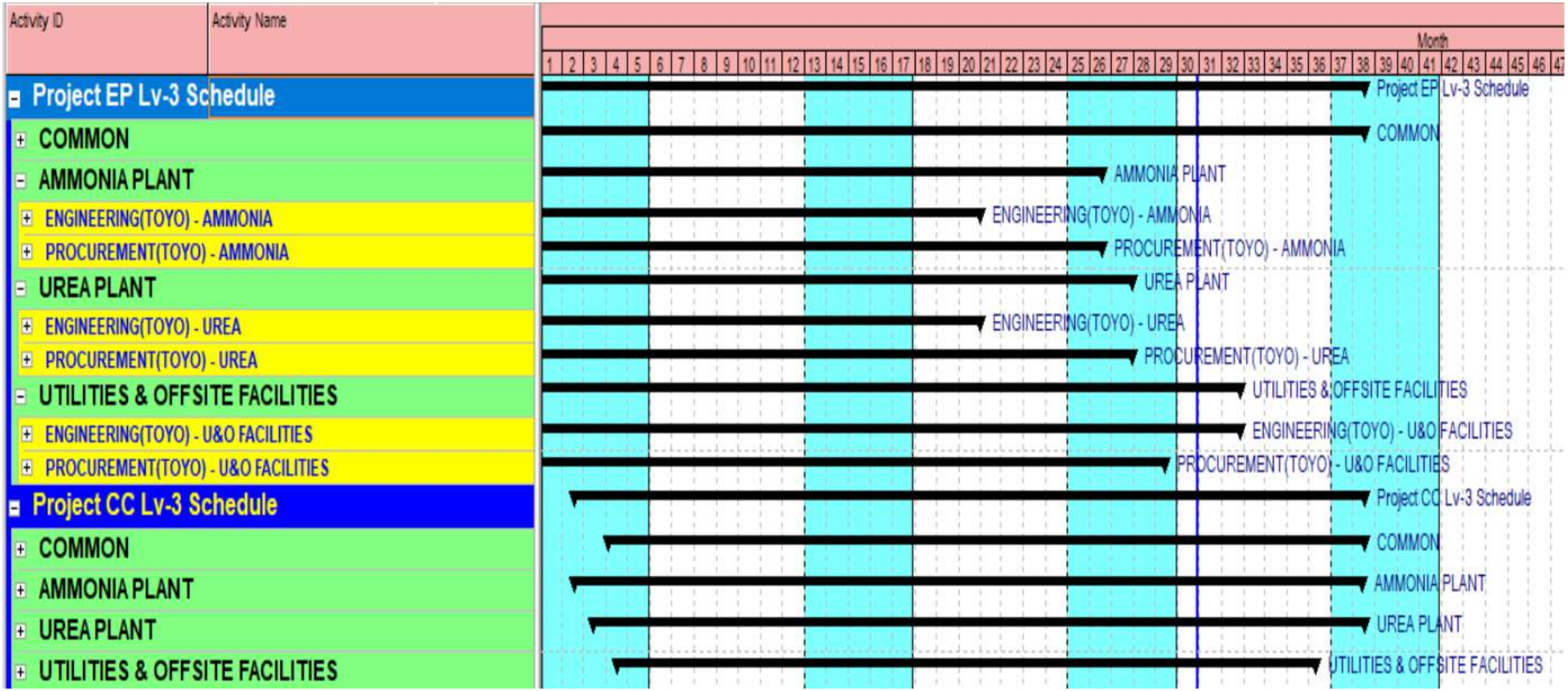


FIGURE 4-15: ANTICIPATED PROJECT SCHEDULE

5. THE ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) PROCESS

5.1 INTRODUCTION

As outlined in Chapter 1, the ESIA for the proposed IFF Line 2 Fertilizer Project has been undertaken in compliance with Nigerian legislation, including the Environmental Impact Assessment Act, Cap E12 Laws of the Federation of Nigeria 2004, and S.I. No. 109, Environment Impact Assessment Procedures and Charges Regulations, 2021. The ESIA has also been developed in alignment with applicable international standards and good international industry practice, including the International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability (2012), African Development Bank Integrated Safeguard System (2023), the World Bank Group General and sector-specific Environmental, Health and Safety (EHS) Guidelines, and relevant Indorama environmental, health and safety policy commitments.

The purpose of the ESIA is to assess how the Project may influence the quality of the physical, biological, cultural and social environment, and the well-being of affected individuals and communities. In line with current international practice, the ESIA integrates environmental and social considerations, including stakeholder engagement, into Project planning and decision-making, with the objective of avoiding, minimising or mitigating adverse impacts and enhancing Project benefits. The project team applied the Mitigation Hierarchy—Avoid, Minimise, Restore, and Compensate/Offset since project planning rather than treating environmental and social management as post-design additions. The use of the operational proven technology with same production capacity and project footprint; use of existing land for project; use of existing access roads, drainage network and laydown areas; utilized shared utilities, identical structural layouts, and compact plant configurations; engineering control measures like as SCR in Reformer Stack to reduce NOx emissions, enclosed conveyor systems, acoustic enclosures, low-noise equipment/turbines, and silencers for noise reduction; are few examples of embedded mitigation measures incorporated into the project planning and design. A key outcome of the ESIA process is the development of practical mitigation, management and monitoring measures that can be implemented and tracked throughout the Project lifecycle.

As part of the environmental approval and lender due diligence process for the IFF Line 2 Fertilizer Project, an ESMMP has been developed to address the impacts identified in the ESIA. The ESMMP forms an integral component of the overall ESIA package and provides the mechanism through which mitigation measures, monitoring requirements and management commitments identified in the ESIA are implemented, assigned, monitored and reported. In this way, the ESIA provides the analytical basis for impact identification and significance evaluation, while the ESMMP provides the framework for implementation and performance management. The ESIA findings also informed project design decisions and environmental risk management throughout project development. The proposed installation of SCR in reformer stack to reduce NOx emissions; use of existing land, road & drainage network; utilise shared utilities and processing of treated effluent in wastewater recovery plant are few examples embedded in project development.

For IFF Line 2, the ESIA process was undertaken as a structured but iterative sequence of interrelated stages. These stages did not occur in a strictly linear manner; rather, they informed one another as additional baseline data, specialist findings, design information and stakeholder inputs became available. The principal stages of the process comprised:

- Screening for Project categorization
- scoping and review of the ToR;
- approval of the ToR by FMEnv;
- review of proposed baseline methodologies and technical guide notes;
- wet-season and dry-season baseline data collection supervised by FMEnv & RSMEnv;
- Participation of ERM SME in dry-season collection;
- QA/QC review of the baseline data [17];
- impact assessment and development of mitigation measures;
- integration of mitigation and residual impact evaluation into the ESIA;
- development of the ESIA and ESMMP reporting framework; and
- change management and continuing refinement of assumptions where new information became available.

This chapter therefore describes the ESIA process actually followed for the Project and the methodology used to develop the assessment. It explains how the study area was defined, how baseline data were collected and reviewed, how impacts were identified and evaluated, how mitigation and residual significance were determined, and how the findings were translated into management and monitoring commitments. Chapter 5 should accordingly be read as the methodological bridge between the Project description and baseline chapters on the one hand, and the impact assessment, mitigation and management chapters on the other.

The ESIA has been undertaken in accordance with applicable Nigerian regulatory requirements and aligned with international good practice, including the IFC PSs (2012), AfDB ISS (2023) and the WBG EHS Guidelines.

The assessment methodology has been designed to ensure that environmental and social risks and impacts associated with the Project are identified, assessed, and managed in a manner commensurate with the nature, scale, and complexity of the proposed development. This includes a systematic approach to baseline data collection, impact identification and evaluation, application of the mitigation hierarchy, and the development of appropriate management and monitoring measures.

Baseline studies were undertaken to characterise the existing environmental and social conditions within the Project's area of influence, drawing on both primary data collection and relevant secondary sources. Impact assessment was conducted using a structured

[17] Baseline data were collected by accredited in-country Local Consultants and technical specialists across relevant environmental and social disciplines. While these specialists are understood to possess appropriate academic and professional qualifications consistent with their respective fields of study, detailed information on individual personnel and credentials is not presented in this ESIA where such information is commercially sensitive or subject to confidentiality restrictions. The ESIA relies on independent review and quality assurance processes to confirm that all baseline inputs meet required regulatory and international good practice standards.

methodology that considers the magnitude, extent, duration, reversibility, and likelihood of impacts, together with the sensitivity of receptors, to determine overall significance.

Mitigation measures have been developed in accordance with the mitigation hierarchy, prioritising the avoidance of impacts where feasible, followed by minimisation, restoration, and, where necessary, compensation or offsetting. These measures are consolidated within the Environmental and Social Management and Monitoring Plan (ESMMP) (refer to Chapter 10), which defines the actions, responsibilities, and monitoring requirements necessary to manage identified risks and impacts.

The ESIA has been undertaken by ERM, an independent international environmental and social consultancy, supported by qualified and experienced specialists across all relevant environmental and social disciplines, in accordance with the requirements of IFC Performance Standard 1 and AfDB Operational Safeguard 1.

Specialist studies, including but not limited to air quality modelling, biodiversity assessment, socio-economic assessment, and community health and safety evaluation, were undertaken by suitably qualified subject matter experts in accordance with international good practice and applicable IFC EHS Guidelines.

This multidisciplinary approach ensures that the assessment of environmental and social risks and impacts is commensurate with the nature, scale, and complexity of the Project, and that findings are technically robust, evidence-based, and aligned with international lender expectations.

Internal quality assurance and review processes have been applied throughout the ESIA to ensure consistency, accuracy, and technical rigour across all specialist inputs.

5.2 SCOPING

The purpose of the scoping stage for the IFF Line 2 Fertilizer Project was to identify key environmental and social sensitivities and Project activities with the potential to result in significant impacts to physical, biological, and socio-economic receptors. The scoping process also informed the refinement of Project siting, layout, and design considerations, taking into account the existing industrial setting of the Indorama complex and the integration of the Project within this developed footprint.

The key objectives of the scoping stage were to:

- Identify the potentially significant environmental and social impacts associated with the Project;
- Obtain stakeholder and regulator input through consultation to inform the assessment process; and
- Define the scope of the ESIA through the development of an agreed ToR, ensuring that the assessment and reporting are focused on key issues and consistent with regulatory and lender expectations.

Following submission of the Project proposal and completion of site verification activities, the Federal Ministry of Environment (FMEnv) categorised the Project as a Category I development, requiring a full ESIA in accordance with S.I. No. 109 of 2021 and the EIA Act (Cap E12). FMEnv further advised that baseline data collection and stakeholder engagement should be undertaken in line with national requirements and international good practice.

A Scoping Report and ESIA Terms of Reference (ToR) were subsequently prepared in consultation with relevant stakeholders and regulatory authorities. The ToR defined the spatial and temporal boundaries of the assessment, the key impact pathways, baseline data requirements, and the approach to impact evaluation and mitigation. The ToR was submitted to FMEnv and formally approved, authorising progression to the detailed ESIA phase.

5.3 TOR METHODOLOGY REVIEW

Following scoping and approval of the ToR, a structured review of the proposed baseline methodologies was undertaken to confirm whether the baseline programme would be sufficient to support a scientifically robust, regulator-ready and lender-aligned ESIA. The review focused on the sampling design, media coverage, frequency, seasonality, equipment, QA/QC requirements and the respective roles of the local and international consultants. The purpose of the exercise was to identify any methodological weaknesses early, so that these could be addressed before the baseline campaigns were completed.

The baseline methodologies proposed for air quality, terrestrial biodiversity and ecosystem services, aquatic biodiversity and ecosystem services, surface water quality, terrestrial soils and fluvial sediments, geology / hydrogeology, treated effluent, stack emissions, noise, traffic, and socio-economic and cultural heritage were reviewed. The review concluded that the overall baseline framework was appropriate, but that a number of topic-specific refinements were required to strengthen scientific defensibility, seasonal representativity, receptor coverage, and lender compliance.

In broad terms, the key findings of the review exercise were as follows:

- for air quality, the review identified the need to strengthen the receptor network and to ensure that meteorological inputs used for dispersion assessment were adequate for robust modelling;
- for surface water, the review identified the need for stronger integration of hydrology, discharge points, downstream receptor sensitivity and flow-related data;
- for soils, geology and groundwater, the review focused on improving parameter coverage, depth coverage, QA/QC and the appropriate use of existing complex-wide information where justified;
- for traffic, the review highlighted the need for seasonal representation, coverage of both daytime and night-time conditions, and like-for-like survey design across the affected road network;
- for social and cultural heritage, the review emphasised the need to address cumulative social pathways, community health and safety linkages, and to apply a clearer methodology for cultural heritage survey, documentation and chance finds.

The review exercise also identified a number of cross-cutting requirements that applied across the specialist studies. These included clearer indicator selection, stronger conceptual models, improved seasonality and ancillary data capture, more explicit QA/QC and chain-of-custody requirements, and better cross-disciplinary integration to support impact assessment and cumulative effects analysis. The outcome of the review was a set of technical recommendations that were provided to the LC so that the baseline study design could be refined before completion of the surveys. As a result, the work plan was updated accordingly and that the supplemented approach was approved by FMEnv.

For IFF Line 2, the review exercise therefore acted as the bridge between scoping and field data collection. It ensured that the baseline programme ultimately implemented for the ESIA was not limited to the original Terms of Reference, but was strengthened where needed to produce sufficient, representative and auditable data for the subsequent impact assessment.

5.4 WET AND DRY SEASON BASELINE DATA COLLECTION

A key objective of the ESIA process for the IFF Line 2 Fertiliser Project was to establish a robust understanding of the existing physical, biological, cultural and socio-economic environment in order to identify receptors and resources that may be affected by the Project. Chapter 7 of this ESIA presents the baseline conditions that inform the assessment of environmental and social impacts, while the impact assessment findings are set out in Chapter 8 and the associated mitigation and management measures are provided in Chapter 9.

The baseline description was developed to:

- identify key environmental and social conditions and sensitivities within the Project area and wider AoI;
- provide the basis for understanding future conditions in the absence of the Project;
- support the prediction and evaluation of potential Project-related impacts;
- incorporate relevant secondary information and existing monitoring data where appropriate;
- capture stakeholder concerns, perceptions and expectations;
- inform the development of mitigation and management measures; and
- establish a benchmark against which future changes and the effectiveness of mitigation measures can be assessed.

Baseline data collection for IFF Line 2 was undertaken by an FMEnv-accredited LC under the supervision of the FMEnv, with ERM providing technical oversight, quality assurance, and alignment with lender requirements. One ERM Subject Matter Expert (SME) participated in the dry-season field data collection undertaken in February 2026. This arrangement formed part of an enhanced supervision model developed during the proposal stage for the dry-season campaign. The model envisaged on-site ERM specialist presence within the complex, review of method statements and Standard Operating Procedures (SOPs,) verification of equipment and quality assurance systems, end-of-day data reviews, chain-of-custody checks, and the maintenance of QA/QC logs and corrective action records.

Baseline data collection was undertaken during both wet- and dry-season campaigns to capture seasonal variability and strengthen the representativeness of the baseline. The timing of the principal field campaigns is summarised as follows:

- Noise baseline surveys were undertaken from 16 to 25 October 2025 during the wet season and from 20 February to 5 March 2026 during the dry season;
- Traffic baseline surveys included wet-season investigations undertaken in November 2025 and dry-season investigations undertaken in February 2026. Daytime (07:00–22:00) and night-time (22:00 – 07:00) traffic counts were conducted during both survey campaigns, with data collected between 6–12 November 2025 and 8–14 February 2026 to capture seasonal variations in traffic conditions and road use patterns;

- Surface water sampling was undertaken during the wet season from 16 to 18 October 2025 and during the dry season from 17 to 19 February 2026;
- Biodiversity field investigations were undertaken in October 2025, January 2026 and February 2026 to ensure seasonal representation;
- Geology, soils and groundwater baseline investigations were undertaken in two phases to account for seasonal variability, commencing with a wet-season field campaign in October 2025 and for dry season in February 2026, with both wet- and dry-season groundwater level data subsequently recorded for the inventoried boreholes.

The wet- and dry-season baseline programme covered meteorology and climate, ambient air quality, noise, geology and soils, hydrogeology and groundwater, surface water and sediments, biodiversity and ecosystem services, socio-economic conditions, traffic and transport, and cultural heritage. These datasets were supplemented, where appropriate, by desktop review, previous monitoring information, existing validated data from the wider industrial complex, and contextual regulatory and published information.

In practical terms, the baseline programme combined specialist field surveys, direct measurements, laboratory analyses, desk-based review and QA/QC review. Meteorological conditions were characterised using site-specific and regional meteorological information; noise monitoring was undertaken at representative sensitive receptor locations using unattended monitoring equipment; surface water and groundwater investigations included in situ measurements, sample collection and laboratory analysis; biodiversity work included habitat mapping, species recording and ecosystem services review; traffic surveys captured both daytime and night-time conditions; and stakeholder engagement activities contributed directly to the social and cultural heritage baseline.

The baseline programme for IFF Line 2 was therefore not limited to a single seasonal campaign. Rather, it comprised a staged process beginning with scoping, followed by formal review of methodologies, then wet-season baseline collection, supervised dry-season baseline collection, data validation and QA/QC review, and integration of those datasets into the ESIA baseline and impact assessment chapters. This approach was intended to improve representativity, reduce uncertainty and provide a defensible basis for multidisciplinary impact assessment.

5.5 QA/QC REVIEW OF BASELINE DATA

Following completion of the wet- and dry-season baseline campaigns, the next step in the ESIA process was the QA/QC review of the LC's baseline data. This step formed a critical part of the overall ESIA process and was undertaken to ensure that the data collected were complete, internally consistent, methodologically defensible and suitable for use in the assessment of impacts.

The QA/QC process was consistent with the enhanced supervision and data assurance approach defined during Project planning. For the supervised dry-season campaign, this included:

- daily technical interface with the LC;
- participation in daily safety briefings and task reviews;
- review of method statements and sampling procedures;

- verification of field equipment and QA systems;
- end-of-day data handover and review;
- metadata checks, chain-of-custody verification, completeness and consistency screening; and
- the maintenance of formal QA/QC records, corrective action logs and oversight notes.

As baseline information became available, ERM undertook a structured review of the submitted field and laboratory data before those data were accepted for use in the ESIA. This QA/QC review focused on four principal areas:

- completeness and coverage, including confirmation that planned surveys, monitoring events, sample analyses and reporting outputs had been completed and that any deviations or omissions were identified and assessed;
- data consistency and accuracy, including cross-checking whether field observations, monitoring results and laboratory outputs were internally coherent and realistic in the context of the known characteristics of the study area;
- laboratory and analytical quality assurance, including verification that analytical results were derived from accredited laboratories and that appropriate quality control measures such as blanks, duplicates, standards and documented QA procedures had been applied; and
- documentation of limitations and assumptions, including identification of any remaining uncertainties, the need for cautious interpretation, and any actions required to close residual gaps.

The QA/QC review also assessed whether the submitted baseline data were aligned with the approved ToR and with the applicable international standards informing the ESIA. The ESIA draft records that ERM reviewed the baseline data submitted by the LC to verify this alignment, and that any data gaps identified through the review were addressed through clarification requests or additional information requests. Where longer-term actions were required to achieve full alignment with lender expectations, these were identified for inclusion as post-ESIA commitments within the ESMMP.

The outcome of the QA/QC process was therefore not simply acceptance or rejection of datasets. Rather, it was an iterative validation process through which the baseline evidence base was strengthened, outliers and anomalies were interrogated, methodological limitations were clearly documented, and any remaining uncertainty was carried forward transparently into the impact assessment. This ensured that the environmental and social baseline used in the ESIA was sufficiently robust, traceable and auditable for both regulatory review and lender due diligence.

5.6 IMPACTS ASSESSMENT AND MITIGATION METHODOLOGY

5.6.1 INTRODUCTION

The impact assessment stage evaluates how the IFF Line 2 Fertilizer Project may interact with elements of the physical, biological, cultural and socio-economic environment to generate changes in identified receptors and resources (Figure 5-1). This process comprises a series of structured steps used to identify, predict and evaluate the nature and significance of Project-related impacts during construction, operation and, where relevant, decommissioning. For

most environmental and social topics, the ESIA applies a standard significance framework based on the interaction between impact magnitude and receptor sensitivity / vulnerability / importance. For certain technical disciplines, however, a more quantitative or specialist-led approach is applied where impacts can be predicted directly against adopted criteria, standards or scenario-based risk thresholds.

The evaluation of pre-mitigation significance takes account of control measures already embedded within the Project design. This avoids assigning significance to a hypothetical version of the Project that excludes design controls already committed to as part of the Project description. Additional mitigation measures are then identified where necessary, and residual significance is evaluated on the assumption that those measures are effectively implemented.

NOTE:

The general ESIA impact assessment methodology combines impact magnitude and receptor sensitivity to determine overall significance. This framework is applied across the majority of topics assessed in this ESIA. For certain disciplines, including air quality and noise, impacts are assessed using more quantitative methods in which predicted levels are compared directly against adopted criteria and standards that already reflect receptor type and land-use context. Additional specialist methods are also used for physical climate change risk, greenhouse gases (GHG) and cultural heritage, where significance is determined through materiality, benchmarking or heritage-specific criteria rather than the generic receptor matrix alone.

Box 5.1: Application of the Standard and Topic-Specific Methods

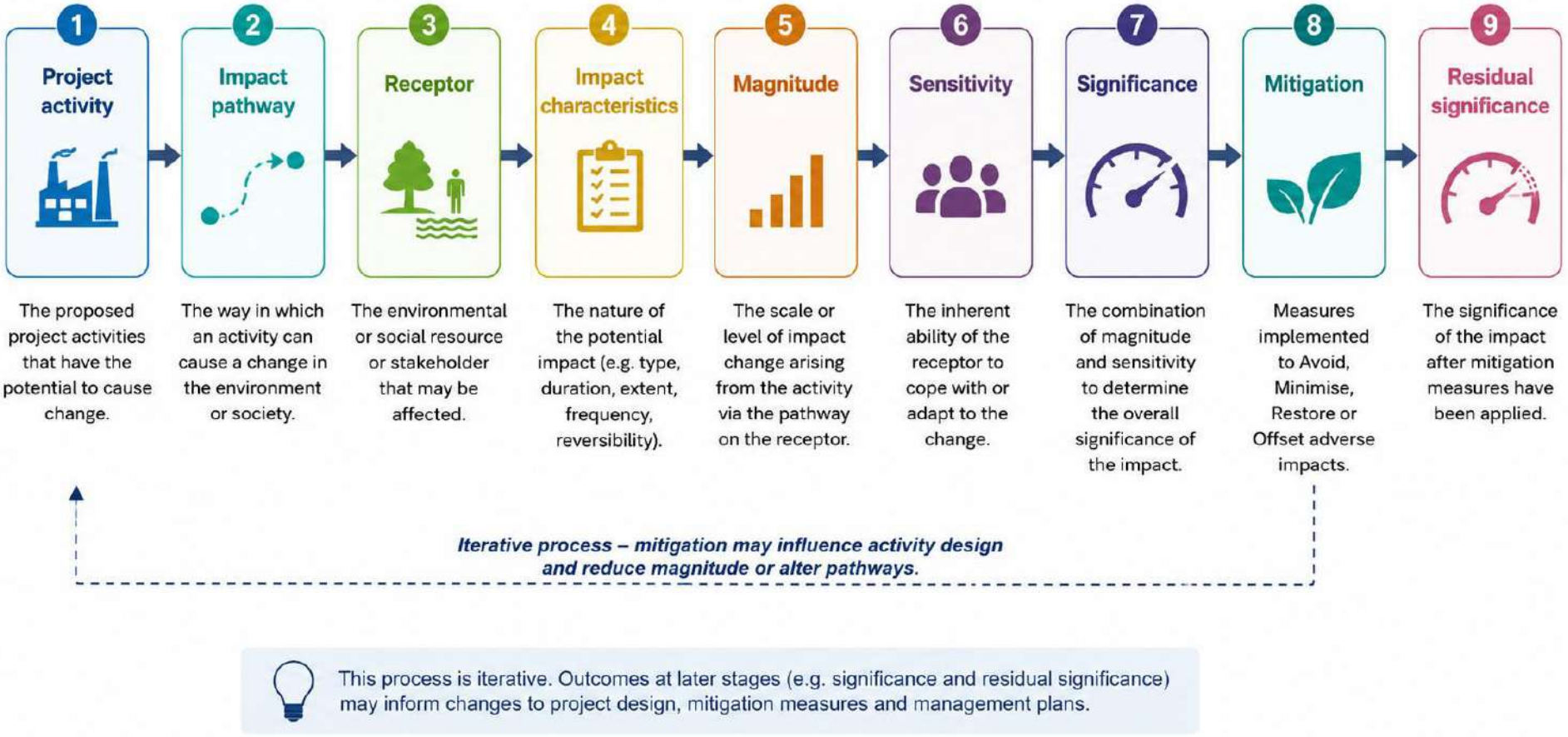


FIGURE 5-1: STANDARD ESIA IMPACT ASSESSMENT WORKFLOW

5.6.2 IMPACT ASSESSMENT METHOD

5.6.2.1 IMPACT IDENTIFICATION

Potential impacts are identified through review of the Project description, baseline conditions, known source–pathway–receptor linkages, and stakeholder concerns. The assessment addresses direct, indirect, induced and cumulative effects, and considers both adverse and beneficial changes where relevant. For each potential impact, the assessment identifies:

- the source of the impact;
- the pathway through which the impact may occur;
- the receptor / resource that may be affected; and
- the consequence of that interaction.

5.6.2.2 IMPACT MAGNITUDE

Impact magnitude describes the degree of change expected to occur in a receptor or resource as a result of Project activities. It reflects not only the intensity of the impact, but also its spatial and temporal characteristics and overall scale. Magnitude is typically defined based on a combination of type, extent, duration, scale, frequency and, where relevant, likelihood. For positive impacts, magnitude may be expressed as Positive unless sufficient information is available to support a more differentiated assignment of small, medium or large magnitude.

Definitions used to characterise the different components of magnitude within this ESIA are provided in Table 5-1 below.

TABLE 5-1: IMPACT CHARACTERISTIC TERMINOLOGY

Characteristic	Definition	Designations
Type	A descriptor indicating the relationship of the impact to the Project (in terms of cause and effect).	Direct Indirect Induced
Extent	The "reach" of the impact (e.g., confined to a small area around the Project Footprint, projected for several kilometres, etc.).	Local Regional International
Duration	The time period over which a resource / receptor is affected.	Temporary Short-term Long-term Permanent

Characteristic	Definition	Designations
Scale	The size of the impact (e.g., the size of the area damaged or impacted, the fraction of a resource that is lost or affected, etc.).	[no fixed designations; intended to be a numerical value where appropriate]
Frequency	A measure of the constancy or periodicity of the impact.	[no fixed designations; intended to be a numerical value where appropriate]
Likelihood	The probability of the impact occurring, used for unplanned events.	Unlikely; Possible; Likely

The magnitude designations applied in this ESIA are Positive, Negligible, Small, Medium and Large. The final assignment of magnitude is topic-specific and takes into account all relevant dimensions of the predicted impact. Some changes may be immeasurable, undetectable or within the range of normal natural variation; such changes are characterised as negligible magnitude.

5.6.2.3 DESIGNATION DEFINITIONS

For the universally defined impact characteristics, the designation definitions applied in this ESIA are set out in Table 5-2 below. These are applied consistently across all disciplines, while resource-specific interpretation is reflected through the final assignment of magnitude and sensitivity

In the case of ***type***, the designations are defined universally (i.e., the same definitions apply to all resources/receptors and associated impacts).

TABLE 5-2: DESIGNATION DEFINITIONS

Designation	Definition
Type	
Direct	Impacts that result from a direct interaction between the Project and a resource/receptor (e.g., between occupation of a plot of land and the habitats which are affected).
Indirect	Impacts that follow on from the direct interactions between the Project and its environment as a result of subsequent interactions within the environment (e.g., viability of a species population resulting from loss of part of a habitat as a result of the Project occupying a plot of land).
Induced	Impacts that result from other activities (which are not part of the Project) that happen as a consequence of the Project (e.g., influx of camp followers resulting from the importation of a large Project workforce).

Designation	Definition
Extent	
Local	Impacts that affect an area in proximity to the development area within an area defined on a resource/receptor-specific basis.
Regional	Impacts occurring at a regional scale as determined by administrative boundaries or which affect regionally important resources or ecosystems.
International	Impacts that extend across international boundaries or affect resources such as features, resources or areas protected by international conventions.
Duration	
Temporary	Impacts are predicted to be of short duration (in the order of days) and/or intermittent/occasional.
Short-term	Impacts that are predicted to last only for the duration of the construction period (i.e. – 8 years).
Medium-term	Impacts that will continue for a period of 5 to 10 years following the completion of the construction phase e.g., where the impact may reverse or affected resources or receptors recover within this period of time.
Long-term	Impacts that will continue for the life of the Project, but will either cease when the Project stops operating or is decommissioned, or where the impact may reverse or the affected resource / receptor recovers or reverts to a near-natural state after 10 or within 20 years following the completion of the construction phase.
Permanent	Impacts that cause a permanent change in the affected receptor or resource (e.g., removal or destruction of ecological habitat) that endures substantially beyond 20 years following the completion of the construction phase.

5.6.2.4 LIKELIHOOD (FOR UNPLANNED EVENTS)

In the case of ***scale*** and ***frequency***, these characteristics are not assigned fixed designations, as they are typically numerical measurements (e.g., number of acres affected, number of times per day, etc.).

The terminology and designations are provided to ensure consistency when these characteristics are described in an impact assessment deliverable. However, it is not a requirement that each of these characteristics be discussed for every impact identified.

For unplanned events (e.g., accidental release of hazardous materials) the ***likelihood*** of the impact occurring is taken into consideration in deriving the magnitude rating. The likelihood of an impact occurring as a result of an unplanned event is expressed as a probability and is

designated using a qualitative scale (or semi-quantitative, where appropriate data are available), according to the attributes described in Table 5-3.

TABLE 5-3: DEFINITIONS FOR LIKELIHOOD DESIGNATIONS (ONLY USED FOR UNPLANNED EVENTS)

Likelihood	Definition
Unlikely	The event is unlikely but may occur at some time during normal operating conditions.
Possible	The event is likely to occur at some time during normal operating conditions.
Likely	The event will occur during normal operating conditions (i.e., it is essentially inevitable).

Likelihood is estimated on the basis of experience and/or evidence that such an outcome has previously occurred.

It is important to note that likelihood is a measure of the degree to which the unplanned event is expected to occur, *not* the degree to which an impact or effect is expected to occur as a result of the unplanned event. The latter concept is referred to as *uncertainty*, and this is typically dealt with in a contextual discussion in the impact assessment deliverable, rather than in the impact significance assignment process.

In the case of impacts resulting from unplanned events, the same resource/receptor-specific approach to concluding a magnitude designation is utilised, but the 'likelihood' factor is considered, together with the other impact characteristics, when assigning a magnitude designation. There is an inherent challenge in discussing impacts resulting from (planned) Project activities and those resulting from unplanned events. To avoid the need to fully elaborate on an impact resulting from an unplanned event prior to discussing what could be a very low likelihood of occurrence for the unplanned event, this methodology incorporates likelihood into the magnitude designation (i.e., in parallel with consideration of the other impact characteristics), so that the "likelihood-factored" magnitude can then be considered with the resource/receptor sensitivity/vulnerability/importance in order to assign impact significance. Rather than taking a prescriptive (e.g., matrix) approach to factoring likelihood into the magnitude designation process, it is recommended that this be done based on professional judgment, possibly assisted by quantitative data (e.g., modelling, frequency charts) where available.

Once the impact characteristics are understood, these characteristics are used (in a manner specific to the resource/receptor in question) to assign each impact a *magnitude*. In summary, magnitude is a function of the following impact characteristics:

- Extent;
- Duration;
- Scale;

- Frequency; and
- Likelihood.

Magnitude essentially describes the degree of change that the impact is likely to impart upon the resource/receptor. As in the case of extent and duration, the magnitude designations themselves (i.e., negligible, small, medium, large) are universally used and across resources/receptors, but the definitions for these designations will vary on a resource/receptor basis, as is discussed further below. The universal magnitude designations are:

- Positive;
- Negligible;
- Small;
- Medium; and
- Large.

The magnitude of impacts takes into account all the various dimensions of a particular impact in order to make a determination as to where the impact falls on the spectrum (in the case of adverse impacts) from *negligible* to *large*. Some impacts will result in changes to the environment that may be immeasurable, undetectable or within the range of normal natural variation. Such changes can be regarded as essentially having no impact, and should be characterised as having a *negligible* magnitude.

Thresholds between the magnitude designations are quantitative wherever a recognised numerical standard, guideline or modelling output exists for the receptor, and qualitative, defined topic-by-topic in the impact rating tables of Chapter 8, where it does not. Quantitative thresholds are applied for air quality (process contribution as a percentage of the air quality standard, Table 5-5), noise (decibels above or below the adopted criterion, Tables 5-8 and 5-10), greenhouse gas emissions (annual tCO_2e benchmark bands, Section 5.6.3.4) and groundwater (modelled drawdown and saline-interface movement relative to sustainable yield). For receptors without numerical limits, such as biodiversity, socio-economic conditions and cultural heritage, the designations follow the generic definitions below, applied by the specialists using the extent, duration, scale, frequency and reversibility of the change, consistent with good international industry practice (IFC PS1 and AfDB OS1 Guidance) and the ERM Impact Assessment Standard:

- Negligible – no perceptible change, or a change within the range of normal natural variation;
- Small – a perceptible change that remains well within applicable standards and natural variability, affects a small proportion of the receptor, and is temporary or short-term and fully reversible;
- Medium – a noticeable change that approaches, but remains within, applicable standards or limits, affects a moderate proportion of the receptor, or is medium-term but reversible; and
- Large – a change that exceeds applicable standards or limits, affects a large proportion of the receptor or its function, or is long-term or irreversible.

5.6.2.5 SENSITIVITY

In addition to characterising the magnitude of impact, the other principal step necessary to assign significance for a given impact is to define the sensitivity/vulnerability/importance of the impacted resource/receptor to the type of activity proposed (e.g., habitat clearance, topsoil removal, etc.) or the consequences of a Project activity (e.g., dust, noise, water pollution, or induced population influx). This requires a range of physical, biological, cultural or human factors to be taken into account and may also need to include other factors such as legal protection, government policy, stakeholder views and economic value.

Characterisation of sensitivity for a physical or biological resource or receptor (e.g., a water feature or parameter, cliff, vegetation type) will take into account its conservation status and importance (on a local, national and international scale), its vulnerability to disturbance, and its resilience to recover or withstand a specific impact or type of impact. Where the receptor is human or cultural, the value of that social and cultural heritage receptor/s and its vulnerability to the impact is considered, taking into account the receptor's resilience, including ability to adapt to change or use alternatives where available.

As in the case of magnitude, the sensitivity/vulnerability/importance designations themselves are universally consistent, but the definitions for these designations will vary on a resource/receptor basis. The universal sensitivity/vulnerability/importance designations are:

- Low;
- Medium; and
- High.

5.6.2.6 EVALUATING SIGNIFICANCE

Once magnitude of impact and sensitivity/vulnerability/importance of resource/receptor have been characterised, the significance of the impact is assigned using the impact significance matrix shown in **Table** 5-4.

For impacts resulting from unplanned events (typically accidents, such as a major oil spill or other event that cannot be reasonably foreseen), the above methodology is applied but likelihood is also considered when assigning the magnitude designation, as classified in **Table** 5-4.

TABLE 5-4: IMPACT SIGNIFICANCES

Evaluation of Significance		**Sensitivity/Vulnerability/Importance of Resource/Receptor**		
		Low	**Medium**	**High**
Magnitude of Impact		**Negative Impacts**		
	Negligible	Negligible	Negligible	Minor
	Small	Negligible	Minor	Moderate

	Medium	Minor	Moderate	**Major**
	Large	**Moderate**	**Major**	**Critical**

The matrix applies universally to all resources/receptors, and all impacts to these resources/receptors, as the resource/receptor- or impact-specific considerations are factored into the assignment of magnitude and sensitivity designations that enter into the matrix.

An impact of **Negligible** significance is one where a resource/receptor (including people) will essentially not be affected in any way by a particular activity or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations.
An impact of **Minor** significance is one where a resource/receptor will experience a noticeable effect, but the impact magnitude is sufficiently small (with or without mitigation) and/or the resource/receptor is of low sensitivity/ vulnerability/ importance. In either case, the magnitude should be well within applicable standards.
An impact of **Moderate** significance has an impact magnitude that is within applicable standards, but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. Clearly, to design an activity so that its effects only just avoid breaking a law and/or cause a major impact is not best practice. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently.
An impact of **Major** significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. An aim of IA is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a facility. It is then the function of regulators and stakeholders to weigh such negative factors against the positive ones, such as employment, in coming to a decision on the Project.
An impact of **Critical** significance after all feasible mitigation measures have been identified and assessed warrants the highest level of attention and concern. As with residual impacts of major significance, the regulators and stakeholders will need to closely evaluate whether the positive impacts of the project outweigh residual negative impacts of critical significance. In many cases residual critical impacts can be considered as potential fatal flaw of the project.

Box 5.2 Context of Impact Significances

5.6.2.7 MITIGATION OF IMPACTS

Once the significance of a given impact has been characterised using the above mentioned methodologies, the next step is to evaluate what mitigation measures are warranted. In keeping with the Mitigation Hierarchy, the priority in mitigation is to first apply mitigation measures to the source of the impact (i.e., to avoid or reduce the magnitude of the impact from the associated project activity), and then to address the resultant effect to the resource/receptor via abatement or compensatory measures or offsets (i.e., to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude).

It is important to have a solid basis for recommending mitigation measures. The role of any given ESIA is to help develop a consentable project, and to help clients meet their business objectives in a responsible manner. Impact assessment is about identifying the aspects of a project that need to be managed and demonstrating how these have been appropriately dealt with. As key influencers in the decision-making process, the role of the impact assessment is not to stop development or propose every possible mitigation or compensatory measure imaginable, but rather to make balanced judgements as to what is warranted, informed by a high-quality evidence base.

Additional mitigation measures should not be declared for impacts rated as not significant, unless the associated activity is related to conformance with an 'end of pipe' applicable requirement. Further, it is important to note that it is not an absolute necessity that all impacts be mitigated to a not significant level; rather the objective is to mitigate impacts to an 'as low as reasonably possible' (ALARP) level.

As previously mentioned, embedded controls (i.e., physical or procedural controls that are planned as part of the project design and are not added in response to an impact significance assignment) are considered as part of the project (prior to entering the impact assessment stage of the impact assessment process).

5.6.2.8 RESIDUAL IMPACT ASSESSMENT

Once mitigation measures are declared, the next step in the impact assessment process is to assign residual impact significance. This is essentially a repeat of the impact assessment steps discussed above, considering the assumed implementation of the additional declared mitigation measures.

5.6.2.9 CUMULATIVE IMPACTS/EFFECTS

Cumulative impacts and effects are those that arise as a result of an impact and effect from the Project interacting with those from another activity to create an additional impact and effect. These are termed cumulative impacts and effects.

The approach for assessing cumulative impacts is influenced by the availability of information about the impact of the other activity, and whether or not it already exists or is only proposed. Cumulative impacts of the Project are identified and briefly described in a qualitative manner in the context of other existing or planned development Projects.

5.6.2.10 DEALING WITH UNCERTAINTY

Even with a final design and an unchanging environment, impacts are difficult to predict with certainty. Uncertainty stemming from on-going development of the Project design is inevitable, and the environment is typically variable from season to season and year to year. Where such uncertainties are material to ESIA findings, they will be clearly stated and conservatively approached ('the precautionary approach') in order to identify the broadest range of likely residual impacts and necessary mitigation measures.

Potential impacts may be assessed using tools ranging from quantitative techniques such as mathematical modelling to qualitative techniques based on expert judgment and historical information. The accuracy of these assessment tools depends on the quality of the input data and available information. Where assumptions have been made, the nature of any

uncertainties associated with the assumption is discussed. For qualitative predictions/assessments, some uncertainty is removed through consultation.

5.6.2.11 MANAGEMENT AND MONITORING

Management and monitoring measures are defined in the ESMMP in order to identify whether:

- Impacts or their associated Project components remain in conformance with applicable standards or performance targets;
- Mitigation measures are effectively ameliorating impacts to the extent predicted or an acceptable level; and
- Additional mitigation or management measures or other investigations are required to further ameliorate project impacts.

The ESMMP identifies the designated responsibility for implementing mitigation measures, the performance targets to be achieved, and the assurance mechanisms and protocols required to verify the proper implementation of the mitigation measures.

5.6.3 TOPIC-SPECIFIC ASSESSMENT METHODS

5.6.3.1 AIR QUALITY IMPACT ASSESSMENT

Air quality impacts were assessed using a topic-specific methodology combining baseline monitoring, meteorological characterisation, construction-phase screening tools and operational atmospheric dispersion modelling. The assessment considered the pollutants most relevant to the Project, namely oxides of nitrogen (NO_x), and by association nitrogen dioxide (NO_2), particulate matter (PM_{10} and $PM_{2.5}$), sulphur dioxide (SO_2) and ammonia (NH_3). The assessment was undertaken with reference to the Nigerian National Environmental (Air Quality Control) Regulations, S.I. No. 88, 2021 and IFC/WHO air quality guidelines, with the Project-adopted standards based on the most stringent applicable values.

For the purposes of the assessment, the air quality study area was defined on the basis of direct effects at sensitive receptors. For construction, the study area extends to 250 m from construction activities for dust and 50 m from construction access routes for traffic-related effects. For operation, the study area extends to 10 km from the proposed plant to reflect the potential dispersion of stack emissions. Baseline air quality was characterised using passive sampling, supplemented by particulate monitoring, while meteorological conditions were characterised using site-specific observations from an on-site automated weather station together with regional data from Port Harcourt International Airport. The combined wet- and dry-season monitoring results indicated that baseline concentrations used in the assessment were below 50% of the applicable air quality standards and that, for the pollutants assessed, the airshed could therefore be considered undegraded.

Construction-phase air quality impacts were assessed separately for dust and traffic-related exhaust emissions. Dust impacts were assessed using a construction dust methodology based on the scale of earthworks, the expected number of vehicles using internal unpaved roads, and the volume of materials to be handled (Figure 5-2). Traffic-related air quality impacts were assessed using a screening method based on the UK Design Manual for Roads and Bridges (DMRB) and IFC guidance, adapted for the traffic fleet likely to occur in Nigeria (Figure 5-3). This is a semi-quantitative method that uses traffic emission factors and a dispersion factor derived from ADMS-Roads for a typical road to estimate roadside pollutant increments and to

provide screening thresholds for minor, moderate and major impacts. This method applies only to road traffic exhaust emissions; dust from vehicle movements on unpaved roads is addressed separately under the construction dust assessment.

For the operational phase, impacts were assessed using atmospheric dispersion modelling (Figure 5-4). The AQIA used the USEPA Aermod 24142 dispersion model to predict pollutant concentrations arising from Project emissions within a 10 km × 10 km modelling domain. Building effects were included in the model, terrain was excluded on the basis that topography is not significant in the vicinity of the Project, and five years of hour-sequential Weather Research and Forecasting (WRF) meteorological data for the period 2018 to 2022 were used. NOx to NO2 conversion was undertaken using 35% for short-term concentrations and 70% for long-term concentrations.

Two operational scenarios were assessed. The first represented emissions from the proposed IFF Line 2 sources, including operation of selective catalytic reduction (SCR) on the IFF Line 2 primary reformer. The second represented the in-combination operation of both IFF Line 1 and IFF Line 2. Model outputs were used to determine the increase in pollutant concentrations attributable to the Project and the resulting total ambient concentrations at sensitive receptors.

The operational significance framework is based on the concepts of Process Contribution (PC) and Predicted Environmental Concentration (PEC). PC is the increase in ground-level pollutant concentration attributable to Project emissions only, while PEC is the PC added to the existing baseline concentration. Significance is determined using a risk-based framework derived from IFC guidance, which recognises that both the Project's incremental contribution and the existing air quality conditions are relevant when evaluating significance. The method is applied in two stages. First, the magnitude of impact is determined by comparing the PC against the adopted air quality standard, with the criteria adjusted according to whether the resulting PEC remains below the standard or exceeds it. Second, the significance of the effect is assigned by considering this magnitude together with receptor sensitivity.

TABLE 5-5: DEFINITION OF MAGNITUDE CRITERIA FOR AIR POLLUTANTS

Magnitude of impact	PEC < AQS	PEC > AQS
Negligible	PC < 10% of AQS	PC < 5% of AQS
Small	PC between 10% and 25% of AQS	PC between 5% and 10% of AQS
Medium	PC between 25% and 75% of AQS	PC between 10% and 25% of AQS
Large	PC > 75% of AQS	PC > 25% of AQS

PC = Process Contribution; **PEC** = Predicted Environmental Concentration; **AQS** = Air Quality Standard.

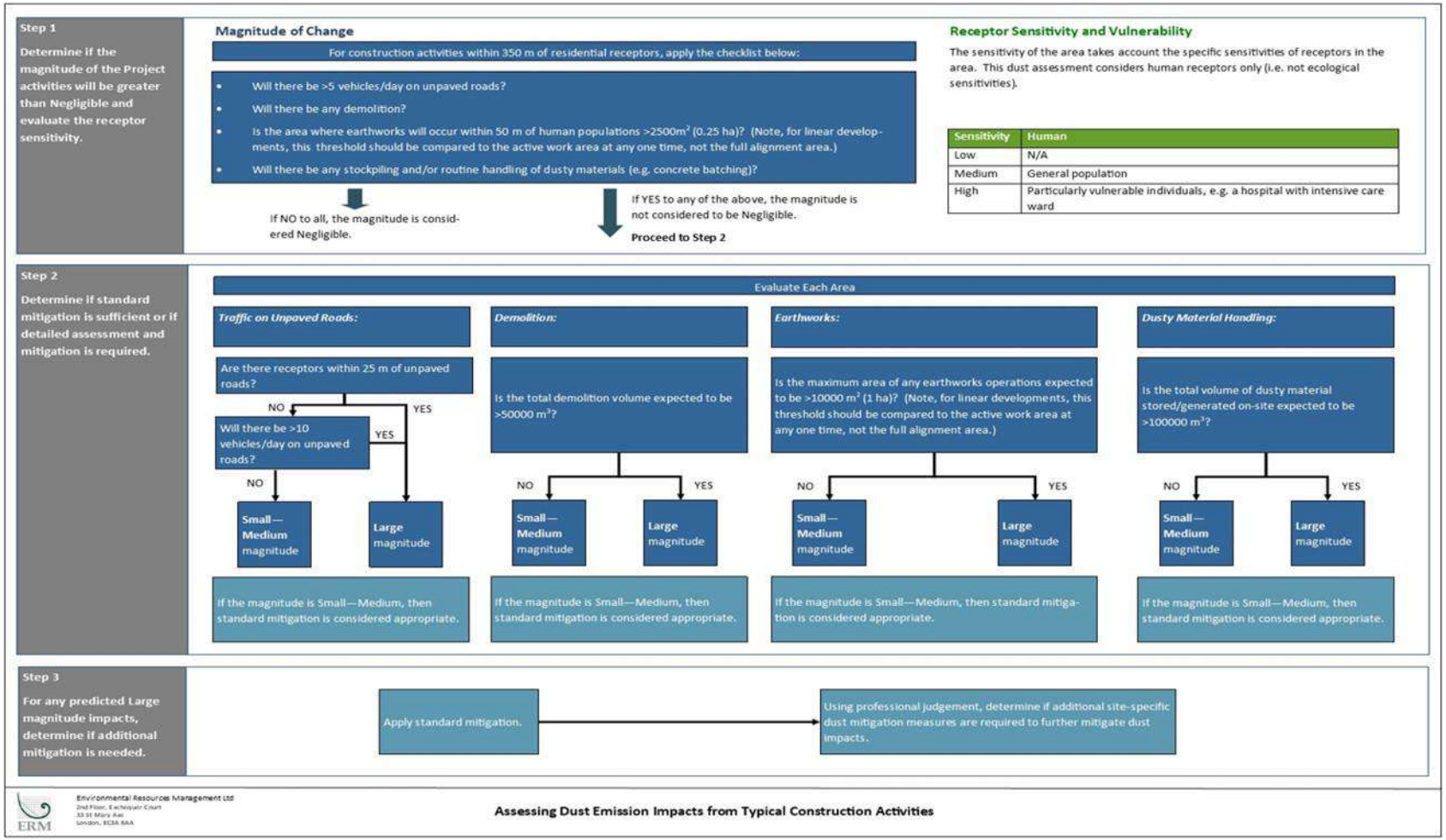


FIGURE 5-2: CONSTRUCTION DUST ASSESSMENT METHODOLOGY

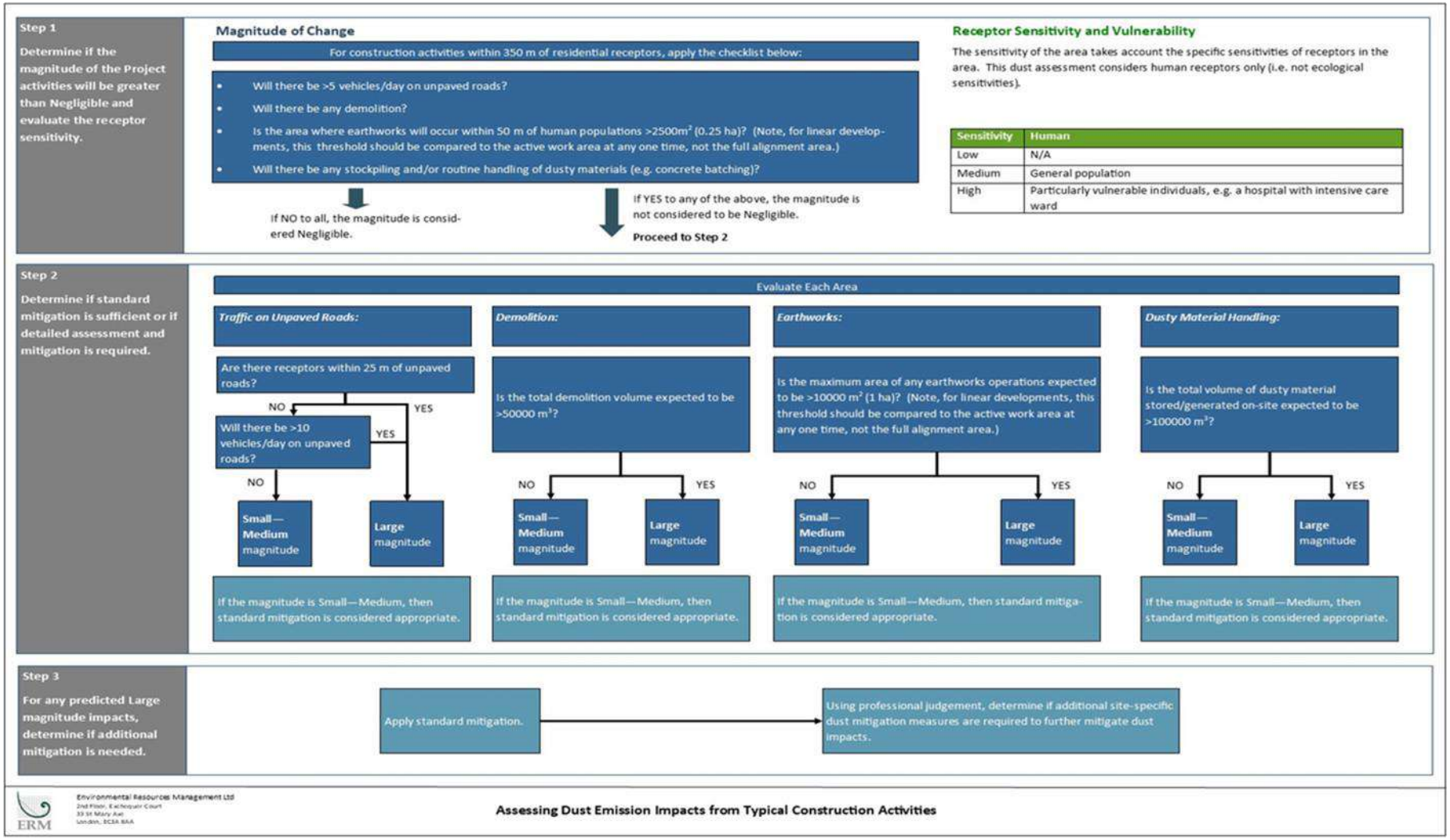


FIGURE 5-3: CONSTRUCTION TRAFFIC AIR QUALITY ASSESSMENT METHODOLOGY

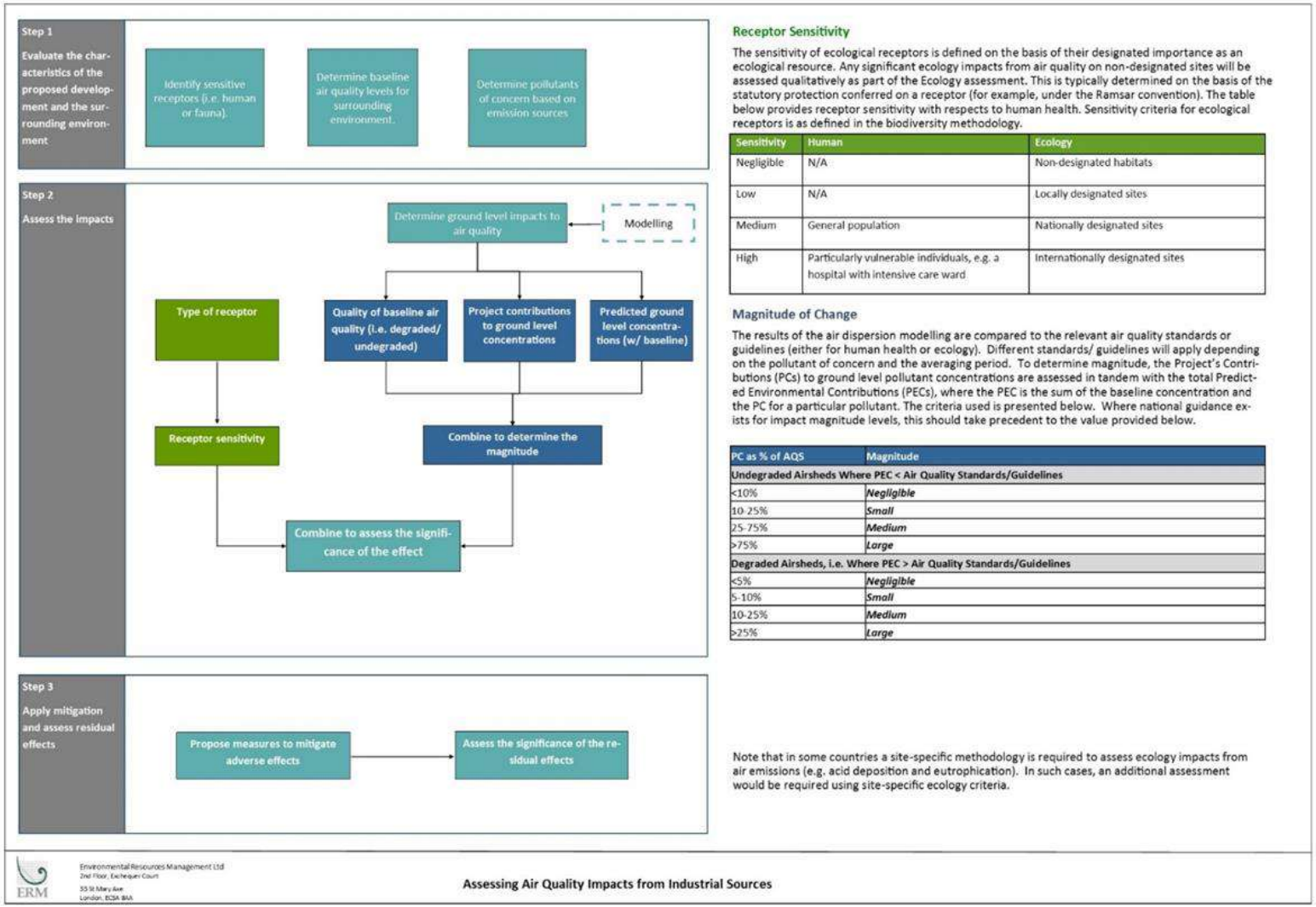


FIGURE 5-4: ASSESSMENT METHODOLOGY OPERATIONAL ACTIVITIES

Receptor sensitivity for air quality was defined to reflect differences in population vulnerability. High sensitivity applies to receptors where particularly vulnerable individuals may be present, including hospitals and schools. Medium sensitivity applies to receptors where the general population is present for large periods of the year, such as residential areas, towns and villages. Low sensitivity applies to receptors where people are transient or present only for short periods, such as agricultural or fishing areas. Within the model domain, the AQIA notes that the sensitivity of human health within the general population at the sensitive human receptors is considered to be medium, given that the adopted air quality standards are already set to protect the most vulnerable members of society and therefore inherently contain a margin of safety.

TABLE 5-6: DETERMINATION OF SIGNIFICANCE FROM MAGNITUDE AND SENSITIVITY FOR AIR QUALITY

Evaluation of Significance		Sensitivity/Vulnerability/Importance of Receptor		
		Low	Medium	High
Magnitude of Impact	Negligible	Negligible	Negligible	Negligible
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

The AQIA also considered cumulative air quality impacts. The cumulative assessment was based on the premise that the monitored baseline already incorporates contributions from surrounding industrial activities, traffic emissions and regional air pollution sources, and then evaluates this baseline in conjunction with the modelled incremental contribution from the combined operation of IFF Line 1 and IFF Line 2. On this basis, the cumulative assessment concluded that, while the Project contributes incrementally to pollutant concentrations, it does not result in exceedance of relevant air quality limits and is therefore associated with a low cumulative impact significance. No additional mitigation measures were identified specifically for cumulative air quality impacts beyond those already defined for the AQIA, including dust management during construction and SCR on the reformer stack.

Accordingly, air quality in this ESIA is assessed using a discipline-specific methodology rather than the generic ESIA significance matrix alone. Construction dust and construction traffic emissions are assessed using screening-based methods appropriate to those impact mechanisms, while operational impacts are assessed using dispersion modelling, Process Contribution (PC) and Predicted Environmental Concentration (PEC,) adopted air quality standards, and receptor sensitivity. Residual significance is then determined after incorporation of the mitigation and management measures set out in Chapter 9 and the ESMMP.

5.6.3.2 NOISE IMPACT ASSESSMENT

Noise impacts were assessed using a dedicated Noise Impact Assessment (NIA) methodology rather than the generic ESIA significance matrix alone. This reflects the fact that noise effects are primarily determined through comparison of predicted noise levels with adopted receptor-specific criteria and by the degree of exceedance above those criteria, together with other relevant factors such as activity duration and receptor context. The NIA was undertaken with due regard to the National Environmental (Noise Standards and Control) Regulations, 2009,

the IFC General EHS Guidelines, Section 1.7 Environmental Noise Management, and BS 5228-1:2009+A1:2014 for construction and open sites.

Scope and Approach

The noise assessment considered the potential effects of both construction and operation on nearby noise sensitive receptors (NSRs). The specialist study focused on noise emissions associated with construction activities, operational plant and related infrastructure, and compared predicted levels with adopted project noise criteria at identified receptors. The study also confirmed that, due to the distances between the Project and surrounding receptors, vibration from construction and operation is anticipated to be insignificant and was therefore scoped out.

An important part of the assessment was the quantification of the existing acoustic environment. Baseline noise monitoring was undertaken at 11 locations during both the wet season and dry season, and results were processed for daytime and night-time periods consistent with the IFC criteria. However, for the purposes of impact prediction, only receptors N2, N3 and N4 were treated as assessment locations because the remaining baseline locations are at greater distances from the Project and were not considered relevant to Project-induced changes. N2, N3 and N4 are located close to the proposed project site at distances approximately 200meters from complex perimeter fences.

The specific noise sensitive receptors used in the assessment, and their distances from the Project, are listed in Table 5-6A. Receptors N2, N3 and N4 are the nearest receptors to the IFF Line 2 footprint, each located approximately 200 m from the Indorama complex perimeter fence; all other baseline locations (N1 and N5–N11) are further from the Project footprint and were used to characterise the baseline acoustic environment only.

TABLE 5-6A: NOISE SENSITIVE RECEPTORS USED FOR IMPACT PREDICTION

Receptor	Description	UTM 32N Easting / Northing (m)	Approximate distance from Indorama complex perimeter fence	Receptor type
N2	Secondary vegetation, north side of the Project	291605.80 / 534469.06	~200 m	Residential / mixed (scattered dwellings)
N3	Iriebe area	290334.67 / 536157.98	~200 m	Residential
N4	New Akpajo area	288839.11 / 535716.09	~200 m	Residential

Applicable Standards and Assessment Criteria

The NIA applies different criteria for the construction and operational phases, reflecting the temporary nature of construction noise and the continuous nature of operational industrial noise. For construction, the assessment uses the Nigerian construction noise criteria. For operation, the assessment adopts the more stringent IFC criteria for residential, institutional and educational receptors.

Construction Phase Criteria

For temporary construction activities, significant adverse effects are judged by comparison with the Nigerian construction noise criteria and the IFC EHS Guidelines. Although the IFC EHS Guidelines do not set noise limits specific to construction, the IFC General EHS Guidelines noise level guidelines (55 dB(A) daytime and 45 dB(A) night-time at residential, institutional and educational receptors) have also been applied to construction noise as the more stringent criterion (Table 5-7A). The specialist report states that construction activities are expected to take place during the daytime only, and the significance of construction noise is therefore assessed using the daytime criteria only.

TABLE 5-7: PROJECT NOISE CRITERIA FOR CONSTRUCTION PHASE

Receptor	**Maximum noise level permitted L_{Aeq} dB(A)**	
	Day time	Night-time
Hospitals, schools institutions of higher learning, homes for the disabled, etc.	60	50
Buildings other than those prescribed above	75	65

Construction activities will take place only during the day time, therefore the assessment of construction noise is based only on the daytime noise criteria (i.e. – those included in bold in Table 5-7).

The daytime and night-time periods applied to all noise criteria in this ESIA are 07:00–22:00 (daytime) and 22:00–07:00 (night-time). In response to lender review, construction noise has also been assessed against the IFC General EHS Guidelines noise level guidelines, which are more stringent than the Nigerian construction criteria for residential, institutional and educational receptors. For the impact assessment, the more stringent value is adopted, as summarised in Table 5-7A.

TABLE 5-7A: CONSTRUCTION NOISE CRITERIA – COMPARISON OF NIGERIAN AND IFC EHS GUIDELINE VALUES (ONE-HOUR LAEQ, DB(A))

Receptor	Nigerian construction criteria – Day (07:00–22:00) / Night (22:00–07:00)	IFC General EHS Guidelines – Day (07:00–22:00) / Night (22:00–07:00)	Criterion adopted for the construction noise assessment
Residential, institutional and educational receptors (including hospitals, schools and homes for the disabled; NSRs N2, N3 and N4)	60 / 50 (hospitals, schools etc.); 75 / 65 (other buildings)	55 / 45, or a maximum increase of 3 dB above background	55 / 45 dB(A) (IFC – more stringent)
Industrial and commercial receptors	75 / 65	70 / 70	70 / 65 dB(A)

Should construction noise monitoring at any noise sensitive receptor show the adopted criterion being exceeded (LAeq,1h above 55 dB(A) during the day, or above 45 dB(A) during any unavoidable night-time work), or an increase of more than 3 dB above the measured

background, IFF shall require the contractor to stop or modify the activity and implement additional controls under the Construction Noise Management Plan before work resumes. These include temporary acoustic barriers or hoardings between the works and the receptor, relocation or acoustic enclosure of stationary plant, use of lower-noise methods and equipment, restriction of high-noise activities such as piling to 08:00–18:00 on weekdays, and advance notification of the affected community (Section 9.2.5).

The assessment of construction noise significance differs from most other ESIA topics. The significance of a construction noise impact is derived primarily from the degree of exceedance above the adopted criterion, but may also take account of other factors such as the duration of the activity and the capacity of receptor infrastructure to attenuate sound. Receptor sensitivity is therefore embedded within the criteria and the significance interpretation.

The Project noise criteria used to assess the magnitude and significance of construction noise effects are included in Table 5-8.

TABLE 5-8: MAGNITUDE AND SIGNIFICANCE OF CONSTRUCTION NOISE EFFECTS

Exceedance of criteria, dBA	Magnitude of predicted impact	Other relevant factors	Resulting Significance of effect
5 or more below the criteria	Negligible	Factors which may influence significance of effects, e.g. duration of construction activity	Negligible
> 5 below, up to the criteria	Small		Minor
Up to 5 dB above the criteria	Medium		Moderate
> 5 above the criteria	Large		Major

The classification of significance refers to Negligible, Minor, Moderate and Major. Impacts rated as Moderate or Major should be mitigated where practicable, feasible and reasonable with proportionately more emphasis on the Major items. Mitigation may not fully eliminate an impact but would be expected to reduce its severity.

Project Nosie Criteria – Operational Phase

For Project activities during the operational phase to create a significant noise impact, the noise generated must be above the noise impact threshold levels, as summarised in Table 5-9 and Table 5-10**.**

TABLE 5-9: PROJECT NOISE CRITERIA FOR OPERATIONAL PHASE AT RECEPTORS

Receptor	One Hour L_{Aeq} (dB(A))	
	Daytime (07:00 – 22:00)	Night (22:00 – 07:00)
Residential; institutional; educational	55	45

The Project noise criteria used to assess the magnitude and significance of operational noise effects are included in Table 5-9 **.** Existing baseline noise levels at the assessed receptors N2, N3 and N4 are below the IFC absolute criteria for day and night time, and therefore the assessment for operational noise is based on the absolute IFC criteria for day and night time, and the assessment for construction noise on the more stringent of the National and IFC criteria (Table 5-7A).

TABLE 5-10: MAGNITUDE AND SIGNIFICANCE OF OPERATIONAL NOISE EFFECTS

Exceedance of criteria, dBA	Magnitude of predicted impact	Other relevant factors	Resulting Significance of effect
> 5 below, up to the criteria	Negligible	Factors which may influence significance of effects, e.g., how well NSR infrastructure can attenuate noise	Negligible
Up to 5 dB above the criteria	Small		Minor
> 5 to 10 dB above the criteria	Medium		Moderate
> 10 dB above the criteria	Large		Major

Note (Interpretation of Noise Significance): In the context of the noise assessment, Negligible indicates no significant effect and no mitigation requirement; Minor indicates a detectable but limited effect; Moderate indicates a significant effect for which mitigation should be considered; and Major indicates a significant and undesirable effect for which mitigation must be considered. Impacts rated moderate or above are therefore the focus of mitigation and management attention.

Baseline Noise Conditions

The baseline component of the NIA established the acoustic context against which Project-induced noise changes were assessed. Measurements were undertaken at 11 monitoring locations between 16 to 25 October 2025 during the rainy season and 20 February to 5 March 2026 during the dry season. Measurements were processed over daytime (07:00–22:00) and night-time (22:00–07:00) in order to align with IFC criteria. To improve reliability, data collected during rainfall and at wind speeds above 5 m/s were excluded from the analysis. The

specialist report states that LAeq was used as the principal metric for impact assessment because it is the metric referenced in both Nigerian regulations and IFC guidance.

The baseline results show that daytime LAeq levels remained below 55 dB at all monitored locations. At night-time, measured LAeq exceeded the 45 dB IFC criterion at location N9 only. As noted above, only N2, N3 and N4 were used as assessment receptors in the impact modelling because they are the receptors nearest to the Project footprint. These receptors are closest to the project site and distances approximately 200 meters from the project perimeter fence

Predictive Noise Modelling

Project-specific predictive noise modelling was undertaken for both the construction and operational phases to estimate Project-induced noise levels at nearby NSRs. The specialist report states that modelling was carried out using iNoise V2026.1 (DGMR) and ISO 9613-2:2024, which is the international engineering method for the prediction of sound pressure levels outdoors. The software allowed topography, ground conditions, building structures and receptor locations to be represented in the model in order to estimate the contribution from multiple sources under relevant scenarios.

Significance Determination and Residual Effect

The pre-mitigation and residual significance of noise impacts are interpreted within the noise-specific framework described above. For construction, the specialist report concludes that noise associated with construction activities would result in a direct, negative, negligible impact at the assessed receptors against the Nigerian criteria; against the more stringent IFC daytime value adopted for this ESIA, worst-case construction noise at N3 is of Moderate significance before targeted mitigation and Minor after (Section 8.2.4). For operation, noise associated with plant engines, ventilation, air-charge intakes and other installations is likewise assessed as a direct, negative, negligible impact. In both cases, the receptors are treated as being of medium sensitivity in the context of the specialist impact tables.

Despite the low predicted impact, the specialist report recommends that periodic noise monitoring be undertaken at representative NSRs during both construction and operation in order to confirm compliance with adopted criteria. It also recommends that, if exceedances are identified, corrective actions should be implemented through a Noise Management Plan.

Noise monitoring shall be undertaken at receptors N2, N3 and N4, and at any location where a noise complaint is received, at the following frequency: monthly during construction (weekly during piling and other high-noise activities near the northern site boundary); once after commissioning with the plant at full load; and annually thereafter during operation, or following any significant plant modification or noise complaint. Results shall be compared with the criteria in Tables 5-7A and 5-9 and reported in the monthly construction E&S report and the annual environmental and social monitoring report. A Noise Management Plan has been developed as part of the ESMMP (Appendix C).

Accordingly, noise in this ESIA is assessed using a discipline-specific methodology based on adopted construction and operational criteria, predictive acoustic modelling, and explicit phase-specific modelling assumptions, rather than through application of the generic receptor–magnitude significance matrix alone. This approach is consistent with the source-specific and

receptor-specific nature of industrial noise assessment and provides a transparent basis for interpreting predicted noise levels at the nearest sensitive receptors.

5.6.3.3 PHYSICAL CLIMATE CHANGE RISK ASSESSMENT

Physical climate change risk is assessed using a hazard-based screening and scenario analysis methodology rather than the standard significance matrix. The assessment considers acute and chronic climate hazards that may affect the Project during construction and operation and how those risks may evolve over time. It therefore differs from the conventional receptor-based impact method used for most ESIA topics.

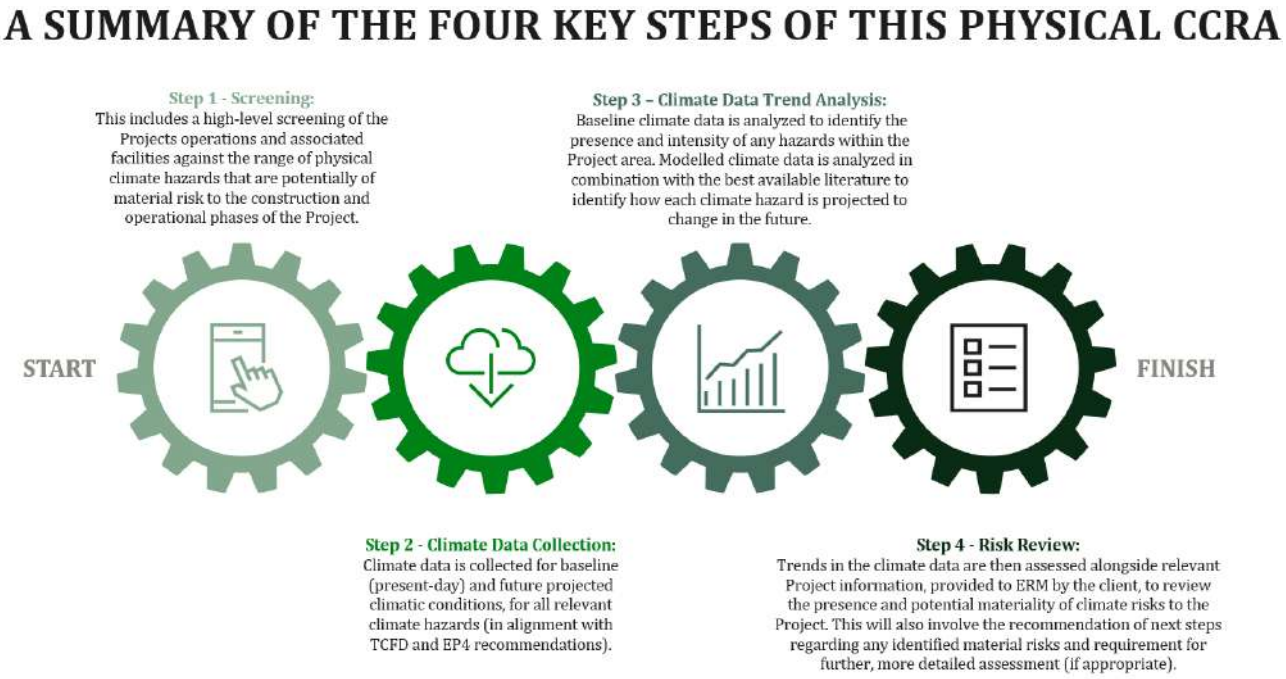


FIGURE 5-5: PHYSICAL CLIMATE CHANGE RISK ASSESSMENT PROCESS

TABLE 5-11: CLIMATE SCENARIOS USED IN THE PHYSICAL CCRA

Scenario	Definition	Mean annual temperature increase by 2100 compared with pre-industrial average
SSP1-2.6	Sustainable pathway with significant emissions reduction	+1.8°C
SSP5-8.5	Very high emissions pathway	+4.4°C

TABLE 5-12: TIME HORIZONS INCLUDED IN THE PHYSICAL CCRA

Future Time Horizon	Justification
Baseline (present-day)	**Existing climate trends and near-term construction conditions**
2030	**Near-term operational conditions**
2050	**Later operational conditions**

The output of the physical climate risk assessment is a materiality rating, rather than a conventional ESIA significance class. Materiality is categorised as High, Moderate, Low or Unlikely material, according to the degree to which a climate hazard could materially affect Project assets, access, operations or surrounding receptors.

TABLE 5-13: MATERIALITY RATINGS USED FOR THE PHYSICAL CCRA

Materiality Rating	Description
High	Significant potential risk to Project assets and likely material effect on one or more receptor types
Moderate	Moderate risk to Project assets and likely effect on one or more receptor types
Low	Minimal risk to Project assets; effects likely minor and limited
Unlikely material	Negligible risk with no credible pathway to material effect

5.6.3.4 GREENHOUSE GAS ASSESSMENT

Greenhouse gas emissions are assessed using a dedicated accounting and benchmarking method rather than the standard receptor–magnitude significance matrix. This reflects the global and long-term nature of greenhouse gas impacts and the need to evaluate significance in a broader policy and benchmarking context. The assessment applies recognised greenhouse gas accounting principles and reports emissions in tonnes of carbon dioxide equivalent.

Construction emissions are estimated using a Tier 1 approach based on indicative fuel and equipment assumptions. Operational emissions are estimated using a Tier 2 approach based on more refined activity data. Significance is then evaluated using benchmark thresholds and contextual proportionality rather than through direct comparison with receptor sensitivity.

TABLE 5-14: BENCHMARK THRESHOLDS FOR ANNUAL CO_2E EMISSIONS

GHG Emissions (tCO_2e/annum)	Qualitative Rating
< 10,000	Nominal / Negligible
10,001 – 25,000	Low
25,001 – 100,000	Medium-Low
100,001 – 1,000,000	Medium-High
> 1,000,001	High

Note: For GHGs, significance is not assigned through the standard ESIA impact significance matrix because the consequence of emissions is diffuse, cumulative and global rather than localised to a single environmental or social receptor. Benchmarking and proportional context are therefore used to interpret significance.

5.6.3.5 CULTURAL HERITAGE IMPACT ASSESSMENT

Cultural heritage is assessed using a heritage-specific methodology that considers the value and significance of both tangible and intangible heritage resources, together with the extent to which Project activities may directly, indirectly or cumulatively affect them. A precautionary

approach is applied where uncertainty exists, and a Chance Finds Procedure is required as part of Project implementation to manage previously unidentified resources.

For cultural heritage, receptor sensitivity is categorised according to heritage value and irreplaceability. Impact magnitude is determined according to the degree of physical loss, setting change, access restriction or structural damage associated with the Project. This differs from the generic ESIA method because significance is strongly influenced by the legal protection, non-replicability and stakeholder value of the heritage resource.

TABLE 5-15: CULTURAL HERITAGE SENSITIVITY CRITERIA

Low	Medium	High
Replicable cultural heritage with limited legal or stakeholder value	Non-replicable cultural heritage with considerable cultural or scientific value	Critical cultural heritage protected by law and of substantial stakeholder value

TABLE 5-16: IMPACT MAGNITUDE DEFINITIONS FOR CULTURAL HERITAGE

Magnitude	Cultural Heritage Resources
Negligible	No discernible change in physical condition, setting or accessibility
Small	Small part of site lost or damaged; limited setting change; temporary restriction of access
Medium	Significant portion of site lost or damaged; permanent setting change; site inaccessible for the life of the Project
Large	Entire site damaged or lost; near-complete or complete loss of cultural value or functionality

5.6.4 MITIGATION HIERARCHY, RESIDUAL SIGNIFICANCE AND MONITORING LINKAGE

Mitigation measures identified through the ESIA are developed in accordance with the mitigation hierarchy: avoid, minimise, restore, and offset / compensate where relevant. Measures are designed to be specific, practical, measurable and capable of implementation through the Project's management system. Once mitigation has been defined, residual significance is re-evaluated so that the remaining level of risk or effect can be clearly communicated.

The methodology described in this section therefore establishes a direct line of traceability between: baseline condition → impact pathway → significance assignment → mitigation measure → residual significance → monitoring requirement.

This linkage is carried forward into Chapter 8, Chapter 9 and the ESMMP to ensure internal consistency across the ESIA and auditability for regulatory and lender review (Figure 5-6).

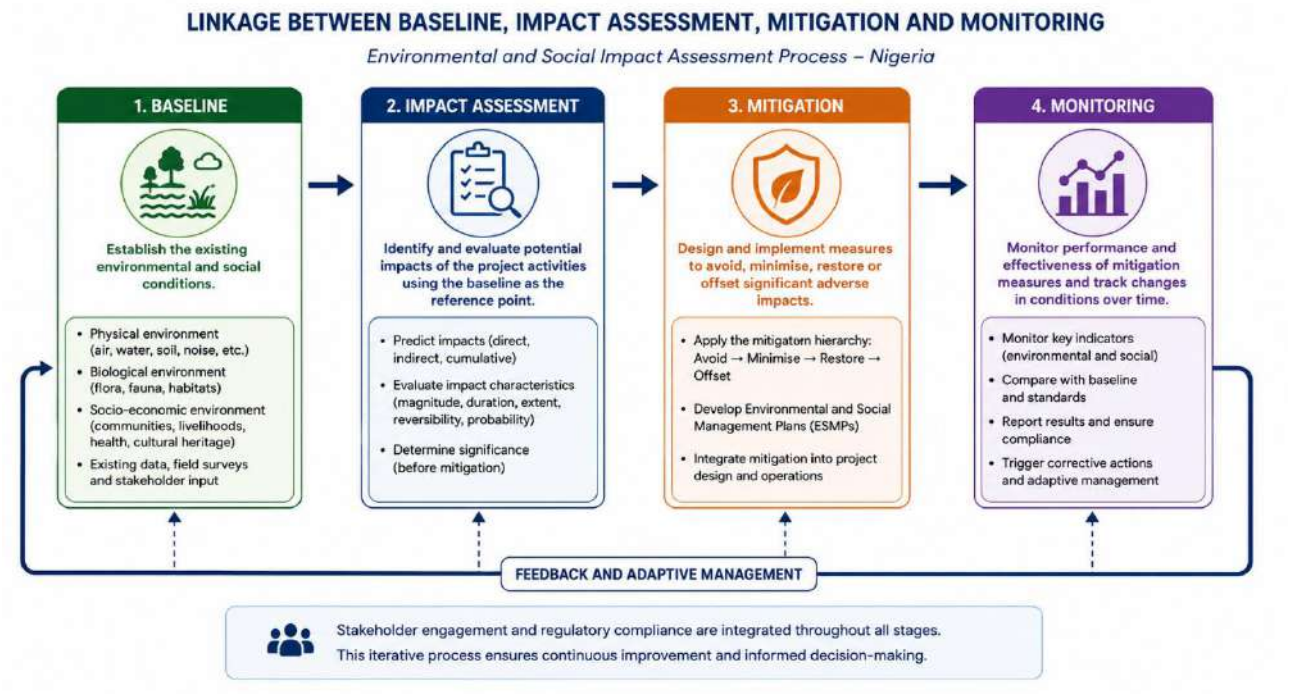


FIGURE 5-6: ENVIRONMENTAL ASSESSMENT PROCESS FLOW DIAGRAM

5.7 ESIA AND ESMMP REPORTING

Following completion of the detailed environmental and social impact assessment, the findings were consolidated into the ESIA and translated into a structured set of management, mitigation and monitoring commitments through the ESMMP. This stage of the process ensures that the technical findings of the specialist studies and the integrated impact assessment are not presented as stand-alone conclusions, but are instead converted into practical, auditable and implementable project commitments aligned with the Applicable Project Standards and the requirements of the FMEnv.

5.7.1 ESIA REPORTING

Using the data generated through the specialist studies and the integrated impact assessment process, ERM prepared the ESIA in accordance with the ERM Impact Assessment Standard and the Applicable Project Standards. The reporting process was iterative and ran in parallel with project design development, so that environmental and social considerations could be incorporated into project decision-making as design information became available and as assumptions were refined. This approach also drew on validated information and relevant contextual material already available for the wider industrial complex, where appropriate, while ensuring that the ESIA remained focused on the incremental impacts, interfaces and commitments associated with the IFF Line 2 Project.

In reporting the results of the impact assessment, impacts on each resource and receptor were presented in three linked stages:

- a description of the potential impact together with assignment of a pre-mitigation significance level;
- a summary of the mitigation measures or controls committed to by the Project; and

- a description and significance rating of the residual impact, that is, the impact expected to remain after mitigation has been applied. This structure ensures that the ESIA provides a transparent line of reasoning from baseline condition, through predicted effect, to mitigation and residual outcome.

TABLE 5-17: ESIA REPORTING LOGIC APPLIED AFTER IMPACT ASSESSMENT

Step	Purpose	ESIA Output
Impact description and pre-mitigation significance	To document the nature of the predicted impact and its significance before additional mitigation	Impact text and pre-mitigation rating in Chapter 8
Mitigation identification	To define the Project controls and additional measures required to avoid, minimise, manage or offset impacts	Mitigation measures in Chapters 8 and 9
Residual impact evaluation	To determine the significance of the impact after mitigation is assumed to be effectively implemented	Residual significance in Chapter 8 and linked commitments in Chapter 9 / ESMMP

5.7.2 DEVELOPMENT OF THE ESMMP

The draft ESIA culminated in the preparation of the draft ESMMP, which provides the mechanism through which the mitigation and monitoring commitments arising from the ESIA are carried forward into project implementation. The purpose of the ESMMP is to set out the measures required to avoid, minimise or reduce adverse environmental and social impacts, while also providing for the enhancement or realisation of positive impacts where relevant. The ESMMP therefore serves as the operational bridge between the analytical findings of the ESIA and the practical requirements that will apply during pre-construction, construction and operation.

The ESMMP contains the set of management, mitigation and monitoring measures to be implemented during the planning (pre-construction), construction and operational phases of the Project. It details the specific actions required to implement the agreed controls and mitigation measures identified through the ESIA and establishes the basis for performance tracking, compliance verification and adaptive management. The Management Plans included within the ESMMP are intended to be refined as detailed design progresses and are to be reflected in contractor method statements, procedures and work practices.

TABLE 5-18: MAIN FUNCTIONS OF THE ESMMP

Function	Description
Mitigation implementation	Converts ESIA mitigation measures into defined actions for project implementation
Monitoring and verification	Identifies the parameters, indicators and performance requirements needed to confirm that mitigation measures are effective
Roles and accountability	Supports allocation of responsibilities through the wider ESMS and project management arrangements
Adaptive management	Provides the basis for corrective action, follow-up measures and refinement of controls where required

Function	Description
Contractor integration	Requires contractors and subcontractors to align their procedures and work practices with the Management Plans

5.7.3 LINKAGE TO THE ENVIRONMENTAL AND SOCIAL MANAGEMENT SYSTEM

The ESMMP forms an integral part of the wider ESMS for the Project. In this way, the ESIA addresses the core planning elements of environmental and social management by identifying impacts and defining mitigation measures, while the ESMS provides the framework through which those measures are implemented, monitored, checked and continually improved. This approach is aligned with IFC Performance Standard 1, AfDB Operational Safeguard 1 and is intended to provide assurance to regulators, stakeholders and lenders regarding the Project's environmental and social performance.

Under this framework, the ESMS supports:

- prioritisation and management of significant environmental and social impacts;
- implementation of mitigation measures identified in the ESIA and ESMMP;
- compliance monitoring, inspection, auditing and reporting;
- integration of environmental, social and project-related health considerations into decision-making; and
- management of unforeseen impacts or changes that may arise during construction or operation.

5.7.4 REVIEW, DISCLOSURE AND FINALISATION PROCESS

Once prepared, the draft ESIA and draft ESMMP were issued for Client review and comment. The proposal allowed for a formal review cycle comprising draft issue, review by the Client, incorporation of comments by ERM and issue of revised documents. Thereafter, the draft ESMMP and ESIA were intended to undergo public disclosure and review by national authorities and lenders. Provision was also made for a further review cycle to address comments received from those authorities and lenders, as well as for limited engagement with lenders to discuss comments on the draft report.

This review and disclosure process is important because it allows the ESIA and ESMMP to function not only as technical reports, but also as disclosure and due diligence documents. Through this process, the reporting stage supports transparency, public participation, regulatory review and lender appraisal, while also allowing deferred actions, data gaps or follow-up measures to be documented clearly and carried through into implementation requirements where necessary.

For finalization of ESIA document, the standard/ agreed protocol will be used. The Lenders comments will be addressed in documents directly in track mode and clean & track mode will be shared electronically with Lenders. The FMEnv comments will be addressed and final ESIA including Comments-Response matrix will be submitted to FMEnv in Hard & Soft copies for review and approval.

In line with standard AfDB practice under the Integrated Safeguards System (OS1 and OS10), the draft ESIA and ESMMP for a Category 1 operation are first reviewed and cleared by the

Bank. Only then are they submitted to the FMEnv for public display and review, and disclosed by the Bank, so that the documents released to the public already meet lender requirements.

5.7.5 REPORTING OF MONITORING AND PERFORMANCE

The management framework developed for the Project includes internal and external reporting mechanisms to assess the effectiveness of the ESMS and the implementation of the ESMMP. Internal reporting is intended to support the identification and correction of environmental, social and health and safety non-conformances, while external reporting may be prepared on defined issues of interest or concern to local communities, regulators or other stakeholders. Monitoring data generated through implementation of the ESMMP are to be reviewed by the Project, and annual performance reporting is envisaged to support review of performance and the setting of targets and objectives for subsequent periods.

The environmental and social performance monitoring report will also be submitted to the lenders as per the frequency and format agreed according to loan agreement.

The environmental and social reporting obligations of IFF to AfDB and the other lenders are summarised in Table 5-18A. The exact frequencies, formats and notification periods shall follow those stipulated in the Common Terms Agreement (CTA) and loan agreements; where the CTA is silent, the indicative arrangements in Table 5-18A apply.

TABLE 5-18A: SUMMARY OF ENVIRONMENTAL AND SOCIAL REPORTING OBLIGATIONS TO LENDERS AND REGULATORS

Report / notification	Recipient	Frequency / timing	Key content and performance indicators
Monthly E&S progress report (construction)	AfDB and other lenders; lenders' independent E&S consultant	Monthly from financial close to completion of construction	Status of ESMMP and ESAP actions; environmental monitoring results and exceedances; OHS statistics (fatalities, lost-time injuries, LTIFR/TRIR); workforce numbers and share of local recruitment; labour influx and accommodation; grievances received and closed within the agreed timeframe (community and worker); stakeholder engagement; contractor non-conformances and corrective actions; training
Quarterly Monitoring Report (operation)	AfDB and other lenders, in the lenders' prescribed formats	quarterly, for the life of the loan	ESMS performance; compliance with emission, effluent, ambient and noise standards; GHG inventory and intensity; water abstraction and groundwater monitoring; waste; OHS and community health and safety indicators; grievances; community investment; status of ESAP actions
Serious incident notification	AfDB and other lenders; FMEnv / NESREA / RSMEnv as applicable	Within 3 working days of a serious incident (fatality, serious injury, major release or spill, significant community or security incident), or as stipulated in the CTA	Description of the incident, immediate response and containment, preliminary cause; followed by a root-cause investigation report and corrective action plan within 30 days

Report / notification	Recipient	Frequency / timing	Key content and performance indicators
Lender monitoring visits and audits	AfDB and other lenders; independent E&S consultant	Semi-annual during construction and annual during operation, or as agreed	Verification of ESMMP/ESAP implementation and corrective actions

Where monitoring shows impacts different from those predicted in the ESIA, or performance indicators are not met, IFF shall apply adaptive management through the ESMS: the deviation shall be investigated, corrective and preventive actions defined and implemented, monitoring intensified until the issue is resolved, and the ESMMP, management plans and contractor requirements updated. Material changes and their resolution shall be reported to the lenders in the next periodic report, or immediately where they constitute a serious incident.

In this way, the reporting process does not end with issue of the ESIA. Rather, the ESIA and ESMMP establish the initial framework for environmental and social management, while the wider Project reporting system supports implementation, corrective action, periodic review and continuous improvement over the life of the Project.

6. STAKEHOLDER ENGAGEMENT

6.1 INTRODUCTION

This Chapter presents a summary of the stakeholder engagement activities undertaken and planned as part of the ESIA process for the IFF Line 2 Fertilizer Project. It also serves as a summary of the more detailed Stakeholder Engagement Plan (SEP), which sets out the engagement approach, identifies stakeholders, and describes the mechanisms through which stakeholders have been and will continue to be engaged. The SEP has been developed for the life of the Project and provides an implementation framework for engagement during the remainder of permitting, construction, operation and decommissioning. The complete SEP is included in Appendix B.

The stakeholder engagement process has been designed to meet both Nigerian ESIA requirements for public participation and international good international industry practice, including the requirements of IFC PS1, AfDB OS1 and AfDB OS10 (Stakeholder Engagement and Information Disclosure) for ongoing, meaningful, inclusive and culturally appropriate stakeholder engagement. In line with these requirements, the SEP is intended to ensure that stakeholders receive timely and accessible information, are given opportunities to express views and concerns, and are able to influence project planning and management through structured engagement and grievance mechanisms.

Stakeholder engagement for IFF Line 2 has not been undertaken in isolation. Because the Project is an expansion within an existing industrial complex, the engagement approach has built on longstanding stakeholder relationships maintained by Indorama since 2007, the stakeholder records and lessons from earlier projects, and the broader operations-wide stakeholder engagement strategy that ERM prepared for Indorama's operations in Eleme. The project-specific SEP for IFF Line 2 was then aligned to this wider operational framework so that stakeholder identification, engagement approaches, communication channels and grievance arrangements remained consistent across the wider Indorama context while still reflecting IFF Line 2–specific issues and sensitivities.

6.2 OBJECTIVES AND PRINCIPLES OF STAKEHOLDER ENGAGEMENT

The key objectives of stakeholder engagement for this Project are to:

- To understand the interests, influence, and concerns of various Project stakeholders.
- To ensure effective, transparent, and timely communication between the Project and its stakeholders, to engender an environment of trust and mutual respect.
- To engage stakeholders on their concerns regarding the Project, and appropriately address these through dialogue and corrective actions.
- To establish effective means of communication to disseminate information from the Project to stakeholders.
- To design stakeholder engagement mechanisms and standards that respect local traditions and cultural norms.
- To effectively manage the expectations of stakeholders regarding socio-economic benefits derived from the Project.

- Establish the appropriate management mechanisms and identify necessary capacity building and training requirements for the effective implementation of the SEP.

The key principles guiding the Project's approach to stakeholder engagement are as follows:

- **Transparency**: to be open and transparent with stakeholders.
- **Accountability**: to be willing to accept responsibility as a corporate citizen and to account for impacts associated with the Project activities.
- **Trust**: to have a relationship with stakeholders that is based on mutual commitment to acting in good faith.
- **Mutual Respect**: to respect stakeholders' interests, opinions, and aspirations.
- **Collaboration**: to work cooperatively with stakeholders to find solutions that meet common interests.
- **Responsiveness**: to coherently respond in good time to stakeholders.
- **Proactiveness**: to act in anticipation of the need for information or potential issues.
- **Fairness**: to engage with stakeholders such that they feel they are treated fairly, and their issues and concerns are afforded fair consideration.
- **Accessibility**: to be within reach of stakeholders so that they feel heard and to provide meaningful information as needed.
- **Inclusivity**: to proactively anticipate, identify and include all relevant stakeholders.

These principles are consistent with the operations-wide stakeholder management framework and the requirements of IFC PS1 and AfDB OS1 and OS10 for meaningful consultation. They are also consistent with the commitment in the project SEP that engagement should be free from manipulation, interference, coercion and intimidation.

In practical terms, these principles mean that Indorama's engagement approach for IFF Line 2 has aimed to: provide stakeholders with understandable information in appropriate formats and languages; engage potentially affected stakeholders early enough for issues to be identified and considered; ensure that vulnerable groups are not excluded from project processes; maintain predictable and structured channels for information sharing; and provide accessible grievance pathways through which concerns can be raised and addressed. These features are particularly important in the Eleme context, where socio-economic vulnerability, reliance on informal livelihoods, and historic perceptions of industrial development can affect how communities interpret project risks and opportunities.

6.3 IDENTIFICATION OF STAKEHOLDERS

For the purposes of this ESIA, a stakeholder is any individual or group who may be affected by the Project, or who has an interest in the Project and its potential impacts. Because the Project is an expansion adjacent to existing Indorama activities, stakeholder identification for IFF Line 2 drew on the existing stakeholder databases and engagement records from the earlier projects, and on the consolidated operational-level stakeholder engagement strategy for the wider Indorama operations in Eleme. Stakeholder identification and mapping are treated as a continuous process, and the SEP provides that the stakeholder database should be updated as new stakeholders emerge or as stakeholder relationships change over time.

The SEP identifies stakeholders across both the Area of Direct Influence (ADI) and the Area of Indirect Influence (AII). This reflects the fact that IFF Line 2 may generate both direct impacts in immediately adjacent communities and indirect effects along transport corridors, service networks and wider socio-economic systems. The stakeholder universe therefore includes government and regulatory authorities, host communities, non-host communities within the wider AoI, vulnerable groups, civil society, business and labour organisations, media, academia and the general public.

A particularly important feature of the stakeholder landscape is the distinction between the six host communities represented through the Project Advisory Committee (PAC) and other communities in the wider AoI. The SEP records that the PAC comprises representatives from Aleto, Okerewa, Agbonchia, Njuru, Akpajo and Elelenwo (Wakoahu Family) and serves as the principal formal interface between Indorama and host communities on matters such as ESIA consultation, MoU implementation, employment, contracts and community development commitments. The broader social baseline and household survey also included Iriebe as part of the Area of Direct Influence for socio-economic assessment purposes, indicating that the wider social baseline extends beyond the formal host community structure**.**

TABLE 6-1: STAKEHOLDER IDENTIFICATION[18]

Stakeholder Category	Stakeholder Groups	Stakeholders	Connection to Project
Government	• Federal Ministry of Environment • Rivers State Ministry of Environment • Rivers State Ministry of Chieftaincy and Community Affairs • Nigerian Ports Authorities • Eleme Local Government	• Director, Environment Assessment Department, Federal Ministry of Environment • Director, Pollution Control & Environment Health Department, Federal Ministry of Environment • Rivers State Commissioner of Ministry of Environment • Director, Pollution Control Department, Rivers State Ministry of Environment • Director, Environment Assessment Department, Rivers State Ministry of Environment • DG, National Environmental Standards and Regulations Enforcement Agency (NESREA) • Director, Planning & Policy analysis, National Environmental Standards and Regulations Enforcement Agency (NESREA) • Rivers State Commissioner of Chieftaincy & Community Affairs • Chief Environment Office, NPA, Onne Port Complex,	Environmental Regulatory bodies are of primary importance in terms of establishing policy, granting permits or other approvals for the Project, and monitoring and enforcing compliance with Nigerian law throughout all stages of the Project life cycle. Regional and Local Governments may input into the permitting process and may have a role in monitoring the implementation of Project commitments included in the ESMP.

[18] A full database of all stakeholders should be maintained separately from the SEP and should be updated as new stakeholders are identified, or at least on an annual basis.

Stakeholder Category	Stakeholder Groups	Stakeholders	Connection to Project
		• Supervisor to Environment, Eleme Local Government	
Communities and Leadership	• Eleme Council of Traditional Rulers • Clan Heads and council of chiefs in respective Clan / Communities • Community Development Committees	• King of Eleme • Emere Nchia • Respective Clan Heads of following six (6) Host Communities: Aleto Okerewa Agbonchia Njuru Akpajo Elelenwo (Wakoahu Family)	Originally the land was acquired by Rivers State Government in the year 1984. Government has paid compensation to all impacted communities. Since then, communities are not carrying out any socio-economic activities in the said 250 hectares of land. However, there will be social, environmental, and economic impacts connected to project construction and operation of manufacturing facility. Traditional rulers play vital role in community development, civil administration, and socio-economic wellbeing in their domain by interfacing with the government. Traditional rulers are custodian of cultures, customary territorial rights, and privileges of people in their communities. Traditional rulers preside over civil and customary grievance / dispute resolution processes. Traditional rulers represent and protect the socio – economic interest of the communities before government and external agencies. Traditional rulers participate in Public Forum discussions and Technical Panel review as part of ESIA. Traditional rulers' interface with Indorama for MOU and its implementation. Rivers State government has constituted a Project Advisory Committee (PAC). PAC members are nominated by respective host communities. PAC has the primary responsibility to interface with the company and preside over MOU and its implementation. • Monitoring implementation of MOU for the following: Community Development Projects Contracts and supplies

Stakeholder Category	Stakeholder Groups	Stakeholders	Connection to Project
			Employment during construction and operation phase. Scholarship programmes for youth studying in universities. Micro Grant for women for micro business Skill development programme for young men and women.
Directly Impacted Communities and Leadership	• Communities impacted by operations. • Community Development Committee • Traditional rulers • Youth Representatives	– Aleto – Okerewa – Agbonchia – Njuru – Akpajo – Elelenwo – Iriebe	Traditional rulers, members of community development committees, PAC members, youth representatives, women representatives; • Participate in ESIA Public forums to discuss positive / negative impacts of the project and the mitigation measures. • Participation in ESIA Technical Panel review to observe the evaluation process of mitigation measures set out to address the adverse impacts be social / economic / environmental impacts by experts and regulatory authorities. • Manage communications in the communities regarding the outcome of public forums and technical panel review. • Stakeholder Engagement Plan (SEP) – there is a well documented Stakeholder Engagement Plan. • Grievance Management Procedure – there is well laid down Grievance Management Procedure
	•	•	
Indirect Impacted Communities	• Communities falling within AII and transport routes	• Onne, Alode, Ebubu, Ogale, Alesa, Umuebula, Rumukrushi, Woji, Okujagu, Abam Ama	Stakeholder Engagement for communication of unforeseen event and actions Community Development Committee members participate in Project Scoping, Public Forum, Technical Panel Review

Stakeholder Category	Stakeholder Groups	Stakeholders	Connection to Project
			Access to Grievance Management Procedure
Vulnerable Groups	• Women • Youth • Widows • People with disabilities	• Eleme Women Leaders • Eleme Youth Council • Host Community Youth Forum	Women have representation in PAC and Host Community Youth Forum as representative body participate in the discussion and decision-making process of ESIA public forum, technical panel review, adverse impacts / mitigation measures, MOU, community development projects, employment, skill acquisition programme, subcontracts & supplies and grievance management process during ESIA / construction / operation phase of the project. Women leaders exclusively participate in discussion and decision-making process of Micro Grant Scheme. Host Community Youth Forum exclusively participates for discussion and implementation MOU for the Youth. Eleme Youth Council exclusive participates for extension of benefits such as office upkeep, subcontracts, surveillance contracts, employment etc.
Civil Society and Interest Groups	• Community-Based Organisations / Association • Non-Governmental Organisations (NGOs)	• Eleme Fishing Association • Eleme Hunters Association • Eleme Graduate Forum	Indigenes have advanced to modern methods of fish farming, poultry, piggery etc. These groups participate in skill development programmes and receive financial assistance under Youth Entrepreneurship Scheme in collaboration with PAC. Eleme Graduate Forum is a Non-Government Organisation (NGO) which in general represent the interest of members for employment
Employment and Business Associations	• Workers Unions • Employment Forums • Business Forums • Business Associations	• Welders and Fitters Association • Indigenous Suppliers Forum	Elected representatives of unions participate in collective bargaining agreements for betterment of condition of service, discussion on betterment of working condition, grievance management process, disciplinary management process, conflict and dispute resolution process during the construction and operation phase of the project. Elected / nominated members of Indigenous Suppliers represent their members for access to information with regards to contracts, supplies, grievance management dispute / conflict resolutions.

Stakeholder Category	Stakeholder Groups	Stakeholders	Connection to Project
Other stakeholders	• Academia • Media	• Professors / teachers • Radio and Print media	Linkage between theory and practical through industrial training, new skill development and recruitment and funding for research and development. Information from source via direct meeting or site visit, coverage of CSR events via invitation to events

6.4 APPROACH TO STAKEHOLDER ENGAGEMENT

It is neither practical nor necessary to engage all stakeholder groups with the same level of intensity at all times. As such, stakeholder analysis and prioritisation are essential to determine appropriate engagement methods, frequency, and level of effort. Given the evolving nature of stakeholder interests and community dynamics within the Project area, stakeholder analysis will be periodically reviewed and updated throughout the lifecycle of the IFF Line 2 Fertilizer Project.

The Project is located within the established Indorama industrial complex and builds on existing operations in the area. Accordingly, the stakeholder analysis draws on previous engagement experience and baseline understanding of stakeholders within the Project area, supplemented by stakeholder engagement activities undertaken specifically for the IFF Line 2 ESIA process. These inputs have been used to refine stakeholder identification and update the assessment of stakeholder interests, influence, and potential concerns.

The broad groups of stakeholders identified are presented in Table 6-1. These stakeholder groups are further analysed based on their potential influence on Project activities and their level of interest or support for the Project, as presented in Table 6-2. An appropriate engagement approach for each stakeholder category is defined in Table 6-3, taking into account the need for targeted, proportionate, and culturally appropriate engagement.

TABLE 6-2: IMPACT-SUPPORT MATRIX

Stakeholder Cluster	Influence Level	Support Level	Engagement Approach
Environmental and Permitting Authorities	**High**	**High**	Work Together
Regional Government	**High**	**High**	Work Together
Local Government	**High**	**Medium**	Keep Engaged
Traditional Leaders	**High**	**Medium**	Keep Engaged
Community Leaders	**High**	**Medium**	Keep Engaged
Directly Affected Communities	**Medium**	**Medium**	Keep Engaged
Women	**Low**	**Medium**	Keep Informed
Youth	**Medium**	**Medium**	Keep Informed
Existing Natural Resource Users	**Low**	**Low**	Keep Informed
Civil Society Groups	**Low**	**Medium**	Keep Informed

TABLE 6-3: SUMMARY OF POTENTIAL ENGAGEMENT APPROACHES

Engagement Approach	Process
Work Together	• Share information. • Consult on key Project issues. • Collaborate on Project delivery.
Keep Engaged	• Share information. • Consult on key Project issues.
Keep Informed	• Share information.
Show Consideration	• Share information. • Consult on key Project issues.

Priority should be given to stakeholders that are highly influential including those that are both supportive and unsupportive.

Engaging stakeholders who are unsupportive and influential, or those with deep-rooted challenges, requires engagement with pro-active and hands on approach. Effective engagement typically combines approaches - from informing to activities such as consultation or collaboration. In analysing these stakeholders and developing an approach to engagement, consideration has also been given to:

- Level of interest in the Project construction/operation;
- Anticipated impact of the Project on the stakeholder;
- Vulnerability status of the stakeholder; and
- Relationships with high influence stakeholders, including their ability to influence these stakeholders.

Stakeholders that have low influence but are unsupportive should be monitored closely, with a particular focus on their ability to influence, and their relationships with, other stakeholders. Less intensive forms of engagement such as monitoring or disseminating information will be adequate for engaging less influential, supportive stakeholders. Individual stakeholders can share a collective voice and access to legal guidance and resources thereby becoming more influential. Considering the outcomes of the stakeholder analysis, the high priority stakeholders for this Project are:

- Environmental and Permitting Authorities;
- Federal government;
- State government
- Local government;
- Traditional leaders; and
- Community leaders.

6.5 SUMMARY OF PREVIOUS ENGAGEMENT

As the Project is an extension of an existing operational site, stakeholder engagement by Indorama has been ongoing since 2007. Relational contexts, ways of working, and perceptions of the existing operations will all influence the perceptions of the Project, and should be taken into consideration when implementing the SEP.

In terms of engagements specific to the IFF Project, Table 6-4 highlights what has taken place during IFF Line 1.

TABLE 6-4: SUMMARY OF PREVIOUS ENGAGEMENTS

Date	Stakeholder	Purpose	No. of attendees
14 July 2021	Environment Assessment Department (EAD) of Federal Ministry of Environment	Discuss proposed IEFCL Train 3 Project and draft Terms of Reference for Institutional Consultation	10
26 July 2021	• Federal Ministry of Environment • Rivers State Ministry of Environment	Site verification required for Project categorization	7
20 August 2021	• Federal Ministry of Environment • Rivers State Ministry of Environment • Eleme Local Government Area • Directly Affected Communities • Traditional Leaders and Community Leaders • Vulnerable Groups • Civil Society and Interest Groups	Scoping workshop for ESIA, Terms of Reference and Scope of Work	89
10 November 2021	Agbonchia community stakeholders: • The Paramount Ruler of • Agbonchia • Community Chairman • Youth President and Executives • Women group • Youth Rep. of Eleme Youth • Council • Agbonchia Community Members	Inform participants of the proposed Train 3 Project scope; environmental, social, economic and health aspects. Discuss possible impacts of the Project and obtain community perspectives (expectations, benefits, perceptions etc.).	77

Date	Stakeholder	Purpose	No. of attendees
11/12 November 2021	Njuru and Akpakpan community stakeholders: • The Paramount Chief • Community Chairman • Security Guards • Youth President/Leader • Women Leader and women groups	Inform participants of the proposed Train 3 Project scope; environmental, social, economic and health aspects. Discuss possible impacts of the Project and obtain community perspectives (expectations, benefits, perceptions etc.).	100
9 November 2021	Okerewa community stakeholders: • The Paramount Ruler Chief of • Okerewa Community • Community Chairman • Youth President and Executives • Women Leader and Executives • Representative of Youths from • Eleme Youth Council • Cross section of Okerewa • Community Members	Inform participants of the proposed Train 3 Project scope; environmental, social, economic and health aspects. Discuss possible impacts of the project and obtain community perspectives (expectations, benefits, perceptions etc.).	99
8 November 2021	Aleto community stakeholders: • The Paramount Ruler of Aleto • Community • Aleto Community Development • (CDC) Chairman • Fishermen and Hunters Association • Host Community Youth • President • Women Leaders and Executives • Cross section of Aleto Community	Inform participants of the proposed Train 3 Project scope; environmental, social, economic and health aspects. Discuss possible impacts of the Project and obtain community perspectives (expectations, benefits, perceptions etc.).	65
5 November 2021	Akpajo community stakeholders: • The Paramount Ruler of Akpajo Community Development • Committee (CDC) Chairman • Fishermen and Hunters • Host Community Youth • President • Women Leader	Inform participants of the proposed Train 3 Project scope; environmental, social, economic and health aspects. Discuss possible impacts of the Project and obtain community perspectives (expectations, benefits, perceptions etc.).	102

Date	Stakeholder	Purpose	No. of attendees
15 November 2021	• Elelenwo (Wakoahu Family) • Stakeholders: • Community Development • Committee (CDC) Chairman • Host Community Youth • President • Women Leader • Cross section of Wakoahu community • Wakoahu Youth Leader and • Executive • Wakoahu PAC member	Inform participants of the proposed Train 3 Project scope; environmental, social, economic and health aspects. Discuss possible impacts of the Project and obtain community perspectives (expectations, benefits, perceptions etc.).	94
7 December 2021	Project Advisory Committee (PAC)	Inform the PAC of the proposed Train 3 Project scope; environmental, social, economic and health aspects. Clarify the roles and responsibilities of the PAC with regards to the Project.	21
13 January 2023	FMEnv, RSMEnv, Eleme LGA and King of Eleme Kingdom with Council of Chiefs, Paramount Rulers of respective Communities, Elders, Women and women leaders, Youths, NGOs, Civil societies, Farmers, Traders, Fishers, students etc.	A broader engagement to further educate participants on the proposed Train 3 project scope, environmental, social, economic and health aspects. Possible impacts of the project and community perspective (expectation, benefits, and perception etc.)	121

In addition to the historical engagement events listed above, stakeholder engagement relevant to the IFF Line 2 Project also takes place through existing operational and community interface mechanisms maintained by Indorama. These include the PAC, implementation and monitoring of the host community MoU, the Community Relations & Development function and associated Community Relations Officers, and the existing grievance management system. While these mechanisms are not all recorded as discrete ESIA consultation events, they form an important part of the Project's broader engagement context and provide continuing channels for communication, feedback, issue resolution and management of community expectations.

The outcomes of previous and ESIA-phase engagement, and the way in which the issues raised have influenced Project decision-making, design and the ESMMP, are summarised in the consultation outcome matrix in Table 6-4A. Examples of design changes arising directly from engagement include the wastewater recovery plant, which recovers about 90% of treated wastewater for reuse and originated from ideas shared by participants during IFF Line 1

engagement, and the selective catalytic reduction (SCR) unit on the IFF Line 2 primary reformer stack, adopted in response to stakeholder concerns about air quality.

TABLE 6-4A: CONSULTATION OUTCOME MATRIX

Issue raised	Stakeholder group(s)	Project response	How incorporated (ESIA / design / ESMMP)
Increase in traffic volumes, deterioration of roads and risk of road accidents	Host communities; community leaders; PAC	Wet- and dry-season day and night traffic surveys; routing of construction and export traffic via the Northeast Gate and Agbonchia New Road; scheduling of deliveries; driver training and speed control	Sections 7.8, 8.6 and 9.6; Transport Management Plan in the ESMMP
Influx of migrant workers and job seekers; pressure on housing, services, safety and security	Host communities; youth and women's groups; traditional leaders	Labour influx assessed as a specific impact; local-first recruitment with no gate hiring; contractor accommodation and worker code of conduct; coordination with local authorities	Sections 8.4.3 and 9.4.1.2; Labour Influx Management Plan in the ESMMP
Air quality and associated public health	Host communities; PAC; public forum participants	SCR on the reformer stack; dispersion modelling of IFF Line 2 alone and with IFF Line 1; construction dust controls; continued ambient air monitoring	Sections 8.2.3 and 9.2.4; Project design; Air Quality Management Plan
Pollution of groundwater, surface water and biodiversity (Okulu River)	Host communities; fishermen and hunters' associations	Wastewater recovery and reuse (an outcome of earlier engagement); wet- and dry-season water, sediment and biodiversity baseline; monitoring of the Okulu River upstream and downstream; groundwater abstraction limits and monitoring	Sections 8.2.6, 8.2.7, 8.3, 9.2.7, 9.2.8 and 9.3; Water and Biodiversity Management Plans
Emergency preparedness, process safety and community safety	Host communities; regulators	Complex QRA updated to include IFF Line 2; consolidated on-site and off-site EPRP with community alert and evacuation arrangements and joint drills	Section 8.4.8; EPRP; ESMMP
Fair distribution of employment, contracts and CSR benefits; MoU implementation	Host communities and PAC; Eleme Youth Council; Indigenous Suppliers Forum; women leaders	Monitoring of MoU implementation through the PAC and its sub-committees (employment, contracts, scholarships, micro grants, skills); local recruitment and procurement targets	Sections 8.4.1, 8.4.4, 8.4.5 and 9.4.1; SEP; Local Content commitments
Women's access to benefits and youth expectations	Women leaders; youth groups; widows; persons with disabilities	Dedicated focus group discussions; women's micro grant scheme; youth engagement every other month during construction; transparent communication of job criteria	Section 6.7; Section 9.4.1; SEP
Insufficient ongoing engagement between Indorama and host communities	Host communities	Life-of-Project SEP; quarterly PAC engagement; monthly Project updates during construction; PAC communiqués and public notices; accessible grievance mechanism	Section 6.8; SEP (Appendix B)

6.6 EXISTING STAKEHOLDER CONCERNS

The following high-level stakeholder concerns have been captured based on engagements conducted thus far for IFF Line 2 (Line 4).

- **Increase in Traffic Volumes:** Further deterioration of already poor roads due to increased traffic volumes. The increased traffic volume may lead to increased road incident/accident
- **Population Influx:** Increase in migrant workers and jobseekers and the resulting effect on housing, services community stability, safety and security.
- **Environmental Impacts:** Negative impacts on the natural environment and biodiversity such as groundwater, and surface water.The poor air quality due to air pollution. Environmental pollution may lead to public health impact
- **Socioeconomic Benefits:** Distribution of employment, procurement, and corporate social investment benefits between communities, effective implementation of MOU and a perceived insufficiency of such interventions given the scale of need in the area
- **Ongoing Engagement:** A perceived lack of sufficient ongoing engagement between Indorama and host communities.

The SEP and social baseline materials also show that these concerns should be interpreted in the context of a broader socio-economic sensitivity profile characterised by unemployment, low household income, reliance on informal livelihoods, and existing pressure on infrastructure and services. In this setting, concerns about local hiring, contracting opportunities, women's access to benefits, youth expectations and cumulative environmental effects are not isolated issues; they are linked to the wider development context and to how communities experience industrial expansion in Eleme. For lenders, this is important because it demonstrates that stakeholder concerns are being understood not just as stand-alone complaints, but as expressions of underlying socio-economic vulnerability and expectations.

These concerns have directly shaped the scope of the impact assessment and the ESMMP. Traffic safety concerns informed the wet- and dry-season day and night traffic surveys, the traffic impact assessment (Section 8.6) and the Transport Management Plan (Section 9.6). Air quality, pollution and health concerns informed the scope of the air quality, water and community health assessments (Sections 8.2.3, 8.2.6, 8.2.7 and 8.4.6), the adoption of SCR on the reformer stack and the environmental monitoring programme. Employment and benefit-sharing concerns are addressed through local recruitment, procurement and community investment measures (Section 9.4.1) monitored through the PAC. Security and influx concerns are addressed by the labour influx and security management measures (Sections 8.4.3 and 9.4.1). Emergency preparedness, which is a key concern in the context of an operating ammonia complex, is addressed through the QRA update and the consolidated EPRP (Section 8.4.8), including community alert, evacuation and joint drills. The frequency of engagement going forward (quarterly PAC meetings, monthly Project updates during construction and engagement with youth every other month) and the measures to close the identified engagement gaps are set out in Section 6.8 and the SEP.

6.7 ESIA ENGAGEMENT

The current ESIA phase for IFF Line 2 involved both targeted stakeholder engagement and broader socio-economic fieldwork. The SEP records that stakeholders were consulted in their communities at venues and times approved by community chiefs, and that the engagement approach emphasised use of English and local dialects, explanation of the project briefing material, and documentation of issues raised. In parallel, the socio-economic baseline

programme included approximately 350 household surveys across seven communities within the AoI, together with focus group discussions with CDCs, youth, women's groups and the PAC, and key informant interviews with community leaders and institutional stakeholders. An institutional engagement was also held with the FMEnv in Abuja.

The ESIA study phase engagements undertaken specifically for IFF Line 2 included a regulatory engagement in September 2025, a sequence of community engagements in October and November 2025, a public forum in February 2026, and a further stakeholder engagement session in May 2026. These engagements collectively covered regulators, traditional leaders, host communities, wider community representatives, youths, NGOs, associations and communities in the wider AoI. Refer to Table 6-5 below.

The engagement undertaken during Line3 and feedback received laid the foundation of Line4. Some of the initiatives like Wastewater recovery plant are the outcome of engagements where ideas shared by participants. The Line4 engagements are undertaken further during ESIA process. The installation of selective catalytic reduction (SCR) is one of the initiative to be implemented in the Line 4 is the out come of the stakeholder engagement feedback on air quality.

TABLE 6-5: ESIA ENGAGEMENT UNDERTAKEN FOR IFF LINE 2

S/No.	Date	Location / Venue	Participants	Engagement type
1	11/09/2025	Conference Room, FMEnv EA Department, Abuja	15	Regulatory engagement
2	29/10/2025	Palace of HRH, Emere of Okerewa Community	57	Community engagement
3	30/10/2025	Palace of HRH, Emere of Njuru Community	26	Community engagement
4	30/10/2025	Palace of HRH, Emere Joseph Ngeto, King of Agbonchia Clan	26	Community engagement
5	01/11/2025	Palace of HRH, Emere Olungwe Fineman, JP, King of Akpajo Clan	36	Community engagement
6	01/11/2025	Palace of HRH, Emere Sunday Obo, King of Akpajo Clan	11	Community engagement
7	07/11/2025	Palace of HRH, Emere Engr. Isaac Bajor Osaro, Emere Aleto Community	11	Community engagement
8	02/11/2025	Wakoahu Family, Elelenwo Community	14	Community engagement
9	11/11/2025	CDC Office, Iriebe Community	12	Community engagement
10	02/11/2025	Ogale Community Hall	13	Community engagement
11	03/11/2025	Alesa Community, residence of Youth President, Eleme Kingdom	14	Focus group discussion with youths
12	06/11/2025	Palace of HRH, Emere Godwin Chinwi, Emere of Ebubu Clan	4	Engagement with HRH
13	13/11/2025	Palace of HRH, Emere Loveday O. Osara, Alode Community	18	Community engagement
14	26/02/2026	Hotel Golden Tulip, Port Harcourt	188	Public forum
15	29/05/2026	Hotel Golden Tulip, Port Harcourt	30	Stakeholder engagement
16	24/02/2026	Aleto community townhall, Eleme Graduate Forum	13	Stakeholder engagement
17	24/02/2026	Eleme Hunters Association Chairman residence, Alode	9	Focus group discussion with Hunters
18	12/03/2026	Agbonchia community townhall	103	Focus group discussion with Widows
19	12/03/2026	Eleme Physically Challenged Association Coordinator residence	17	Focus group discussion with physically challenged persons
20	19/02/2026	Project Advisory Committee (PAC) Indorama Complex,	15	Stakeholder engagement

6.8 POST-ESIA ENGAGEMENT

A summary of post ESIA engagement activities is presented in Table 6-6. For a more detailed overview of post-ESIA engagement please refer to the SEP (Appendix B). It should be noted that the plan for post-ESIA engagement will be updated should the need arise for more intensive engagement with certain stakeholder groups or should there be a substantial change to the Project plan.

TABLE 6-6: STAKEHOLDER ENGAGEMENT PHASES AND ACTIVITIES

Engagement Phase	Engagement Activities
Pre-Construction	Monitor implementation of subsisting MOU 2023 – 2025
	Quarterly engagement with PAC
	Provide quarterly project updates
	Engagement with employment sub committee
	Engagement with PAC sub committees on employment, community development projects, grievance management, skill acquisition programme, scholarship, micro grant etc.
	Review of grievance and grievance tracking
	Engage local authorities, traditional rulers and community leaders for briefing the completion of ESIA process and commencement of construction phase of the project
Construction Phase	Provide monthly project updates
	Quarterly engagement with PAC
	Every other monthly engagement with youth
	Monitoring of grievances
	Engagement with PAC sub committees on employment, community development projects, grievance management, skill acquisition programme, scholarship, micro grant, etc.
Operational Phase	Quarterly engagement with PAC
	Provide broader project updates as required
	Monitoring of grievances
	Engagement with PAC sub committees on employment, community development projects, grievance management, skill acquisition programme, scholarship, micro grant etc
Decommissioning Phase	Announcement of intended decommissioning
	Quarterly engagement with PAC
	Provide broader decommissioning updates as required
	Monitoring of grievances
	Engagement with PAC sub committees on employment, community development projects, grievance management, skill acquisition programme, scholarship, micro grant etc

An important enhancement in the current SEP is the explicit communication and disclosure framework. Indorama commits to provide timely updates, particularly on environmental monitoring results, ESMP implementation and construction / operational performance; to use structured channels such as quarterly PAC communiqués, public notices and community briefings; to ensure accessibility through translation and inclusive formats for women, youth, low-literacy groups and elders; and to provide transparent reporting on grievances, including categories, trends and corrective actions. These commitments are important for lender review because they demonstrate how the Project intends to maintain trust, transparency and responsiveness after the ESIA has been submitted.

Finally, the SEP confirms that the grievance management procedure is intended to be a core element of ongoing engagement. The grievance mechanism is designed to provide accessible submission channels, systematic handling and recording of grievances, defined responsibilities and periodic monitoring and reporting. Together with the PAC and broader engagement channels, this mechanism is intended to provide a practical basis for ongoing consultation, issue resolution and monitoring of stakeholder relationships over the life of the Project.

7. DESCRIPTION OF THE ENVIRONMENT

7.1 INTRODUCTION

It is important to gain a sound understanding of the physical, biological and socio-economic characteristics of the area in which the proposed IFF Line 2 Fertilizer Project is to be developed and of the surrounding environment. The description of the baseline environment is essential in that it represents conditions prior to Project development and therefore provides the reference point against which potential environmental and social impacts are assessed and future changes monitored. The baseline environment therefore establishes the current or status quo conditions within the Project area and its surrounds and forms the basis for impact prediction, evaluation and the development of mitigation and management measures in this ESIA.

The proposed IFF Line 2 Fertilizer Project is an expansion within the established Indorama Free Zone in broader Indorama Manufacturing Complex in Eleme Local Government Area, directly adjacent to the existing IFF Line 1 (Train 3) facility and broader petrochemical and fertilizer operations. Because the Project is co-located with existing operations and within the same receiving environment considered for IFF Line 1 (Train 3), a number of regional and contextual baseline characteristics remain unchanged, while field-based monitoring and survey data have been updated for the new footprint and current project AoI.

This chapter presents the physical environment, the biophysical environment, the socio-economic environment and health baseline, cultural heritage, and traffic and transport conditions. It also identifies the key physical, ecological, social and transport sensitivities that are relevant to the impact assessment presented in later chapters.

7.2 STUDY AREA AND AREA OF INFLUENCE

The proposed IFF Line 2 Fertilizer Project will be developed within the Indorama Free Zone, an established industrial precinct in broader Indorama Manufacturing Complex in Eleme Local Government Area, Rivers State, Nigeria (Figure 1-1). The Project occupies an approximately 80-hectare site within the wider 250-hectare free zone and is positioned directly north of the existing IFF Line 1 facility. The site is bounded by the wider Indorama Complex to the south and undeveloped land to the north, east and west (Figure 4-2).

For the purposes of the ESIA, the Project Area refers to the development footprint and directly associated infrastructure to be developed or controlled by the Project. The broader AoI includes all areas likely to be affected directly or indirectly by construction, operation and decommissioning activities, including areas potentially affected through environmental pathways, community use patterns, traffic routes, watercourses, and cumulative interaction with existing operations in the wider Indorama complex. The exact spatial extent varies by specialist discipline and is linked to the relevant receptor or pathway (Table 7-1).

The extent of the AoI for each discipline is based on the reach of the Project's impact pathways, as defined by the modelling and specialist studies undertaken for the IFF Line 2 Project and earlier projects in the complex. The 3 km Area of Direct Influence (ADI) encompasses the seven host and neighbouring communities, the nearest noise sensitive receptors (approximately 200 m from the complex perimeter) and the area within which construction dust, noise and traffic effects and groundwater drawdown can be perceptible.

Operational stack emissions were modelled over a wider 10 km × 10 km domain; the Project-alone process contributions are below 10% of the air quality standards throughout this domain (Section 8.2.3) and are therefore negligible well within 3 km of the site. For biodiversity, a 1 km buffer has been added to the 3 km ADI, giving a 4 km study area, to capture the home ranges of mobile fauna (birds, bats and small to medium-sized mammals), the connected riparian, freshwater swamp and mangrove habitats along the Okulu River, and the ecosystem services used by the communities. Larger buffers (for example 10 km, 25 km or 50 km) are typically applied to greenfield projects involving large-scale habitat conversion, linear infrastructure or long-range emissions. As IFF Line 2 is a brownfield development within an existing fenced industrial footprint, with no new land take outside the Indorama Free Zone and with physical effects predicted to be confined within a few hundred metres of the site, a 4 km buffer is considered conservative. Where a pathway extends further, the AoI is extended accordingly; for example, the surface water and aquatic ecology study area extends approximately 5 km downstream of the outfall along the Okulu River.

In practical terms, the AoI includes the Project footprint, immediate surrounding industrial land, nearby communities, the local drainage and riverine system connected to the Okulu River, public transport routes linking the site to the wider road network and the port, and the broader social and cultural area surveyed during the socio-economic and heritage baseline studies (Figure 7-1). This approach is consistent with the locked ESIA methodology and ensures that the baseline reflects the actual areas within which impacts may propagate.

TABLE 7-1: SUMMARY OF AREA OF INFLUENCE BY SPECIALIST TOPIC

Specialist topic	Area of influence / study area
Meteorology and climate	Regional Port Harcourt / Eleme climatic setting and Project site
Climate risks	Full Project footprint and connected operational asset area
Air quality	Project footprint and surrounding sensitive receptors within the model domain. Project footprint plus a 3km study area
Noise	Project site and nearest noise-sensitive receptors, located within approximately 200 meters from the perimeter fence
Geology, soils and groundwater	Project footprint, monitoring borehole network and wider hydrogeological context. Project foot print plus a 3km study area
Surface water	Local drainage channels, tributaries and the Okulu River / downstream estuarine system 2km upstream and 5km downstream of the existing outfall on Okulu river and control samples from nearby waterbody.
Biodiversity	Project footprint, immediate receiving habitat, and wider ecological study area including a 4 km buffer
Socio-economic environment and health	Project AoI communities surveyed in 2025 / 2026 and wider directly and indirectly affected communities. 7 communities falling within 3km from complex perimeter fence. 10 communities falling within 5km from complex perimeter fence for engagement
Cultural heritage	Project footprint plus a 3 km study area

Specialist topic	Area of influence / study area
Traffic	Public roads used during construction and operation, including site access roads, the East West Road, Onne Road and the Federal Ocean Terminal Road

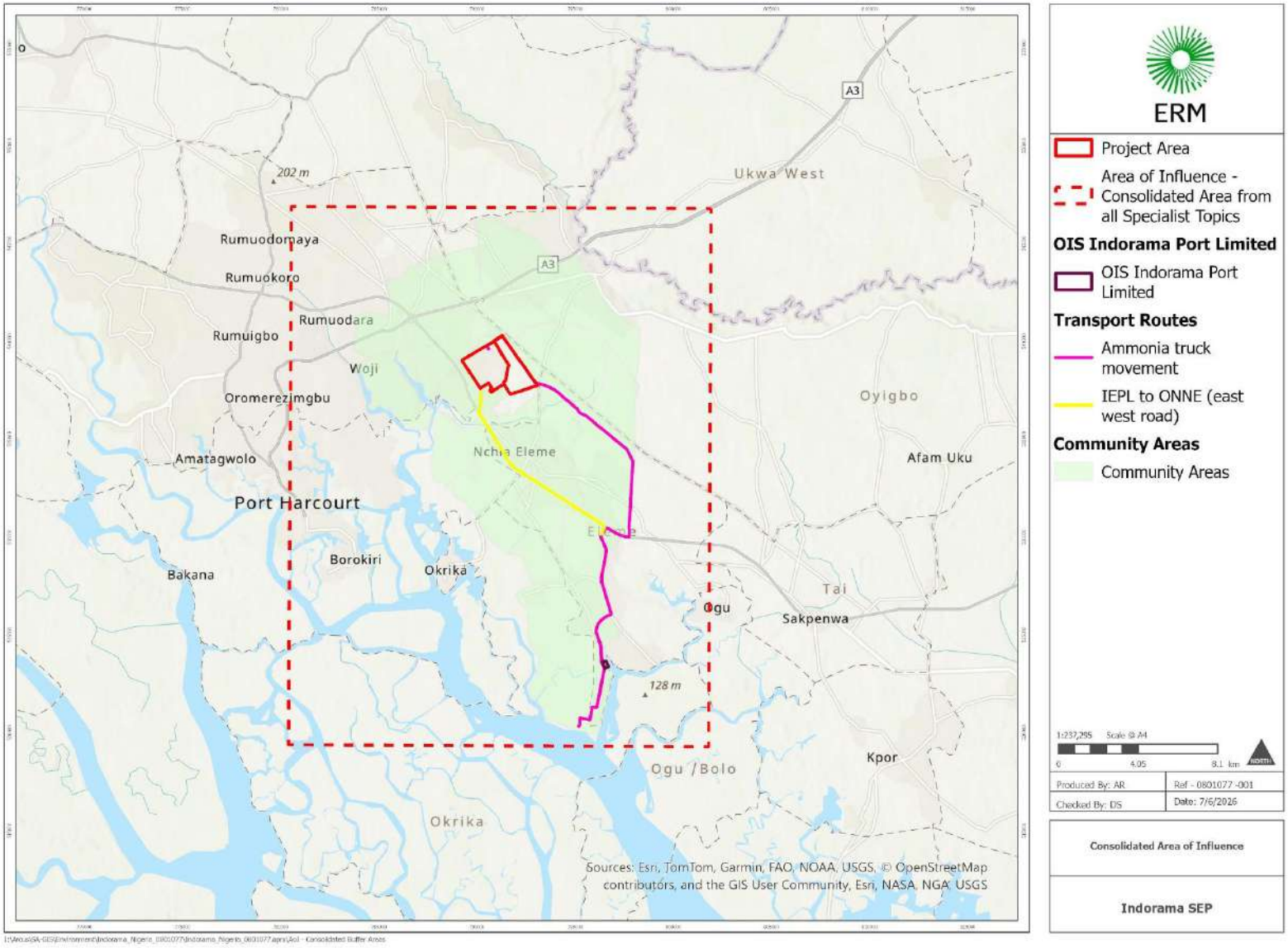


FIGURE 7-1: CONSOLIDATED AOI

7.3 BASELINE DATA ACQUISITION METHODS

Baseline data acquisition for the IFF Line 2 Fertilizer Project combined desk-based review, interpretation of existing Project and regional data, field monitoring, laboratory analysis, and direct environmental and social surveys. Baseline collection was undertaken across both wet and dry season windows where seasonality was relevant, particularly for air quality, groundwater, surface water, biodiversity and the wider hydrological setting. This follows the same broad approach as IFF Line1 (Train 3), but applies updated monitoring and survey data specific to the IFF Line 2 footprint and current AoI.

The air quality baseline used site and regional meteorological data together with wet- and dry-season ambient air monitoring. The noise baseline was established through long-term unattended monitoring at identified noise-sensitive receptor locations. Soils, geology and groundwater were characterised through wet-season and dry-season fieldwork, including borehole and monitoring network information, soil sampling and groundwater chemistry review. Surface water and sediment baseline work included riverine and drainage sampling in the Okulu River system and associated control points. Biodiversity baseline work combined desktop screening, field surveys and seasonal ecological observations. Socio-economic and cultural heritage baselines were derived through household surveys, interviews, focus group discussions, field observation, and a heritage field survey across the defined AoI. Traffic baseline data were obtained through traffic counts, road observations and quality assurance review of the survey datasets. Refer to Table 7-2.

TABLE 7-2: SUMMARY OF BASELINE DATA ACQUISITION METHODS

Baseline topic	Key method
Meteorology / climate / air quality	Regional weather data, site observations, wet- and dry-season monitoring
Noise	Long-term unattended noise monitoring
Geology / soils / groundwater	Field sampling, monitoring boreholes, laboratory analysis, hydrogeological interpretation
Surface water / sediments	Surface water and sediment sampling, field measurements and laboratory analysis
Biodiversity	Desktop review, field ecology surveys, seasonal baseline sampling and mapping
Socio-economic and health	Household surveys, Key Informant Interviews (KIIs), Focus Group Discussions (FGDs), field observation
Cultural heritage	Desk review, remote sensing, historic mapping and field survey
Traffic	Manual counts, route review, validation and traffic baseline analysis

7.4 PHYSICAL ENVIRONMENT

This Section provides the baseline environmental conditions for the physical environment. It covers meteorology and climate, air quality, GHG emissions, surface and groundwater, noise, geology, and soils.

7.4.1 METEOROLOGY AND CLIMATE

7.4.1.1 OVERVIEW OF THE CLIMATE

Nigeria is characterised by four distinct climate zones: a tropical wet climate in the south, a tropical savannah climate for most of the central regions, and a Sahelian hot and semi-arid climate in the north of the Country. This leads to a gradient of declining precipitation from south to north. Figure 7-2 shows a breakdown of the climatic classification in Nigeria. The Project falls within the 'tropical monsoon climate' classification, highlighted in dark blue representing monsoon climate (Am). Nigeria is broken down into nine diverse ecological zones (extending from an arid north to a tropical south), the Project falls within the south.

The rainfall pattern in the Country varies by region and season. In the south, rainfall is experienced throughout the year with less rainfall between December and March.

Nigeria's mean annual temperature ranges between 17°C to 37°C in the south. During the dry season, Harmattan winds bring dry air from the Sahara Desert to Nigeria, while during the rainy season moist air is brought from the Atlantic Ocean (USAID, 2019).

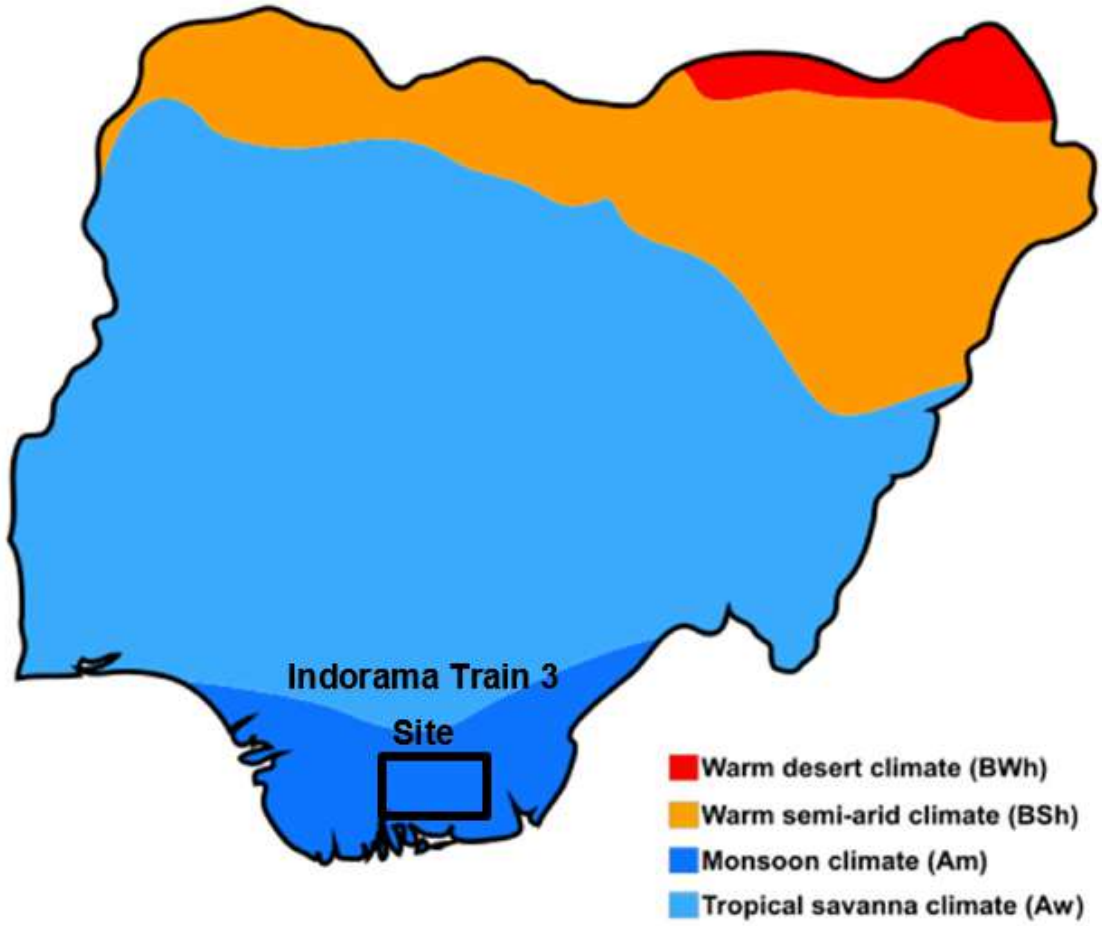


FIGURE 7-2: MAP OF NIGERIA'S CLIMATE CLASSIFICATION

Source: Beck et al., 2018

7.4.1.2 RAINFALL PATTERN

The Project Area falls within the monsoon climatic zone (Figure 7-2*)*. The annual distribution of rainfall in this climatic zone is characterised by two distinct seasons: wet season that runs from mid-March through to November and a dry season that runs from December through to March. The mean annual rainfall for the Study Area is above 2,300 mm. The highest precipitation is experienced in September at 374.5 mm, while the lowest is experienced in January at 17.2 mm (refer to Figure 7-3).

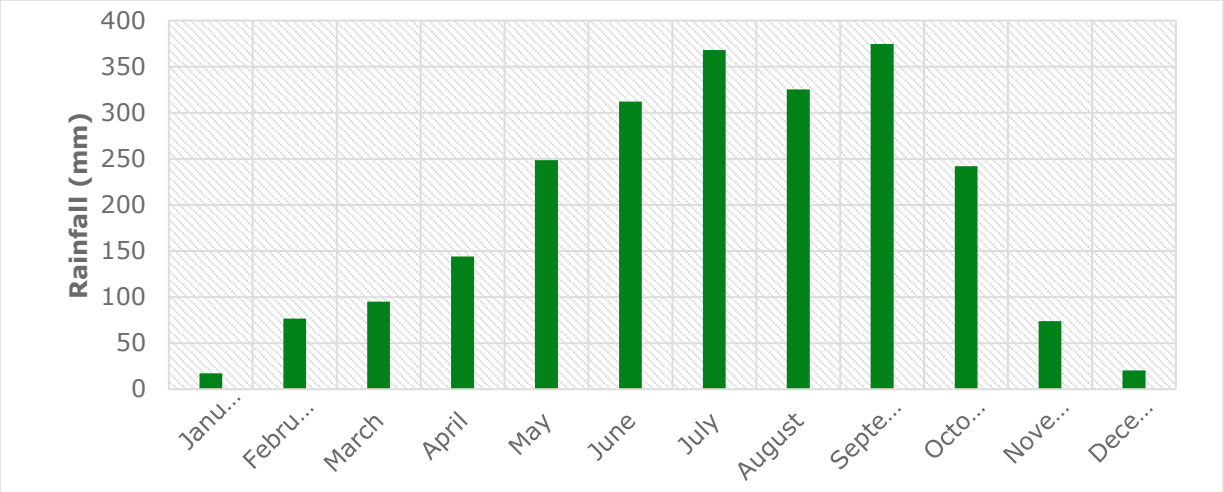


FIGURE 7-3: MONTHLY RAINFALL DISTRIBUTION IN THE STUDY AREA

Source: Average Weather Trend for Port Harcourt (1990-2020), NIMET[19], Port Harcourt

7.4.1.3 TEMPERATURE

The region experiences relatively high temperatures throughout the year, typical of a tropical climate. The most significant temperature difference in Nigeria is between the coastal areas and its interior as well as between the plateau and the lowlands. On the plateau, the mean annual temperature varies between 21°C and 27°C, whereas in the interior lowlands, temperatures are generally over 27°C. The coastal fringes have lower means than the interior lowlands. Seasonal mean temperatures are consistently over 20°C throughout the country and diurnal variations are more pronounced than seasonal ones. Highest temperatures occur during the dry season and vary little from the coast to inland areas.

- Average temperatures remain consistently warm with limited seasonal variations.
- Higher temperatures during the dry season may enhance atmospheric reactions[20].

Table 7-3 presents the recorded temperature data for Port Harcourt International Airport, illustrating the prevailing thermal conditions within the region, 2018 – 2022.

TABLE 7-3: SUMMARY OF TEMPERATURE DATA FOR PORT HARCOURT INTERNATIONAL AIRPORT

Year	Minimum Temperature (°C)	Maximum Temperature (°C)	Average Temperature (°C)
2018	19.4	38.2	28.1
2019	20.6	38.6	28.1
2020	19.4	38.6	27.9
2021	20.7	37.7	27.9

[19] Home - Nigerian Meteorological Agency (nimet.gov.ng)
[20] Castelhano, F.J. and Réquia, W.J., 2024. Weather impact on ambient air pollution and its association with land use types/activities over 5,572 municipalities in Brazil. *Heliyon*, *10*(11).

2022	18.5	37.9	27.7

Data recorded during the wet season monitoring period between October and November, and February and March for dry season, obtained from the Automatic Weather Station (AWS) weather station, are outlined in Table 7-4.

TABLE 7-4: AWS STATION TEMPERATURE DATA

Year	Minimum Temperature (°C)	Maximum Temperature (°C)	Average Temperature (°C)
2025 (October & November)	22.3	32.9	27.4
2026 (February & March)	22.9	35.1	28.8

Temperature data obtained from Port Harcourt International Airport and the onsite AWS station indicate broadly similar climatic conditions within the study area. However, it should be noted that the AWS dataset is limited to a short-term monitoring period of less than one month, whereas the Port Harcourt dataset represents a longer-term record spanning from 2018 to 2022, and is therefore considered more representative of prevailing regional temperature trends.

The use of both datasets provides a balanced approach, whereby the long-term data from Port Harcourt International Airport establishes baseline climatic conditions and seasonal variability, while the short-term AWS data offers site-specific insight into local meteorological conditions during the monitoring period.

7.4.1.4 RELATIVE HUMIDITY

Relative humidity in the Project area is high throughout the year, reflecting the coastal tropical setting and the predominance of wet climatic conditions. Regional data indicate average relative humidity values generally around 73–74%, while site observations from the wet season recorded higher values, with an average of approximately 87.1% during the monitoring period. These conditions are typical of the coastal Niger Delta and influence cloud formation, evaporation, atmospheric stability and dust suppression.

Table 7-5 presents the recorded relative humidity data for Port Harcourt, illustrating humidity within the region, 2018 – 2022[21].

[21] Meteorology_Report.pdf

TABLE 7-5: SUMMARY OF RELATIVE HUMIDITY FOR PORT HARCOURT INTERNATIONAL AIRPORT

Year	Minimum Relative Humidity (%)	Maximum Relative Humidity (%)	Average Relative Humidity (%)
2018	63.6	95.5	89.1
2019	68.1	95.6	88.9
2020	60.1	96.1	88.5
2021	62.7	95.8	89.6
2022	66.5	95.4	88.7

Data recorded during the wet season monitoring period between October and November, February and March for dry season, obtained from the AWS weather station, are outlined in Table 7-6.

TABLE 7-6: AWS STATION RELATIVE HUMIDITY DATA

Year	Minimum Relative Humidity (%)	Maximum Relative Humidity (%)	Average Relative Humidity (%)
2025 (October & November)	73	94	87.1
2026 (February & March)	57	93	84.6

The average relative humidity recorded at the Port Harcourt weather station ranges between 73% and 74%, indicating persistently high atmospheric moisture conditions. Such conditions can influence air quality by promoting the removal of particulate matter from the atmosphere.

7.4.1.5 WIND SPEED AND DIRECTION

Wind patterns are a key driver of pollutant dispersion.

- Prevailing wind directions define the primary dispersion pathways of emissions originating from the project site and their potential transport towards surrounding sensitive receptors.
- Moderate wind speeds promote effective atmospheric dispersion under normal conditions; and
- Periods of low wind speeds (i.e., <2 m/s), representative of calm conditions, may occur and can result in reduced dispersion, thereby increasing the potential for localised pollutant accumulation.

Table 7-7 presents the recorded wind data for Port Harcourt International Airport, illustrating the prevailing wind conditions within the region, 2018 – 2022.

TABLE 7-7: SUMMARY OF WIND DATA FOR PORT HARCOURT INTERNATIONAL AIRPORT

Year	Minimum Wind Speed (m/s)	Maximum Wind Speed (m/s)	Average Wind Speed (m/s)	Wind Direction
2018	0.28	7.61	2.68	225
2019	0.28	7.02	2.69	221
2020	0.28	7.94	2.75	228
2021	0.28	7.65	2.65	223
2022	0.25	8.33	2.74	222

Data recorded during the wet season monitoring period between October and November, February and March for dry season, obtained from the AWS weather station, are outlined in Table 7-8.

TABLE 7-8: AWS STATION WIND SPEED DATA

Year	Minimum Wind Speed (m/s)	Maximum Wind Speed (m/s)	Average Wind Speed (m/s)
2025 (October & November)	1.6	11.3	2.3
2026 (February & March)	0.0	12.9	0.5

Data obtained from Port Harcourt International Airport indicate an average wind speed of approximately 2 m/s, which is consistent with measurements recorded at the onsite AWS station. These relatively low wind speeds suggest that calm to light wind conditions are prevalent within the study area. Such conditions are typically associated with reduced atmospheric mixing and dispersion, thereby increasing the potential for localised accumulation of pollutants, particularly during stable atmospheric conditions.

The average wind direction, ranging between 220° and 228°, indicates that winds predominantly originate from the south-west and travel towards the north-east (Figure 7-4).

This prevailing wind pattern defines the primary transport pathway of emissions from the project site. Consequently, sensitive receptors located to the north-east of the project area are more likely to be influenced by emissions under these conditions.

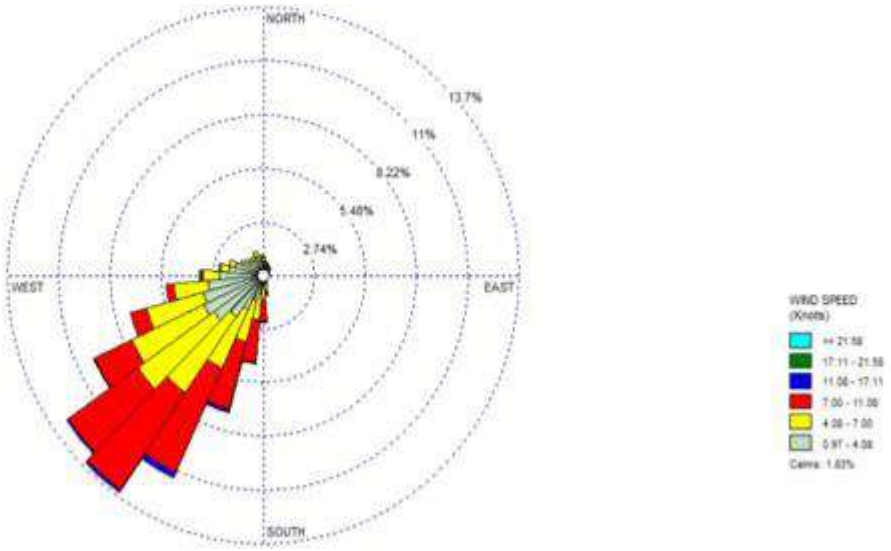


FIGURE 7-4: WIND ROSE, WRF DATA 2018 – 2022

7.4.1.6 CLOUD COVER

According to the 30-year weather data for Port Harcourt, the study area depicts a cloud cover of over 6 oktas across the year. Sky conditions are estimated in terms of how many eighths of the sky are covered in cloud, ranging from 0 oktas (clear sky) to 8 oktas (completely overcast). An average of over 6 oktas indicates a high level of moist-air convection linked to the abundant atmospheric moisture content. High cloud cover tends to inhibit atmospheric instability and can reduce plume dispersion, while lower cloud cover is associated with more unstable conditions and enhanced dispersion. Cloud cover is generally more prominent during the rainy period and lower during the dry season.

7.4.2 CLIMATE RISKS

7.4.2.1 INTRODUCTION

The potential physical impacts that climate change could have on the Project have been considered in this section. The assessment has been undertaken through a physical climate change risk assessment, which examines how current and projected climate conditions may affect the design, construction and operation of the proposed IFF Line 2 Fertilizer Project over its lifetime. The purpose of the assessment is to identify the principal climate-related physical hazards relevant to the Project, to understand how these hazards may change over time, and to inform the integration of appropriate resilience and adaptation measures into Project planning and design.

The assessment focuses on physical climate risk and follows a structured hazard-based methodology. This methodology includes three main components: hazard identification, scenario analysis, and hazard assessment. Hazard identification is used to determine which climate hazards are potentially material to the Project and which can reasonably be screened out. Scenario analysis is then used to explore how climate indicators linked to the identified hazards may change in the future. The hazard assessment considers the implications of these

hazards for Project components and site receptors during both the construction and operational phases.

In accordance with the methodology applied in the updated CCRA, the assessment distinguishes between acute physical risks and chronic physical risks. Acute risks include event-driven hazards such as extreme precipitation, extreme heat, drought and wildfires, while chronic risks include longer-term changes such as higher average temperatures, changing precipitation patterns, and sea-level-related influences. A wider range of possible climate hazards was initially considered; however, only those hazards regarded as relevant and potentially material to the Project have been taken forward into the detailed assessment.

The scenario analysis uses climate scenarios from the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6), specifically SSP1-2.6 and SSP5-8.5, to assess how climate conditions may evolve under different emissions pathways. These scenarios are considered for a baseline (present-day) condition and for the future time horizons of 2030 and 2050, selected to align with the expected construction and operational phases of the Project. The baseline provides context for present-day climate conditions, while the 2030- and 2050-time horizons provide insight into near-term and longer-term operational climate trends.

Unlike the older IFF Line 1 (Train 3) climate-risk screening, the updated IFF Line 2 assessment does not rely on numerical asset risk score graphics. Instead, it applies a materiality rating framework to describe the significance of each physical climate hazard to the Project. Under this approach, hazards are classified as High, Moderate, Low, or Unlikely material, depending on the extent to which they may materially affect Project assets, access, operations, or surrounding receptors. This provides a clearer basis for identifying the main physical climate risks requiring consideration in Project design, operational planning, and long-term resilience management.

7.4.2.2 LITERATURE REVIEW

Baseline Data

Literature review

Research suggests that, since 1960, Nigeria's average temperatures have increased by 0.8°C between 1960 and 2006, with the greatest increases experienced since 1980. When reviewing the precipitation observations, there has been a decrease of approximately 3.5mm per month, per decade between 1960 and 2006. (USAID, 2019).

The table and figure below (Table 7-9 and Figure 7-5) shows the results of the World Bank's Climate Change Knowledge Portal (2021) research on Nigeria's climate from 1991 to 2020:

- 27.2°C is Nigeria's mean annual temperature.
- The average monthly temperatures range from 24°C in December and January and in April with a high of 30°C.
- 1 162.8 mm is Nigeria's mean annual precipitation (with most rainfall between April to October).

TABLE 7-9: DATA SNAPSHOTS: SUMMARY STATISTICS

Climate Variables	1991–2020
Mean Annual Temperature (°C)	27.2°C
Mean Annual Precipitation (mm)	1 162.8 mm
Mean Maximum Annual Temperature (°C)	33.2°C
Mean Minimum Annual Temperature (°C)	21.3°C

Source: The World Bank Group, 2021

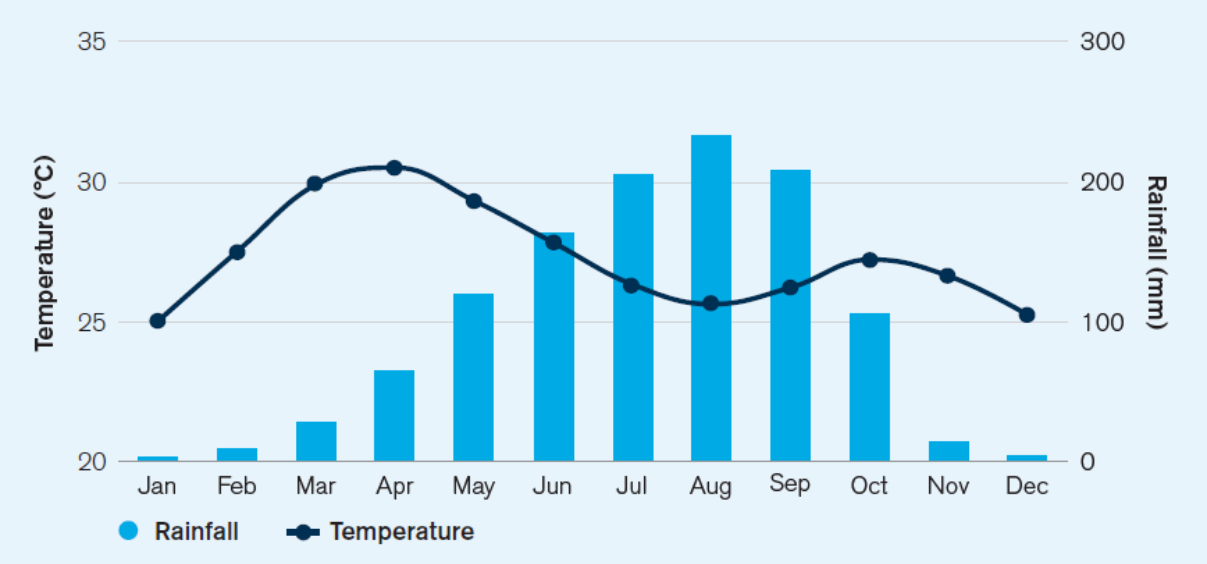


FIGURE 7-5: AVERAGE MONTHLY TEMPERATURE AND RAINFALL FOR NIGERIA, 1991–2020

Source: The World Bank Group, 2021

Water stress

The World Resources Institute (WRI) Aqueduct water data assesses drought risk, accounting for overall water risk[22]. Results for the Project are shown Table 7-10 and Figure 7-6.

TABLE 7-10: WATER RISK DATA FOR INDORAMA LINE 2

Climate Variable / Event	Historic Data
Drought Risk / Overall Water Risk	High (3-4) overall water risk

[22] *" Overall water risk measures all water-related risks, by aggregating all selected indicators from the Physical Quantity, Quality and Regulatory & Reputational Risk categories. Higher values indicate higher water risk. "(WRI Aqueduct, 2019).*

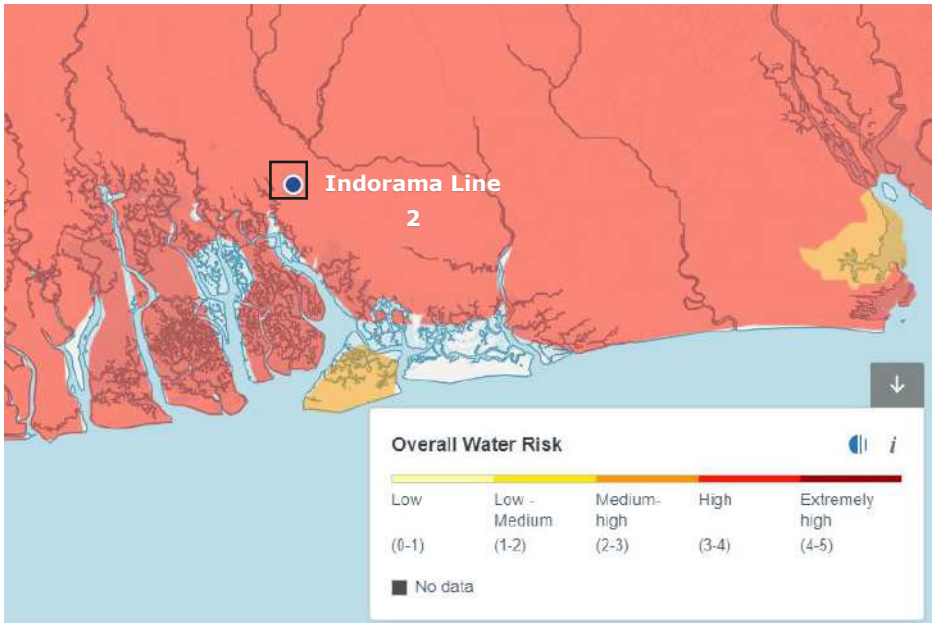


FIGURE 7-6: OVERALL WATER RISK DATA FOR INDORAMA LINE 2

Source: WRI (Aqueduct)

Future Climate Projections (Predictions)

Literature review

Research from UNEP GRID (2019) suggests that by 2060, Nigeria's average temperatures may increase between 1.1°C and up to 2.5°C, with higher rates of warming in the north. Rainfall variability and extreme rainfall events are also projected to increase across most of the country. Coastal areas are also expected to experience an increase of 0.4-1.0m in mean sea level by 2100. In addition, the number of cold nights is projected to decrease drastically, even to near zero by 2090, while the number of extreme heat days is projected to increase to 260 days by 2100 (it was 10 days in 1990).

The World Bank Group (2021) projects that temperatures will increase across the country progressively through to the end of the century, with a potential increase of between 2.9°C and 5.7°C, and that average temperatures will also increase. Night-time temperatures are expected to increase by 4.7°C. By the 2100s, it is expected that the duration of heat waves will increase by an additional 8 to 55 days.

Additionally, there is a projection of heavy rainfall intensifying, plus, during the summer rainy seasons, flooding events due to extreme rainfall, precipitation events, and extreme events are expected to impact surface water runoff and rivers. This, plus an intensification and increase in the frequency of droughts, may lead to more natural disasters. Precipitation quantities are most likely to increase from the end of the rainy season until the start of the dry season, which will be from September up until December (The World Bank Group, 2021).

"*Nigeria is at risk of numerous natural hazards and prone to floods, storms, ocean surges, droughts, and wildfires. Nigeria's coastal states face extensive risks from storm surge along*

the entire coast, and inland flooding and wildfires in the Niger Delta region, and negative rainfall anomalies in the southeast" (The World Bank Group, 2021, pg. 11). See Figure 7-7, the site falls within High Risk for both aspects of Flooding and Wildfires.

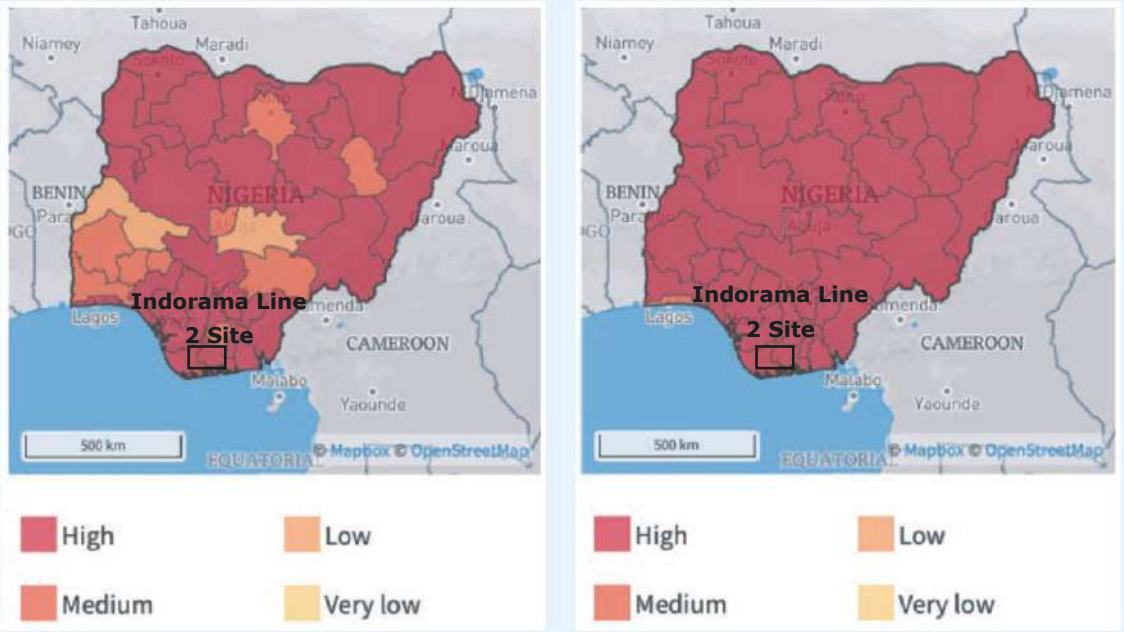


FIGURE 7-7: NIGERIA'S RISK OF URBAN FLOOD (LEFT) AND RISK OF WILDFIRE (RIGHT)
Source: The World Bank Group, 2021

Water stress

The WRI Aqueduct offers projections to 2040 under a pessimistic[23] Scenario. Results for the Project for drought risk / the projected change in water stress[24] is shown in Table 7-11 and Figure 7-8.

TABLE 7-11: PROJECTED WATER STRESS FOR INDORAMA LINE 2

Climate Variable / Event	Projection
Water Stress	Low (<10%) water stress

[23] *The "pessimistic" scenario represents a fragmented world with uneven economic development, higher population growth, lower GDP growth, and a lower rate of urbanization, all of which potentially affect water usage; and steadily rising global carbon emissions, with CO_2 concentrations reaching ~1370 ppm by 2100 and global mean temperatures increasing by 2.6–4.8°C relative to 1986–2005 levels.*

[24] *Water stress is an indicator of competition for water resources and is defined informally as the ratio of demand for water by human society divided by available water." (WRI Aqueduct 2015)*

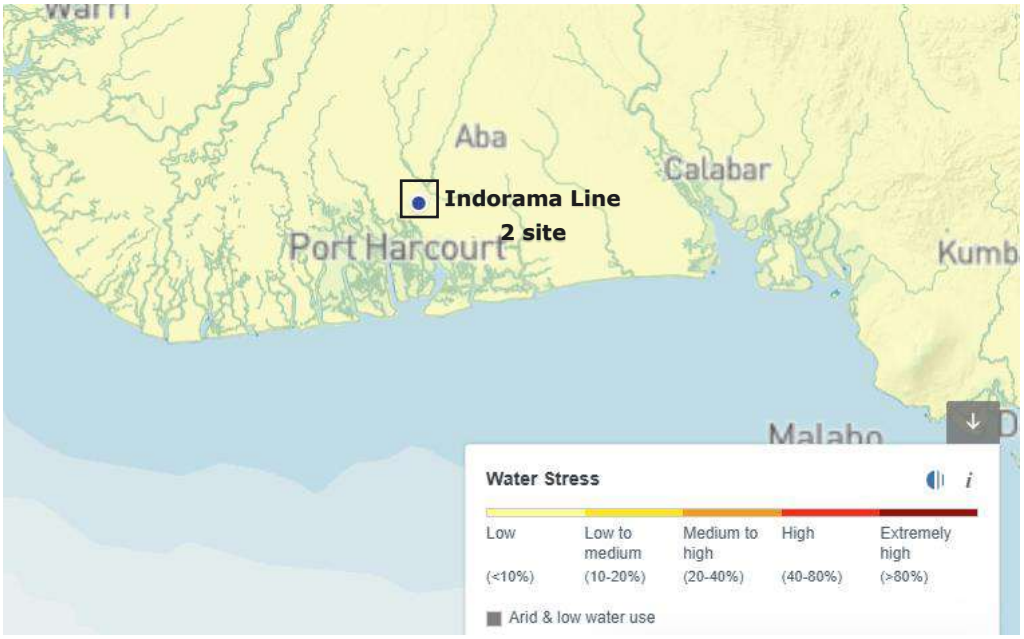


FIGURE 7-8: PROJECTED WATER STRESS FOR INDORAMA LINE 2

Source: WRI (Aqueduct)

7.4.2.3 CLIMATE HAZARD SCREENING AND MATERIALITY ASSESSMENT

A physical climate change risk assessment was undertaken for the Project using the approach described in Chapter 5. This subsection summarises the hazards screened into and out of the baseline climate-risk profile and presents their relative materiality to the Project. The assessment considered the principal Project assets at Indorama North and Indorama South, which together represent the main areas of the proposed IFF Line 2 development assessed for current and future physical climate hazards.

The screening process considered a broad set of acute and chronic physical climate hazards relevant to the Project location. The full set of hazards initially considered is shown in Table 7-12 and includes extreme precipitation, extreme heat, cyclones and hurricanes, landslides, drought and wildfires, together with longer-term climate shifts such as higher average temperatures, sea-level rise and coastal flooding, changing precipitation patterns, ocean acidification and colder average temperatures.

TABLE 7-12: PHYSICAL CLIMATE HAZARDS

Acute Physical Risks	Chronic Physical Risks
Extreme precipitation	Higher average temperatures
Extreme heat	Sea level rise and coastal flooding
Cyclones and hurricanes	Changing precipitation patterns
Landslides	Ocean acidification

Acute Physical Risks	Chronic Physical Risks
Drought	Colder average temperatures
Wildfires	Increased wildfire-conducive conditions

Following hazard screening, three climate hazards were excluded from the detailed baseline climate-risk profile because they are not considered credible or material at the Project location. These are colder temperatures, rainfall-induced landslides, and cyclones. Colder temperatures were screened out because Port Harcourt remains warm throughout the year and future climate projections indicate that cold extremes become progressively less frequent and less severe over time. Rainfall-induced landslides were excluded because no triggering terrain or rainfall conditions were identified for the Project area. Cyclones were excluded because tropical cyclone wind conditions are not considered credible for the Project location and no such events were identified in the modelled climate data. The rationale for screening out these hazards is summarised in Table 7-13.

TABLE 7-13: CLIMATE HAZARDS SCREENED OUT OF THE CCRA

Climate Hazard	Rationale for Exclusion
Colder temperatures	Port Harcourt does not typically experience cold conditions; although temperatures are relatively lower during the wet season, the city remains warm throughout the year, and cold extremes are not considered a material climate hazard. Climate projections indicate that cold extremes become both less frequent and less severe across the assessed Project assets over time. The Cold Spell Duration Index (tn10p6d) declines from a baseline of 4.90 days per year to 2.20 days per year under SSP1-2.6 and 1.20 days per year under SSP5-8.5 days by 2030. By 2050, the index decreases further to 1.40 days per year under SSP1-2.6 and 0.00 days per year under SSP5-8.5, indicating that prolonged unusually cold conditions become increasingly rare under future climate conditions. This reduction in cold-spell frequency is accompanied by an increase in the minimum daily minimum temperature (tnn). Baseline values of 18.51°C increase to between 19.25°C and 19.99°C by 2030, and rise further to between 20.24°C and 20.96°C by 2050 across the assessed scenarios. These projections indicate that the coldest nights become progressively warmer over time, reinforcing the overall decline in the likelihood and persistence of extreme cold conditions across the Project area. While isolated cooler events cannot be entirely ruled out, the combined reduction in cold-spell duration and increase in the minimum daily minimum temperature indicate that cold extremes are unlikely to represent a significant operational risk for the Project. Colder conditions are therefore considered a low-likelihood, low-consequence hazard and are screened out from further assessment and adaptation planning, subject to standard operational procedures for occasional cooler-than-normal conditions.
Rainfall-Induced Landslide	Rainfall-induced landslide potential at the Project area is consistently zero across all assets and all future climate scenarios. Baseline values show 0.00 days with rainfall conditions capable of triggering a landslide event, and projections for 2030 and 2050 under SSP1-2.6 and SSP5-8.5 also remain at 0.00 days for every asset. This indicates that no part of the Project area is exposed to rainfall thresholds or terrain conditions typically associated with landslide occurrence, including steep slopes, unstable soils, or antecedent rainfall accumulation. The complete absence of landslide-triggering conditions in both the historical baseline and all future projections demonstrates that rainfall-induced landslides are not expected to develop under any climate

Climate Hazard	Rationale for Exclusion
	scenario. As a result, this hazard is considered low likelihood and low consequence and has been excluded from further assessment.
Cyclones	Tropical cyclones are not a typical climate hazard for Nigeria. Nigeria's location in the Gulf of Guinea places it close to the equatorial zone, where tropical cyclone formation is strongly limited by weak Coriolis forcing (NOAA, 2025). Consistent with this, available cyclone climatology and Nigeria-specific projection datasets indicate negligible historical and projected tropical cyclone occurrence and landfall for the Nigerian coast. For Indorama North and Indorama South, climate scenario data indicate no tropical cyclone wind events within the assessed proximity threshold. Specifically, the maximum sustained tropical cyclone windspeed indicator shows 0.00 knots across the historical baseline and all future projections (SSP1-2.6 and SSP5-8.5) for all project assets in both 2030 and 2050 time horizons. This indicates that, under the modelled dataset used for this assessment, tropical cyclone wind conditions are not projected to affect the project footprint. On this basis, tropical cyclone wind hazards are considered a low-likelihood hazard for the project area and are excluded from further analysis.

The hazards retained in the climate-risk baseline are extreme heat, extreme rainfall flooding, wildfires, and water stress and drought. These are the hazards considered most relevant to the Project's physical setting, planned infrastructure and longer-term operation, and climate resilience has been incorporated into the Project design: the IFF Line 2 storm-water drainage system is designed for a worst-case rainfall intensity of 99 mm per hour, and this drainage design basis has been adopted in the impact assessment in this ESIA. Their materiality ratings are based on the extent to which they may affect Project assets, access, operations and associated receptors over time. The materiality categories applied in the assessment are High, Moderate, Low, and Unlikely material, and the definitions of those categories are provided in Table 7-14.

TABLE 7-14: MATERIALITY RATING AND DESCRIPTION

Materiality Rating	Description
High	The hazard presents significant potential risks to Project assets. It is likely to materially affect one or more site receptor types during construction and/or operation, resulting in major disruption or delays with potential knock-on effects across the Project.

Materiality Rating	Description
	• **Receptor reach:** at least one key receptor type is materially affected, with plausible cascading effects. • **Disruption severity:** major disruption or prolonged delays are plausible (e.g., repeated stoppages, extended access limitations, or interruption of critical systems).
Moderate	The hazard presents moderate potential risks to Project assets. It is likely to affect one or more site receptors, but impacts are generally less severe and more contained. Disruption or delays may occur but are typically intermittent or confined to specific activities/areas, with limited knock-on effects at Project level. • **Receptor reach:** impacts are generally confined to a specific receptor type, location, or activity. • **Disruption severity:** noticeable disruption or delays are plausible but typically intermittent and not Project-wide.
Low	The hazard presents minimal potential risks to Project assets. Effects on receptors are expected to be minor, infrequent and short-lived, with limited or no impact on overall construction sequencing or operational performance. Any disruption is expected to be localised and readily recoverable. • **Receptor reach:** impacts, if they occur, are isolated and do not materially escalate. • **Disruption severity:** minor delays only; no credible pathway to critical interruption or major performance loss.
Unlikely material	The hazard presents negligible potential risks to Project assets. Exposure and/or consequences are expected to be very limited, with no credible pathway for the hazard to materially affect Project receptors. • **Receptor reach:** minimal exposure of receptors. • **Disruption severity:** no credible pathway to meaningful disruption.

Of the retained hazards, extreme heat is assessed as a High materiality hazard and is the most significant climate-related physical hazard for the Project. This reflects both the observed warming trend in the wider Port Harcourt area and the Project-specific projections presented later in this section. The increase in maximum daily temperature and the substantial increase in the duration of warm spells indicate that prolonged hot conditions are likely to become a more persistent feature of the Project environment over time.

Extreme rainfall flooding is assessed as a Moderate to High materiality hazard. This reflects the broader flood-prone setting of Port Harcourt and the eastern Niger Delta, together with site-specific modelling indicating that the northern portion of the Project area is exposed to persistent flood depth under baseline and future climate scenarios. Flood risk is therefore considered material to the Project, particularly in relation to drainage design, access, and the resilience of low-lying infrastructure.

Wildfires are assessed as a Moderate hazard. Historical burned-area data indicate that wildfire has occurred within the broader surrounding landscape, although future fire-weather conditions remain low in absolute terms and do not indicate a strongly escalating hazard pattern over time. Wildfire therefore remains part of the Project's climate-risk baseline, but at a lower level of materiality than extreme heat and flooding.

Water stress and drought are also assessed as a Moderate hazard. Historical rainfall variability indicates that the wider Port Harcourt area has experienced episodic dry anomalies and moderate drought conditions, even within an overall humid climatic setting. However, future climate projections for the Project indicate that long-term water-stress ratios remain very low. The inclusion of this hazard in the baseline therefore reflects the importance of seasonal variability and short-term water balance fluctuations rather than an expectation of severe structural water scarcity.

The retained hazards and their materiality are summarised in Table 7-15. This table should be read together with the hazard-specific baseline descriptions and supporting figures and tables that follow in the remainder of this climate-risk section.

TABLE 7-15: SUMMARY OF CLIMATE HAZARD MATERIALITY FOR THE PROJECT

Climate hazard	Included in detailed assessment	Materiality rating	Summary basis
Extreme heat	Yes	High	Retained as a material hazard on the basis of projected increases in daily maximum temperatures and a substantial increase in the Warm Spell Duration Index across the assessed Project assets.
Extreme rainfall flooding	Yes	Moderate to High	Retained as a material hazard because of the wider flood-prone setting of Port Harcourt and the site-specific inundation depths modelled for Indorama North under baseline and future scenarios.
Wildfires	Yes	Moderate	Retained as a material hazard on the basis of historical burned-area evidence in the surrounding landscape and continued, albeit low, projected wildfire-conducive conditions.
Water stress and drought	Yes	Moderate	Retained as a material hazard because of historical rainfall variability and episodic dry anomalies, although projected long-term water-stress ratios remain very low.
Colder temperatures	No	Screened out	Screened out because Port Harcourt remains warm throughout the year and projected cold extremes become less frequent and less severe over time.
Rainfall-induced landslide	No	Screened out	Screened out because no rainfall-triggering or terrain conditions associated with landslide occurrence were identified for the Project area.
Cyclones	No	Screened out	Screened out because tropical cyclone wind hazards are not considered credible for the Project location and no such events were

Climate hazard	Included in detailed assessment	Materiality rating	Summary basis
			identified in the climate data used in the assessment.

The identified climate hazards have been incorporated into Project design and operational planning as follows: (i) extreme rainfall flooding – the IFF Line 2 storm-water drainage system is designed for a worst-case rainfall intensity of 99 mm per hour, and is integrated with the existing lined channels, culverts, retention pond and standby outfalls of the complex (Sections 4.4.12 and 7.4.9.13), with flood-sensitive equipment to be sited or elevated above modelled flood levels during detailed design (Section 9.2.1); (ii) extreme heat – equipment and electrical infrastructure are specified for high ambient temperatures and heat-stress procedures for workers are mandated (Section 9.2.1.1); (iii) wildfires – perimeter vegetation management, fire detection and the 24-hour complex fire station (Sections 4.3.1.1 and 9.2.1); and (iv) water stress and drought – water recovery and reuse through the wastewater recovery plant, three back-up boreholes and the Water Management Plan (Sections 4.4.2, 4.4.3 and 9.2.1).

Overall, the climate hazard screening indicates that the Project's baseline climate-risk profile is dominated by extreme heat and extreme rainfall flooding, with wildfires and water stress / drought remaining relevant but of lower materiality. These hazards form the core physical climate-risk baseline for the Project and provide the context for the more detailed climate-change hazard descriptions presented in the following subsections.

7.4.2.4 SUMMARY OF KEY CLIMATE CHANGE HAZARDS APPLICABLE TO THE PROJECT

The climate-risk baseline indicates that the principal physical climate hazards applicable to the Project are extreme heat, extreme rainfall flooding, wildfires, and water stress and drought. Of these, extreme heat represents the most material long-term hazard to the Project, while extreme rainfall flooding is also important because of the broader flood-prone setting of the Port Harcourt area and the site-specific inundation projected for part of the Project area. Wildfires and water stress / drought remain relevant, but are of lower materiality than extreme heat and flooding.

Extreme heat is assessed as a High materiality hazard. This reflects both wider regional warming trends and Project-specific climate projections indicating rising maximum daily temperatures and a substantial increase in the persistence of prolonged hot conditions. Across the assessed Project assets, maximum daily temperatures are projected to increase above current baseline levels by both 2030 and 2050, while the Warm Spell Duration Index indicates a marked increase in the number of days forming part of prolonged warm spells. These trends indicate that thermal stress is likely to become a more persistent feature of the Project environment over time.

Extreme rainfall flooding is assessed as a Moderate to High materiality hazard. This reflects the existing flood sensitivity of the wider Port Harcourt setting, which is characterised by low-relief coastal terrain, high rainfall, high groundwater levels, and the influence of rivers, creeks,

swamps and tidal channels. At site level, modelled inundation depth indicates that flood hazard is concentrated at Indorama North, where baseline and future scenario outputs indicate persistent flood depth exceeding 1 m, while Indorama South remains unaffected in the modelled results. The flood-vulnerability context of the wider metropolitan area, together with the Project-specific inundation depths, indicates that flooding remains a material physical climate hazard for the northern portion of the Project area.

Wildfires are assessed as a Moderate hazard. Historical burned-area data indicate that wildfire has occurred within the broader landscape surrounding the Project, demonstrating that the area is not free from fire-related risk. Future projections of wildfire-conducive meteorological conditions remain low in absolute terms and do not indicate a strongly escalating hazard profile over time; however, the historical evidence confirms that wildfire remains a relevant baseline climate hazard for the broader receiving environment.

Water stress and drought are also assessed as a Moderate hazard. Historical rainfall variability indicates that the wider Port Harcourt area has experienced episodic dry anomalies and moderate drought conditions, despite its overall humid climatic setting. Future climate projections indicate that long-term structural water stress remains very low across the assessed Project assets; however, seasonal water-balance variability and short-term dry anomalies remain relevant in the baseline because they may influence water management conditions during certain periods.

In addition to the hazards taken forward, three hazards were screened out of the detailed climate-risk profile because they are not considered credible or material for the Project location. These are colder temperatures, rainfall-induced landslides, and cyclones. Screening out these hazards allows the climate-risk baseline to focus on the hazards that are most relevant to the Project’s physical setting and expected operational life.

The principal physical climate hazards applicable to the Project are summarised in Table 7-12. This table should be read together with the supporting climate-risk figures and hazard-specific baseline descriptions presented in this section.

7.4.2.5 DATA GAPS AND LIMITATIONS

The physical climate change risk assessment provides a high-level, desk-based review of the principal climate-related physical hazards relevant to the Project. As such, it is intended to establish the baseline climate-risk context for the ESIA and to identify the hazards most likely to require consideration in Project planning, design and operation. It is not intended to function as a detailed engineering climate-resilience study.

The assessment is subject to several assumptions and limitations. First, it is a desk-based assessment, and the evaluation of climate-related exposure and vulnerability is therefore based on the available Project information together with ERM’s review of climate datasets, literature and other available technical sources. ERM did not independently verify all Project design information used in the assessment.

Second, the assessment relies substantially on Global Climate Models (GCMs) and ERM’s Global Climate Database (GCD), supplemented by other external data sources. The assessment did not include the collection of additional local climate-monitoring data

specifically for the Project footprint. Existing reports, modelled datasets and other available sources were used to characterise both present-day and projected climate conditions for the Project area.

Third, not all possible natural hazards are considered within the climate-risk baseline. In particular, seismic hazards such as earthquakes were excluded because they are not climate-related hazards. In addition, some climate hazards were screened out because they were considered to have low likelihood or low consequence for the Project location, including colder temperatures, rainfall-induced landslides, and cyclones.

A further limitation is that climate science is inherently uncertain. Climate projections do not represent deterministic forecasts, and projected changes in hazard frequency, severity or timing remain subject to uncertainty associated with emissions pathways, model selection, downscaling approaches and natural climatic variability. The results of the assessment should therefore be interpreted as an informed indication of plausible future trends rather than as exact predictions of future site conditions.

In relation specifically to flood-related hazards, the assessment notes that downscaled climate datasets may under-represent short-duration, high-intensity convective rainfall events of the type that commonly drive flash flooding across parts of sub-Saharan Africa. For this reason, model-based flood projections should be interpreted with appropriate caution and, where necessary, supplemented during later design stages by more detailed local engineering and drainage analysis.

Notwithstanding these limitations, the assessment is considered sufficient to identify the principal physical climate hazards relevant to the Project and to establish a climate-risk baseline appropriate to the level of detail required for the ESIA. The findings should, however, be refined further where detailed engineering design, drainage studies, or operational planning require more site-specific climate-resilience inputs.

7.4.2.6 PROJECT CONTRIBUTION TO CLIMATE CHANGE

During the operational phase, the Project is anticipated to generate approximately **686,590 tonnes of carbon dioxide equivalent (tCO_2e) per annum** scope 1 and 2 greenhouse gas (GHG) emissions. When assessed against Nigeria's estimated national GHG emissions of approximately 345 million tCO_2e per annum (Boyle, 2024), the Project's emissions would account for approximately **0.20% of the national total**. Although the Project is characterised by relatively high GHG emissions at the facility level, reflecting the energy-intensive nature of its industrial operations, its proportional contribution to Nigeria's overall GHG emissions inventory remains comparatively limited. Nevertheless, given the cumulative and global nature of GHG emissions and their contribution to climate change, the Project's absolute emissions warrant appropriate consideration and management. Accordingly, the Project's contribution to national GHG emissions may be regarded as relatively low in proportional terms. However, IFF has committed to reducing the Project's GHG emissions through the GHG emission reduction initiatives and the monitoring, reporting and verification framework described in Section 9.2.2, consistent with Nigeria's Climate Change Act (2021) and Nationally Determined Contribution.

7.4.3 AIR QUALITY

This chapter presents the results of the ambient air quality monitoring conducted within the project area, and identified sensitive receptors, as part of the ESIA for the IFF Line 2 Fertilizer Project. Monitoring was undertaken using passive sampling methods to characterise baseline air quality conditions and assess potential impacts associated with the proposed development.

The Study Area is defined in terms of areas where direct and indirect impacts may occur as a result of the construction, operation or decommissioning of the proposed Project. In terms of air quality, the study considers only direct impacts to sensitive receptors. As such, the Study Area is based on the following distances from the infrastructure design:

Construction phase:

- 250 m from any construction activities, as this is the maximum distance downwind that dust will travel as a precautionary approach; and
- 50 m from construction access routes.

Operational phase:

- 10 km from the proposed IFF Line 2 Plant.

The pollutants of interest are:

- Oxides of nitrogen (NO_x), and by association nitrogen dioxide (NO_2) arising from combustion sources;
- Particulate matter as PM_{10} and $PM_{2.5}$ arising from combustion and production;
- Sulphur dioxide (SO_2), from diesel powered vehicles and machinery and
- Ammonia (NH_3) arising from production sources.

7.4.3.1 INTRODUCTION

Baseline air quality typically varies across the study area. In essence, the baseline can be considered in the following components:

- **Natural Baseline** – this represents the pollution concentrations that are ubiquitous in the region due to sources other than human activity. This primarily influences PM_{10} /$PM_{2.5}$ concentrations. Naturally occurring NO_x and NO_2 are typically minimal.
- **Regional Sources** – this represents the pollution concentrations that arise from large point or non-point sources that will affect substantial areas.
- **Local Sources** – this represents pollutant concentrations that vary on a small spatial scale but may be substantially elevated on a local level. An example of such sources includes road traffic and in the middle of towns where there are vehicles, industry and multiple small-scale sources. These sources can lead to elevated pollutant concentrations on a localised scale, for the pollutants of interest.

Within the Project area the main sources of air pollution are:

- Nearby residential areas that include household heating fires, cooking;
- Agriculture;
- Dust from nearby paved and unpaved road;
- Indorama's operating plants;
- Oil and Gas refining and storage and

- Urban Traffic.

7.4.3.2 SAMPLING LOCATIONS

A description of the sampling locations for the rainy and dry seasons, including their respective coordinates, is provided in Table 7-16.

TABLE 7-16: SAMPLING LOCATIONS

Sample IDs	Locations	Coordinates	
		Latitude	Longitude
AQ1 - P	Iriebe Area	04º 51’ 09.37”	07º 6’ 27.10”
AQ2- P	Secondary Forest Towards N--E	04º 51’ 21.15”	07º 8’ 04.58”
AQ3 - P	Agbonchia farmland	04°49'54.52"	07° 8'33.81"
AQ4 - P	Aleto Area	04º 47’ 38.19”	07º 6’ 46.68”
AQ5 - P	Agbonchia	04º 48’ 07.41”	07º 7’ 24.23”
AQ6 - P	Elelenwo Area	04°51'08.75"	07° 5'22.30"
AQ7 - P	Akpajo Axis	04°49'16.65"	07° 5'12.32"
AQ8 - P	North Area of the Facility	04º 50’ 51.55”	07º 6’ 29.20”
AQ9 - P	Recreation Area of the Facility	04º 50’ 10.87”	07º 5’ 27.04”
AQ10- P	DPP Open Area of the facility	04º 49’ 21.63”	07º 6’ 09.24”
AQ11 - P	Oyigbo area	04°52'33.35"	07° 8'4.28"
AQ12 - P	GTC/Zoo area	04°48'23.85"	07° 4'3.21"

The locations of the sampling sites are shown in Figure 7-9, highlighting their distribution across the project area and proximity to identified sensitive receptors and potential emission sources.

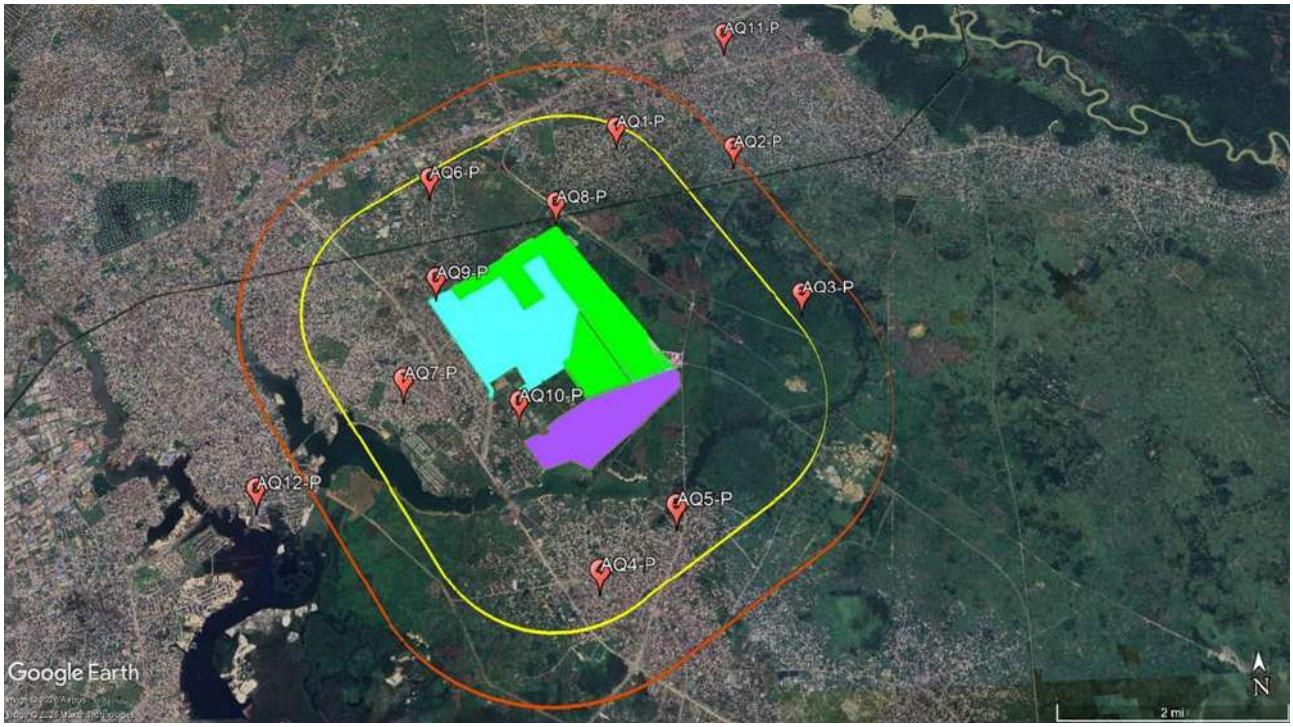


FIGURE 7-9: SAMPLING LOCATIONS

7.4.3.3 DESCRIPTIONS OF THE SAMPLING LOCATIONS

Table 7-17 below describes the sampling locations used for IFF Line 2.

TABLE 7-17: IFF LINE 2 AIR QUALITY SAMPLING LOCATIONS FIELD OBSERVATIONS

Sample IDs	Locations	Field observations
AQ1–P	Iriebe Area	Bright weather, with ambient temperature of 29.8°C and Relative Humidity (RH) of 82%. Installed in a location close to access road. Local activities observed in this area during installation were use of diesel and petrol generators, burning of used tyres, open burning of waste, cattle ranch/ feed lot and livestock poultry farming activities.
AQ2-P	Secondary Forest Towards N--E	Sunny weather, with ambient temperature of 31.2°C and RH of 78.0%. Installed in a location close to access road. Local activities observed in this area during installation were vehicular movement, and use of fossil fuel electric generators.
AQ3 – P	Agbonchia farmland	Cloudy weather, thunderstorms with ambient temperature of 26.0°C and RH of 89.0%. Installed in a location close to the major road. Vehicular movement, truck haulage of excavated laterite soil, use of fossil fuel electric generators, bush burning during farming, agricultural activities and livestock poultry farming activities.

Sample IDs	Locations	Field observations
AQ4 – P	Aleto Area	Sunny weather, with ambient temperature of 32.0°C and RH of 77.0%. Installed in a compound close to access road. Local activities observed in this area during installation were use of diesel and petrol generators, burning of used tyres, open burning of waste, use of motorcycles and tricycles for transportation, bush burning and livestock poultry farming activities.
AQ5 – P	Agbonchia	Rain, thunderstorms with ambient temperature of 24.6 °C and RH of 98.0%. Installed in a compound not close to major road. Local activities observed in this area during installation were use of diesel and petrol generators, burning of used tyres, open burning of waste, use of motorcycles and tricycles for transportation. Livestock poultry farming activities.
AQ6 – P	Elelenwo Area	Cool weather, with ambient temperature of 25.5 °C and RH of 97.0%. Installed in a compound not close to access road. Local activities observed in this area during installation were use of diesel and petrol generators, open burning of waste, use of motorcycles and tricycles for transportation. Livestock poultry farming activities.
AQ7 – P	Akpajo Axis	Cool weather, with ambient temperature of 25.5 °C and RH of 98.0%. Installed inside NNPC staff quarters. Local activities observed in this area during installation were use of diesel and petrol generators, and livestock poultry farming activities.
AQ8 – P	North Area of the Facility	Sunny weather, with ambient temperature of 31.5 °C and RH of 79.0%. Local activities observed in this area during installation were construction works.
AQ9 – P	Recreation Area of the Facility	Sunny clear weather, with ambient temperature of 31.5 °C and RH of 78.0%. installed on the barbwire in an open space.
AQ10—P	DPP Open Area of the facility	Bright weather, with ambient temperature of 30.5 °C and RH of 80%. Installed in an open area, pilling activities on going around the areas.
AQ11—P	Oyigbo area	Sunny clear weather, with ambient temperature of 32.8 °C and RH of 58.3%. Local activities observed in this area during installation were use of diesel and petrol generators, open burning of waste, use of motorcycles and tricycles for transportation.
AQ12—P	GTC/Zoo area	Sunny clear weather, with ambient temperature of 33.1 °C and RH of 50.7%. Local activities observed in this area during installation were use of diesel and petrol generators, burning used tyres, open burning of waste, use of motorcycles and tricycles for transportation, bush burning. Livestock poultry farming activities.

7.4.3.4 SAMPLING RESULTS

A total of sixty (60) tubes were deployed across ten (10) pre-selected locations within the project area during the rainy season, while seventy-two (72) tubes were installed at twelve (12) locations during the dry season. To ensure accurate and representative measurement of ambient air pollutants, all tubes were placed in locations with adequate, unobstructed air circulation.

TABLE 7-18: WET SEASON SUMMARY OF RESULT AIR QUALITY

Location	NH_3 (µg NH_3/m^3)	NO (µg NO/m^3)	NO_2 (µg NO_2/m^3)	NOx (µg NO_2/m^3) *	SO_2 (µg SO_2/m^3)	TVOC (µg TVOC/m^3)
AQ1-P	15.1	1.6	17.6	20.1	<1.59	73.6
AQ2-P	17.9	2.9	13.1	17.5	<1.60	73.4
AQ3-P	13.1	5.5	11.8	20.2	<1.64	59.6
AQ4-P	19.2	10.1	20.2	35.7	<1.64	111.0
AQ5-P	15.5	1.6	18.3	20.8	3.88	215.0
AQ6-P	18.9	2.2	21.0	24.4	<1.66	59.3
AQ7-P	5.4	< 1.3	14.9	16.9	2.22	53.5
AQ8-P	23.3	4.3	19.4	25.9	<1.58	108.8
AQ9-P	10.1	< 1.3	22.6	24.6	<1.59	91.9
AQ10-P	8.7	< 1.3	19.8	21.8	<1.58	89.9
Average	**14.7**	**4.0**	**17.9**	**22.8**	**3.05**	**93.6**
Nigerian (Annual)	**600**	**-**	**40**	**-**	**80**	-
IFC limit (Annual)	**200**	**-**	**40**	**-**	**20**	-

*Note: The NO_x data used is not based on directly monitored results. Instead, it was derived by converting the monitored NO concentrations to NO_2 and then adding this converted value to the measured NO_2 results.

TABLE 7-19: DRY SEASON SUMMARY OF AIR QUALITY RESULT

Location	NH_3 (µg NH_3/m^3)	NO (µg NO/m^3)	NO_2 (µg NO_2/m^3)	NOx (µg NO_2/m^3) *	SO_2 (µg SO_2/m^3)	TVOC (µg TVOC/m^3)
AQ1-P	26.7	< 1.2	15.2	17.0	<1.56	240.1
AQ2-P	20.7	< 1.2	17.1	18.9	<1.56	79.5
AQ3-P	8.6	2.7	13.6	17.7	<1.57	90.9

AQ4-P	25.1	< 1.3	18.7	20.7	<1.58	85.1
AQ5-P	22.3	3.4	19.5	24.7	<1.57	273.0
AQ6-P	25.5	< 1.3	18.9	20.9	<1.59	151.0
AQ7-P	6.8	< 1.3	14.2	16.2	<1.58	85.6
AQ8-P	53.8	< 1.3	24.3	26.3	<1.59	59.7
AQ9-P	10.5	< 1.2	19.0	20.8	<1.59	77.4
AQ10-P	8. 6	< 1.3	16.2	18.2	<1.56	70.4
AQ11-P	23.4	< 1.2	14.2	16.0	<1.56	108.5
AQ12-P	15.8	< 1.3	23.2	25.2	<1.56	86.0
Average	**21.7**	**3.0**	**17.8**	**20.7**	**<1.57**	**117.2**
Nigerian (Annual)	**600**	**-**	**40**	**-**	**80**	-
IFC limit (Annual)	**200**	**-**	**40**	**-**	**20**	-
*Note: The NO_x data used is not based on directly monitored results. Instead, it was derived by converting the monitored NO concentrations to NO_2 and then adding this converted value to the measured NO_2 results.						

The results for particulate matter (PM) are presented in Table 7-20 below. This present one month continuous monitoring data at each locations considering the prevailing wind direction and used for the impact assessment.

TABLE 7-20: PM10 MONITORING RESULTS

Location	PM_{10}	$PM_{2.5}$
AQ9-P	30.9	11.5
AQ10-P	25.8	9.7
AQ8-P	22.4	9.0
Average	26.4	7.5

The combined average results of the two monitoring campaigns demonstrate that baseline concentrations for all monitored pollutants remain below 50% of the applicable Air Quality Standards (Table 7-21), therefore the airshed can be considered undegraded.

TABLE 7-21: Baseline Used in thE ASSESSMENT (µG/M^3) **

Parameter	Baseline used	Project Guideline AQS	% AQS
NO_2 (Annual Mean)	17.9	40	44%
NO_2 (24h maximum)	61.2*	120	30%
NO_2 (1h maximum)	61.2*	200	18%

PM_{10} (Annual Mean)	26.4	60	44%
PM_{10} (24h maximum)	52.8*	150	35%
NH_3 (Annual Mean)	18.2	200	9.1%
* Long term (annual) baseline multiplied by a factor 2 as per UK Defra (2009) Local Air Quality Management Technical Guidance Note TG (09)			

7.4.3.5 ACTIVE AIR QUALITY MONITORING

The ambient air quality monitoring exercise was conducted from 16th to 25th October 2025 for rainy season period; and from 28th of February to 3rd of March for dry season period. The air quality survey was carried out at 28 pre-established stations (Table 7-22) within the proposed project geographical zone. Sampling of air quality was also carried out using AI analytics Miri Air modular samplers at the twelve stations within the proposed project environment along with diffusion tubes passive sampling. The concentration levels of sulphur dioxide (SO2), nitrogen dioxide (NO2), Ozone (O3), Volatile organic compounds (VOCs), ammonia (NH3), particulate matter (PM10), and particulate matter (PM2.5) were monitored and expressed in microgram per cubic meter (µg/m3), which gives an understanding of the baseline existing environmental setting and condition of the project area.

The sampling period of ambient air quality within the project area and its environs was varied from minimum eight hours to twenty hours depending on sampling location and security of equipment and personnel. At each locations the readings of all the parameters taken every hour. The monitoring period was carried out from day to day so that reading could be taken from early morning to late at night over the monitoring period. The series of monitors with specific sensors head are fixed in a stand about 2-3m above the ground level in open space and allowed to run for an hour to determine the values. After recording the values, the instrument was allowed to run for suitable period with recording values every hour.

Table 7-22 below show the ambient air quality monitoring stations with respective GPS coordinates, and location on google map is shown in Figure 7-10.

TABLE 7-22: AIR QUALITY MONITORING STATIONS

Station Code	Description	Coordinates	
		Longitude (North)	Latitude (East)
AQ1	West end of the Project site	4o50’42.20”	7o06’18.00”
AQ2	North End of the Project Site	4o50’48.80”	7o06’29.00”
AQ3	Between North & East End of the Project Site	4o50’08.60”	7o06’57.60”
AQ4	East End of the Project Site	4o49’30.00”	7o07’26.00”
AQ5	South End of the Project Site	4o49’16.80”	7o06’43.50”
AQ6	Centre of the Project Site	4o50’05.30”	7o06’49.70”
AQ7	Flare area of Indorama Complex	4o49’54.20”	7o06’37.00”

Station Code	Description	Coordinates	
		Longitude (North)	Latitude (East)
AQ8	ETP Area of Indorama Complex	4o49’32.20”	7o06’30.50”
AQ9	D/W of Urea Warehouse (Indorama Complex)	4o50’25.20”	7o05’49.80”
AQ10	Vegetation area towards North of Project Site	4o50’45.50”	7o07’35.80”
AQ11	IRC within Indorama Complex	4o50’10.70”	7o05’27.00”
AQ12	Main gate of Indorama Complex (Close to East-West Expressway)	4o48’47.00”	7o05’52.00”
AQ13	Agbonchia Community	4o48’20.00”	7o07’31.60”
AQ14	Aleto Community	4o48’40.00”	7o06’09.80”
AQ15	Akpajo Community	4o49’44.50”	7o05’17.60”
AQ16	Elelenwo Community	4o50’15.00”	7o04’43.00”
AQ17	Steel Market	4o51’10.00”	7o05’01.60”
AQ18	Axis of Iriebe Market	4o51’45.00”	7o05’47.00”
AQ19	Axis of Iriebe Community	4o52’09.00”	7o06’58.00”
AQ20	Between Edutex and farming settlement	4o50’14.50”	7o08’53.50”
AQ21	Njuru Community	4°48'14.65"	7°07'13.96"
AQ22	Okerewa Community	4°48'22.77"	7°06'26.71"
AQ23	Agbonchia farmland	4°49'12.75"	7°08'13.42"
AQ24	Iriebe Community	4°51'29.40"	7°07'16.94"
AQ25	NNPC Housing area	4°48'59.25"	7°05'09.62"
AQ-C1	GSS – Oyigbo Community	4o52’43.00”	7o08’23.00”
AQ-C2	Rumukrushi Community	4o50’23.00”	7o03’32.00”
AQ-C3	Alesa Community	4o47’14.72”	7o06’33.30”



FIGURE 7-10: GOOGLE MAP SHOWING AMBIENT AIR QUALITY MONITORING STATIONS

Continuous real-time measurement instruments (AQM 65 and digital AEROQUAL 500 series monitor) with sensor heads were used to monitor and record the priority parameters of ambient air quality. The different and calibrated sensor heads were used for the specific gases and particulate matter monitored. The battery-operated monitors have on-board diagnostics, which informed user about the functionality of sensor head. The monitor can log up to 8188 data points. The data were downloaded to a PC after a 24-hour data logging at each sampling station. The data logging interval was set in one-hour increments from either the monitor or the PC. The suspended particulate matter was monitored using battery operated mini-volume sampler whereas PM10, PM2.5 and gases were monitored by using Aeroqual 500 series monitors fixed with sensor heads. The details of sensors heads used are shown in below Table 7-23.

TABLE 7-23: SENSOR DETAILS FOR AEROQUAL 500 SERIES MONITORS

Sensor	Sensor type	Range	Minimum detection limit	Accuracy	Resolution
Nitrogen dioxide (NO2)	GSE (Gas Sensitive Electrochemical)	0-1ppm	0.005ppm	<±0.02ppm 0-0.2ppm <±10% 0.2-1ppm	0.001ppm
Sulphur dioxide (SO2)	GSE (Gas Sensitive Electrochemical)	0-10ppm	0.04ppm	<±0.05ppm 0-0.5ppm <±10% 0.5-10 ppm	0.01ppm

Sensor	Sensor type	Range	Minimum detection limit	Accuracy	Resolution
Ozone (O3)	GSE (Gas Sensitive Electrochemical)	0-10ppm	0.01ppm	<±0.01ppm + 7.5%	0.01ppm
Ammonia (NH3)	GSE (Gas Sensitive Electrochemical)	0-25ppm	0.05ppm	<±0.5ppm 0-5ppm <±10% 5-25 ppm	0.01ppm
Volatile organic compounds (VOCs)	PID (Photo Ionization Detector)	0-20ppm	0.01ppm	<±0.02ppm +10%	0.01ppm
Particulate Matter (PM2.5 & PM10)	LPC (Laser Particle Counter)	0.001-1000 mg/m3	0.001mg/m3	±0.005 mg/m3 +15%	0.001 mg/m3

A brief description of AQ65

The Aeroqual AQM 65 is a modular compact, IP65-rated temperature-controlled ambient air quality monitoring station designed for continuous, real-time measurements of up to 20 gaseous (such as SO2, NO2, CO, and NH3, VOCs) and particulate (PM10 and PM2.5) pollutants simultaneously. It provides "near-reference" data using active sampling and thermal management, suitable for urban/industrial monitoring, with 4G/Wi-Fi connectivity. It is frequently used for urban and industrial monitoring, providing "near-reference" data quality traceable to international standards like the U.S. EPA (40 CFR Part 53). It uses gas-sensitive electrochemical sensors and a near-forward scattering nephelometer for particulates (laser source: 670 nm). It has a continuously auto-corrects the gas measurement that "zeros" every 60 seconds to eliminate drift and cross-interferences. The sampling system consists of a Teflon and glass-coated stainless-steel inlet to prevent chemical reactions with incoming gas samples at part per billion (ppb) levels. The details of measurement principles of the instruments, range and resolution/detection limits are shown in Table 7-24.

TABLE 7-24: SENSOR DETAILS FOR AEROQUAL AQM 65

Sensor	Sensor type	Range	Lower detectable limit	Precision	Resolution
Nitrogen dioxide (NO2)	GSE (Gas Sensitive Electrochemical)	0-0.2ppm	0.001ppm	<3% of reading or 0.003 ppm	0.001ppm
Sulphur dioxide (SO2)	GSE (Gas Sensitive Electrochemical)	0-10ppm	0.009ppm	<3% of reading or 0.009 ppm	0.001ppm
Ozone (O3)	GSE (Gas Sensitive Electrochemical)	0-0.5ppm	0.001ppm	<2% of reading or 0.002 ppm	0.001ppm
Ammonia (NH3)	GSE (Gas Sensitive Electrochemical)	0-25ppm	0.01ppm	<2% of reading or 0.01 ppm	0.01ppm
Volatile organic	PID (Photo Ionization Detector)	0-20ppm	0.01ppm	<2% of reading or 0.01 ppm	0.001ppm

Sensor	Sensor type	Range	Lower detectable limit	Precision	Resolution
compounds (VOCs)					
Particulate Matter (PM2.5 & PM10)	Nephelometer (light scattering)	0 to 2000 µg/m3	<1 µg/m3	<±(2 µg/m3 + 5% of reading)	<1 µg/m3

A brief description of Miri Air Quality Instrument

Miri air Africa air quality device is manufactured by Climate in Africa. It is a solar-powered, modular, multi-parameter environmental monitoring station capable of measuring particulate matter, gaseous pollutants, and meteorological variables with real-time cloud connectivity and AI analytics. It is designed for high reliability in harsh environments, compliant with international standards, and suitable for government, industrial, and research applications across Africa. Miri Air's sensors are calibrated against regional certified reference standards. Miri Air is compliant with the World Meteorological Organization's Guide to Instruments and Methods of Observation (WMO-No. 8), which sets the global standards for the performance, calibration, and air quality instruments.

Miri Air air quality monitoring devices were installed across twelve strategic locations within project environment where passive samplers were also installed to capture key pollution indicators and environmental parameters at ground level. These devices operate continuously, ensuring uninterrupted data collection. All the captured data were transmitted to the Miri Console, where they were processed, stored, and analyzed in real time. The details of measurement principles of the instruments, range and resolution/detection limits are shown in Table 7-25.

TABLE 7-25: SENSOR DETAILS FOR MIRI AIR INSTRUMENT

	CH4	SO2	PM2.5	PM10	NO2	03	CH20	CO2	CO	VOC	NOISE	HUMIDITY	TEMP-ERATURE	ATM PRESSURE
Type	NDIR Dual Beam	Electro chemical	Laser Scattering & Airflow	Laser Scattering & Airflow	Electro chemical	Electro chemical	Electro chemical	Non-Dis persive Infrared	Electro chemical	Electro chemical		Capacitive Sensor	Linear Tempera ture	Piezo-Resistive Sensor
Unit	ppm	ppm	µg/m³	µg/m³	ppm	ppb	ppm	ppm	ppm		dBA	%RH	°C	hPa
Measure-ment Range	0 ~ 50,000 ppm	0 ~ 20ppm	0.0 ~ 999.9µg / m³	0.0 ~ 999.9µg / m³	0.05ppm ~ 10ppm	0 to 9999ppb	0~5ppm	400 ppm ~ 5000 ppm	0 ~ 1000ppm	Electro chemical	30 to 120 dBA 20 to 12.5 KHz	0 to 100% RH	0 to 100 °C	300hPa ~ 1100hPa
Resolution	500ppm	0.1ppm	0.3µm	0.3µm	0.25ppm	≤1ppb	0.01ppm	1ppm	1ppm			0.1%RH	0.01 °C	0.01hPa
Operating Temp Range	-20 ~ 60°C	-20 ~ 50°C	-10 ~ 50°C	-10 ~ 50°C		-20 ~ 50°C	-20 ~ 50°C	-10~+ 60 °C	-10 ~ 40°C		-40 ~ 60°C	-40°C to +85°C	0 to 100 °C	-40—+85 °C
Operating RH Range	0 ~ 90% RH	15 ~ 90% RH	0 ~ 90% RH	0 ~ 90% RH		15%RH-90%RH	15%RH-90%RH	0~95%	5 ~ 90% RH		25 ~ 90 % RH	0 to 100% RH	0 to 100 %RH	0 to 100 %RH
Operating Life	5 YRS	2 YRS	12 Months	12 Months		3 YRS	2 YRS	≥10 YRS	5 YRS		Device time life	Device time life	Device time life	Device time life
Accuracy	±3% F.S.	±3% F.S.	Max (± 15% & ± 10µg/m³)	Max (± 15% & ± 10µg/m³)		±10ppb or ± 10%	±1%	± (50ppm + 5% of Reading)	≤1ppm		± 0.5dB	±2%RH (Max ± 5%RH)	±0.9°C	±0.15hPa
Response Time	40s	30s	1s	1s	<250s	≤60s	≤60s	3 mins	≤30s		1.5s			

Monitored Data

The result of air quality monitoring in the wet season is shown in Table 7-26; while the result obtained in the dry season is shown in Table 7-27 (Please refer to Annexure 4-2 for detail monitoring data for both seasons).

TABLE 7-26: WET SEASON SUMMARY OF AIR QUALITY RESULTS

Parameter/ Station	SO2 (µg/m3)	NO2 (µg/m3)	O3 (µg/m3)	VOC (µg/m3)	NH3 (µg/m3)	PM10 (µg/m3)	PM2.5 (µg/m3)
AQ1	1.99	19.96	11.02	44.7	20.03	24.33	14.41
AQ2	2.37	15.63	11.02	45.12	13.41	25.37	14.01
AQ3	2.28	15.27	8.06	55.77	14.23	25.12	13.93
AQ4	2.19	14.23	9.91	52.29	14.77	25.04	14.31
AQ5	2.57	16.02	16.19	57.4	14.90	26.51	13.65
AQ6	2.46	16.55	7.76	59.51	12.86	25.33	13.50
AQ7	2.47	16.29	12.26	56.36	14.23	25.14	13.75
AQ8	2.12	14.74	11.36	67.77	13.57	25.88	14.10
AQ9	2.32	16.87	11.33	59.47	13.38	24.84	13.91
AQ10	2.01	16.61	8.18	61.21	14.92	25.74	13.84
AQ11	2.29	23.38	12.23	29.71	14.75	24.96	12.04
AQ12	2.24	14.50	7.74	31.57	15.81	26.67	14.79
AQ13	2.34	17.71	9.80	29.31	17.85	22.54	14.17
AQ14	2.33	25.14	8.87	29.18	16.25	23.11	14.40
AQ15	2.69	30.71	6.92	28.13	16.71	23.52	14.23
AQ16	2.50	29.75	9.92	26.57	16.98	26.13	14.75
AQ17	2.69	14.29	8.28	35.28	17.21	23.14	14.50
AQ18	2.44	11.91	9.22	32.84	24.52	22.32	11.80
AQ19	2.55	14.67	8.45	34.14	11.55	21.95	14.09
AQ20	2.38	12.43	9.18	34.81	14.48	22.18	11.99
AQ21	2.52	12.52	8.57	29.27	15.12	21.55	12.08
AQ22	2.06	13.81	8.86	30.54	14.76	23.87	12.95
AQ23	2.12	13.42	9.10	31.93	13.59	25.83	12.35
AQ24	1.95	12.93	23.82	31.08	12.31	26.92	14.25
AQ25	4.36	22.10	20.69	67.79	20.27	20.46	11.46

Parameter/ Station	SO2 (µg/m3)	NO2 (µg/m3)	O3 (µg/m3)	VOC (µg/m3)	NH3 (µg/m3)	PM10 (µg/m3)	PM2.5 (µg/m3)
AQ-C1	3.27	26.02	13.74	74.43	34.75	22.88	14.29
AQ-C2	2.73	29.78	10.88	29.24	23.17	22.88	16.00
AQ-C3	5.45	29.86	10.80	31.9	20.27	22.58	24.04
NESREA limit	80	40	-		600	-	-
IFC limit	20	40	-		200	-	-

TABLE 7-27: DRY SEASON SUMMARY OF AIR QUALITY RESULTS

Parameter/ Station	SO2 (µg/m3)	NO2 (µg/m3)	O3 (µg/m3)	VOC (µg/m3)	NH3 (µg/m3)	PM10 (µg/m3)	PM2.5 (µg/m3)
AQ1	1.69	16.17	13.62	49.99	14.62	57.63	21.38
AQ2	1.74	24.31	13.35	47.41	14.14	40.01	11.13
AQ3	1.96	18.71	14.60	59.83	13.03	57.82	23.51
AQ4	1.43	15.81	12.61	51.98	11.62	56.16	23.01
AQ5	1.37	16.05	12.96	50.60	15.18	58.89	21.54
AQ6	1.62	16.88	12.03	52.35	15.64	55.38	23.35
AQ7	1.49	17.48	14.37	52.78	16.19	56.92	24.22
AQ8	1.87	17.22	16.15	52.87	17.92	61.91	25.39
AQ9	2.25	16.73	14.06	59.36	17.47	60.43	23.73
AQ10	1.93	17.31	11.96	50.39	12.90	26.38	17.34
AQ11	1.52	24.55	12.30	46.77	13.54	21.65	9.21
AQ12	5.45	16.93	20.61	45.19	20.27	21.25	13.00
AQ13	4.36	25.71	22.49	61.14	17.38	21.67	13.25
AQ14	4.36	25.63	24.59	39.88	17.38	21.54	12.25
AQ15	8.73	30.57	26.34	18.61	11.58	22.33	12.33
AQ16	1.09	22.02	32.23	45.19	11.58	22.46	12.29
AQ17	4.36	25.79	19.30	66.46	40.54	21.54	12.75
AQ18	1.31	25.08	31.41	29.24	11.58	21.63	11.63
AQ19	7.64	27.43	22.00	45.19	23.17	21.58	12.79
AQ20	2.18	24.69	27.24	67.79	8.69	21.13	11.58
AQ21	1.19	25.79	17.45	51.84	14.48	23.75	12.79
AQ22	1.23	24.30	21.59	57.15	20.27	21.83	12.75
AQ23	2.18	22.42	31.74	78.42	26.06	21.00	12.29
AQ24	8.73	26.96	19.22	74.43	20.27	22.35	15.79

Parameter/ Station	SO2 (µg/m3)	NO2 (µg/m3)	O3 (µg/m3)	VOC (µg/m3)	NH3 (µg/m3)	PM10 (µg/m3)	PM2.5 (µg/m3)
AQ25	3.27	22.65	28.05	46.52	14.48	20.71	11.88
AQ-C1	6.55	27.20	19.22	85.07	17.38	21.96	11.92
AQ-C2	7.64	29.00	15.46	67.79	20.27	21.83	11.38
AQ-C3	3.27	26.18	14.45	69.12	14.48	21.96	11.50
NESREA limit	80	40	-		600	-	-
IFC limit	20	40	-		200	-	-

Ambient Air Quality of Study Environment

Result (Table 7-26) obtained in the rainy season shows that average concentration of sulphur dioxide ranges from 1.95µg/m3 at AQ24 to 5.45 µg/m3 at AQC3; while, average SO2 in the dry season (Table 7-27) ranges from 1.09µg/m3 at AQ16 to 8.73µg/m3 at AQ15. Average concentration of NO2 in the rainy season ranges from 11.91µg/m3 at AQ18 to 30.71 µg/m3 at AQ15; while average NO2 in the dry season ranges from 15.81µg/m3 at AQ4 to 30.57µg/m3 at AQ15. Average ground level O3 in the rainy season ranges from 6.92 µg/m3 at AQ15 to 23.82 µg/m3 at AQ24; while average O3 in the dry season anges from 11.96µg/m3 at AQ10 to 32.23µg/m3 at AQ16. Rainy season average concentration of VOC ranges from 26.57 µg/m3 at AQ16 to 74.43µg/m3 at AQC1; while, average VOC in the dry season ranges from 18.61µg/m3 at AQ15 to 85.07µg/m3 at AQC1. Average concentration of NH3 in the rainy season (Table 7-26) ranges from 11.55 µg/m3 at AQ19 to 34.75µg/m3 at AQC1; while average NH3 in the dry season (Table 7-27) ranges from 8.69µg/m3 at AQ20 to 40.54µg/m3 at AQ17. Average concentration of PM10 in the rainy season (Table 7-26) ranges from 20.46µg/m3 at AQ25 to 26.92 µg/m3 at AQ24; while average PM10 in the dry season (Table 7-27) ranges from 20.71µg/m3 at AQ25 to 61.91µg/m3 at AQ8. Rainy season average concentration of PM2.5 ranges from 11.46 µg/m3 at AQ25 to 24.04µg/m3 at AQC3; while average PM2.5 in the dry season) ranges from 9.21µg/m3 at AQ11 to 25.39µg/m3 at AQ8.

Seasonal variation in particulate matter. The active monitoring results show a clear seasonal difference in particulate concentrations (Table 7-26 and Table 7-27). In the wet season (16–25 October 2025), PM10 ranged from 20.46 to 26.92 µg/m³ (mean 24.2 µg/m³ across the 28 stations) and PM2.5 from 11.46 to 24.04 µg/m³ (mean 14.1 µg/m³). In the dry season (28 February–3 March 2026), PM10 ranged from 20.71 to 61.91 µg/m³ (mean 33.0 µg/m³) and PM2.5 from 9.21 to 25.39 µg/m³ (mean 15.6 µg/m³), with the highest values at the Project-area stations AQ1–AQ9 (PM10 40.01–61.91 µg/m³). The higher dry-season concentrations reflect Harmattan dust, reduced wet deposition and dust from unpaved roads. All seasonal values are below the Project-adopted 24-hour standards (PM10 150 µg/m³; PM2.5 40 µg/m³). As the adopted PM10 baseline (26.4 µg/m³, Table 7-21) is lower than the dry-season Project-area values, a sensitivity check was made using the highest dry-season PM10 value of 61.91 µg/m³: combined with the highest predicted 24-hour PM10 process contribution for IFF Line 1 and IFF Line 2 together (44.2 µg/m³), the predicted environmental concentration of about 106 µg/m³ remains below the 150 µg/m³ standard. The dry season is therefore the critical period for dust management during construction (Section 9.2.4).

7.4.4 NOISE

7.4.4.1 INTRODUCTION

An important part of the noise assessment is the quantification and understanding of the existing acoustic environment, including the identification baseline noise levels at potentially NSRs. The baseline environment can be defined as the conditions that would prevail in the absence of the Project.

This section presents the results of the baseline noise survey undertaken between 16 to 25 October 2025 (rainy season) and 20 February to 5 March 2026 (dry season). The quantification of baseline noise levels provides the basis for the assessment of potential noise impacts at NSRs as a result of the Project. Noise measurement locations were chosen to achieve a representative understanding of the noise baseline at NSRs in the vicinity of the Project.

7.4.4.2 NOISE MONITORING LOCATIONS

Noise baseline measurements were proposed to be conducted at 11 locations. These 11 locations were considered to be representative of the acoustic environment around the vicinity of the Project. Noise monitoring locations were selected before the finalization of the Project's design. Noise measurement locations are provided in Table 7-28 and Figure 7-11.

TABLE 7-28: NOISE MEASUREMENT LOCATIONS

Noise Monitoring Location	Description	WGS 1984 UTM 32N	
		Easting	Northing
N1	Near Project site boundary towards Iriebe	291951.49	533770.11
N2	Secondary vegetation towards N-side	291605.80	534469.06
N3	Iriebe area	290334.67	536157.98
N4	New Akpajo area	288839.11	535716.09
N5	Akpajo area	288089.50	535009.74
N6	School opposite NNPC Housing Estate	288370.99	534066.39
N7	Front Side Molam Hotels	288730.69	533537.27
N8	Residential area close to Indorama Complex Gate	289039.95	533149.62
N9	Mini-Market Environs	289110.02	532416.09
N10	Life Camp (West side of Project Site)	289643.64	533025.36
N11	South of the Project Site	290490.19	533127.77

Source: Indorama, 2026.

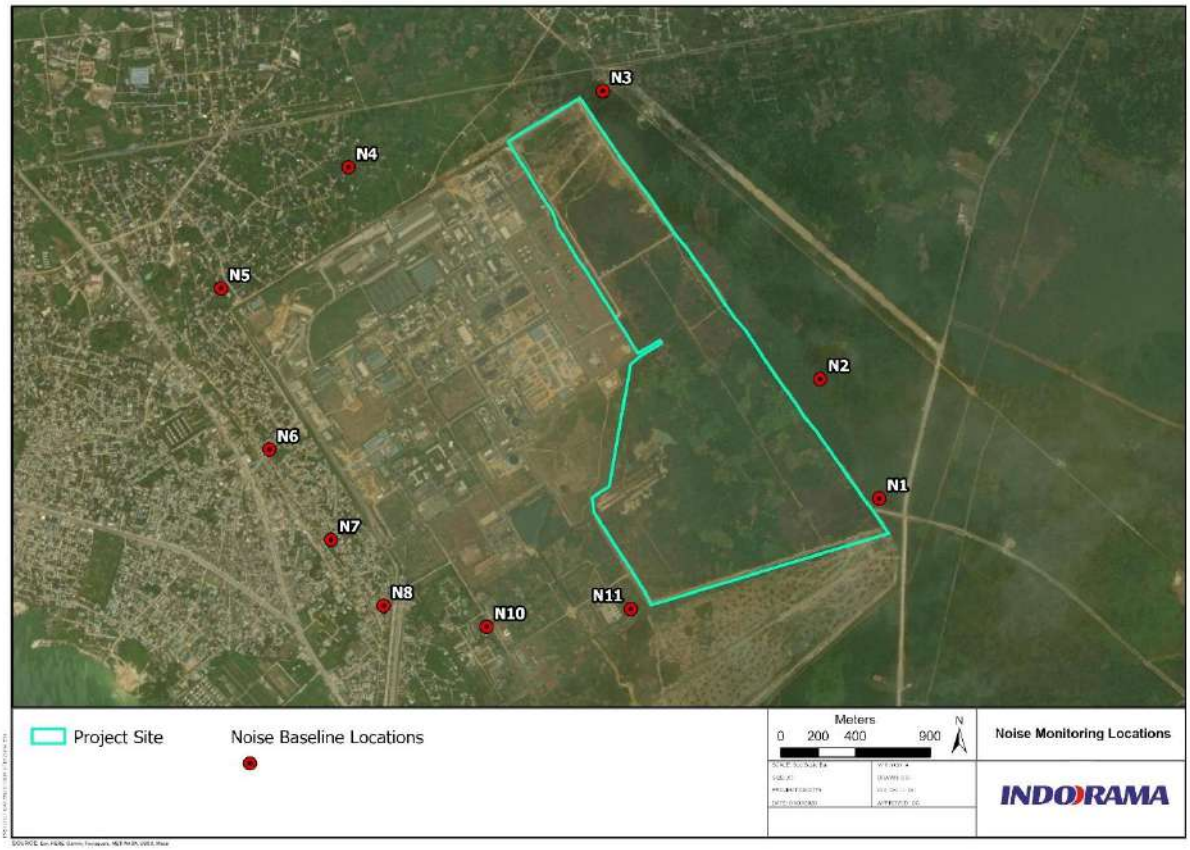


FIGURE 7-11: NOISE MEASUREMENT LOCATIONS

Source: ERM, 2026.

7.4.4.3 NOISE MODELLING

The Noise Impact Assessment report states that the following general modelling inputs and assumptions were applied:

- ground factor = 0.5 for the study area;
- temperature = 20°C;
- relative humidity = 60%;
- receptor predictions at 1.5 m height; and
- all predicted sound pressure and sound power levels expressed in dB(A).

These inputs form the general basis for the predictive acoustic model and should be read together with the phase-specific assumptions below.

Construction Noise Modelling Assumptions

The specialist report sets out a number of explicit assumptions for the construction noise model. These assumptions are important because they define the representative worst-case scenario used to derive predicted receptor levels. The construction model assumes that:

- construction activities will take place during the daytime only;
- the construction period will extend for approximately 33 months;
- the worst-case construction scenario is defined on the basis of the number of equipment items and their sound power levels, especially the heaviest equipment;

- earthworks and site clearance are the activities expected to generate the highest construction noise; and
- the construction noise sources are modelled as a source area on the footprint of the operational plant.

For each item of construction equipment, a sound power level was assigned using the BS 5228 database, and the source inventory used for the representative construction scenario is presented in the specialist report. The total combined sound power level for the construction activity was estimated at 131 dB(A).

TABLE 7-29: EARTHWORKS CONSTRUCTION EQUIPMENT

Equipment	Quantity	BS5228 Reference	Sound Power Level dBA	Sum Sound Power Level dBA
Air compressor (upper 100 cfm)	8	D.7.9	102	111
Generator (heavy)	2	D.7.48	98	101
Man lift, straight	16	C.4.38	113	125
Water truck	3	D.11.52	117	122
Concrete pump car	3	D.6.16	109	114
Dump truck	11	D.3.60	110	120
Excavator	16	D.8.15	103	115
Mixer truck	6	D.6.5	102	110
Motor grader	2	D.3.75	112	115
Self-load mixer	1	C.4.20	108	108
Wheel loader	7	D.3.3	102	110
Crawler crane	21	C.4.50	99	112
Hydraulic crane (rt)	14	C.4.43	98	109
Forklift	10	D.7.94	116	126
Forklift, telescopic	1	C.2.35	99	99
Vibratory roller	2	D.3.116	106	109
Batch plant	1	D.6.10	106	106
Total				**131**

The specialist modelling results indicate that predicted construction noise levels at receptors N2, N3 and N4 remain below the adopted daytime construction criteria, and the resulting construction noise impact magnitude is therefore assessed as negligible at all assessment locations.

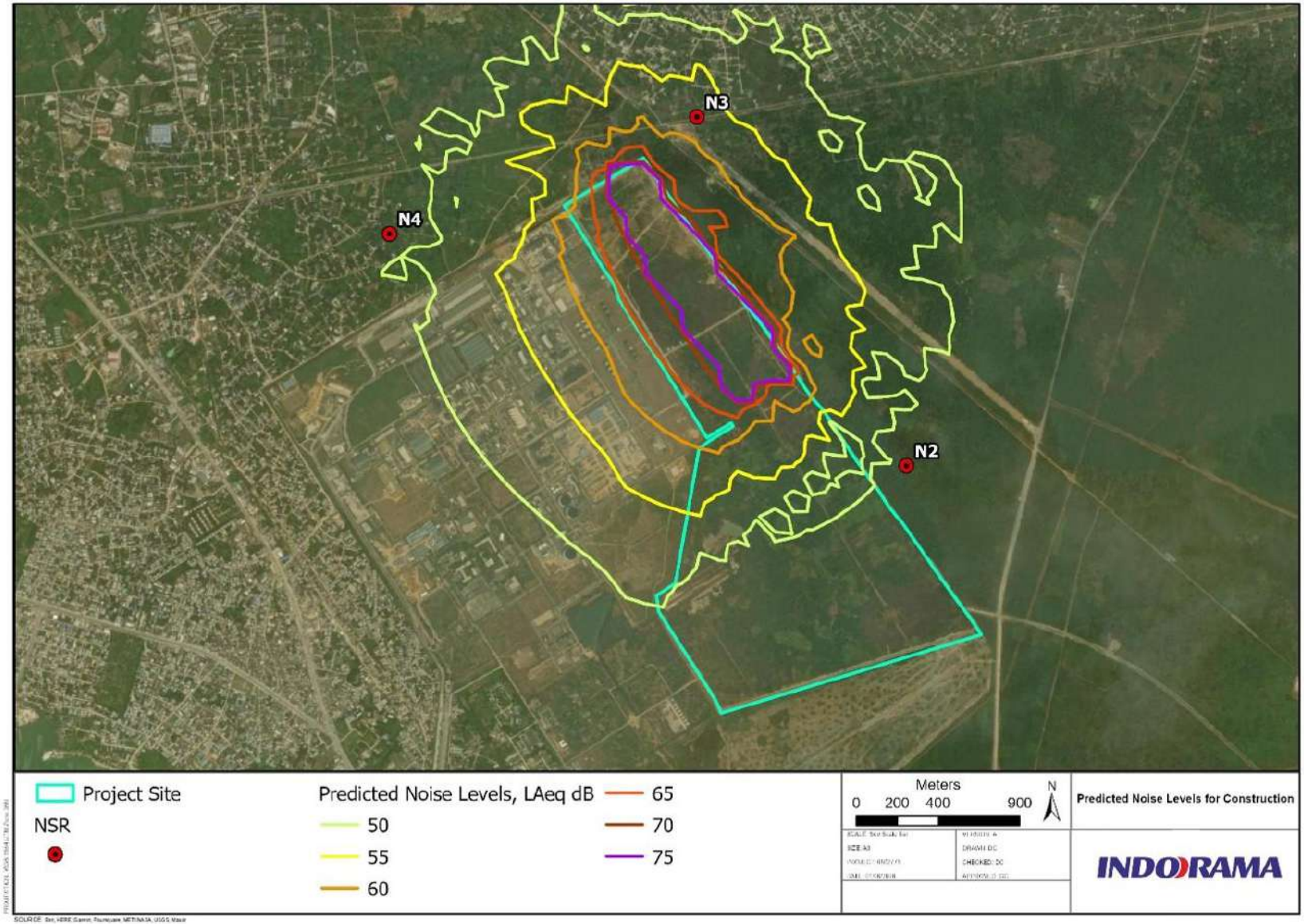

N3
N4
N2
Project Site
NSR
Predicted Noise Levels, LAeq dB
50
55
60
65
70
75
Meters
0 200 400 900
N
Predicted Noise Levels for Construction
INDORAMA

FIGURE 7-12: PREDICTED NOISE CONTOURS DURING CONSTRUCTION

Operational Noise Modelling Assumptions

The specialist report also sets out explicit assumptions for the operational noise model. These assumptions were used to represent Project operation under a conservative scenario and should therefore be described in the ESIA methodology. The operational model assumes that:

- the plant will operate 24 hours per day, seven days per week;
- outdoor equipment is modelled as point sources;
- only ammonia equipment located indoors is modelled as emitting through the façades and roof of the building;
- a 15 dB reduction index is applied to all walls and roofs as a conservative assumption; and
- all operational equipment is assumed to face directly toward the façades and roof, representing a worst-case configuration, because potential attenuation from internal rooms and ceilings is not taken into account.

The specialist report then presents the operational source inventories for the ammonia plant, urea plant and plant periphery sources. These include compressors, turbines, pumps and blowers, each defined by quantity, sound pressure level and whether the source is indoors or outdoors. A limited number of indoor urea sources were modelled as outdoors where specified in the specialist report.

Noise sources related to the operation are presented Table 7-30, Table 7-31 and Table 7-32.

TABLE 7-30: AMMONIA NOISE SOURCES

ID	Source description	Quantity	Sound Pressure Level at 1m, L_{Aeq} dB	Location
A-101-J	Air Compressor	1	85	Indoor Comp Building
A-102-J F	Feed gas Compressor	1	85	Indoor Comp Building
A-103-J	Synthesis Gas Compressor	1	85	Indoor Comp Building
A-105-J	Ammonia Refrigerant Compressor	1	85	Indoor Comp Building
A-101-JT	Steam Turbine for 101-J (101-J package)	1	85	Indoor Comp Building
A-103-JT	Turbine for 103-J (103-J package)	1	85	Indoor Comp Building
A-105-JT	Turbine for 105-J (105-J package)	1	85	Indoor Comp Building

ID	Source description	Quantity	Sound Pressure Level at 1m, L_{Aeq} dB	Location
A-107-JAHT	Hydraulic Turbine for 107-JA	1	85	Outdoor
A-104-JA/JB/JC	HP BFW Pumps	2	85	Outdoor
A-107-JA,JB,JC	Semi-Lean Solution Pump	2	85	Outdoor
A-108-J,JA	Lean Solution Pump	1	85	Outdoor

Source: ERM based on data from the client, 2026.

TABLE 7-31: UREA NOISE SOURCES

ID	Source description	Quantity	Sound Pressure Level at 1m, L_{Aeq} dB	Location
U-GB-101	CO2 Compressor	1	85	Indoor Comp Building*
U-GB701	N2 Compressor	1	85	Outdoor
U-GT-101	Turbine for CO2 Compressor	1	85	Indoor Comp Building*
U-GA101A, B	Ammonia Feed Pump	1	85	Outdoor
U-GA102A, B	Carbamate Feed Pump	1	85	Outdoor
U-GB604	Dust Collection Blower	1	85	Indoor Granulation Building*

* Has been modelled as outdoors

Source: ERM based on data from the client, 2026.

TABLE 7-32: PLANT PERIPHERY NOISE SOURCES

ID	Source description	Quantity	Sound Pressure Level at 1m, L_{Aeq} dB	Location
B-GA 1301A,B	BFW Pump for Package Boiler	1	85	Outdoor
C-GA 6001A,B,C	Cooling Water Pump for Ammonia	2	85	Outdoor

ID	Source description	Quantity	Sound Pressure Level at 1m, L_{Aeq} dB	Location
W-GB-1001A,B	Mixing Blower (In Polisher Unit)	1	85	Outdoor

Source: ERM based on data from the client, 2026.

Two operational scenarios were assessed:

- IFF Line 2 operating independently; and
- the cumulative operation of IFF Line 1 and IFF Line 2.

The modelling results indicate that predicted operational noise levels comply with the adopted day- and night-time criteria at all assessment locations in both scenarios, and the resulting impact magnitude is therefore assessed as negligible.

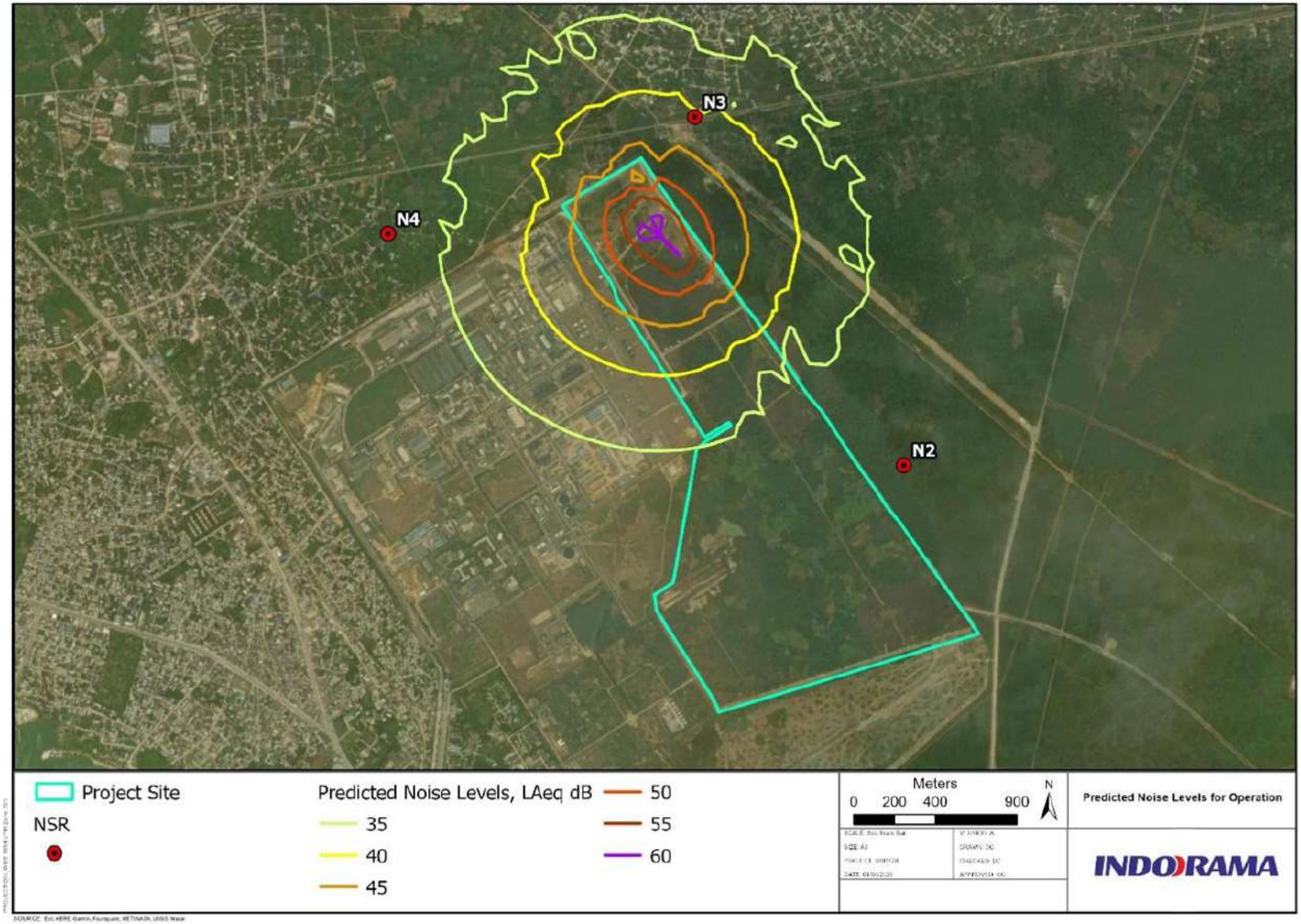

N3
N4
N2
Project Site
NSR
Predicted Noise Levels, LAeq dB
35
40
45
50
55
60
Meters
0 200 400 900
N
Predicted Noise Levels for Operation
INDORAMA

FIGURE 7-13: PREDICTED NOISE CONTOURS DURING OPERATION - IFF LINE 2

Source: ERM, 2026.

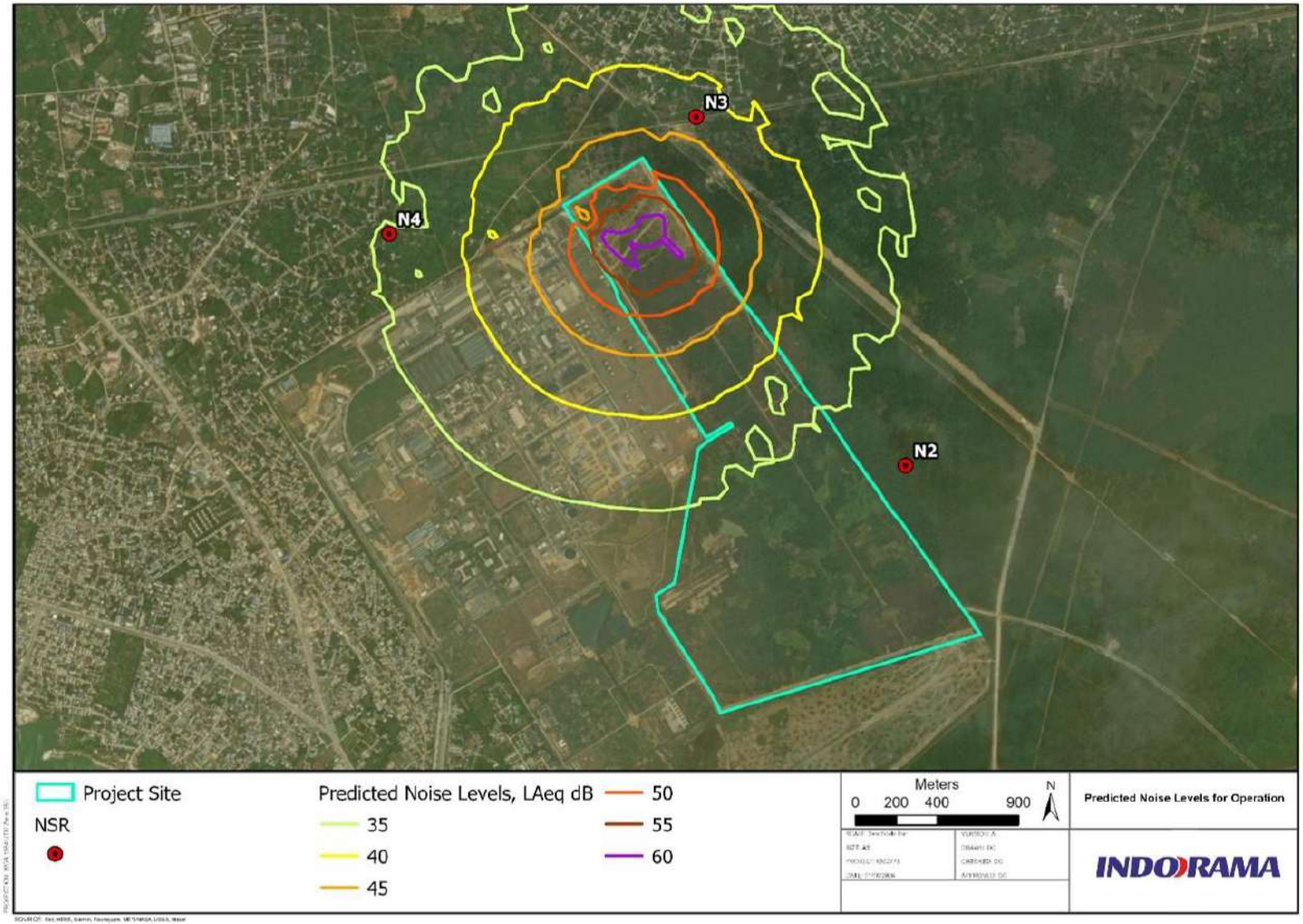

N3
N4
N2
Project Site
NSR
Predicted Noise Levels, LAeq dB
35
40
45
50
55
60
Meters
0 200 400 900
N
Predicted Noise Levels for Operation
INDORAMA

FIGURE 7-14: PREDICTED NOISE CONTOURS DURING OPERATION - IFF LINE 1 AND LINE 2

Source: ERM, 2026.

7.4.4.4 NOISE MONITORING RESULTS

The results of measurements recorded at the long-term noise monitoring locations are summarized in Table 7-33. The measurements were undertaken between 07:00 to 22:00 hours for the daytime period and 22:00 to 07:00 hours for the night-time period. To eliminate any potential influence of rainfall and significant wind speed on the measured noise levels, the data analysis excluded noise data collected during rainfall and wind speeds above 5 m/s.

The overall L_{Aeq} levels are the logarithmic average of the $L_{Aeq,15min}$ values, representing the equivalent energy average noise level for the period. The $L_{A90,T}$ is considered to be representative of the typical background noise level for the daytime and night-time periods. For this noise assessment, the L_{Aeq} is the metric that is used to assess Project noise impacts since L_{Aeq} is referred to in the Nigerian noise regulations and IFC's Guidelines.

TABLE 7-33: LONG TERM UNATTENDED NOISE MONITORING RESULTS

ID	Period (T)	Measurement Parameter, dB				
		L_{Aeq}	L_{A90}	L_{A10}	L_{Amax}	L_{Amin}
N1	Daytime	43	41	44	46	40
	Night-time	43	39	43	45	39
N2	Daytime	46	46	48	51	40
	Night-time	44	41	43	44	40
N3	Daytime	46	42	49	51	40
	Night-time	42	38	42	42	39
N4	Daytime	46	41	50	51	41
	Night-time	44	39	44	47	38
N5	Daytime	50	43	52	56	41
	Night-time	42	38	43	44	39
N6	Daytime	43	38	45	46	37
	Night-time	40	36	39	41	36
N7	Daytime	46	42	51	56	40
	Night-time	42	39	44	46	40
N8	Daytime	46	45	50	51	40

ID	Period (T)	Measurement Parameter, dB				
		L_{Aeq}	L_{A90}	L_{A10}	L_{Amax}	L_{Amin}
	Night-time	42	37	42	43	39
N9	Daytime	54	44	53	64	39
	Night-time	46	43	46	50	39
N10	Daytime	49	44	52	56	40
	Night-time	44	39	44	48	39
N11	Daytime	46	46	50	51	39
	Night-time	42	39	46	48	38

For assessment purposes, L_{Aeq} values have been calculated over 07:00–22:00 (daytime) and 22:00–07:00 (night-time), in order to ensure consistency with IFC noise guideline limits.

Source: Indorama, 2026.

Daytime noise levels (L_{Aeq}) remain below the 55 dB criterion at all the locations. However, during night-time, measured noise levels (L_{Aeq}) exceed the 45 dB criterion at location N9.

7.4.4.5 DATA GAPS AND LIMITATIONS

No material unresolved data gap was identified in the available noise baseline information. The baseline comprises wet-season and dry-season monitoring undertaken at 11 noise measurement locations between 16 to 25 October 2025 and 20 February to 5 March 2026, providing coverage of the existing acoustic environment under both seasonal conditions.

A number of limitations and assumptions should, however, be noted when interpreting the baseline and the associated assessment. First, the noise monitoring locations were selected before finalisation of the Project design. The baseline network was therefore established to provide a representative understanding of the acoustic environment in the vicinity of the Project, rather than being optimised against the final Project layout and final source configuration.

Second, although baseline monitoring was undertaken at 11 locations, the subsequent impact assessment focused on a smaller set of assessment receptors. The ESIA draft states that only receptors N2, N3 and N4 were taken forward into the predictive assessment because the remaining baseline locations were at greater distances from the Project and were not considered relevant to Project-induced changes. The baseline dataset is therefore broader than the receptor set used in the modelling.

Third, the baseline results were filtered to exclude weather conditions that could distort measured noise levels. Data recorded during rainfall and at wind speeds above 5 m/s were excluded from the analysis in order to reduce the influence of non-representative meteorological conditions on the reported baseline noise levels. While this improves the

reliability of the acoustic baseline, it also means that the dataset does not characterise noise conditions during those weather events.

Fourth, the assessment does not include vibration. The ESIA draft states that, because of the distances between the Project and surrounding receptors, vibration from construction and operation was anticipated to be insignificant and was therefore scoped out. The baseline and subsequent assessment therefore focus on airborne noise only.

Finally, the predictive assessment is based on standardised acoustic modelling assumptions. The modelling used iNoise V2026.1 and ISO 9613-2:2024, with defined inputs including a ground factor of 0.5, temperature of 20°C, relative humidity of 60%, and receptor height of 1.5 m. These are appropriate engineering assumptions for the purposes of the assessment, but they remain model assumptions rather than measured operating conditions for all future Project scenarios.

Notwithstanding the above, the available baseline information is considered sufficient to characterise the existing acoustic environment and to support the noise impact assessment for the ESIA. Periodic noise monitoring during construction and operation has nevertheless been recommended in order to confirm compliance with the adopted criteria and to verify the assessment outcomes under actual Project conditions.

7.4.5 GEOLOGY

This section describes the regional and local geological setting of the Project Area, located within the Niger Delta Basin in southern Nigeria. The basin represents one of the world's largest regressive delta systems, which has formed since the Early Palaeocene to the present through the sustained deposition of fluvial, deltaic, and shallow marine sediments, transported predominantly by the River Niger and its distributaries (Doust and Omatsola, 1990; Reijers, 2011). The regional geological framework is shown in Figure 7-15.

7.4.5.1 REGIONAL GEOLOGY

The Niger Delta Basin is characterised by thick accumulations of unconsolidated to weakly consolidated sediments deposited under alternating continental, transitional, and marine conditions. The regional stratigraphy comprises three principal Tertiary lithostratigraphic units, the Akata, Agbada, and Benin Formations; overlain by Quaternary deposits (Short and Stauble, 1967; Reijers, 2011).

The Benin Formation (Coastal Plain Sands) forms the uppermost Tertiary stratigraphic unit and represents the continental depositional environment of the Niger Delta. It consists predominantly of course to medium-grained unconsolidated sands, with minor interbedded clay and silt lenses, deposited under fluvial conditions. This formation constitutes the principal freshwater-bearing aquifer system regionally due to its high permeability, thickness, and lateral continuity (Edet, 2016).

The Agbada Formation underlies the Benin Formation and represents paralic delta front depositional environments. It is characterised by alternating sequences of sand and shale, deposited under transitional marine and fluvial conditions. While it hosts the major hydrocarbon reservoirs of the Niger Delta, its sandy intervals may locally contribute to deeper groundwater systems, with shale units acting as aquitards (Doust and Omatsola, 1990).

The Akata Formation forms the basal unit and is composed predominantly of thick marine shale sequences deposited in pro-delta to deep marine environments. This formation serves as the primary hydrocarbon source rock and represents the deepest regional geological unit of significance (Reijers, 2011).

Overlying the Tertiary formations are Quaternary deposits, typically ranging between approximately 40 and 150 m in thickness. These deposits comprise unconsolidated sands, silts, and clays, with increasing clay content toward coastal and mangrove environments, reflecting recent deltaic and alluvial processes (NGSA, 2010). The regional stratigraphy is summarised in Table 7-34, while the geological framework is illustrated in Figure 7-15.

TABLE 7-34: GEOLOGICAL AND LITHOLOGICAL UNITS OF THE NIGER DELTA

Geological Unit	Lithology	Age
Alluvial	Gravel, sand, clay silt	Quaternary
Freshwater back swamp	Sand, clay, some silt, and gravel	
Meander belt		
Mangrove and salt Water/backswamps	Medium-fine sand, clay and some silt	
Active/abandoned beach ridges	Sand, clay and some silt	
Benin Formation (Coastal Plain Sand)	Coarse to medium sand with subordinate silt and clay lenses	Tertiary
Agbada Formation	Alternating sequences of sand, silt and shale	
Akata Formation	Shale, sandy in some places	

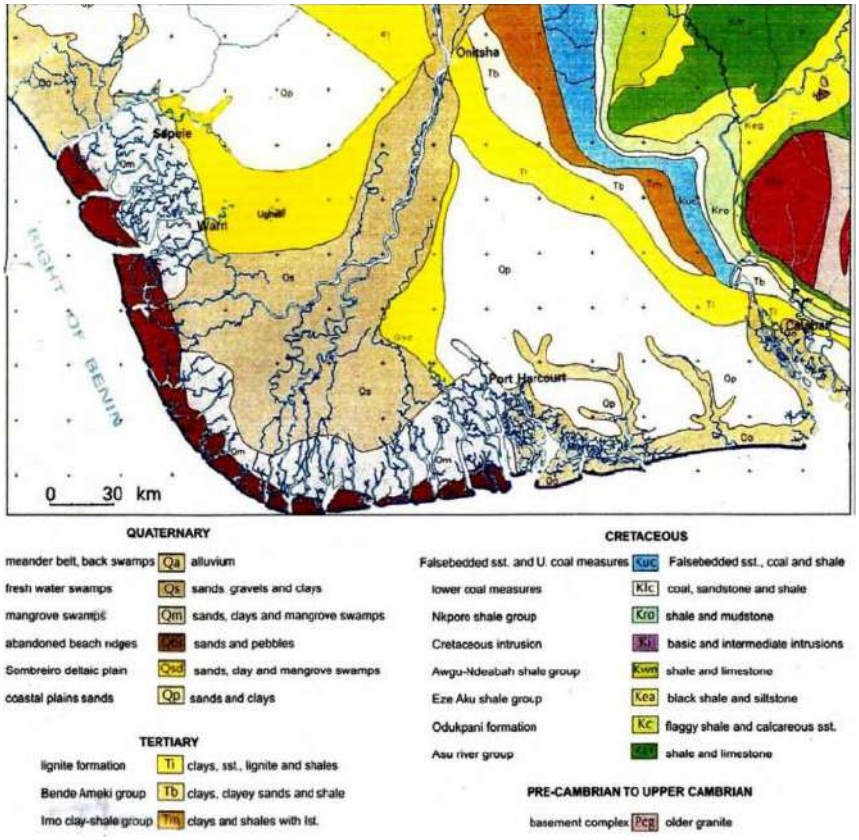


FIGURE 7-15: GEOLOGICAL CHARACTERISTICS OF THE NIGER DELTA

7.4.5.2 LOCAL GEOLOGY

The Study Area is situated within the coastal plain of the eastern Niger Delta in Rivers State and is underlain predominantly by recent Quaternary deltaic and alluvial deposits associated with fluvial processes. These sediments comprise unconsolidated to semi-consolidated sands, silts, clays, and minor gravel deposited under variable continental and marginal marine conditions (FISAS, 2022).

Subsurface investigations, including borehole logs from within and surrounding the Indorama Manufacturing Complex, indicate that the site is underlain by stratigraphy consistent with the Benin Formation, characterised by thick, laterally continuous sand units interbedded with discontinuous clay horizons.

Near surface materials (approximately 0–15 m below ground level [m bgl]) comprise sandy clay to clayey sand with moderate plasticity and variable permeability. This is underlain by a sand dominated sequence extending to approximately 30 m bgl, indicative of deposition under high energy fluvial conditions.

At intermediate depths, semi-continuous clay and clayey sand layers are present, which locally act as aquitards and may influence vertical groundwater movement. At depths exceeding approximately 150 mbgl, a regionally extensive sand unit is encountered. This unit is laterally continuous and forms part of a highly productive aquifer system across the Indorama Complex.

The overall stratigraphic sequence reflects repeated cycles of channel sand deposition alternating with lower energy floodplain and swamp deposits, consistent with deltaic depositional processes described for the Niger Delta (Doust and Omatsola, 1990; Reijers, 2011).

No evidence of significant faulting, structural deformation, or geologically induced hazards have been identified within the Project Area, indicating a relatively stable geological environment.

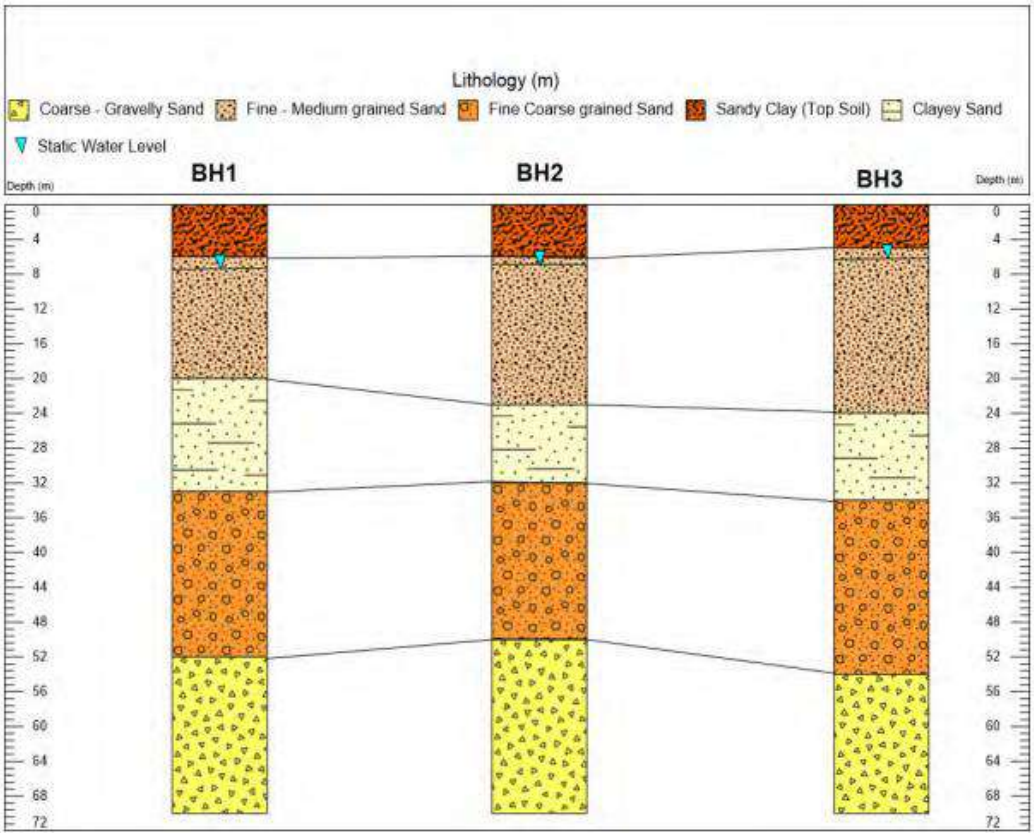


FIGURE 7-16: LITHOSTRATIGRAPHY OF BH1 TO BH3 DRILLED WITHIN THE PROJECT AREA
Lithostratigraphy of the area (BH1: N:04° 50′ 36.7”, E:007°06′ 32.7”; BH2: N: 04° 50′ 18.9”, E: 007°06′ 51.7”, N: 04°50′ 10.93”, E:007°06′ 36.18”).

7.4.5.3 GEOMORPHOLOGY

The Niger Delta is characterised by three principal geomorphic units that transition from inland to coastal environments: the dry deltaic plain, freshwater swamp zones, and coastal mangrove swamps comprising estuaries, streams, and lagoons (Allen, 1965; Reijers, 2011). The Project Area is located within the dry deltaic plain of the eastern Niger Delta.

This geomorphic unit is defined by low relief, gentle regional gradients, and extensive fluvial depositional features. Elevations across the Indorama Industrial Complex range from approximately 6 m above mean sea level (amsl) in the south to about 28.5 m amsl in the north. The terrain exhibits a consistent north to south gradient, which controls surface water drainage patterns and influences shallow groundwater flow toward adjacent river and stream systems.

The landscape is generally flat to gently undulating, with no evidence of steep slopes or unstable terrain. Localised seasonal waterlogging may occur during periods of high rainfall, reflecting the low-lying nature of deltaic environments; however, there is no indication of significant erosion, land instability, or geomorphological degradation within the Project Area.

Fluvial processes largely shape the geomorphology of the area, with well-developed channel systems forming the dominant landscape features. In some locations, these channels display braided characteristics, while meander belts are relatively less pronounced. The vegetation reflects a typical transitional deltaic setting, with raffia palms commonly found in floodplain

areas and mixed palm species occurring across interfluvial zones. In addition, lateritic soil horizons are present and can locally reach thicknesses of up to approximately 12 m, indicating prolonged weathering and soil forming processes acting on the underlying sandy parent material.

7.4.6 HYDROGEOLOGY

7.4.6.1 REGIONAL HYDROGEOLOGY

The regional hydrogeological regime of the Niger Delta is dominated by the Benin Formation (Coastal Plain Sands), which constitutes the principal aquifer system due to its high permeability, thickness, and lateral continuity (Edet, 2016; NGSA, 2010).

Groundwater occurs within a multi-layered aquifer system comprised of thick, highly permeable sand units interbedded with discontinuous clay and silt horizons. These sandy units form extensive unconfined to semi-confined aquifers with high transmissivity and significant storage capacity. The interbedded clay layers function locally as aquitards, resulting in a complex but hydraulically connected system (Edet, 2016).

Recharge to the aquifer system occurs mainly through the direct infiltration of rainfall, supported by high annual precipitation and the permeable nature of the soils. As a result, groundwater levels are generally shallow across much of the coastal plain. Groundwater flow is largely controlled by regional hydraulic gradients and tends to follow the natural topography and drainage network, ultimately discharging into nearby rivers, streams, and wetlands.

At greater depths of 150 m bgl, laterally continuous sandy units constitute semi-confined to confined aquifers that are widely used for water supply due to their high yields and favourable hydraulic properties. Hydraulic conductivity values in the region range from approximately 3.3 to 77.8 m/day, reflecting variations in lithology (Edet, 2016). These values indicate a highly transmissive system capable of rapid groundwater movement and sustained abstraction. These deeper aquifers are typically separated from the shallow system by semi-continuous clay layers (aquitards), which limit vertical flow and provide a degree of protection against surface derived contamination.

Overall, the regional hydrogeological system is characterised by a high groundwater potential, supported by efficient recharge processes and high aquifer transmissivity. However, the elevated permeability of the subsurface materials also makes shallow aquifers particularly susceptible and vulnerable to contamination.

7.4.6.2 LOCAL HYDROGEOLOGY

Site specific investigations confirm that groundwater conditions at the Project Area are consistent with the hydrogeological framework of the Benin Formation, comprised of a heterogeneous, multi-layered aquifer system of unconsolidated sands interbedded with discontinuous clay horizons (FISAS, 2022; Edet, 2016).

Three principal aquifer systems are identified (refer to Figure 7-17):

- Shallow unconfined aquifer: 0–30 m bgl
- Intermediate aquifer: approximately 50–120 m bgl

- Deep semi-confined to confined aquifer: >150 m bgl

The shallow aquifer is developed within sand dominated units with high porosity and permeability and is directly recharged by precipitation. Groundwater levels are relatively shallow, with static water levels typically ranging between approximately 4.9 m and 6.2 m bgl, indicating dynamic and responsive conditions.

Discontinuous clay and clayey sand layers act as semi-confining units, limiting but not preventing vertical groundwater movement. This allows for localised vertical leakage and interconnection between aquifers while providing some attenuation capacity for potential contaminants.

Hydraulic conductivity across the area is relatively high and aligns well with the sandy nature of the Benin Formation. Regionally, values are generally around 13 m/day in the shallow aquifer, increasing slightly, to between 13.16 and 18.96 m/day in the deeper aquifers, which is indicative of a consistently permeable subsurface.

At depths greater than approximately 150 m below ground level, a laterally continuous sand unit constitutes a deep, confined aquifer with high transmissivity and storage capacity. This aquifer serves as the main source of industrial water supply within the Indorama Manufacturing Complex, where boreholes typically extend beyond 200 m. The overlying confining layers potentially provide a level of protection from direct surface influences, which may result in relatively stable groundwater conditions.

Groundwater flow within the Project Area is largely controlled by local topography, with a consistent hydraulic gradient from the slightly elevated northern area toward the southern boundary. Discharge occurs into nearby rivers and streams. Recharge is mainly driven by rainfall, supported by high annual precipitation (approximately 2,400–2,500 mm) and the high infiltration capacity of the sandy soils.

Overall, the shallow hydrogeological system is defined by high permeability and strong hydraulic connectivity, which allow for efficient recharge but also makes these zones more vulnerable to contamination. In contrast, the deeper confined aquifers are potentially better protected and represent a more reliable and sustainable long-term water resource.

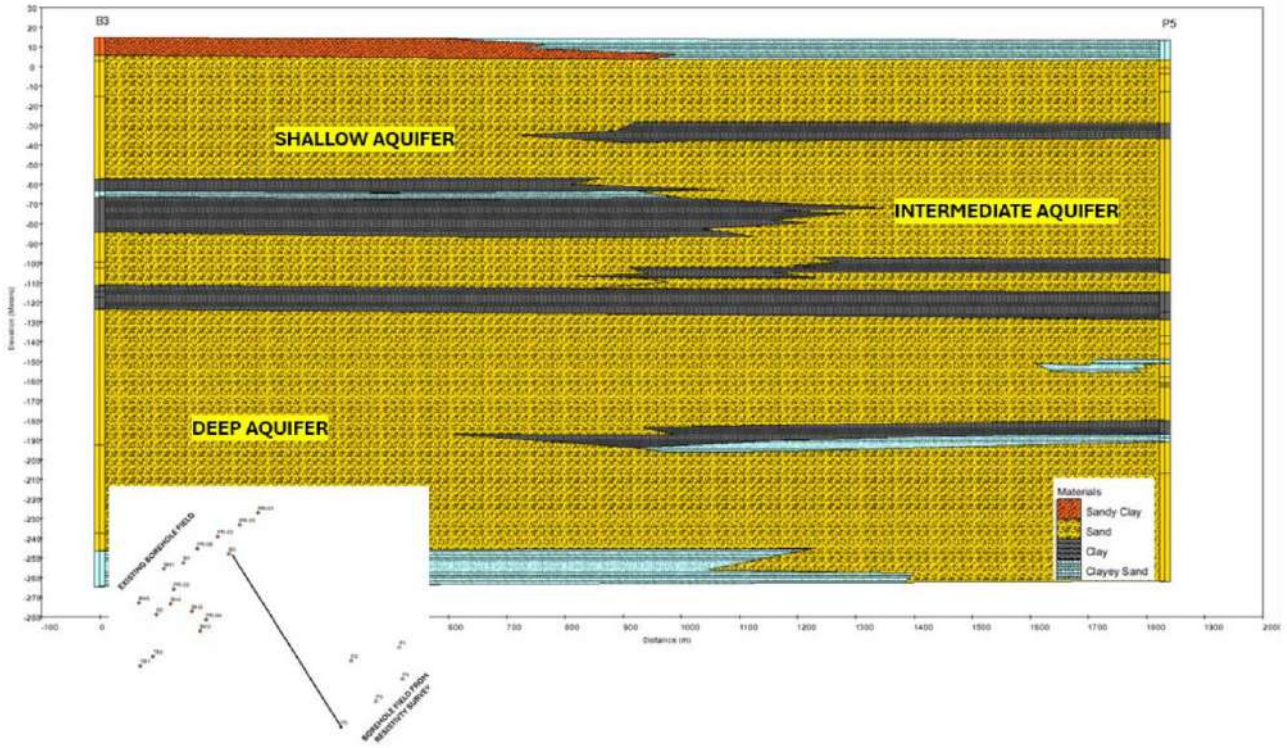


FIGURE 7-17: LOCAL GEOHYDROLOGY MAP SHOWING A PROFILE OF EXISTING AQUIFERS

A NW - SE cross-sectional profile showing the lithologies and aquifer types within the project area (extracts from previous studies on aquifer conducted within the Indorama Manufacturing Complex sourced from unpublished Indorama data, 2024.

7.4.7 SOILS

7.4.7.1 INTRODUCTION

This section provides an overview of baseline soil conditions within the Project footprint (Project Area and Study Area) based on field sampling and laboratory analyses undertaken during the wet (October 2025) and dry (February 2026) seasons by LC on behalf of IFF.

This assessment evaluates the physical, chemical, and microbiological properties of soils within the study area to establish baseline environmental conditions. The analysis undertaken in this section is to understand the potential interactions between the proposed development and the receiving environment, with particular focus on contaminant mobility and soil protection. The analytical results detected in soils are used for impact assessment in accordance with applicable NESREA Standard soil screening values, and to guide the identification of appropriate mitigation and management measures.

7.4.7.2 SOIL SAMPLING LOCATIONS

Soil samples were collected from a total of 28 locations across the project footprint, including three control sites established outside the zone of potential Project influence. Sampling locations were selected to provide representative spatial coverage of the Project Area, surrounding communities, agricultural areas, and existing industrial zones.

All sampling points were geo-referenced using GPS, and their distribution is presented in Table 7-35 and presented in Figure 7-18.

TABLE 7-35: SOIL SAMPLING POSITIONS

Station Code	Location	Coordinates (WGS 84)	
		Longitude (N)	Latitude (E)
SS1	West end of the Project Area	4°50’42.20”N	7°06’18.00”E
SS2	North End of the Project Area	4°50’48.80”N	7°06’29.00”E
SS3	Between North & East End of the Project Area	4°50’08.60”	7°06’57.60”
SS4	East End in the Project Area	4°49’30.00”	7°07’26.00”
SS5	South End in the Project Area	4°49’16.80”	7°06’43.50”
SS6	Centre in the Project Area	4°50’05.30”	7°06’49.70”
SS7	Flare area of the Project Area	4°49’54.20”	7°06’37.00”
SSQ8	Effluent Treatment Plant (ETP) Area of Project Area	4°49’32.20”	7°06’30.50”
SS9	D/W of Urea Warehouse (Indorama Complex)	4°50’25.20”	7°05’49.80”
SS10	Vegetation area towards North of Project Site	4°50’45.50”	7°07’35.80”
SS11	Indorama Recreational Club (IRC) within Indorama Complex	4°50’10.70”	7°05’27.00”
SS12	Main gate of Indorama Manufacturing Complex (Close to East-West Expressway)	4°48’47.00”	7°05’52.00”
SS13	Agbonchia Community	4°48’20.00”	7°07’31.60”
SS14	Aleto Community	4°48’40.00”	7°06’09.80”
SS15	Akpajo Community	4°49’44.50”	7°05’17.60”
SS16	Elelenwo Community	4°50’15.00”	7°04’43.00”
SS17	Steel Market	4°51’10.00”	7°05’01.60”
SS18	Axis of Iriebe Market	4°51’45.00”	7°05’47.00”
SS19	Axis of Iriebe Community	4°52’09.00”	7°06’58.00”

Station Code	Location	Coordinates (WGS 84)	
		Longitude (N)	Latitude (E)
SS20	Between Edutex and farming settlement	4°50’14.50”	7°08’53.50”
SS21	Njuru Community	4°48'14.65"	7°07'13.96"
SS22	Okerewa Community	4°48'22.77"	7°06'26.71"
SS23	Agbonchia farmland	4°49'12.75"	7°08'13.42"
SS24	Iriebe Community	4°51'29.40"	7°07'16.94"
SS25	NNPC Housing area	4°48'59.25"	7°05'09.62"
SSC-1	GSS – Oyigbo Community	4°52’43.00”	7°08’23.00”
SSC-2	Rumukrushi Community	4°50’23.00”	7°03’32.00”
SSC-3	Alesa Community	4°47’14.72”	7°06’33.30”

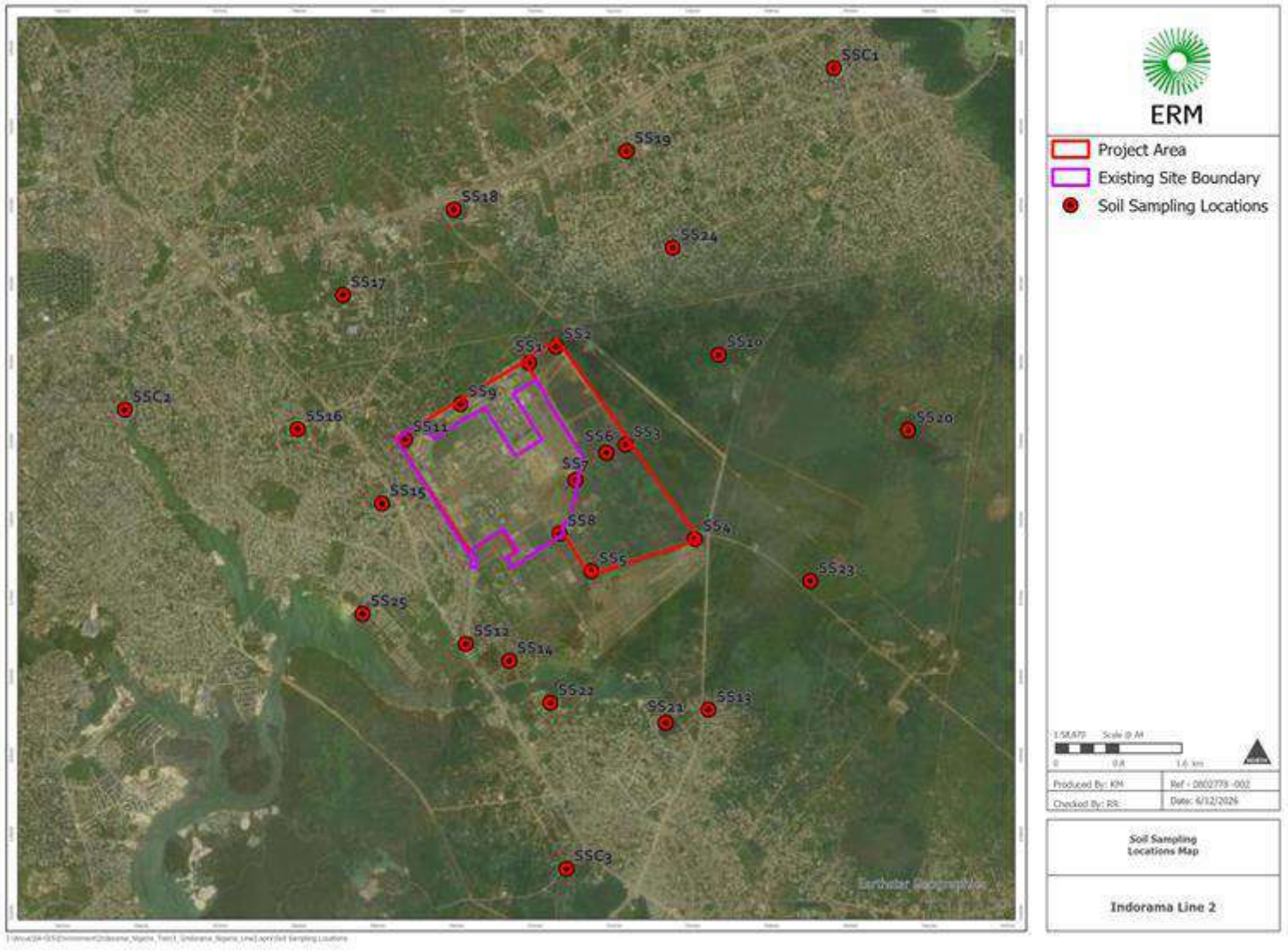

SSC1
SS19
SS18
SS24
SS17
SS1
SS2
SS10
SSC2
SS9
SS16
SS11
SS6
SS3
SS20
SS7
SS15
SS8
SS4
SS5
SS23
SS25
SS12
SS14
SS22
SS21
SS13
SSC3
ERM
Project Area
Existing Site Boundary
Soil Sampling Locations
Produced By: KM
Checked By: RR
Soil Sampling Locations Map
Indorama Line 2

FIGURE 7-18: SOIL SAMPLING LOCALITIES

7.4.7.3 SOIL SAMPLING METHODOLOGY

The soil sampling campaign was undertaken during both the wet and dry seasons (October 2025 and February 2026) in accordance with international best practice, including ISO and USEPA guidelines. At each sampling location, samples were collected from two depth intervals, namely topsoil (0–15 cm) and subsoil (15–30 cm), to reflect potential exposure pathways and vertical contaminant migration.

A total of 56 samples during each sampling campaign were collected within the project footprint, comprising two samples per sampling location corresponding to the defined depth intervals. Samples were assigned a consistent identification system, whereby location codes (e.g. SS1) were linked to sample identifiers (e.g. SS01), representing specific sampling points. Each location therefore yielded a topsoil and a corresponding subsoil sample, labelled according to the established naming convention.

Surface debris was removed prior to sampling to avoid cross-contamination. Samples were collected using clean stainless-steel augers and, where appropriate, composite samples were prepared to ensure representative results. Samples were placed in appropriate containers depending on analytical requirements. Samples were clearly labelled with sample identification location, depth, date, and time. Samples were stored immediately in insulated coolers with ice packs to maintain temperatures at or below 4°C and transported to accredited laboratories within method-specific holding times. Chain of Custody (COC) documentation accompanied all samples (Indorama Local Consultant (LC) documentation of Lab accreditation, CoC, Certificate of analysis, Regulator inspection, QA/QC procedure and calibration certificates, 2026).

According to the laboratory result certificates, the soil analyses were undertaken in accordance with internationally recognised standard methods, including those prescribed by the American Public Health Association (APHA) and ASTM International. Detailed QA/QC information was not included in the analytical certificates; however, such procedures are typically implemented as part of standard laboratory operating protocols and quality management systems where required by the analytical methodology. The reported results are therefore considered suitable for the purposes of this assessment.

7.4.7.4 PHYSICAL DESCRIPTION OF THE SOILS

The soils within the Project footprint are morphologically classified as coastal plain sands, developed over Niger Delta sediments and predominantly grouped as loamy sand (LS) to sandy loam (SL) soils. These soils are characterised by a high sand fraction, resulting in a loose and friable structure when dry and weakly cohesive when moist, reflecting limited plasticity due to low clay content.

Laboratory particle size distribution shows that sand is the dominant soil fraction, ranging from approximately 78–85% in the topsoil (0–15 cm) and 78–83% in the subsoil (15–30 cm). Silt content generally ranges from 9–17%, while clay content is comparatively low, typically varying between 2–9%, with slightly higher values observed in some dry season samples. This composition confirms the classification of the soils as loamy sand to sandy loam and accounts for their high permeability and weak structural development.

Bulk density values across the Project footprint range from approximately 1.2 to 1.5 g/cm³, while porosity values commonly range between 40% and 55%. These results indicate that the soils are loosely packed, moderately aerated, and non-compacted, supporting effective root penetration and rapid water movement. Permeability values (approximately 0.12–0.48 cm/sec) further confirm that the soils are well drained, with rapid infiltration capacity typical of sandy coastal plain soils.

The soils are predominantly brown to strong brown in colour, with occasional dark brown to black horizons, particularly in localized areas and subsoil layers. These darker colours are indicative of moderate organic matter accumulation and variable moisture conditions, influenced by seasonal rainfall patterns, shallow groundwater, and the presence of wetlands within and around the Project Area.

Moisture content shows considerable spatial and seasonal variability, reflecting the hydrological sensitivity of the Niger Delta environment. Topsoil moisture ranges broadly between approximately 7–36%, while subsoil moisture varies between about 5–27%, with higher values typically associated with wet-season sampling and low-lying or poorly drained locations.

Overall, the physical properties indicate that the soils are relatively well-drained, highly permeable, and structurally weak, characteristic of Niger Delta coastal plain sands. While these attributes are favourable for drainage and aeration, they also imply an increased susceptibility to nutrient leaching and erosion, particularly under intense rainfall or surface disturbance. The soil conditions observed therefore provide an appropriate baseline against which potential Project-related impacts on soil structure, stability, and long-term land productivity can be assessed.

7.4.7.5 SOIL CHEMICAL ANALYSIS, CHARACTERISTICS AND INTERPRETATION

Soil Chemical Analysis

Soil chemical analysis was undertaken to characterise the baseline physicochemical properties, nutrient status, and potential presence of contaminants in soils within the Project footprint.

Laboratory analyses were conducted by accredited laboratories using internationally recognised methods, including ISO soil quality standards, USEPA SW-846 procedures, and ASTM protocols. The analytical programme comprised a Comprehensive Soil Quality and Contaminant Screening (CSQC) Assessment, undertaken to evaluate key physicochemical properties and potential contamination within the soil. The assessment included major nutrients nitrate (NO_3^-), phosphate (PO_4^{3-}), and sulphate (SO_4^{2-}), soil organic indicators total organic carbon (TOC) and organic matter(OM), exchangeable base cations (Ca – calcium, Mg – magnesium, K – potassium, and Na – sodium), and selected heavy metals nickel (Ni), copper (Cu), zinc (Zn), lead (Pb), mercury (Hg), arsenic (As), chromium (Cr), and vanadium (V). In addition, petroleum-related hydrocarbons were analysed, including total hydrocarbon content (THC), total petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAHs).

Analytical results were subsequently compared against applicable regulatory standards, including the National Environmental Standards and Regulations Enforcement Agency (NESREA) soil quality guidelines and IFC guideline, to assess compliance and establish baseline environmental conditions.

TABLE 7-36: SUMMARY RESULTS OF PHYSICO-CHEMICAL PROPERTIES OF SOIL WITHIN THE PROJECT FOOTPRINT FOR OCTOBER 2026 WET SEASON

Parameter	NESREA Limit	Wet Season Soil samples for 0-15 cm (Oct 2025)									Wet Season Soil sample for 15-30 cm (Oct 2025)								
		Soils within the Project Area			Soils within the Study Area			Control Sample			Soils within the Project Area			Soils within the Study Area			Control Sample		
		Min	Max	Ave	Min	Max	Ave	SSC1	SSC2	SSC3	Min	Max	Ave	Min	Max	Ave	SSC1	SSC2	SSC3
Sand (%)	~	78.61	84.46	81.46	78.82	84.46	81.15	82.20	82.73	81.07	79.43	82.67	80.80	77.83	82.34	80.43	81.34	81.86	82.63
Clay (%)	~	2.24	7.74	4.82	1.49	7.20	4.60	3.13	4.19	4.29	2.39	5.07	3.95	1.84	6.50	3.81	4.98	7.85	5.32
Silt (%)	~	12.37	15.67	13.72	12.47	16.82	14.25	14.67	13.08	14.64	13.72	16.87	15.25	13.89	17.43	15.75	13.68	10.29	12.05
Texture	~	SL	SL	SL	SL	SL	SL	SL	SL	SL	SL	SL	SL	SL	SL	SL	LS	LS	LS
Colour	~	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Black	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown
Bulk Density (g/cm^3)	~	1.29	1.38	1.33	1.24	1.49	1.36	1.27	1.32	1.31	1.25	1.36	1.30	1.28	1.41	1.34	1.18	1.31	1.39
Porosity	~	45.94	49.61	48.14	41.62	51.46	46.77	50.37	48.35	49.01	46.88	50.00	49.02	44.92	50.00	47.52	53.91	48.83	45.70
Permeability (cm/sec)	~	0.13	0.18	0.16	0.12	0.48	0.18	0.18	0.16	0.14	0.14	0.17	0.15	0.14	0.18	0.15	0.20	0.18	0.19
Moisture Content (%)	~	9.76	26.52	15.60	6.71	36.33	14.99	17.02	14.98	23.76	9.39	25.02	15.02	5.31	21.29	12.08	17.20	15.10	24.05
pH	~	5.45	7.23	6.39	6.06	7.99	7.10	6.89	7.88	7.88	5.06	7.54	6.34	6.18	7.88	7.07	7.40	5.90	6.97
Sulphide, S2- (mg/kg)	~	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sulphate, SO42- (mg/kg)	~	0.24	0.50	0.37	0.30	0.51	0.40	0.50	0.31	0.27	0.59	1.12	0.88	0.60	1.20	0.88	0.50	0.31	0.28
Nitrate, NO3- (mg/kg)	~	1.23	2.17	1.43	1.25	1.48	1.34	1.24	1.25	1.28	1.24	1.37	1.31	1.23	1.38	1.30	1.23	1.24	1.27
Phosphate, PO43- (mg/kg)	~	0.12	0.80	0.34	0.01	0.39	0.19	0.02	0.03	0.23	0.14	0.32	0.23	0.12	0.70	0.48	0.26	0.34	0.22
TOC (%)	~	1.47	2.54	1.98	1.37	2.61	1.97	2.33	1.39	2.57	1.61	2.32	1.93	1.62	2.33	1.97	2.32	1.38	2.56
Total Organic matter (%)	~	3.61	4.69	4.13	3.32	4.94	4.00	4.52	3.26	4.69	3.92	4.86	4.40	3.35	4.91	4.27	4.51	3.25	4.68
Total Nitrogen (%)	~	0.23	0.45	0.32	0.22	0.45	0.32	0.33	0.37	0.34	0.24	0.45	0.34	0.23	0.46	0.34	0.33	0.37	0.34
Ammonia (mg/kg)	~	0.17	0.43	0.27	0.16	0.47	0.29	0.28	0.36	0.34	0.18	0.30	0.23	0.21	0.32	0.28	0.82	0.11	0.54
Urea (Urea)	~	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
THC (mg/kg)	~	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
TPH	~	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PAH	~	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Calcium (cmol/kg)	~	3.04	4.36	3.66	3.11	4.55	3.91	3.30	4.53	3.69	3.13	3.57	3.37	3.62	4.42	4.05	3.31	4.53	3.69
Magnesium (cmol/kg)	~	2.56	2.84	2.70	2.56	2.84	2.68	2.66	2.78	2.75	2.57	2.65	2.61	2.66	2.83	2.75	2.66	2.78	2.74

Parameter	NESREA Limit	Wet Season Soil samples for 0-15 cm (Oct 2025)									Wet Season Soil sample for 15-30 cm (Oct 2025)								
		Soils within the Project Area			Soils within the Study Area			Control Sample			Soils within the Project Area			Soils within the Study Area			Control Sample		
		Min	Max	Ave	Min	Max	Ave	SSC1	SSC2	SSC3	Min	Max	Ave	Min	Max	Ave	SSC1	SSC2	SSC3
Potassium (cmol/kg)	~	1.56	1.82	1.71	1.55	1.81	1.68	1.77	1.71	1.80	1.56	1.78	1.67	1.56	1.81	1.70	1.70	1.79	1.68
Sodium (cmol/kg)	~	4.71	6.10	5.38	4.60	6.19	5.43	5.76	6.21	5.15	5.16	5.98	5.56	5.09	6.05	5.59	5.76	6.20	5.16
Manganese, Mn (mg/kg)	~	**102.71**	**130.52**	**114.60**	**92.61**	**131.59**	**114.05**	**94.51**	**120.13**	**115.70**	**91.27**	**128.38**	**101.93**	**90.43**	**128.46**	**109.31**	**121.03**	**147.67**	**113.58**
Nickel, Ni (mg/kg)	70	0.01	0.06	0.03	0.03	0.10	0.06	0.03	0.03	0.03	0.02	0.06	0.04	0.02	0.06	0.04	0.03	0.02	0.03
Iron, Fe (mg/kg)	~	**1879**	**3146**	**2458**	**1987**	**3554**	**2691**	**2984**	**2876**	**2991**	**1962**	**3018**	**2556**	**1926**	**3065**	**2554**	**1978**	**1882**	**1997**
Copper, Cu (mg/kg)	100	0.07	0.09	0.08	0.07	0.10	0.08	0.07	0.07	0.07	0.07	0.09	0.08	0.07	0.09	0.08	0.07	0.07	0.07
Zinc, Zn (mg/kg)	421	1.69	2.55	2.10	1.72	3.23	2.15	1.69	1.67	1.66	1.85	2.53	2.18	1.72	2.49	2.13	1.68	1.66	1.65
Mercury, Hg (mg/kg)	4	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, As (mg/kg)	20	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead, Pb (mg/kg)	164	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium, V (mg/kg)	~	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium, Cr (mg/kg)	100	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
THB (CFU/g) x10^5	~	2.1	3.8	2.8	2.2	3.7	2.9	1.8	1.6	1.2	2.1	3.2	2.6	2.2	3.7	2.9	17.5	31.3	28.2
THF (CFU/g) x10^4	~	2.1	4.3	3.4	2.2	4.2	3.0	1.7	1.5	1.8	2.4	3.8	3.1	2.3	3.8	2.9	6.0	11.0	17.0
HUB (CFU/g) x 10^4	~	1.2	1.9	1.6	1.2	1.9	1.6	0.8	0.6	0.9	1.3	1.9	1.6	1.1	1.9	1.6	4.8	0.1	16.1
HUF (CFU/g) x 10^3	~	1.1	2.2	1.6	1.1	1.9	1.5	0.9	0.7	0.6	1.1	1.8	1.5	1.1	1.7	1.4	8.0	4.0	11.0

TABLE 7-37: SUMMARY RESULTS OF PHYSICO-CHEMICAL PROPERTIES OF SOIL WITHIN THE PROJECT FOOTPRINT FOR FEBRUARY 2026 DRY SEASON

Parameter	NESREA Limit	Dry Season Soil samples for 0-15 cm (Feb 2026)									Dry Season Soil sample for 15-30 cm (Feb 2026)								
		Soils within the Project Area			Soils within the Study Area			Control Sample			Soils within the Project Area			Soils within the Study Area			Control Sample		
		Min	Max	Ave	Min	Max	Ave	SSC1	SSC2	SSC3	Min	Max	Ave	Min	Max	Ave	SSC1	SSC2	SSC3
Sand (%)	~	80.20	82.34	81.20	79.86	84.62	81.72	81.34	81.86	82.63	79.86	81.78	80.79	79.76	82.34	80.90	80.34	79.85	81.34
Clay (%)	~	3.23	8.45	5.66	4.67	8.67	7.20	4.98	7.85	5.32	5.89	9.34	7.19	6.84	8.45	7.87	7.47	8.45	9.12
Silt (%)	~	11.25	15.01	13.14	8.55	14.99	11.09	13.68	10.29	12.05	10.80	14.22	12.02	9.90	13.32	11.23	12.19	11.70	9.54
Texture	~	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS
Colour	~	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Dark Brown	Dark Brown	Dark Brown
Bulk Density (g/cm^3)	~	1.23	1.55	1.42	1.13	1.64	1.39	1.18	1.31	1.39	1.23	1.56	1.39	1.23	1.62	1.40	1.06	1.34	1.36
Porosity	~	39.45	51.95	44.48	35.94	55.86	45.75	53.91	48.83	45.70	39.06	51.95	45.80	36.72	51.95	45.50	58.59	47.66	46.88
Permeability (cm/sec)	~	0.18	0.23	0.21	0.17	0.26	0.21	0.2	0.18	0.19	0.16	0.23	0.19	0.16	0.31	0.19	0.17	0.20	0.21
Moisture Content (%)	~	9.88	25.90	15.60	6.95	35.1	14.9	17.2	15.1	24.05	9.52	24.85	15.05	5.48	21.14	12.15	15.52	14.16	27.32
pH	~	5.11	7.23	6.52	5.45	7.05	6.18	7.4	5.9	6.97	5.43	7.22	6.45	5.57	7.08	6.13	7.02	5.01	6.67
Sulphide, S2- (mg/kg)	~	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sulphate, SO42- (mg/kg)	~	0.25	0.50	0.37	0.30	0.51	0.40	0.50	0.31	0.28	0.59	1.12	0.87	0.60	1.19	0.87	0.71	0.85	1.03
Nitrate, NO3- (mg/kg)	~	1.23	2.16	1.43	1.25	1.48	1.34	1.23	1.24	1.27	1.24	1.37	1.31	1.22	1.37	1.30	1.35	1.28	1.26
Phosphate, PO43- (mg/kg)	~	0.09	0.41	0.26	0.028	0.385	0.22	0.26	0.34	0.222	0.24	0.35	0.30	0.17	0.42	0.32	0.28	0.42	0.40
TOC (%)	~	1.46	2.53	1.97	1.36	2.6	1.96	2.32	1.38	2.56	1.62	2.31	1.97	1.64	2.34	1.98	1.86	2.24	1.98
Total Organic matter (%)	~	3.60	4.68	4.13	3.31	4.93	4.00	4.51	3.25	4.68	3.86	4.83	4.37	3.78	4.95	4.31	4.34	4.67	4.08
Total Nitrogen (%)	~	0.24	0.44	0.32	0.22	0.45	0.32	0.331	0.368	0.34	0.26	0.45	0.35	0.24	0.46	0.36	0.38	0.25	0.41
Ammonia (mg/kg)	~	0.21	0.88	0.51	0.09	0.95	0.57	0.82	0.11	0.54	0.19	0.67	0.42	0.22	0.73	0.44	0.56	0.44	0.65
Urea (Urea)	~	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
THC (mg/kg)	~	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
TPH	~	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PAH	~	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Calcium (cmol/kg)	~	3.04	4.35	3.66	3.12	4.55	3.91	3.31	4.53	3.69	3.13	3.57	3.37	3.62	4.42	4.05	4.45	4.47	4.49

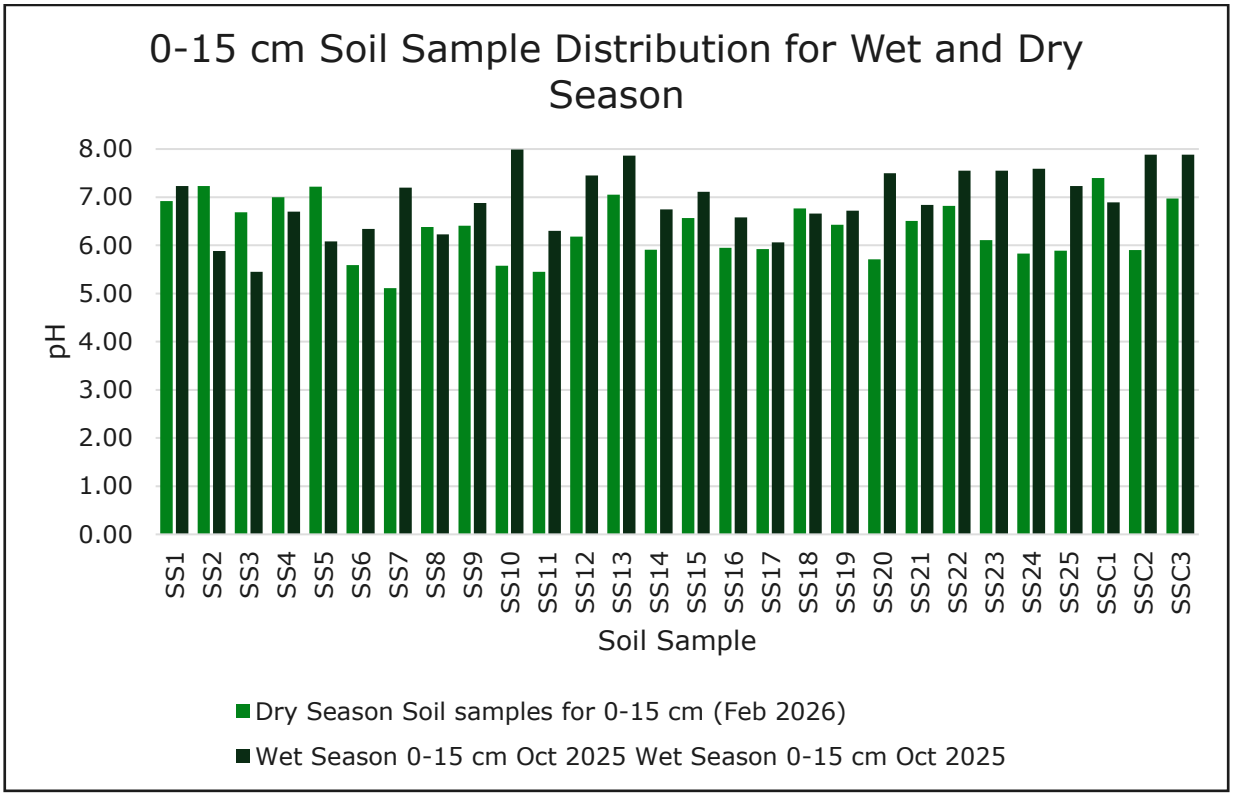
Parameter	NESREA Limit	Dry Season Soil samples for 0-15 cm (Feb 2026)									Dry Season Soil sample for 15-30 cm (Feb 2026)								
		Soils within the Project Area			Soils within the Study Area			Control Sample			Soils within the Project Area			Soils within the Study Area			Control Sample		
		Min	Max	Ave	Min	Max	Ave	SSC1	SSC2	SSC3	Min	Max	Ave	Min	Max	Ave	SSC1	SSC2	SSC3
Magnesium (cmol/kg)	~	2.57	2.83	2.70	2.56	2.83	2.68	2.66	2.78	2.74	2.57	2.66	2.62	2.67	2.83	2.76	2.83	2.83	2.84
Potassium (cmol/kg)	~	1.56	1.82	1.70	1.56	1.81	1.67	1.70	1.79	1.68	1.56	1.81	1.69	1.56	1.80	1.68	1.82	1.67	1.74
Sodium (cmol/kg)	~	4.72	6.10	5.38	4.60	6.19	5.43	5.76	6.20	5.16	5.17	6.03	5.64	5.09	6.02	5.57	5.95	5.31	5.87
Manganese, Mn (mg/kg)	~	**103.41**	**149.30**	**133.23**	**100.81**	**149.52**	**119.47**	**121.03**	**147.67**	**113.58**	**106**	**137**	**119**	**100.4**	**146.4**	**124.5**	**110.6**	**119.8**	**130.0**
Nickel, Ni (mg/kg)	70	0.02	0.06	0.03	0.02	0.09	0.05	0.03	0.02	0.03	0.03	0.06	0.04	0.02	0.06	0.04	0.052	0.033	0.047
Iron, Fe (mg/kg)	~	**1884**	**3105**	**2333**	**1992**	**3548**	**2717**	**1978**	**1882**	**1997**	**1948**	**3052**	**2540**	**1932**	**3024**	**2504**	**2173**	**2849**	**2436**
Copper, Cu (mg/kg)	100	0.07	0.09	0.08	0.07	0.10	0.08	0.07	0.07	0.07	0.07	0.09	0.08	0.07	0.09	0.08	0.08	0.07	0.08
Zinc, Zn (mg/kg)	421	1.69	2.54	2.09	1.72	3.23	2.15	1.68	1.66	1.65	1.75	2.51	2.14	1.74	2.52	2.14	1.983	2.447	2.091
Mercury, Hg (mg/kg)	4	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, As (mg/kg)	20	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead, Pb (mg/kg)	164	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium, V (mg/kg)	~	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium, Cr (mg/kg)	100	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
THB (CFU/g) x10^5	~	4.6	33.8	17.2	6	37.8	20.6	17.5	31.3	28.2	4.56	15.1	9.24	3.90	17.00	10.10	11.90	15.00	49.00
THF (CFU/g) x10^4	~	3.5	19	8.7	3	18	10.2	6	11	17	0.5	3.45	1.26	0.50	8.60	2.01	1.10	0.80	0.40
HUB (CFU/g) x 10^4	~	6.6	27.7	14.8	1.1	29.4	12.8	4.8	0.1	16.1	2.34	6.8	4.23	0.70	31.50	10.88	2.10	8.70	50.20
HUF (CFU/g) x 10^3	~	1.0	9	5.0	2	13	5.9	8	4	11	0.1	0.6	0.28	0.10	12.00	1.59	0.60	0.50	0.10

Soil Chemical Characteristics

Soil Reaction (pH)

Soil pH across the Project Area indicates slightly acidic to neutral conditions, with values ranging from 5.11 to 7.23 in topsoil during the dry season and 5.06 to 7.54 in subsoil during the wet season. The Study Area shows similar ranges of 5.01 to 7.22 (topsoil) and 6.06 to 7.99 (subsoil), while control samples fall within 5.90 to 7.88 (topsoil) and 5.01 to 7.40 (subsoil).

These values are typical of sandy tropical soils and reflect natural processes such as leaching, organic matter decomposition, and weathering. Localised moderately acidic conditions (pH <6) observed at specific sampling samples may reduce the availability of base cations (Ca, Mg, and K) and limit phosphorus bioavailability while enhancing the observed mobility of iron and manganese. The observed conditions in the project footprint are observed to be consistent with natural soil characteristics and may not indicate contamination. Spatial distribution of pH values for wet and dry season are presented in Figure 7-19.



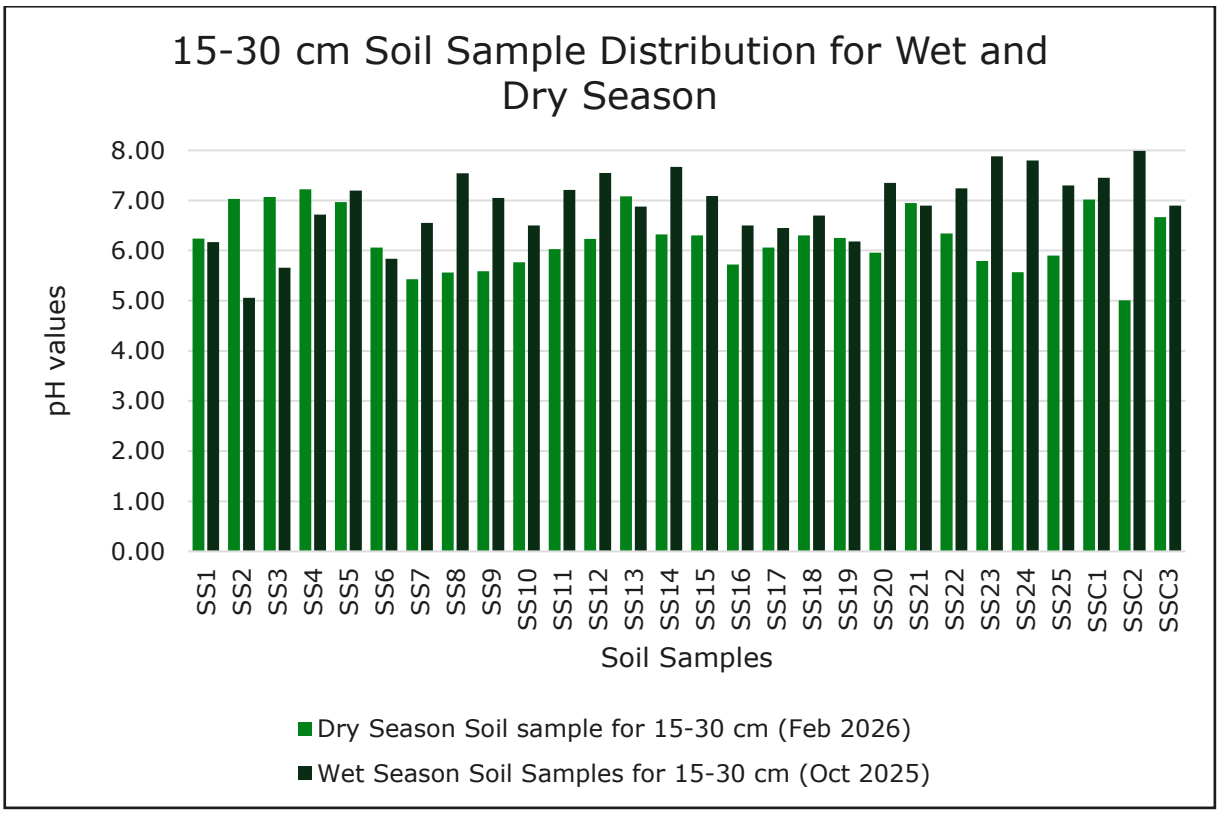


FIGURE 7-19: DISTRIBUTION OF SOIL PH VALUES FOR WET SEASON AND DRY SEASON

Nutrients and Major Ions

Nutrient concentrations are generally low across all sampling domains. Phosphate levels in the Project Area range from 0.09–0.41 mg/kg (topsoil, dry season) and 0.24–0.40 mg/kg (subsoil, wet season), while the Study Area shows values of 0.003–0.39 mg/kg (topsoil) and 0.17–0.42 mg/kg (subsoil). Control site concentrations (0.26–0.34 mg/kg for topsoil and 0.28–0.42 mg/kg for subsoil) fall within similar ranges.

Nitrate concentrations are also low, ranging from 1.23–2.16 mg/kg (topsoil) and 1.24–1.37 mg/kg (subsoil) in the Project Area, with comparable values in the Study Area (1.25–1.48 mg/kg and 1.22–1.37 mg/kg) and control sites (approximately 1.23–1.35 mg/kg).

Sulphate concentrations remain uniformly low, with values of 0.25–0.50 mg/kg (topsoil) and 0.59–1.12 mg/kg (subsoil) in the Project Area, and similar ranges in the Study Area (0.30–0.51 mg/kg and 0.60–1.19 mg/kg) and control locations (0.28–1.03 mg/kg). Slightly higher concentrations during the wet season reflect natural mobilisation under increased soil moisture conditions.

Organic indicators show moderate and consistent values, with total organic matter ranging from 3.60–4.68% (topsoil) and 3.78–4.95% (subsoil), and Total Organic Compounds (TOC) ranging from 1.46–2.53% (topsoil) and 1.62–2.31% (subsoil) in the Project Area. Comparable ranges are observed across the Study Area and control sites.

Overall, the low nutrient concentrations reflect limited retention capacity associated with sandy soils and active leaching processes, while organic content indicates stable natural soil development.

Hydrocarbon and Toxic Metal Assessment

Hydrocarbon parameters, including THC (<0.01 mg/kg), TPH (<0.001 mg/kg), and PAHs (<0.001 mg/kg), were below detection limits in all samples. Toxic metals such as Hg, As, Pb, V, and Cr were also below detection limits, confirming the absence of contamination.

Ammonia concentrations are low, ranging from 0.21–0.88 mg/kg (topsoil) and 0.19–0.73 mg/kg (subsoil) in the Project Area, with similar values recorded in the Study Area and control sites. It is inferred from these results, that the soils in the areas sampled have not been impacted by petroleum hydrocarbons or anthropogenic contamination.

Heavy Metals

Heavy metal concentrations show consistent geochemical patterns across all sampling locations. Manganese ranges between 103.41–149.30 mg/kg (dry season) and 100.50–137.34 mg/kg (wet season) in the Project Area, while iron ranges between 1884–3105 mg/kg (topsoil) and 1948–3052 mg/kg (subsoil).

OTHER TRACE METALS OCCUR AT LOW CONCENTRATIONS, INCLUDING NICKEL (0.02–0.06 MG/KG), COPPER (0.07–0.09 MG/KG), AND ZINC (1.69–3.12 MG/KG) IN THE PROJECT AREA, WITH SIMILAR VALUES RECORDED IN THE STUDY AREA AND CONTROL SITES, FOR HEAVY METAL

DISTRIBUTION REFER TO

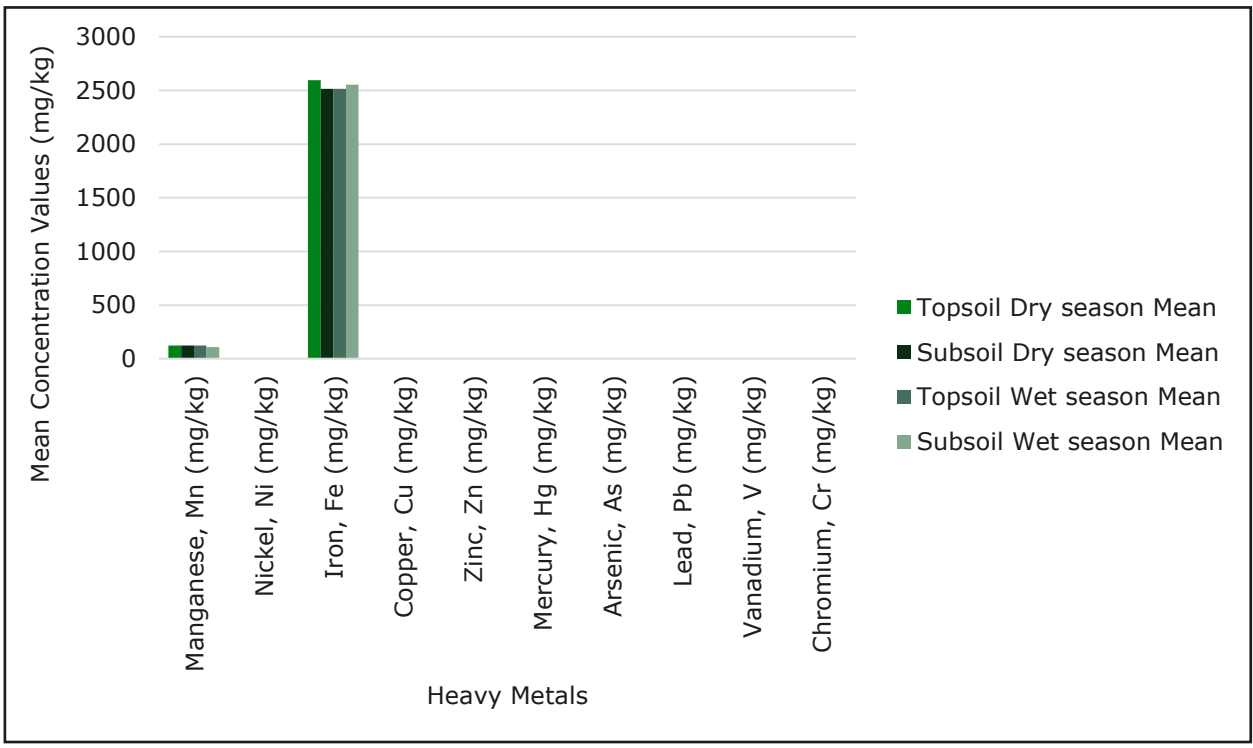


Figure 7-20. The consistency in concentrations across all areas indicates a natural geogenic origin, with higher iron and manganese reflecting background levels typical of tropical soils associated with the observed pH range values. Mean Distribution of heavy metal concentrations is presented in Figure 7-20.

Microbiological Indicators

Microbiological analysis confirms the presence of active soil microbial communities. Total heterotrophic bacteria (THB) range from 4.56–33.80 $\times 10^5$ CFU/g (topsoil) and 4.56–15.10 $\times 10^5$ CFU/g (subsoil) in the Project Area, with comparable values observed in the Study Area and control sites.

Total heterotrophic fungi (THF) vary between 3.45–19.00 $\times 10^4$ CFU/g (topsoil) and 0.50–3.45 $\times 10^4$ CFU/g (subsoil) in the Project Area, showing reduced abundance with depth due to lower oxygen and nutrient availability.

Hydrocarbon-utilising bacteria (HUB) and fungi (HUF) occur at low to moderate concentrations, with HUB ranging from 6.56–27.70 $\times 10^4$ CFU/g (topsoil) and 1.70–6.80 $\times 10^4$ CFU/g (subsoil), and HUF ranging from 1.00–9.00 $\times 10^3$ CFU/g (topsoil) and 0.10–0.60 $\times 10^3$ CFU/g (subsoil). Similar ranges across control sites indicate that these organisms likely represent natural background populations.

Overall, microbial distribution reflects natural soil conditions, with higher activity in topsoil and seasonal variation linked to moisture availability. The low abundance of hydrocarbon-utilising organisms is consistent with the potential absence of hydrocarbon contamination.

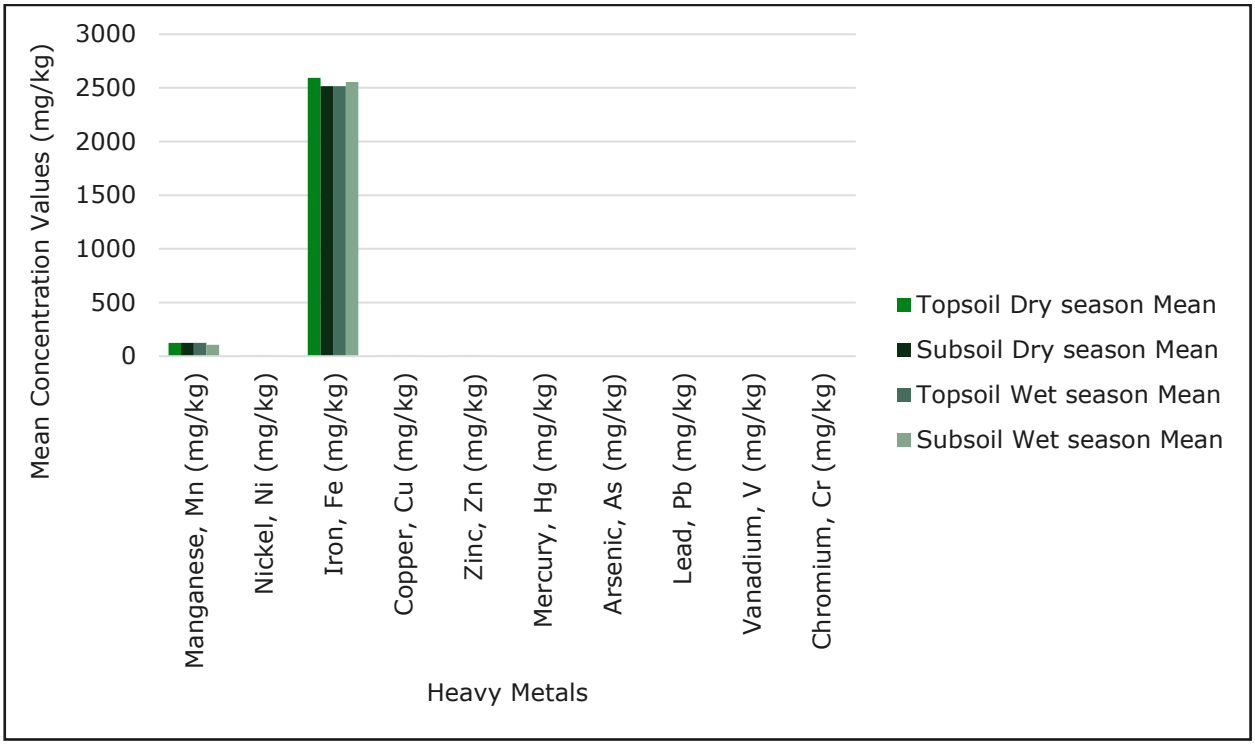


FIGURE 7-20: MEAN DISTRIBUTION OF HEAVY METAL CONCENTRATIONS WITHIN THE SOIL SAMPLES

7.4.7.6 SOIL QUALITY SCREENING RISK ASSESSMENT

The results of the soil screening assessment indicate that, for both the wet (October 2025) and dry (February 2026) seasons and across both depth intervals (0–15 cm and 15–30 cm), the majority of physico-chemical parameters are within applicable NESREA limits screening values, where available. Soil pH values range from slightly acidic to neutral (≈5.06–7.99), within soil samples located in both Project Area, Study Area and control sites.

Elevated concentrations of manganese were observed within soil samples (Mn: ~90–149 mg/kg) and iron (Fe: ~1,879–3,554 mg/kg) substantially consistent across all locations, depths, and control samples, indicating a potentially strong geogenic origin rather than site-specific contamination. Nickel (Ni) concentrations are generally low (≤0.10 mg/kg), remaining well below the NESREA limit (70 mg/kg). Overall, the results demonstrate that soil quality within the Project Footprint are largely compliant with regulatory standards, with no apparent indication of anthropogenic contamination, and that observed exceedances are likely attributable to natural background conditions typical of the regional geology.

7.4.7.7 SUMMARY

Soil chemical characteristics across the Project Area are consistent with natural baseline conditions typical of sandy coastal plain soils. The soils exhibit slightly acidic to neutral pH, with localised variability that influences nutrient availability but does not indicate contamination. Nutrient concentrations, including nitrate, phosphate, and sulphate, are uniformly low, reflecting limited retention capacity and active leaching processes.

No hydrocarbons or toxic metals were detected, which indicate the possible absence of anthropogenic contamination. Higher iron and manganese concentrations are likely attributed to natural geochemical conditions. Microbiological data indicate stable and functional soil ecosystems with no evidence of hydrocarbon influence.

Overall, soil quality is representative of undisturbed baseline conditions, with negligible environmental risk to soil, groundwater, and ecological receptors.

7.4.8 GROUNDWATER

7.4.8.1 INTRODUCTION

This section describes the baseline groundwater conditions within the Project Area and the broader Study Area (Project Footprint), focusing on the occurrence, distribution, and behaviour of groundwater within the underlying aquifer systems. The assessment establishes the hydrostratigraphic framework and evaluates groundwater as a resource by considering recharge processes, natural flow dynamics, abstraction patterns, and discharge mechanisms, including connectivity with surface water systems. The assessment further characterises groundwater quality, occurrences and movement, providing a robust baseline for evaluating potential project impacts and informing groundwater management.

The baseline understanding is informed by borehole groundwater level monitoring data, and regional hydrogeological information supported by laboratory analysis of groundwater samples. The monitoring network comprises shallow, intermediate, and deep abstraction boreholes distributed across the Project Footprint. Monitoring wells and control boreholes have been established across the Project Footprint to provide representative spatial coverage of the aquifer system.

Sampling campaigns were conducted during the wet season (October 2025) and dry season (February 2026) to capture seasonal variability in groundwater conditions. Analytical results were benchmarked against relevant standards, including the Nigerian Standard for Drinking Water Quality (NSDWQ), NESREA guidelines, World Health Organization (WHO) Guidelines for Drinking Water Quality, and the IFC EHS Guidelines.

The findings provide a comprehensive baseline of groundwater availability, quality, and vulnerability, forming the basis for subsequent impact assessment and mitigation planning.

7.4.8.2 HYDROSTRATIGRAPHY

The project Area is underlain by the Benin Formation of the Niger Delta Basin, (Coastal Plain Sands), which consists predominately of thick sequence (often exceeding several hundred metres) of unconsolidated sands interbedded with clay horizons. This stratigraphic configuration gives rise to a multi-layered aquifer system, characteristic of the Niger Delta Basin (Abam and Nwankwoala, 2020) and consistent with conditions observed across the Indorama Manufacturing Complex and surrounding areas.

Based on regional geological understanding and site-specific borehole data, the hydrostratigraphic framework within the Project Area can be broadly described as follows (refer to Figure 7-17):

- Shallow aquifer unit (extending approximately 0–30 m bgl): This unit consists predominantly of unconsolidated, medium- to coarse-grained sands associated with the Benin Formation. These deposits exhibit high permeability and porosity, forming an unconfined aquifer that is hydraulically connected to surface processes such as rainfall infiltration and surface runoff.
- Intermediate confining unit (>30 m bgl <150 m bgl): Beneath the shallow aquifer, semi-continuous clay and clayey sand layers are encountered. These act as local aquitards, restricting vertical groundwater movement and partially separating shallow and deeper groundwater systems. However, due to their discontinuous nature, complete hydraulic isolation is not achieved.
- Deep aquifer unit (>150 m bgl): At greater depths, a regionally extensive sand-dominated unit occurs, consisting of highly permeable coarse sands. This unit constitutes a semi-confined to confined aquifer system with favourable hydraulic properties and is widely utilised for industrial water supply within the Indorama Complex. The overlying clay horizons, where present, provide protection from surface contamination, however, hydraulic connection to the upper aquifers may be present where aquitards are not laterally continuous.

Overall, the hydrostratigraphy is characterised by alternating permeable and semi-confining layers, which control groundwater occurrence, movement, and vertical interaction between aquifer units refer to Figure 7-17.

7.4.8.3 GROUNDWATER RECHARGE

Recharge to the aquifer system within the project footprint predominately occurs through direct infiltration of precipitation, facilitated by the high annual rainfall, and the permeable nature of the sandy soils within the Benin Formation. Across the Niger Delta, annual rainfall can reach up to approximately 3,000 mm (Amajor and Ofoegbu, 1988; Ojo et al., 1992), providing a significant source of groundwater recharge. Rainwater readily infiltrates through the highly permeable, unconsolidated sands, replenishing both shallow and deeper aquifer systems.

Groundwater recharge rates within the Niger Delta are estimated to range between 300–400 mm/year, which corresponds to approximately 8–12% of the Mean Annual Precipitation (MAP) (Abam and Nwankwoala, 2020). These relatively high recharge rates reflect the favourable hydrogeological conditions of the region, including permeable soils, high rainfall intensity, and limited surface runoff in sandy terrains.

Recharge is spatially variable across the Study Area, but it is most effective in areas where the topography is gently sloping and where infiltration exceeds surface runoff. The unconfined nature of the shallow aquifer allows it to respond rapidly to rainfall events, while deeper aquifers are recharged more gradually through vertical percolation where hydraulic connectivity permits.

7.4.8.4 GROUNDWATER USE AND ABSRACTION

Groundwater in the project footprint is primarily used for domestic and industrial purposes. A limited number of industries utilise groundwater for operational needs. Groundwater is used

minimally for irrigation due to fallow farming practices and the prolonged rainy season. A locality map of existing boreholes within the project footprint are presented in Figure 7-21.

Shallow and intermediate aquifers are primarily used for domestic water supply within the surrounding communities, for purposes such as drinking, cooking, and washing, and are typically installed at depths of 60–70 m. Within the Indorama Manufacturing Complex shallow boreholes are installed for monitoring purposes; these boreholes are installed at a depth of 20 m (refer to Table 7-39).

Groundwater within the Indorama Manufacturing Complex is mostly used as a source of water for industrial use. A total of 16 abstraction boreholes are located on site, with an average pump rate of 300 m^3/hr and three more abstraction boreholes will be developed for emergency use (refer to Table 7-38). These boreholes are drilled within the deeper aquifer to depths ranging between 226 m bgl to 311 m bgl. Although 16 abstraction boreholes are present within the Indorama Manufacturing Complex, only 13 will be operated post IFF Line2 plants at any one time, at an average maximum abstraction rate of 3,560 m^3/hr (or 85,440 m^3/day). A further three back-up boreholes will be developed for emergency use. The borehole locations and individual maximum abstraction rates (215–300 m^3/hr) are presented in Table 7-38.

TABLE 7-38: INDORAMA MANUFACTURING COMPLEX OPERATIONAL GROUNDWATER ABSTRACTION RATES AND LOCATIONS

BH-ID	Northing (m)	Easting (m)	Well Radius (m)	Borehole Depth (m)	Maximum Abstraction Rate (m^3/hr.)	Remark
BH1	289868.6	534185.4	0.24475	277	300	Operational
BH2	290105.2	533802.4	0.24475	270	300	Operational
BH3	290174.2	533624.6	0.24475	270	300	Operational
BH4	289925.5	533869.1	0.24475	270	300	Operational
BH5	289655.7	533876.6	0.24475	270	300	Operational
PR-02	289952.7	534002.4	0.24475	311	215	Operational
PR-03	290324.1	534477.1	0.24475	311	215	Operational
PR-04	290226.9	533725.5	0.24475	226	215	Operational
PR-05	290512.3	534584.2	0.24475	311	215	Operational
PR-07	290666.7	534692.7	0.24475	229	215	Operational
PR-08	290152	534369	0.24475	232	215	Operational
B1	290034	534241	0.24475	279	300	Operational
B2	289806	533773	0.24475	270	300	Operational

BH-ID	Northing (m)	Easting (m)	Well Radius (m)	Borehole Depth (m)	Maximum Abstraction Rate (m^3/hr.)	Remark
B3	290419	534320	0.24475	279	300	Operational
TB1	289668	533308	0.24475	280	300	Under construction
TB2	289776	533394	0.24475	275	300	Under construction
P1	291864	533474	0.24475	280	215	Proposed / under study.- to be developed for emergency use.
P2	291457	533355	0.24475	277	215	
P3	291668	532991	0.24475	278	215	

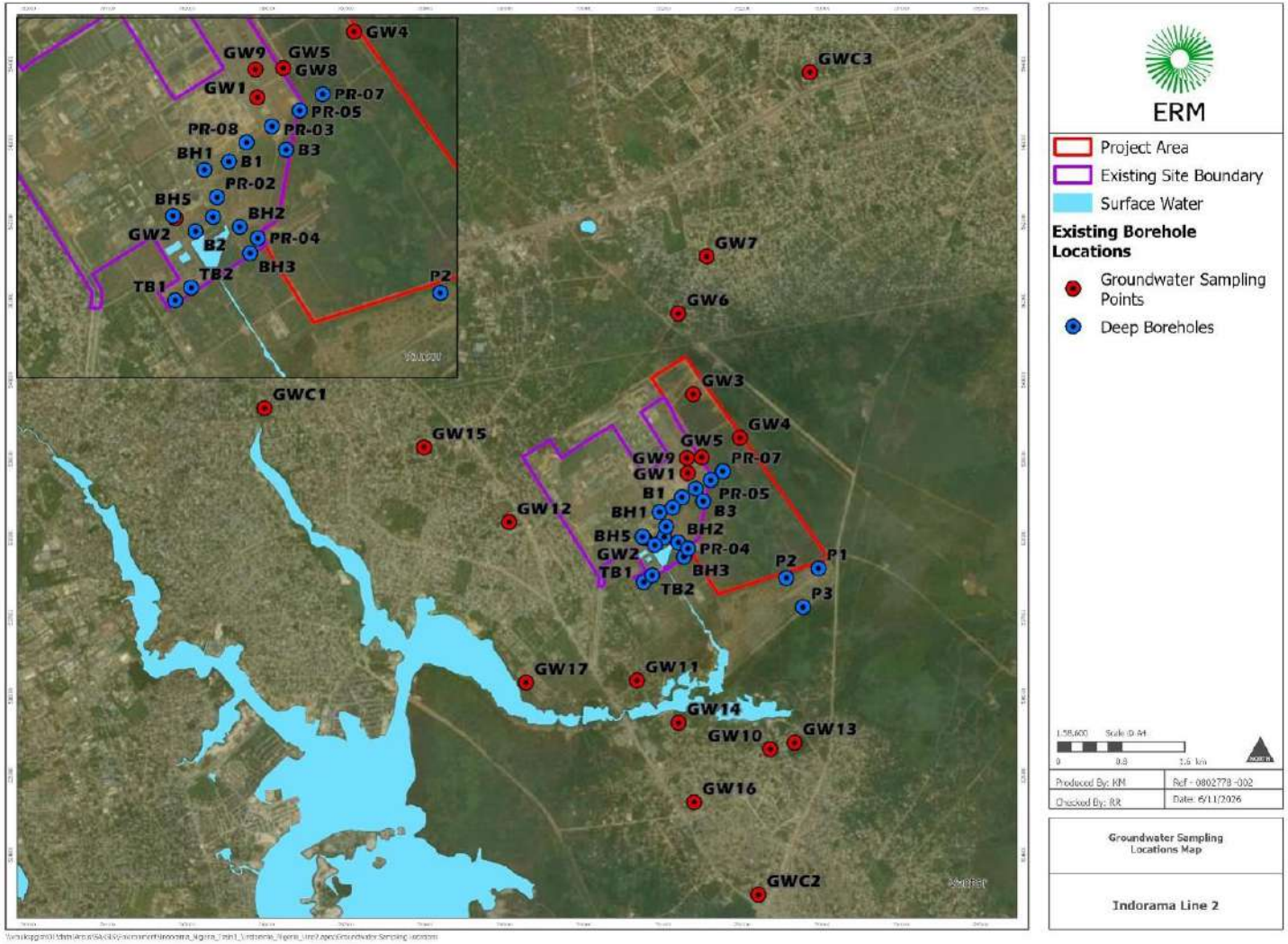

GW4
GW9
GW5
GW8
GW1
PR-07
PR-05
PR-08
PR-03
BH1
B1
B3
PR-02
BH5
BH2
GW2
PR-04
B2
BH3
TB1
TB2
P2
GWC3
GW7
GW6
GW3
GWC1
GW15
GW4
GW5
GW9
PR-07
GW1
B1
PR-05
GW12
BH1
B3
BH2
BH5
PR-04
GW2
P2
P1
TB1
BH3
TB2
P3
GW17
GW11
GW14
GW10
GW13
GW16
GWC2
ERM
Project Area
Existing Site Boundary
Surface Water
Existing Borehole Locations
Groundwater Sampling Points
Deep Boreholes
Produced By: KM
Ref - 0802778 -002
Checked By: RR
Date: 6/11/2026
Groundwater Sampling Locations Map
Indorama Line 2

FIGURE 7-21: GROUNDWATER LOCALITY MAP OF EXISTING BOREHOLES WITHIN THE PROJECT FOOTPRINT SHOWING SHALLOW MONITORING BOREHOLES AND DEEP PRODUCTION BOREHOLES

7.4.8.5 GROUNDWATER LEVELS AND FLOW DIRECTION

A total of 31 existing boreholes within the Project Footprint are reviewed (refer to Table 7-39):

- 4 boreholes within the Project Area (1 production borehole (Pr-07) installed within the deeper aquifer and 3 monitoring boreholes GW3, GW4 and GW5 installed within the shallow aquifer)
- 12 boreholes within the greater Indorama Manufacturing Complex (10 deep production boreholes and 2 shallow monitoring boreholes)
- 12 community boreholes located within the broader Study Area (GW6–GW17)
- 3 control boreholes (GWC1–GWC3) were selected outside the Project Area influence zone to establish background conditions and benchmark environmental quality that are not influenced by the Project activity.

Static water level measurements indicate that groundwater conditions are relatively stable across the wet and dry seasons. Within the shallow aquifer, groundwater levels range from approximately 4.9 m to 6.2 m bgl during the wet season and 5.8 m to 6.7 m bgl during the dry season. The intermediate aquifer exhibits groundwater levels ranging between approximately 6.4 m and 8.5 m bgl in the wet season and 6.0 m to 8.9 m bgl during the dry season.

Groundwater levels within the deep aquifer are relatively stable, generally ranging between approximately 6.5 m and 7.0 m bgl across the wet and dry seasons. The highest hydraulic head (18.41 m amsl) was recorded at BH2 within deep aquifer, while the lowest (12.45 m amsl) was observed at GW2 (shallow aquifer) within the Project Area.

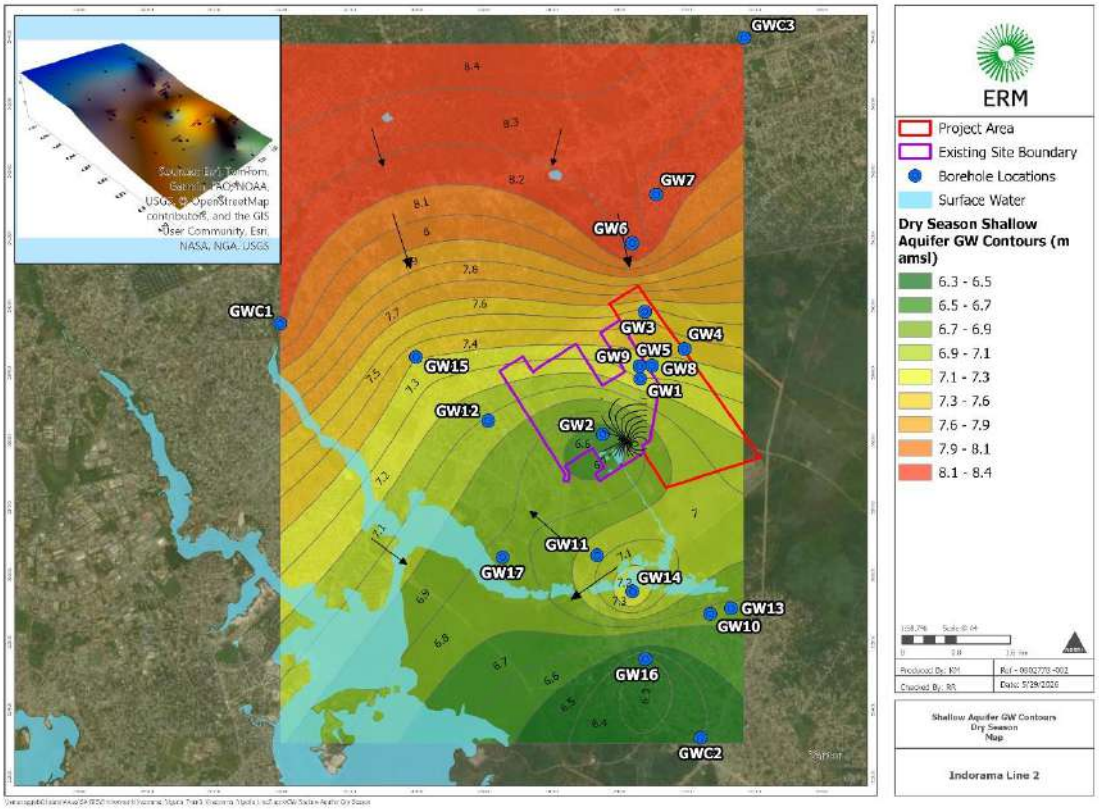
Groundwater flow within the Project Area is controlled primarily by regional topography, with elevations decreasing from north to south. This establishes a corresponding hydraulic gradient directing groundwater flow predominantly toward the south to southwest, mirroring surface water drainage and is inferred to ultimately discharge into the Okulu River (low lying topography, mature river profile, shallow groundwater levels). This behaviour is typical of unconfined aquifer systems and governs both groundwater movement and potential contaminant transport pathways.

The shallow (upper) and intermediate aquifers have been presented together on a single contoured potentiometric surface (Figure 7-22). The two units have been combined in this way because the available data suggest a degree of hydraulic connection between the shallow and intermediate aquifers; the discontinuous clay horizons that locally separate them potentially do not provide complete confinement across the Project Footprint. Whether this connection occurs through natural inter-aquifer leakage across these discontinuous horizons, or is locally enhanced along the annular space of older or poorly sealed boreholes, cannot be resolved from the present dataset and would require targeted hydraulic testing to confirm.

To address this data gap, an additional investigation borehole, of a depth of 70 m, is being considered within the Project Area to characterise the lithology up to the intermediate aquifer. As shallow boreholes already exist within the Project Area, lithological logging of these will be combined with the new borehole to provide a continuous vertical profile, supported by downhole geophysical logging. Targeted hydraulic (pumping) testing is intended to be undertaken separately for the shallow and intermediate units to derive aquifer-specific

hydraulic properties. To maximise the value of this investigation in resolving the inferred shallow–intermediate connection, the following is recommended in addition: that the new borehole be paired with, or located adjacent to, an existing shallow borehole so that water-level response can be cross-monitored during pumping of each unit, allowing vertical hydraulic connectivity to be assessed and, where present, quantified; that consideration be given to extending the borehole depth beyond the upper intermediate aquifer to ensure the profile is fully representative of the intermediate unit; and that the borehole be constructed with a discrete screen and a fully grouted annular seal to avoid introducing an artificial vertical pathway between aquifers. The results will be used to confirm whether the inferred shallow–intermediate connection reflects natural inter-aquifer leakage across the discontinuous clay horizons, and to refine the combined potentiometric interpretation presented in Figure 7-22.

Groundwater contour mapping indicates that the aquifer system is potentially responding to existing abstraction. A developing cone of depression is evident in the deeper aquifer, centred on the Indorama production wellfield in the south-western portion of the Project Area, consistent with sustained pumping from the existing deep production boreholes. A spatially aligned drawdown cone is also evident in the shallow contour surface, centred on monitoring borehole GW2, which records the lowest hydraulic head in the network (12.45 m amsl) and is sited near to deep production borehole BH5 (approximately 25 m). The vertical coincidence of a shallow drawdown cone above an actively abstracting deep borehole reinforces the interpretation that the intervening clay horizons are potentially not fully isolating the units, permitting some vertical leakage between the deep and upper systems at this location. This vertical connection is interpreted to result primarily from natural leakage across the discontinuous clay horizons, where localised fracturing and heterogeneity (zones of sand-mixed clay) reduce confinement - consistent with the groundwater sustainability study conducted for the Indorama Manufacturing Complex (Mogaba, 2025). Borehole integrity is considered a less likely contributor, given the indications for natural leakage in the study; the production boreholes were installed under the IFF Line 1 project (2015) (Mogaba, 2025). The drawdown footprint is otherwise localised to the wellfield; outside it, the regional flow pattern appears to remain broadly consistent with topographic control, and could indicate there is currently no broader disturbance to groundwater–surface water connectivity or to discharge into the Okulu River.



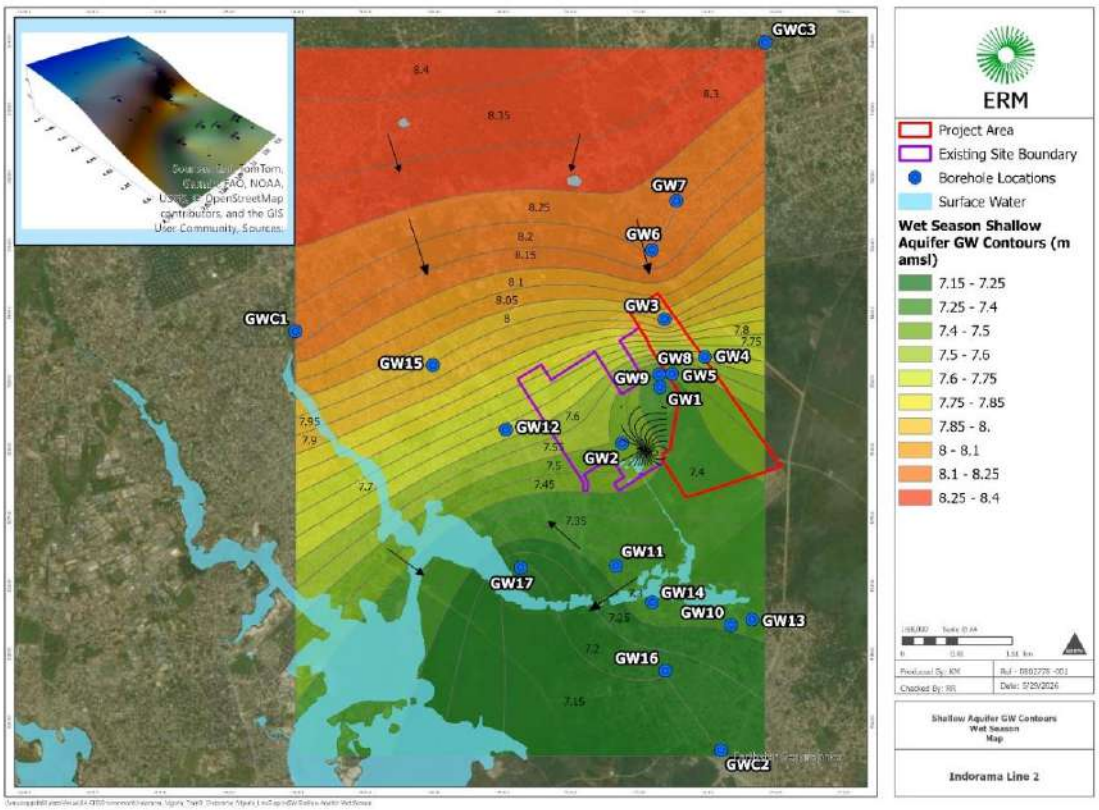


FIGURE 7-22: PROJECT FOOTPRINT GROUNDWATER FLOW DIRECTION FOR WET AND DRY SEASON - SHALLOW TO INTERMEDIATE AQUIFER SYSTEM

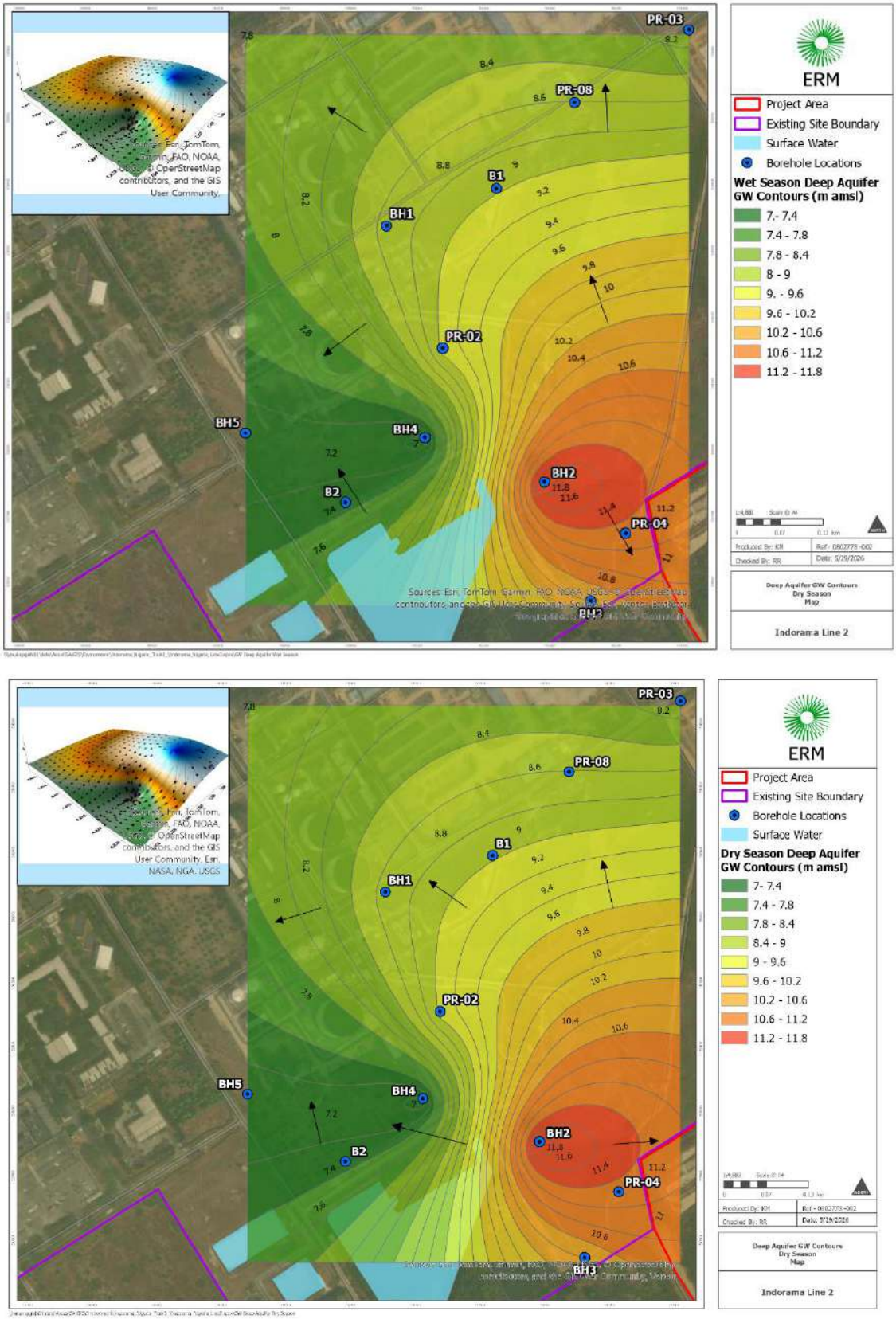


FIGURE 7-23: INDORAMA MANUFACTURING COMPLEX GROUNDWATER FLOW DIRECTION FOR WET AND DRY SEASON - DEEP AQUIFER

7.4.8.6 GROUNDWATER DISCHARGE

Groundwater discharge is interpreted to occur primarily toward the surface water bodies (rivers and streams) in the lower-lying southern portion of the Study Area, consistent with the regional south-to-southwest hydraulic gradient and the alignment between groundwater flow direction and surface drainage. On this basis, these surface water features are inferred to act as hydraulic basins receiving groundwater flow, with the aquifer system contributing to baseflow in the riverine systems and helping to maintain the hydrological balance of the Study Area.

Groundwater level and contour data collected across the wet and dry seasons indicate a recharge–discharge regime that is broadly in equilibrium at the regional scale. Outside the immediate abstraction wellfield (refer to Figure 7-22 to Figure 7-23), the regional flow pattern remains broadly consistent with topographic control, with no apparent indication in the present dataset of broader disturbance to groundwater–surface water connectivity or to discharge into the Okulu River or its tributary.

This interpretation is consistent with the regional groundwater modelling conducted for the Indorama Manufacturing Complex (Mogaba, 2025), which characterises the Okulu River as a hydraulic sink into which groundwater discharges. The relationship nonetheless remains an interpretation rather than a directly measured condition; where direct confirmation is warranted, it could be obtained through the installation of shallow riparian piezometers as part of the project's groundwater monitoring programme.

TABLE 7-39: EXISTING BOREHOLES WITHING THE PROJECT FOOTPRINT FOR WET AND DRY SEASONS:

Borehole ID	Sampling Date	Location	Longitude	Latitude	Depth of Borewell (mbgl)	Aquifer Type	Ground Elevation (masl)	Static Water level (mbgl) (Wet season)	Static Water level (mbgl)(Dry Season)
GW1	16/10/25	Within Indorama Manufacturing Complex (Near Off Site -CCR)	4° 50′ 04.50″	7° 06′ 30.50″	20	Shallow (Upper) Aquifer	na	5.8	6.4
GW2	16/10/25	In front of Lab Building (Behind Display Wall)	4° 49′ 38.07″	7° 06′ 12.57″	20	Shallow (Upper) Aquifer	12.45**	4.9	5.8
GW3	16/10/25	Within the precincts of Indorama FZE (Project Area)	4° 50′ 36.70″	7° 06′ 032.7″	20	Shallow (Upper) Aquifer	14.19**	6.2	6.7
GW4	16/10/25	Within the precincts of Indorama FZE (Project Area)	4° 50′ 18.90″	7° 06′ 51.70″	20	Shallow (Upper) Aquifer	na	5.4	6.5
GW5	16/10/25	Within the precincts of Indorama FZE (Project Area)	4° 50′ 10.93″	7° 06′ 36.18″	20	Shallow (Upper) Aquifer	na	5.1	6.2
GW6	18/10/25	Iriebe Area	4° 51′ 33.74″	7° 06′ 37.68″	65*	Intermediate Aquifer	15.45**	7.2	7.1
GW7	18/10/25	Iriebe Area	4° 51′ 27.23″	7° 06′ 35.51″	70*	Intermediate Aquifer	15.75**	7.5*	7.5*
GW8	17/10/25	Life Camp	4° 47′ 41.21″	7° 06′ 53.37″	65*	Intermediate Aquifer	na	6.4	6
GW9	17/10/25	Life Camp	4° 47′ 07.10″	7° 06′ 09.02″	65*	Intermediate Aquifer	13.85**	6.5*	6.5*
GW10	17/10/25	Agbonchia Area	4° 47′ 41.36″	7° 07′ 14.84″	60*	Intermediate Aquifer	na	7	7.8
GW11	17/10/25	Aleto Area	4° 47′ 41.29″	7° 06′ 56.84″	60*	Intermediate Aquifer	na	8*	8*
GW12	17/10/25	Akpajo Area	4° 49′ 18.65″	7° 05′ 22.86″	70*	Intermediate Aquifer	na	8*	8*
GW13	17/10/25	Nguru Area	4° 47′ 43.03″	7° 07′ 15.46″	65*	Intermediate Aquifer	na	7*	7*
GW14	17/10/25	Okerewa Area	4° 47′ 13.35″	7° 07′ 5.808″	70*	Intermediate Aquifer	14.34**	7*	7*
GW15	17/10/25	Elelenwo Area	4° 50′ 06.85″	7° 04′ 13.36″	70*	Intermediate Aquifer	15.98**	8	8.6
GW16	17/10/25	Aleto Area	4° 47′ 35.56″	7° 06′ 50.04″	60*	Intermediate Aquifer	15.2**	8	8.9
GW17	17/10/25	NNPC Housing Area	4° 48′ 59.58″	7° 05′ 36.17″	65*	Intermediate Aquifer	13.67**	6.5	6.8
GWC1	18/10/25	Rumukrushi Area	4° 50′ 57.88″	7° 03′ 13.91″	70*	Intermediate Aquifer	16.72**	8.5*	8.5*
GWC2	17/10/25	Alesa Area	4° 47′ 42.55″	7° 07′ 0.43″	65*	Intermediate Aquifer	14.7**	7.5	8.2
GW C3	18/10/25	Oyigbo Area	4° 51′ 45.75″	7° 08′ 26.94″	60*	Intermediate Aquifer	16.33**	8*	8*
BH1	16/10/25	Existing production borehole Within Indorama Complex	289868.6	534185.4	277	Deep (Lower) Aquifer	15.38	6.5	

Borehole ID	Sampling Date	Location	Longitude	Latitude	Depth of Borewell (mbgl)	Aquifer Type	Ground Elevation (masl)	Static Water level (mbgl) (Wet season)	Static Water level (mbgl)(Dry Season)
BH2	16/10/25	Existing production borehole Within Indorama Complex	290105.2	533802.4	270	Deep (Lower) Aquifer	18.41	6.5	
BH3	16/10/25	Existing production borehole Within Indorama Complex	290174.2	533624.6	270	Deep (Lower) Aquifer	17.06	6.5	
BH4	16/10/25	Existing production borehole Within Indorama Complex	289925.5	533869.1	270	Deep (Lower) Aquifer	13.6	6.5	
BH5	16/10/25	Existing production borehole Within Indorama Complex	289655.7	533876.6	270	Deep (Lower) Aquifer	13.81	6.5	
PR-02	16/10/25	Existing production borehole Within Indorama Complex	289952.7	534002.4	311	Deep (Lower) Aquifer	15.74	6.5	
PR-03	16/10/25	Existing production borehole Within Indorama Complex	290324.1	534477.1	311	Deep (Lower) Aquifer	15.1	6.8	
PR-04	16/10/25	Existing production borehole Within Indorama Complex	290226.9	533725.5	226	Deep (Lower) Aquifer	17		6.5
PR-05	16/10/25	Existing production borehole Within Indorama Complex	290512.3	534584.2	311	Deep (Lower) Aquifer	15.18		6.9
PR-07	16/10/25	Existing production borehole Within Indorama Complex	290666.7	534692.7	229	Deep (Lower) Aquifer	15.52		7
PR-08	16/10/25	Existing production borehole Within Indorama Complex	290152	534369	232	Deep (Lower) Aquifer	16.45		6.7

GWC1, GWC2, GWC3 are control boreholes. * - Secondary information from borewell owner. na - not available. ** Spot height elevation measured by google earth

7.4.8.7 GROUNDWATER SAMPLING

Baseline groundwater sampling was conducted during the wet season (October 2025) and dry season (February 2026). Three boreholes located within the Project Area (GW3 to GW5), and 14 existing boreholes including GW1-GW2 (located within Indorama Complex), GW6 to GW17 (located within the broader study area) and three control boreholes (GWC1- GWC3) were sampled for physico-chemical and quality analysis. The complete list of monitoring boreholes is presented in Table 7-40, and their locations are shown in Figure 7-21. The monitoring network was strategically designed to include boreholes situated upstream, within, and downstream of the Project Area.

Groundwater sampling and laboratory analysis were conducted against recognised standards, including:

- Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN), Third Edition (2018), issued by the Department of Petroleum Resources (DPR), which outlines field sampling procedures for environmental assessments in Nigeria.
- APHA Standard Methods for the Examination of Water and Wastewater, 21st Edition (2005), which provides detailed procedures for analysing a wide range of water quality parameters.

Samples were analysed at an FMEnv accredited laboratory (A-Dopt International Services NIG Limited Laboratory, Port Harcourt) for a comprehensive suite of physicochemical, organic, and microbiological parameters using the APHA and ASTM international methods. However, a review of the available data indicates that comprehensive QA/QC procedures, such as the systematic use of travel blanks and duplicates, were either not fully implemented or not adequately reported. This represents a key limitation that should be taken into account when interpreting the analytical results. The sampling methodology applied in the field and the analytical results are discussed in the following sections. Groundwater analytical results are presented in Table 7-41 and Table 7-42.

Analytical results were compared against the Nigerian Standard for Drinking Water Quality (NSDWQ), National Environmental Standards and Regulations Enforcement Agency (NESREA), World Health Organization Guidelines for Drinking-water Quality (WHO) and International Finance Corporation Environmental, Health and Safety Guidelines (IFC – GIIP), which specifies permissible limits for drinking water, along with compliance criteria, monitoring requirements, and institutional responsibilities.

TABLE 7-40: BOREHOLES INCLUDED IN THE MONITORING NETWORK

Station	Sample Location Description	GPS Coordinates	
		North (N)	East (E)
GW1	Within Indorama Manufacturing Complex (Near Off-site CCR)	4°50’04.50”	7°06’30.50”
GW2	Infront of Lab building (behind display wall)	4°49’38.07”	7°06’12.57”
GW3		4°50'36.70"	7°06'032.7"

Station	Sample Location Description	GPS Coordinates	
		North (N)	East (E)
GW4	Within precincts of Indorama FZE (Project area)	4°50'18.90"	7°06'51.70"
GW5		4°50'10.93"	7°06'36.18"
GW6	Iriebe area	4°51'09.56"	7°06'26.56"
GW7	Iriebe area	4°51'32.84"	7°06'38.18"
GW8	Life Camp	4°50'10.93"	7°06'36.18"
GW9	Life Camp	4°50'10.64"	7°06'30.06"
GW10	Agbonchia area	4°48’12.00”	7°07’04.00”
GW11	Aleto area	4°48’40.00”	7°06’09.80”
GW12	Akpajo area	4°49’44.50”	7°05’17.60”
GW13	Nguru area	4°48'14.65"	7°07'13.96"
GW14	Okerewa area	4°48'22.77"	7°06'26.71"
GW15	Elelenwo area	4°50'15.00"	7°04'43.00"
GW16	Aleto area	4°47'50.37"	7°06'33.03"
GW17	NNPC housing area	4°48'39.17"	7°05'24.59"
GW-C1	Rumukrushi area	4°50'31.00"	7°03'38.00"
GW-C2	Alesa area	4°47'12.69"	7°06'59.27"
GW-C3	Oyigbo area	4°52'47.87"	7°07'20.20"

Physico-chemical Characteristics

Groundwater across both the Project Area, Study Area (including Indorama Complex) and Control stations are slightly acidic, with pH values ranging between 5.52–6.54 (dry season) and 5.72–6.52 (wet season). These values are slightly below the guideline range of 6.5–8.5 but are typical of sandy deltaic environments where organic matter decomposition and limited buffering capacity influences, observed in the soil analysis Section 7.4.7.5 contribute to groundwater chemistry.

Electrical conductivity ranges from 43–594 µS/cm (wet season) to 52–604 µS/cm (dry season), while total dissolved solids (TDS) range from 23–321 mg/L and 27–324 mg/L, respectively. These values are well below recommended limits, indicating fresh groundwater with low mineralisation.

Turbidity, total suspended solids (TSS), and salinity are consistently low (<1 NTU, <1 mg/L, and 0.02–0.32 ppt), confirming that groundwater is clear and free from suspended particulates. Total hardness ranges between 5–32 mg/L, indicating soft water conditions, while alkalinity (8–20 mg/L) and bicarbonate (9.8–24.4 mg/L) indicate low buffering capacity, consistent with the slightly acidic pH. All these detected values are well within NSDWQ, WHO, and IFC guideline limits. Overall, the groundwater system is classified as fresh and poorly mineralised, with no evidence of salinisation or elevated ionic strength.

Major Ions and Nutrients

Major ions such as chloride and sulphate occur at low concentrations. Chloride ranges from 3.2–54.8 mg/L, while sulphate ranges from 1.8–20.2 mg/L, both well below regulatory limits. These values indicate no influence from saline intrusion or anthropogenic sources.

Nutrient concentrations are also low. Nitrate ranges from 0.49–1.99 mg/L, significantly below the guideline value of 50 mg/L, while phosphate concentrations remain low (0.10–0.16 mg/L). Ammonia and urea are consistently below detection limits (<0.10 mg/L) across all sampling points. Total nitrogen remains low (0.22–0.82 mg/L). These results indicate no evidence of nutrient enrichment, suggesting minimal influence from agricultural runoff, wastewater discharge, or other contamination sources.

Organic Parameters and Hydrocarbons

Dissolved oxygen (DO) concentrations range from 3.9–4.5 mg/L, indicating moderately oxygenated groundwater. Biochemical oxygen demand (BOD) ranges from <1.0–2.8 mg/L, while chemical oxygen demand (COD) ranges from 2.2–8.4 mg/L, suggesting minimal organic loading.

Hydrocarbon indicators, including oil and grease (<0.50 mg/L), VOC (<0.001 mg/L), TPH (<0.001 mg/L), and PAHs (<0.001 mg/L), were not detected in any samples. This indicates the potential absence of petroleum hydrocarbon contamination across both the Project and Study Areas.

Metals and Trace Elements

Major cations such as sodium (5.80–31.45 mg/L) and potassium (0.84–9.80 mg/L) occur at low concentrations. Calcium (1.42–9.96 mg/L) and magnesium (0.12–1.44 mg/L) are also low, supporting the classification of groundwater as soft.

Iron concentrations range from 0.08–0.23 mg/L, remaining below the WHO aesthetic guideline of 0.3 mg/L. Other trace metals, including zinc (0.03–0.16 mg/L), copper (0.03–0.13 mg/L), and manganese (0.03–0.09 mg/L), which are within or marginally below the WHO recommended limit. This slight exceedance suggests the presence of localized manganese enrichment, which may be attributed to natural geogenic processes.

Potentially toxic heavy metals such as Cr, Pb, Hg, Cd, Ni, As, and Co are consistently below detection limits, indicating no evidence of heavy metal contamination and confirming that groundwater quality is not influenced by industrial or anthropogenic activities.

Microbiological Quality

Microbiological analysis indicates the presence of total coliform bacteria, ranging from 2–6 MPN/100 mL, and faecal coliforms, ranging from 0–2 MPN/100 mL across both seasons. These values exceed the WHO guideline of zero for potable water, indicating minor microbial contamination.

Total plate counts range from 120–650 cfu/mL, while hydrocarbon-utilising bacteria (HUB) (0.07–1.17 × 10^2 CFU/mL) and fungi (HUF) (0.14–0.20 × 10^2 CFU/mL) are present at low levels. Total heterotrophic bacteria (THB) range from 0.13–2.60 × 10^3 CFU/mL, confirming active microbial populations.

Interpretation and Summary

Overall, groundwater within the Project Footprint is characterised by low mineralisation, low organic loading, and the potential absence of hydrocarbon and heavy metal contamination, with most parameters compliant with NSDWQ, WHO, and IFC guideline values. The observed slightly acidic conditions are consistent with natural hydrogeochemical processes within sandy deltaic environments. Nutrient concentration remains low, potentially indicating minimal influence from anthropogenic sources.

The primary concern is the detection of total and faecal coliforms, which exceed drinking water quality standards and indicate microbiological contamination within the shallow aquifer system. This reflects the high permeability and limited natural protection of the aquifer, highlighting its vulnerability to surface-derived contamination. As such, while chemical water quality presents a low risk, microbiological contamination represents a moderate risk for potable use without treatment.

7.4.8.8 GROUNDWATER SENSITIVITY AND VULNERABILITY

Groundwater within the Project Footprint is considered to be of high environmental sensitivity, reflecting its hydrogeological characteristics, resource importance, and vulnerability to contamination.

The aquifer system is dominated by highly permeable coastal plain sands, which facilitate rapid infiltration of precipitation and any surface-derived contaminants. The shallow aquifer, in particular, is unconfined and occurs at relatively shallow depths to 30m bgl with shallow groundwater levels (approximately 4.9 to 6.2 m bgl), making it highly susceptible to contamination from surface activities. Although intermediate and deeper aquifers are partially protected by clay horizons, these confining layers are discontinuous and therefore do not provide complete hydraulic isolation.

The system exhibits a strong hydraulic connection between soils, groundwater, and surface water bodies, with groundwater flow directed toward the south to southwest and likely discharging into local river systems (Okulu River). This connectivity creates a potential pathway for contaminant migration between environmental media.

Groundwater also represents a critical resource within the Study Area, supporting both domestic use in surrounding communities and large-scale industrial abstraction within the Indorama Complex. The presence of approximately 16 deep abstraction boreholes, operating at up to 300 m³/hr, is indicative of the significant reliance on the deeper aquifer system.

A further sensitivity arises from the proximity of a brackish, tidally influenced river approximately 2.4 km south of the existing wellfield and approximately 1.7 km from the proposed IFF Line 2 water supply boreholes, with a connected creek extending into the development area. Variable-density (SEAWAT) flow modelling identifies this as a potential source of saline-water intrusion under sustained abstraction. Earlier modelling, based on an extreme, all-wells abstraction assumption (approximately 6,010 m³/hr), indicated limited landward migration of the freshwater–brackish interface confined to the creek and river corridor on Indorama-owned land. Updated re-modelling of the actual operational abstraction regime - 3,560 m³/hr from 13 concurrently producing boreholes (Mogaba, 2026) - predicts no inland encroachment of brackish water from the Okulu River or creek inlet into the shallow, intermediate or deep aquifer over a one-year simulation, and a minor extension of the interface, confined to the Okulu creek inlet, over a continuous five-year simulation. Under both scenarios the interface potentially remains within Indorama-owned land and is not predicted to reach community supply boreholes. Baseline groundwater quality is generally good, with no evidence of hydrocarbon or heavy metal contamination; however, the presence of total and faecal coliforms indicates existing microbiological vulnerability, particularly within the shallow aquifer system. This further confirms the sensitivity of the groundwater environment to surface influences.

Hydrogeological characterisation, including pump tests and hydraulic-conductivity interpretation, together with long-term numerical simulation of aquifer behaviour under sustained abstraction, are presented in the groundwater sustainability study and its 2026 re-modelling for the Indorama Manufacturing Complex (Mogaba, 2026), which predicts that the aquifer can sustain the confirmed operational abstraction regime (3,560 m³/hr). Observed drawdown patterns (cone of depression) indicate that the groundwater system is already responding to abstraction pressures; long-term groundwater-level monitoring across the study area should therefore be maintained to manage potential impacts on the groundwater–surface water discharge relationship and on community groundwater users.

Overall, groundwater within the Project Footprint is classified as highly sensitive, due to:

- High permeability and rapid contaminant transport potential
- Shallow water table conditions (unconfined aquifer)
- Strong surface water connectivity
- Dependence by communities and industrial users
- Existing microbiological vulnerability

TABLE 7-41: PROJECT FOOTPRINT GROUNDWATER ANALYTICAL RESULT AND CONTROL SAMPLES FOR WET INCLUDING GUIDELINE SCREENING CRITERIA STANDARDS

Parameters	Guidelines Standards				Wet Season October 2025																		
					Project Area			Indorama Complex		Study Area												Control Area		
	NSDWQ	NESREA	WHO Guideline	IFC (EHS / GIIP)	GW3	GW4	GW5	GW1	GW2	GW6	GW7	GW8	GW9	GW10	GW11	GW12	GW13	GW14	GW15	GW16	GW17	GWC1	GWC2	GWC3
Depth of Borewell (meter)	~	~			20	20	20	20	20	65*	70*	65*	65*	60*	60*	70*	65*	70*	70*	60*	65*	70*	65*	60*
Static Water level (meter)	~	~			6.2	5.4	5.1	5.8	4.9	7.2	7.5*	6.4	6.5*	7	8*	8*	7*	7*	8	8	6.5	8.5*	7.5	8*
pH	6.5-8.5	6.5-8.5	6.5 – 8.5 (operational range)	6.5 – 8.5	6.3	6.25	6.15	6.5	6.35	5.97	5.85	6.27	6.52	6.11	6.42	5.95	6.1	6.05	6	6.15	5.85	6.05	5.75	5.9
Appearance	NS	NS	NS	NS	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Temperature (oC)	NS	NS	NS	NS	26.8	25.8	26.7	26.2	27.4	28.6	28.2	27	28.2	27	27.4	27.3	27.6	26.3	27.9	25.8	27.3	28.8	27.1	27.8
Elect. Cond. (µS/cm)	1000	NS	1500 (aesthetic control)	1000 – 1500	192	238	225	216	142	214	243	174	196	377	548	82	89	190	43	283	68	72	594	194
TDS (mg/l)	500	1500	≤1000 (acceptable taste)	500 – 1000	104	129	122	117	77	116	131	94	106	204	296	44	48	103	23	153	37	39	321	105
Turbidity (NTU)	5	NS	≤5	≤5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
TSS (mg/l)	NS	NS	NS	NS	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Salinity (ppt)	NS	NS	NS	NS	0.03	0.05	0.04	0.08	0.02	0.03	0.02	0.03	0.02	0.16	0.32	0.02	0.07	0.19	0.03	0.16	0.03	0.04	0.3	0.03
Total Hardness (mg/l)	150	500			10	12	11	11	10	10	11	9	10	16	26	5	6	10	5	16	6	5	32	12
Total Alkalinity as CaCO3(mg/l)	NS	NS	NS	NS	14	12	14	16	14	12	12	16	20	10	16	12	14	12	10	14	10	10	8	10
Bicarbonate as HCO3-(mg/l)	NS	NS	NS	NS	17.1	14.6	17	19.5	17.1	14.6	14.6	19.5	24.4	12.2	19.5	14.6	17	14.6	12.2	17.1	12.2	12.2	9.8	12.2
Chloride, Cl-(mg/l)	250	600	250	250	9.2	11.4	9.2	6.8	7.4	8.8	12	8.6	11.8	20.6	36.4	6.4	8.6	13.6	4.2	18.8	8.2	7.6	54.8	14.4
Sulphate, SO42-(mg/l)	100	400	250 – 500	250	3.8	5.6	6.2	4.8	6.2	6.6	5.8	4.6	5.2	6.6	7.4	2.4	2.2	4.6	1.8	5.8	2.4	2	18.4	7.2
Phosphate, PO43- (mg/l)	NS	NS	NS	NS	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.14	0.11
Nitrate, NO3-(mg/l)	50	NS	50	50	1.16	0.89	0.96	1.23	1.09	1.28	1.07	1.05	0.85	1.15	0.93	0.69	0.49	0.62	0.72	0.65	0.57	0.89	1.95	1.29
Cyanide (mg/l)	0.01	NS	0.05	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silica (mg/l)	NS	NS	NS	NS	11.6	14.5	13.8	12.8	13.7	15.4	11.7	10.2	8.9	12.6	10.2	8.2	7.6	9.4	7.4	9.8	7.8	10.4	14.6	13.6

Parameters	Guidelines Standards				Wet Season October 2025																	
					Project Area			Indorama Complex		Study Area											Control Area		
	NSDWQ	NESREA	WHO Guideline	IFC (EHS / GIIP)	GW3	GW4	GW5	GW1	GW2	GW6	GW7	GW8	GW9	GW10	GW11	GW12	GW13	GW14	GW15	GW16	GW17	GWC1	GWC2	GWC3
Ammonia (mg/l)	NS	NS	NS	NS	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Urea (mg/l)	NS	NS	NS	NS	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Total Nitrogen (mg/l)	NS	NS	NS	NS	0.26	0.37	0.45	0.43	0.34	0.41	0.45	0.34	0.36	0.29	0.24	0.35	0.37	0.29	0.44	0.37	0.26	0.33	0.52	0.44
Formaldehyde (mg/l)	NS	NS	NS	NS	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
DO (mg/l)	NS	NS	NS	NS	4.2	4.4	4.1	4.3	4.2	4.4	4.1	4.3	4.3	4.2	4.3	4.5	4.2	4.4	4.2	4.1	4	4.2	4.1	4.3
BOD (mg/l)	NS	NS	NS	NS	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	2.4	<1.00
COD (mg/l)	NS	NS	NS	NS	3.2	3.6	4	3.4	4	4.8	4.2	3.6	4.2	6.2	6.8	3.8	4.6	5.2	4.3	5.8	2.2	5.4	7.6	5.8
Oil & Grease (mg/l)	NS	0.6	—	0.3 – 0.6	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
VOC (mg/l)	NS	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
TPH (mg/l)	NS	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PAH (mg/l)	0.007	NS	0.0007	0.0007	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sodium, Na (mg/l)	200	NS	200 (aesthetic)	200	9.2	9.6	8.9	8.2	7.9	8	10.2	8.9	11.8	12.6	21.4	7.7	8.5	11.2	5.8	12.7	6.8	7.4	28.6	10.8
Potassium, K (mg/l)	NS	NS	NS	NS	1.5	1.3	2.5	1.8	2.1	2.1	1.9	2.9	4.2	3.1	4.5	1.5	2.3	1.8	1.2	2.7	1.9	2.9	9.8	2.9
Iron, Fe (mg/l)	0.3	1	0.3 (aesthetic)	0.3	0.16	0.21	0.2	0.18	0.14	0.17	0.16	0.12	0.13	0.17	0.22	0.09	0.08	0.11	0.13	0.11	0.1	0.12	0.19	0.17
Calcium, Ca (mg/l)	NS	200			3.42	4.22	3.72	3.86	3.26	3.52	4.06	3.16	3.54	5.28	8.74	1.67	1.85	3.32	1.42	5.38	1.56	1.71	9.96	3.66
Magnesium, Mg (mg/l)	20	150			0.31	0.25	0.31	0.27	0.36	0.26	0.15	0.14	0.17	0.41	0.63	0.13	0.12	0.35	0.19	0.52	0.28	0.17	1.25	0.32
Zinc, Zn (mg/l)	3	15	3 (aesthetic)	3 – 5	0.04	0.06	0.09	0.06	0.07	0.09	0.04	0.05	0.09	0.08	0.1	0.08	0.06	0.04	0.04	0.05	0.09	0.12	0.16	0.08
Copper, Cu (mg/l)	1	1.5	2	2	0.04	0.05	0.03	0.05	0.06	0.07	0.05	0.03	0.04	0.07	0.06	0.08	0.06	0.09	0.05	0.04	0.07	0.06	0.13	0.08
Manganese, Mn (mg/l)	2	0.5	0.08	0.1	0.05	0.08	0.05	0.05	0.06	0.03	0.09	0.07	0.04	0.05	0.04	0.05	0.03	0.05	0.04	0.03	0.05	0.04	0.09	0.06
Chromium, Cr (mg/l)	0.05	0.03	0.05	0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Parameters	Guidelines Standards				Wet Season October 2025																	
					Project Area			Indorama Complex		Study Area											Control Area		
	NSDWQ	NESREA	WHO Guideline	IFC (EHS / GIIP)	GW3	GW4	GW5	GW1	GW2	GW6	GW7	GW8	GW9	GW10	GW11	GW12	GW13	GW14	GW15	GW16	GW17	GWC1	GWC2	GWC3
Lead, Pb (mg/l)	0.01	0.075	0.01	0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury, Hg (mg/l)	0.001	0.001	0.006	0.001 – 0.006	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, Cd (mg/l)	0.003	0.006	0.003	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel, Ni (mg/l)	0.02	0.075	0.07	0.07	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, As (mg/l)	0.01	NS	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt, Co (mg/l)	NS	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Coliform (MPN/100ml)	10	10	0 (non-detectable)	0	3	4	2	4	4	2	2	2	Nil	2	4	Nil	Nil	Nil	Nil	4	Nil	2	6	4
Faecal Coliform (MPN/100ml)	0	0	0 (non-detectable)	0	Nil	2	Nil	2	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	2	Nil
Total Plate Count (cfu/ml)	NS	NS	NS	NS	340	160	240	260	190	210	320	270	240	170	460	330	240	210	270	190	120	230	490	280
HUB (CFU/ml) x 10^2	NS	NS	NS	NS	Nil	0.1	0.2	0.3	0.2	0.2	0.2	0.1	Nil	0.2	0.4	Nil	Nil	Nil	Nil	0.3	0.3	Nil	0.5	0.2
HUF (CFU/ml) x 10^2	NS	NS	NS	NS	Nil	Nil	Nil	0.1	Nil	Nil	Nil	Nil	Nil	Nil	0.2	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.2	Nil
THB (CFU/ml) x 10^3	NS	NS	NS	NS	1.4	1.5	1.7	1.6	1.3	1.5	1.2	1.4	1.8	1.6	1.8	1.7	1.2	1.4	1.3	1.9	1.8	2	2.6	1.8
THF (CFU/ml) x 10^3	NS	NS	NS	NS	0.9	0.4	0.6	1.1	0.8	0.4	0.8	0.7	0.6	0.5	0.6	0.4	0.5	0.7	0.9	0.8	0.8	0.7	1.2	0.9

TABLE 7-42: PROJECT FOOTPRINT GROUNDWATER ANALYTICAL RESULT AND CONTROL SAMPLES FOR DRY SEASON (FEBRUARY 2026) INCLUDING GUIDELINE SCREENING CRITERIA STANDARDS

Parameters	Guidelines Standards				Dry Season February 2026																		
					Project Area			Indorama Complex		Study Area												Control Area		
	NSDWQ	NESREA	WHO Guideline	IFC (EHS / GIIP)	GW3	GW4	GW5	GW1	GW2	GW6	GW7	GW8	GW9	GW10	GW11	GW12	GW13	GW14	GW15	GW16	GW17	GWC1	GWC2	GWC3
Depth of Borewell (meter)	~	~			20	20	20	20	20	65*	70*	65*	65*	60*	60*	70*	65*	70*	70*	60*	65*	70*	65*	60*
Static Water level (meter)	~	~			6.7	6.5	6.2	6.4	5.8	7.1	7.5*	6.0	6.5*	7.8	8*	8*	7*	7*	8.6	8.9	6.8	8.5*	8.2	8*
pH	6.5-8.5	6.5-8.5	6.5 – 8.5 (operational range)	6.5 – 8.5	6.12	6.17	5.85	6.31	6.42	6.03	5.78	6.24	6.54	6.09	6.38	5.68	5.98	6.12	5.89	6.18	5.76	5.89	5.56	5.52
Appearance	NS	NS	NS	NS	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Temperature (oC)	NS	NS	NS	NS	26.8	27.3	27.1	28.7	28.4	26.4	26.9	28.4	27.9	28.4	27.3	26.9	27.4	26.9	28.3	27.4	26.9	27.4	27.8	26.9
Elect. Cond. (µS/cm)	1000	NS	1500 (aesthetic control)	1000 – 1500	234	242	198	286	216	232	256	187	206	387	572	92	102	218	52	312	74	83	604	221
TDS (mg/l)	500	1500	≤1000 (acceptable taste)	500 – 1000	107	129	99	153	115	124	137	100	110	207	306	49	54	117	27	167	39	44	324	118
Turbidity (NTU)	5	NS	≤5	≤5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
TSS (mg/l)	NS	NS	NS	NS	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Salinity (ppt)	NS	NS	NS	NS	0.08	0.05	0.04	0.09	0.06	0.05	0.05	0.04	0.04	0.08	0.11	0.02	0.03	0.04	0.02	0.10	0.02	0.03	0.15	0.07
Total Hardness (mg/l)	150	500			8.0	10.0	7.0	9.0	9.0	9.0	11.0	9.0	10.0	14.0	19.0	6.0	5.0	11.0	5.0	15.0	6.0	6.0	30.0	12.0
Total Alkalinity as CaCO3(mg/l)	NS	NS	NS	NS	14.0	16.0	14.0	18.0	20.0	14.0	18.0	10.0	20.0	12.0	18.0	10.0	12.0	10.0	14.0	16.0	12.0	12.0	14.0	12.0
Bicarbonate as HCO3-(mg/l)	NS	NS	NS	NS	17.00	19.50	17.10	21.90	24.20	17.00	21.80	12.20	24.20	14.60	21.90	12.20	14.60	12.20	17.00	19.50	14.60	14.60	17.10	14.60
Chloride, Cl-(mg/l)	250	600	250	250	7.6	6.2	5.4	5.7	3.8	7.2	6.6	6.8	3.2	14.6	34.8	5.4	7.8	14.6	4.2	19.4	3.6	4.2	51.8	14.8
Sulphate, SO42-(mg/l)	100	400	250 – 500	250	4.6	4.2	5.7	4.2	3.9	4.8	4.3	5.6	5.1	6.6	7.9	2.9	2.0	3.8	2.0	4.4	2.9	2.4	20.2	8.4
Phosphate, PO43- (mg/l)	NS	NS	NS	NS	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.11	0.14	<0.10	<0.10	<0.10	<0.10	0.10	<0.10	<0.10	0.16	0.12
Nitrate, NO3-(mg/l)	50	NS	50	50	1.25	1.14	1.16	1.27	1.18	1.26	1.45	1.28	1.06	1.58	1.43	0.54	0.73	0.98	0.68	1.49	0.85	1.04	1.99	1.71
Cyanide (mg/l)	0.01	NS	0.05	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silica (mg/l)	NS	NS	NS	NS	14.2	13.4	15.1	11.9	12.8	13.9	12.6	11.8	9.6	14.5	12.7	10.3	9.6	8.4	8.1	11.6	8.7	11.8	16.8	14.5
Ammonia (mg/l)	NS	NS	NS	NS	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

Parameters	Guidelines Standards				Dry Season February 2026																	
					Project Area			Indorama Complex		Study Area											Control Area		
	NSDWQ	NESREA	WHO Guideline	IFC (EHS / GIIP)	GW3	GW4	GW5	GW1	GW2	GW6	GW7	GW8	GW9	GW10	GW11	GW12	GW13	GW14	GW15	GW16	GW17	GWC1	GWC2	GWC3
Urea (mg/l)	NS	NS	NS	NS	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Total Nitrogen (mg/l)	NS	NS	NS	NS	0.29	0.35	0.37	0.57	0.46	0.58	0.51	0.28	0.34	0.22	0.32	0.47	0.53	0.41	0.62	0.71	0.34	0.45	0.82	0.64
Formaldehyde (mg/l)	NS	NS	NS	NS	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
DO (mg/l)	NS	NS	NS	NS	4.00	4.30	3.90	4.40	4.30	4.30	4.20	4.40	4.50	4.30	4.40	4.30	4.40	4.50	4.30	4.20	4.10	4.20	4.40	4.10
BOD (mg/l)	NS	NS	NS	NS	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.60	2.60	<1.00	<1.00	<1.00	<1.00	1.80	<1.00	<1.00	2.80	1.60
COD (mg/l)	NS	NS	NS	NS	3.60	3.00	4.40	2.80	3.40	4.20	3.60	3.00	3.60	5.80	7.60	3.40	4.20	3.60	2.80	6.60	3.60	3.20	8.40	6.40
Oil & Grease (mg/l)	NS	0.6	—	0.3 – 0.6	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
VOC (mg/l)	NS	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
TPH (mg/l)	NS	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PAH (mg/l)	0.007	NS	0.0007	0.00007	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sodium, Na (mg/l)	200	NS	200 (aesthetic)	200	8.43	8.50	8.19	9.40	7.88	8.32	9.76	5.80	7.67	11.34	24.13	6.01	7.89	9.32	6.28	13.63	6.59	6.92	31.45	12.36
Potassium, K (mg/l)	NS	NS	NS	NS	1.17	1.52	1.69	1.85	1.24	1.26	1.72	2.10	1.28	2.56	5.23	0.95	1.18	1.41	0.84	3.26	1.34	1.23	7.56	2.74
Iron, Fe (mg/l)	0.3	1	0.3 (aesthetic)	0.3	0.09	0.15	0.18	0.13	0.11	0.16	0.19	0.14	0.11	0.21	0.13	0.17	0.11	0.09	0.14	0.18	0.13	0.17	0.23	0.19
Calcium, Ca (mg/l)	NS	200			2.92	3.38	2.43	2.85	3.17	3.15	3.78	2.97	3.69	4.62	6.85	1.75	1.47	3.86	1.82	5.09	1.93	1.87	9.62	3.96
Magnesium, Mg (mg/l)	20	150			0.23	0.43	0.26	0.34	0.18	0.30	0.27	0.38	0.24	0.46	0.35	0.27	0.42	0.21	0.16	0.39	0.15	0.31	1.44	0.61
Zinc, Zn (mg/l)	3	15	3 (aesthetic)	3 – 5	0.05	0.04	0.08	0.07	0.08	0.06	0.07	0.05	0.08	0.07	0.04	0.09	0.08	0.03	0.06	0.07	0.09	0.09	0.16	0.09
Copper, Cu (mg/l)	1	1.5	2	2	0.05	0.07	0.06	0.08	0.04	0.07	0.03	0.06	0.04	0.07	0.08	0.05	0.09	0.04	0.06	0.05	0.05	0.09	0.09	0.11
Manganese, Mn (mg/l)	2	0.5	0.08	0.1	0.04	0.08	0.06	0.03	0.07	0.05	0.08	0.03	0.06	0.03	0.05	0.04	0.07	0.08	0.06	0.07	0.04	0.07	0.09	0.06
Chromium, Cr (mg/l)	0.05	0.03	0.05	0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead, Pb (mg/l)	0.01	0.075	0.01	0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury, Hg (mg/l)	0.001	0.001	0.006	0.001 –	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Parameters	Guidelines Standards				Dry Season February 2026																	
					Project Area			Indorama Complex		Study Area											Control Area		
	NSDWQ	NESREA	WHO Guideline	IFC (EHS / GIIP)	GW3	GW4	GW5	GW1	GW2	GW6	GW7	GW8	GW9	GW10	GW11	GW12	GW13	GW14	GW15	GW16	GW17	GWC1	GWC2	GWC3
				0.006																				
Cadmium, Cd (mg/l)	0.003	0.006	0.003	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel, Ni (mg/l)	0.02	0.075	0.07	0.07	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, As (mg/l)	0.01	NS	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt, Co (mg/l)	NS	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Coliform (MPN/100ml)	10	10	0 (non-detectable)	0	2	3	Nil	2	2	2	2	2	3	Nil	2	3	Nil	Nil	Nil	4	2	2	4	3
Faecal Coliform (MPN/100ml)	0	0	0 (non-detectable)	0	1	1	Nil	Nil	Nil	Nil	Nil	Nil	1	Nil	Nil	1	Nil	Nil	Nil	1	Nil	Nil	2	1
Total Plate Count (cfu/ml)	NS	NS	NS	NS	160	220	270	290	220	250	180	220	310	260	340	270	350	140	210	260	170	320	650	380
HUB (CFU/ml) x 10^2	NS	NS	NS	NS	0.47	0.81	0.11	0.97	0.32	0.09	0.21	0.93	1.01	0.07	0.38	0.85	0.29	1.17	0.94	0.53	0.25	0.41	0.21	0.55
HUF (CFU/ml) x 10^2	NS	NS	NS	NS	Nil	Nil	Nil	0.14	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.18	Nil
THB (CFU/ml) x 10^3	NS	NS	NS	NS	0.99	1.26	1.03	1.04	1.93	0.43	0.72	1.99	1.21	0.58	0.64	1.22	0.95	1.22	1.37	0.61	0.92	1.05	0.13	0.69
THF (CFU/ml) x 10^3	NS	NS	NS	NS	0.50	0.40	0.10	0.40	0.70	0.20	0.10	0.30	0.20	0.60	0.40	0.50	0.10	0.80	0.30	1.00	<1.00	0.60	0.50	0.50

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7.4.9 RIVERINE SEDIMENTS AND WASTEWATER

7.4.9.1 INTRODUCTION

The proposed IFF Line 2 Fertilizer project is located adjacent to IFF Line 1 within the Indorama Manufacturing Complex, approximately 15 km north-east of Port Harcourt in Rivers State, Nigeria. It is one of the largest single-line nitrogenous fertilizer facilities in the world, producing ammonia and granulated urea through integrated process trains supported by extensive utilities, including raw and demineralised water systems, cooling circuits and effluent treatment infrastructure. The complex abstracts raw water from on-site boreholes. The 580 m^3/h of treated effluent generated will be processed in water recovery plant and recovered 535 m^3/h water will be reused and discharges residual process and storm water, following multi-stage treatment, to an adjacent surface watercourse that ultimately connects to the broader Bonny Estuary and Niger Delta drainage system.

Because the site sits within a hydrologically sensitive, low-lying deltaic environment, the surrounding aquatic system is a key receptor for any operational releases. Nitrogen-based fertilizer manufacturing inherently involves the handling of ammonia, urea, nitrates and other nitrogenous compounds, alongside conditioning chemicals, oils and trace metals associated with utilities and process equipment. If not adequately managed, these constituents can enter receiving waters through treated effluent discharge, surface runoff or accidental release. Once present in the aquatic environment, nutrients and contaminants may dissolve in the water column, accumulate in fine-grained riverine sediments, or partition into aquatic biota. Elevated nutrient loadings, particularly nitrogen and phosphorus are widely recognised internationally as drivers of eutrophication, algal proliferation, dissolved oxygen depletion and degradation of aquatic ecosystems, while sediments act as long-term sinks for metals, organics and persistent contaminants, integrating exposures over time.

The site operates under a defined regulatory framework that includes Nigerian environmental legislation (notably the EIA Act and standards administered by NESREA and the Federal/State Ministries of Environment) and is also benchmarked against international good-practice standards, including the IFC PSs and the WBG EHS Guidelines for Nitrogenous Fertilizer Manufacturing. Sediment quality was assessed against the Canadian Council of Ministers of the Environment (CCME) Interim Sediment Quality Guidelines (ISQG) and Probable Effect Levels (PEL), which provide threshold concentrations for evaluating potential ecological risk. These frameworks require characterisation of the receiving environment, routine monitoring of effluent at the point of discharge, and assessment of ambient conditions both upstream and downstream of the outfall to verify that operations do not cause material deterioration of the surrounding aquatic system.

This section presents the baseline and monitoring context for four interlinked aquatic components:

- Surface water resources: describing the receiving river system in physical and hydrological terms, including channel characteristics, flow regime, seasonality, tidal/estuarine influence, drainage configuration and the location of the discharge point relative to upstream and downstream receptors;

- Surface water quality: characterising the chemical and microbiological condition of the receiving water column through physico-chemical parameters (pH, conductivity, dissolved oxygen, turbidity, temperature), nutrient species (ammoniacal nitrogen, nitrate, nitrite, total nitrogen, phosphate), major ions, hydrocarbons, trace metals and indicator bacteria;
- Riverine sediments: assessing grain size, organic content and concentrations of nutrients, metals and organic contaminants in depositional zones that integrate longer-term inputs and reflect cumulative loading to the system; and
- Wastewater: evaluating the quality, treatment performance and discharge characteristics of effluent streams leaving the plant prior to release, including compliance with applicable national limits and IFC EHS sector benchmarks.

Together, these four lines of evidence allow an integrated assessment of: whether the operation of the Indorama fertilizer plant is consistent with regulatory limits and international good practice; the current baseline condition of whether the receiving environment shows any signature of plant-related influence to provide the basis for assessment of potential future impact; and where targeted management or mitigation measures may be warranted. This section presents the baseline environmental conditions of surface water, riverine sediments, and associated wastewater systems within the Project Area and the broader Study Area. It also presents the quality of treated effluent from the existing wastewater treatment system as part of the receiving-environment baseline; the treatment process itself is described in Section 4.4.7.

7.4.9.2 REGIONAL SETTING

The project area lies within the Niger Delta hydrological basin, one of the largest and most hydrologically complex deltaic systems in Africa, draining the lower reaches of the River Niger before its discharge into the Atlantic Ocean. The basin extends across a low-lying coastal plain of subdued relief and is defined hydrologically by a dense, anastomosing network of distributary channels, perennial streams, tidal inlets, and estuarine reaches interspersed with extensive freshwater swamp forests, mangrove wetlands, and seasonally inundated floodplains that grade progressively toward the Atlantic coastline. The basin's hydrological function is therefore controlled jointly by upstream fluvial inputs from the Niger and its major tributaries, by intense localised precipitation generated within the delta itself, and by downstream tidal forcing transmitted from the Gulf of Guinea through the estuarine outlets. Within this wider system, the Project Area lies within the Bonny Estuary basin of the Niger Delta (Figure 7-24).

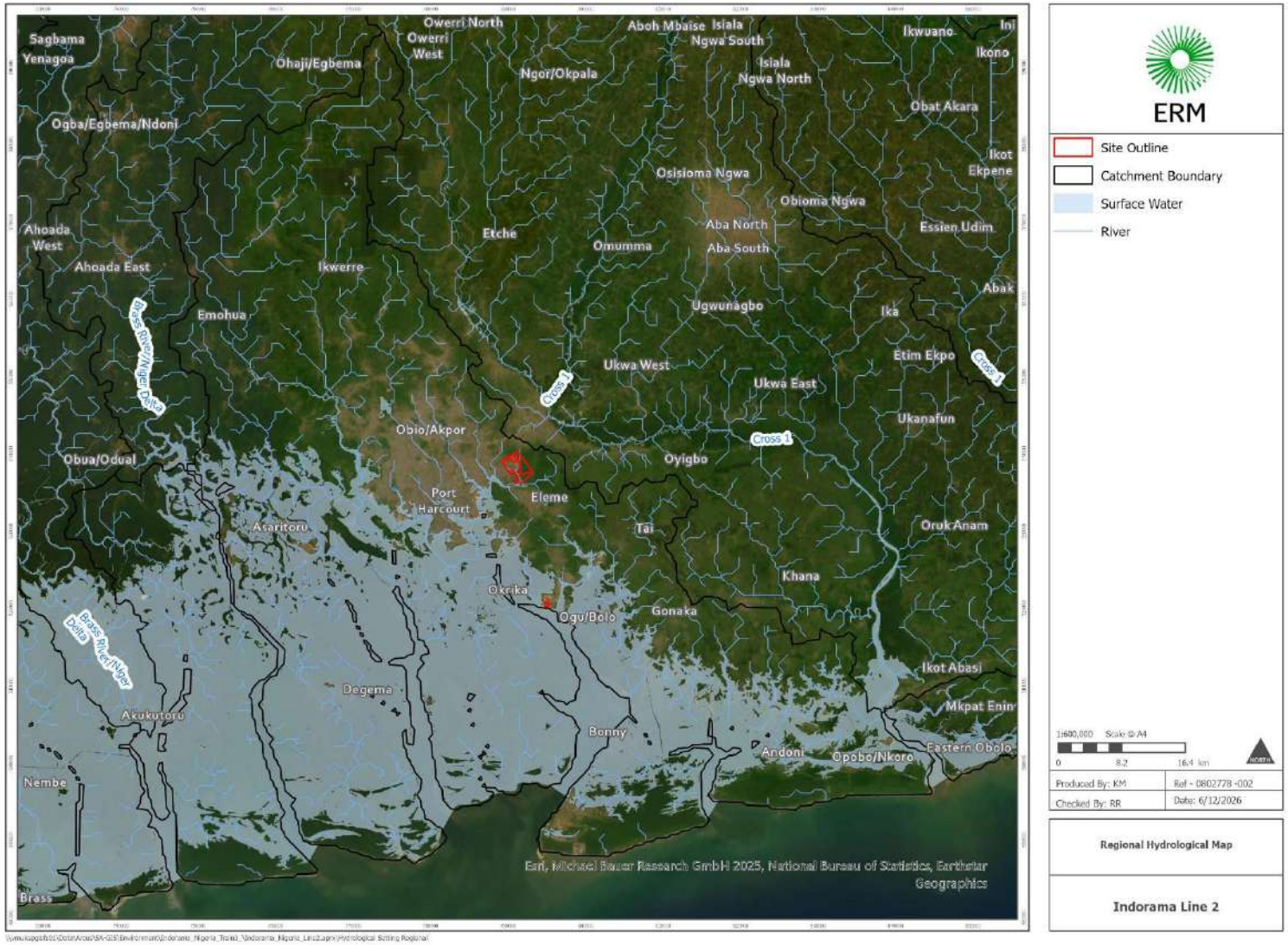

Sagbama
Yenagoa
Owerri North
Owerri West
Ohaji/Egbema
Ngor/Okpala
Aboh Mbaise
Isiala Ngwa South
Isiala Ngwa North
Ikwuano
Ini
Ikono
Obat Akara
Ogba/Egbema/Ndoni
Ikot Ekpene
Osisioma Ngwa
Obiomia Ngwa
Ahoada West
Ahoada East
Etche
Omumma
Aba North
Aba South
Essien Udim
Ikwerre
Abak
Emohua
Ugwunagbo
Ika
Etim Ekpo
Ukwa West
Ukwa East
Ukanafun
Obio/Akpor
Obua/Oduai
Oyigbo
Port Harcourt
Eleme
Tai
Oruk Anam
Asaritoru
Khana
Okrika
Ogu/Bolo
Gonaka
Ikot Abasi
Degema
Mkpat Enin
Akukutoru
Bonny
Andoni
Opobo/Nkoro
Eastern Obolo
Nembe
Brass
Cross 1
Brass River/Niger Delta
Esri, Michael Bauer Research GmbH 2025, National Bureau of Statistics, Earthstar Geographics
ERM
Site Outline
Catchment Boundary
Surface Water
River
1:600,000 Scale @ A4
0 8.2 16.4 km
Produced By: KM
Ref - 0802778 -002
Checked By: RR
Date: 6/12/2026
Regional Hydrological Map
Indorama Line 2

FIGURE 7-24: REGIONAL HYDROLOGICAL SETTING

Discharge from the basin to the Gulf of Guinea occurs through a series of distributary channels and estuarine mouths rather than through a single defined outlet, producing a tidally influenced, low-gradient deltaic flow system. Hydraulic gradients across the delta are gentle, residence times of surface water are long, and the boundary between fluvial, estuarine, and marine hydrological domains is diffuse and shifts seasonally in response to river stage and tidal range.

The basin's hydrological regime is governed by the tropical wet climate of the Niger Delta, comprising two distinct hydrological seasons: a prolonged wet season from April to October, marked by high-intensity, often convective rainfall under the influence of the West African Monsoon and the seasonal northward migration of the Inter-Tropical Convergence Zone, and a dry season from November to March, during which rainfall is markedly reduced and evapotranspiration becomes a more dominant component of the catchment water balance. As a consequence, regional river systems exhibit strong hydrological seasonality, with sharply elevated wet-season discharges, widespread channel overtopping, floodplain inundation, and elevated suspended-sediment loads, contrasted against substantially reduced dry-season flows.

7.4.9.3 CATCHMENT SETTING

Within the broader Niger Delta basin, surface water drainage in the project area is organised around the Okulu River system, a lower-order fluvial network that forms an integral component of the lower Niger Delta hydrological framework and connects hydraulically with the broader Bonny estuary further downstream. The Okulu river functions as the principal watercourse draining the area surrounding the Indorama Manufacturing Complex and serves as the dominant local receiving water body for stormwater and surface runoff (Figure 7-25) originating from the site and from adjacent industrial, commercial, and residential developments within its contributing catchment.

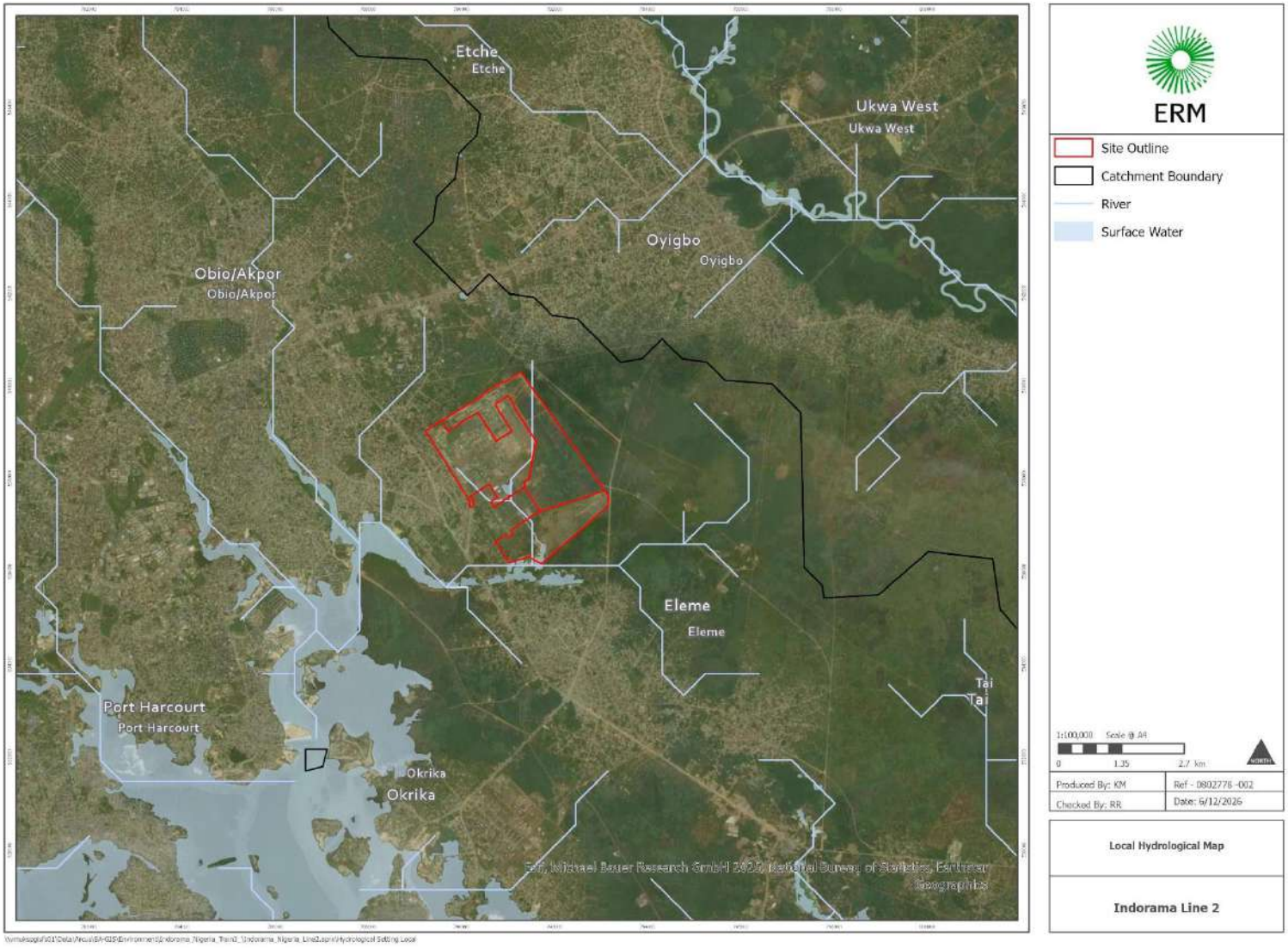

Etche
Etche
Ukwa West
Ukwa West
Oyigbo
Oyigbo
Obio/Akpor
Obio/Akpor
Eleme
Eleme
Tai
Tai
Port Harcourt
Port Harcourt
Okrika
Okrika
ERM
Site Outline
Catchment Boundary
River
Surface Water
1:100,000 Scale @ A4
0
1.35
2.7 Km
NORTH
Produced By: KM
Ref - 0802778 -002
Checked By: RR
Date: 6/12/2026
Local Hydrological Map
Indorama Line 2

FIGURE 7-25: SURFACE WATER RESOURCES AND DRAINAGE NETWORK WITHIN THE PROJECT AREA

The catchment is structured as a series of low-relief sub-catchments drained tributaries and associated minor streams that converge southward into the Okulu River across the gently undulating deltaic plain. Surface flow generated within these sub-catchments is conveyed through this drainage network and ultimately discharges into the Okulu River, which in turn delivers brackish water, sediment, and any entrained dissolved or particulate constituents into the Bonny estuarine system, where mixing with tidal saline water occurs. The catchment therefore functions as a transitional hydrological unit between the upland deltaic plain and the tidally dominated estuarine receiving environment.

Climatic drivers operating at the catchment scale mirror those of the wider basin, with the result that flows in the Okulu River and its tributaries exhibit pronounced hydrological seasonality. Wet-season conditions are characterised by elevated stream discharges, increased flow velocities, raised river stage, and intermittent overbank flow into adjoining floodplains and wetland margins, whereas dry-season conditions are associated with substantially reduced flows and contracted active channel widths.

7.4.9.4 LOCAL (SITE) SETTING

The IFF Line 2 project site is located within the Indorama Manufacturing Complex at Eleme, in the Eleme Local Government Area of Port Harcourt, Rivers State, Nigeria, at approximate geographic coordinates of 4°49′N latitude and 7°6′E longitude. The Indorama Manufacturing complex occupies a 611-hectare industrial landholding and hosts Petrochemicals and Fertilizer production facilities. The proposed IFF Line 2 facility will be constructed on a previously delineated portion of the existing complex, directly adjacent to the IFF Line 1 ammonia and urea plants and will be integrated into the existing site-wide stormwater management and process water infrastructure.

7.4.9.5 SURFACE WATER FEATURES AND DRAINAGE NETWORK

A series of defined drainage lines and minor watercourses occur within and around the proposed IFF Line 2 footprint, functioning as the primary conduits for the conveyance of overland flow and channelised runoff generated within the immediate site catchment. These local drainage features discharge into tributaries of the Okulu River. The Okulu River receives the integrated runoff from the broader Indorama Manufacturing Complex and from neighbouring land uses. The Okulu River therefore constitutes the dominant local receiving water body for all stormwater and surface drainage ultimately leaving the site and represents the principal pathway by which any site-derived hydrological or water-quality signal would propagate downstream into the Bonny estuarine system.

7.4.9.6 RUNOFF BEHAVIOUR AND SURFACE FLOW CHARACTERISTICS

Topographic relief across the Indorama Complex and its immediate surroundings is markedly subdued, consistent with the gently sloping morphology of the Niger Delta coastal plain. Slope gradients are typically shallow and surface flow paths are short, with the result that direct runoff is generated predominantly as diffuse sheet flow across vegetated and unsealed surfaces during and immediately following rainfall events, rather than as concentrated channelised flow within incised pathways. Where short, localised drainage lines do exist, they

convey runoff over comparatively limited distances before flow is dissipated and progressively attenuated across the permeable surficial soils.

Within the developed portions of the complex, the natural runoff regime has been substantially modified by site infrastructure including paved access roads, hardstanding areas, building footprints, and engineered drainage channels, all of which act to concentrate stormwater, reduce time-of-concentration, and elevate peak flow velocities relative to undisturbed conditions. However, these increased flow energies and runoff volumes remain confined within the engineered stormwater drainage system of the existing complex, which has been designed to accommodate the cumulative site runoff and into which the IFF Line 2 stormwater network will be hydraulically tied.

7.4.9.7 EROSION AND SEDIMENT DYNAMICS

More pronounced erosional features, including localised bank scour, undercutting, and channel incision, are evident along the incised reaches of the Okulu River and its larger tributaries, where channelised flow velocities are significantly higher, where seasonal variation in river stage drives repeated wetting and drying of bank materials, and where fluctuating shear stresses progressively destabilise channel margins. Sediment transport within the local hydrological system is therefore principally a wet-season phenomenon, dominated by in-channel processes of bank erosion, bedload mobilisation, and suspended-sediment transport along the main river channels, rather than by sheet runoff and rill erosion across the wider catchment surface. The dominant anthropogenic influence on these dynamics is extensive in-channel sand mining, which reworks the bed and banks, destabilises the channel margins, and alters local patterns of sediment transport and deposition. The Project's treated-effluent discharge, by contrast, is not a material contributor to erosion and sediment dynamics: its volume is small relative to the river's fluvial and tidal flows, and any effect is confined to localised scour in the immediate vicinity of the discharge point.

7.4.9.8 HYDROLOGICAL SOIL GROUPS

For the purpose of characterising the runoff-generation potential of the site catchment, soils across the proposed IFF Line 2 footprint can be classified within Group A of the standard hydrological soil group classification, which is widely used in catchment hydrology and stormwater design to relate soil texture, structure, and drainage characteristics to direct runoff response:

- **Group A: Low stormflow potential:** soils within this group are characterised by high infiltration rates, rapid permeability, low water-holding capacity, and a deep, well-drained profile. They correspond closely to the sandy alluvial deposits and lateritic surficial soils that dominate the Indorama complex and the surrounding deltaic plain. Hydrologically, these soils generate low volumes of direct runoff under all but the most intense or prolonged rainfall events, with the majority of precipitation rapidly infiltrating the surface horizon.

7.4.9.9 SURFACE WATER AND RIVERINE SEDIMENT STUDY AREA

The Study Area for surface water and riverine sediments has been defined to capture locations most likely to be influenced by Project activities while accounting for potential downstream and tidal dispersion.

The Study Area encompasses the area of direct influence - the Okulu River and drainage channel immediately downstream of the Project Area, including all areas draining to the retention pond/canal, extending approximately 1 km south to the first major confluence - and an area of indirect influence covering the broader Okulu River catchment up to approximately 5 km downstream, including riparian zones and floodplains, primarily to the south and southwest in accordance with regional flow directions (refer to Figure 7-25).

Due to the tidal nature of the river, contaminants entering the system may migrate both downstream and upstream, resulting in a dynamic zone of influence.

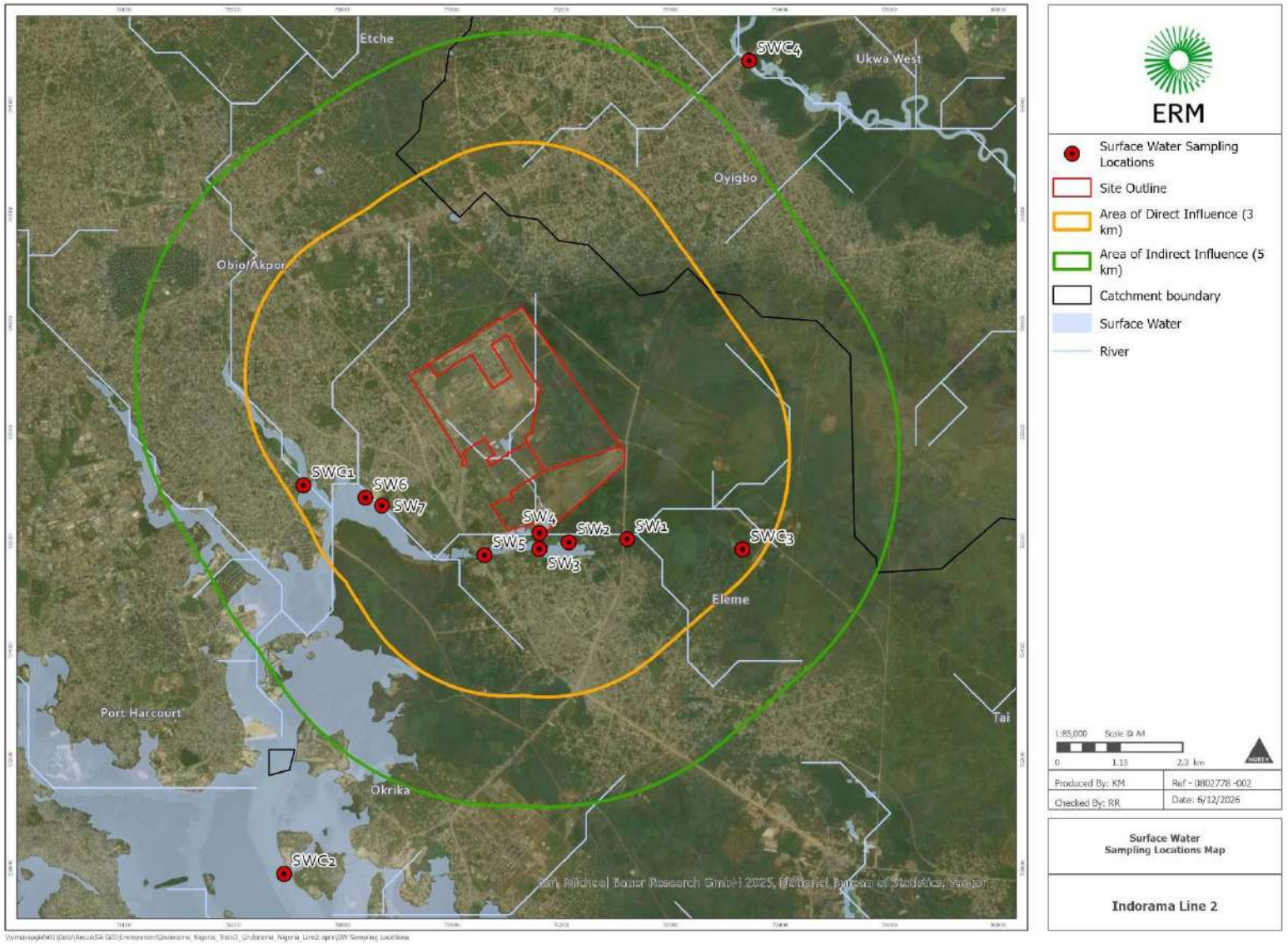

Etche
Ukwa West
Oyigbo
Obio/Akpor
Eleme
Port Harcourt
Okrika
Tai
SWC4
SWC1
SWC2
SWC3
SW1
SW2
SW3
SW4
SW5
SW6
SW7
ERM
Surface Water Sampling Locations
Site Outline
Area of Direct Influence (3 km)
Area of Indirect Influence (5 km)
Catchment boundary
Surface Water
River
1:85,000
Scale @ A4
0
1.15
2.3 km
NORTH
Produced By: KM
Ref - 0802778 -002
Checked By: RR
Date: 6/12/2026
Surface Water Sampling Locations Map
Indorama Line 2

FIGURE 7-26: PROJECT AREA OF INFLUENCE SHOWING SURFACE WATER FEATURES OF INTEREST AND SURFACE WATER SAMPLING SITES

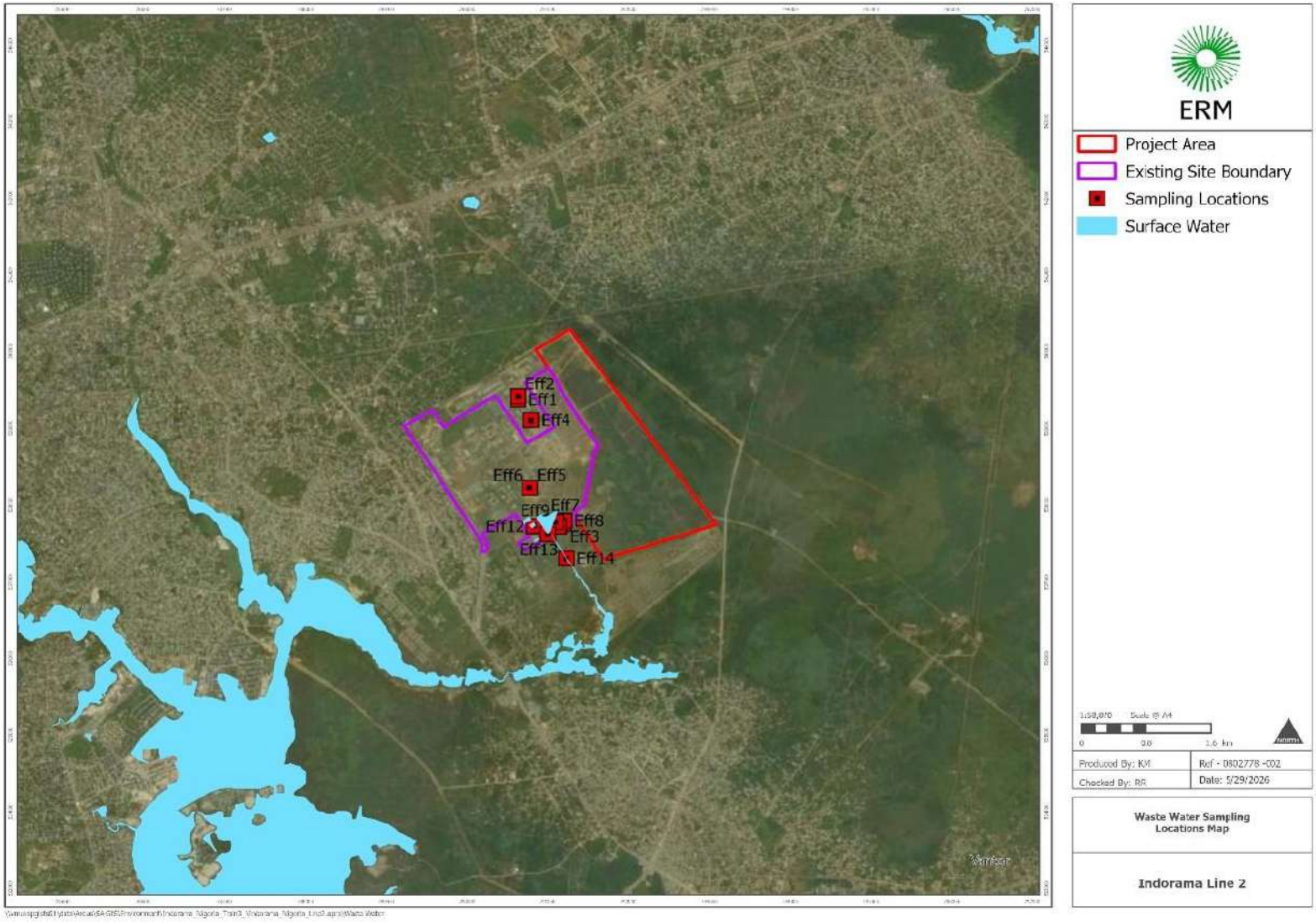

Eff2
Eff1
Eff4
Eff6
Eff5
Eff9
Eff7
Eff8
Eff12
Eff3
Eff13
Eff14
ERM
Project Area
Existing Site Boundary
Sampling Locations
Surface Water
Produced By: KM
Ref - 0802778 -002
Checked By: RR
Date: 5/29/2026
Waste Water Sampling Locations Map
Indorama Line 2

FIGURE 7-27: INDORAMA EFFLUENT SAMPLING SITES

7.4.9.10 METHODOLOGY

Hydrometric Measurements and Field observation

Hydrometric measurements were undertaken at surface water location SW1–SW7 (Okulu River) and SWC1–SWC4 (control sites: streams, estuary, upstream river) to characterise flow dynamics within the surface water system, including flow velocity, discharge, and direction, using the velocity area method. Measurements were conducted along established river cross-sections positioned perpendicular to the direction of flow, where the channel was subdivided into segments to allow for representative assessment of depth and velocity. Water depth was measured at each segment, and flow velocity was determined using a portable flow meter at appropriate depths within the water column to reflect average flow conditions. These measurements were undertaken under varying hydrological conditions, including both tidal and non-tidal regimes, to capture the influence of flood and ebb tidal cycles as well as seasonal variability. Flow direction was determined using a handheld compass, taking into account the bidirectional nature of tidal systems.

In addition to quantitative measurements, qualitative field observations were recorded to support interpretation of hydrological and water quality conditions. These included observations of channel morphology, riverbank condition, sediment characteristics, water clarity, and evidence of anthropogenic activities, such as dredging, sand mining, waste disposal, and effluent discharge points. Observations of vegetation cover, erosion features, and proximity to human activities were also documented to provide context for potential contaminant sources and pathways. Collectively, the hydrometric measurements and field observations provided a comprehensive understanding of the hydrodynamic behaviour of the river system and its interaction with sediments and wastewater inputs, thereby supporting the interpretation of baseline environmental conditions

Surface water sampling

Surface water sampling locations were selected using a judgmental sampling approach, considering hydrological characteristics, ecological relevance, proximity to potential impact sources, and representation of upstream, midstream, downstream, and control conditions refer to Table 7-43 and Figure 7-26.

Sampling was undertaken from SW1–SW7 (Okulu River) and SWC1–SWC4 (control sites: streams, estuary, upstream river) across the Okulu River system under varying hydrological and tidal conditions, including high tide, low tide, and freshwater flow conditions, to ensure representative baseline conditions. Surface water samples were collected at approximately 30 cm below the water surface, at mid-channel or representative points, and against the direction of flow or tidal movement to minimise sampling bias.

In-situ measurements of pH, temperature, dissolved oxygen (DO), electrical conductivity (EC), and salinity were conducted immediately after sample collection using calibrated multi-parameter probes. Samples were collected in pre-cleaned containers and preserved in accordance with standard protocols prior to laboratory analysis.

Riverine Sediment and Analysis

Sediment sampling was undertaken concurrently with surface water sampling to assess interactions between water quality and sediment dynamics from SW1–SW7 and SWC1–SWC4. Sediment samples were collected from the riverbed at designated stations using an Eckman grab sampler, ensuring recovery of representative surficial sediments.

Samples were carefully handled by wrapping in aluminium foil, placed in labelled containers, and transported under control conditions to prevent contamination. Laboratory preparation included air-drying, removal of debris, crushing, sieving, and homogenisation prior to analysis.

Chemical analysis of sediment samples included nutrients, hydrocarbons, and metals, while Toxicity Characteristic Leaching Procedure (TCLP) testing was conducted in accordance with US EPA methods to assess the leachability and mobility of contaminants.

TABLE 7-43: SURFACE WATER AND RIVERINE SEDIMENT SAMPLING LOCATIONS

Station	Sample Location Description	Riverine Sample Depth	GPS Coordinates	
			North (N)	East (E)
SW1	Okulu River - Agbonchia section (Near Bridge)	0.5	4°48'26.82"	7° 07'27.75"
SW2	Okulu River - Aleto section	5.3	4°48'27.91"	7° 06'58.91"
SW3	Okulu River - Aleto section (Near Pipeline)	5.6	4°48'27.33"	7° 06'39.19"
SW4	Okulu River – Aleto section (Outfall Area)	1.8	4°48'38.46"	7° 06'30.80"
SW5	Okulu River - Aleto section (Near E-W Bridge)	5.8	4°48'26.05"	7° 06'08.12"
SW6	Okulu River - Aleto section (Near NNPC housing)	5.9	4°48'24.55"	7° 05'40.93"
SW7	Okulu River – D/S of NNPC housing	6.6	4°48'45.87"	7° 05'06.86"
SW-C1	Rumukrushi stream	6.9	4°49'12.15"	7° 04'17.66"
SW-C2	Bonny Channel Estuary	7.7	4°47'35.75"	7°03'59.19"
SW-C3	Upstream of SW1	0.8	4°48'28.56"	7°08'39.89"
SW-C4	Imo River (Near Imo Gate)	1.2	4°53'17.68"	7°08'43.77"

Wastewater (Treated Effluent) Sampling and Analysis

Wastewater sampling focused on characterising effluent quality across different stages of the treatment and discharge process. Samples were collected from process units, effluent treatment plant outlets, equalisation basins, holding ponds, retention ponds, and final

discharge channels, representing the full treatment pathway refer to Table 7-44 and Figure 7-27.

Sampling was conducted using the grab sampling method, which is appropriate for effluent characterisation and compliance assessment. Samples were collected in pre-cleaned containers specific to each parameter group, including HDPE bottles for general chemistry and glass bottles for hydrocarbons and metals.

Sample preservation followed APHA (2017) standard methods, including refrigeration at approximately 4°C and acidification to pH < 2 for metal analyses.

The analytical programme included physicochemical parameters, nutrients, organic indicators (BOD and COD), hydrocarbons, metals, and microbiological indicators, enabling a comprehensive assessment of effluent quality.

TABLE 7-44: WATER TREATMENT PLANT SAMPLING LOCATIONS

Station	Sample Location Description	GPS Coordinates	
		North (N)	East (E)
Eff1	IFZ – Line 1 ISBL Treated Effluent Pit	4°50’22.33”	7°06’08.72”
Eff2	IFZ – Line 2 Treated Effluent Pit	4°50’23.64”	7°06’08.71”
Eff3	Cooling Tower Blowdown	4°49’30.10”	7°06’26.64”
Eff4	Cooling Tower Side stream backwash Pit	4°50’13.56”	7°06’13.89”
Eff5	DM – 1 Neutralization Pit	4°49’45.27”	7°06’13.48”
Eff6	DM – 2 Neutralization Pit	4°49’45.16”	7°06’13.27”
Eff7	Equalization Basin - A	4°49’31.42”	7°06’25.81”
Eff8	Equalization Basin - B	4°49’31.34”	7°06’27.15”
Eff9	Holding Pond - A	4°49’30.28”	7°06’24.01”
Eff10	Holding Pond - B	4°49’28.96”	7°06’24.97”
Eff11	IFZ – Holding Pond Discharge	4°49’30.79”	7°06’23.60”
Eff12	IPL – Holding Pond Discharge	4°49’29.18”	7°06’15.20”
Eff13	Retention Pond Discharge	4°49’25.73”	7°06’20.52”
Eff14	Discharge channel	4°49’15.47”	7°06’28.03”

7.4.9.11 CHEMICAL ANALYSIS, CHARACTERISTICS AND INTERPRETATION

Hydrological Setting

The Okulu River forms part of the Bonny estuarine system and is characterised by a tidally influenced mixed flow regime. Flow conditions vary spatially and seasonally, with upstream freshwater conditions transitioning into brackish and saline environments downstream.

Surface water low velocities measurements in monitoring location indicate a clear variation during the tidal and non-tidal conditions. Surface water flow velocity during high tidal influence ranges from approximately 0.025 to 0.384 m/s and during low tidal influence, flow velocity ranged from 0.021 to 0.379 m/s. In surface water sample locations where there is no tidal influence, flow velocity ranged from 0.0166 to 0.177 m/s.

River depth shows a corresponding spatial and temporal variation, increasing from approximately 1.8 to 6.9 during low tide and from 2.1 to 7.9m during high tide. Depths are generally shallower in upstream, non-tidal sections and increase significantly within the tidal reaches. This pattern reflects the influence of tidal dynamics on channel morphology and hydraulic conditions within the Study Area.

Flow direction reverses under tidal influence, with landward flow during high tide and seaward flow during low tide. This bidirectional flow regime has significant implications for contaminant dispersion, allowing upstream as well as downstream migration.

River morphology is dynamic, with channel widening, erosion, and sediment redistribution influenced by tidal energy and anthropogenic activities such as dredging and sand mining

Hydrometric measurements and Field observations

Hydrometric measurements carried out along the Okulu River indicate a highly variable and tidally influenced flow system. River widths ranged from narrow upstream channels (~6.5 m) to very wide downstream sections (up to 574 m) towards SW6, with depths varying from 0.6 m to 6.9 m, increasing downstream.

During the wet season, higher velocities (up to 0.72 m/s upstream) reflect increased runoff and river discharge, whereas the dry season shows generally lower velocities (0.02–0.16 m/s) due to reduced freshwater input.

Flow direction consistently reverses between high tide and low tide, confirming strong tidal forcing. Upstream control locations (SW1, SWC3, SWC4) exhibit unidirectional flow, indicating a clear separation between freshwater and tidal zones.

Flow velocities were generally low to moderate (0.0166–0.1627 m/s), with higher velocities and stronger flows recorded in downstream sections. Correspondingly, river discharge increased significantly downstream, ranging from very low flows (~0.17 m^3/s upstream) to high flows (>490 m^3/s in tidal sections).

Water depths remain consistently higher in downstream sections (~5–8 m) compared to upstream freshwater areas (<1.5 m), demonstrating a well-defined estuarine channel system with high hydraulic capacity.

Field observations further indicated that river conditions are influenced by channel morphology, sediment disturbance, and human activities such as dredging and sand mining, particularly in midstream and downstream areas. Overall, the system is hydrodynamically dynamic, with flow behaviour controlled by tidal forcing and local environmental conditions.

TABLE 7-45: RIVER FLOW MEASUREMENTS FOR HIGH AND LOW TIDE

STATION	Description	Northing	Easting	Width of River Transect (m)	HIGH TIDE				LOW TIDE				NO TIDE			
					Depth at sampling point (m)	Average Flow Velocity (m/s)	Total River Discharge (Flow Rate) (cu.m/s)	River Flow Direction	Depth at sampling point (m)	Average Flow Velocity (m/s)	Flow Rate (cu.m/s)	River Flow Direction	Depth at sampling point (m)	Average Flow Velocity (m/s)	Total River Discharge (Flow Rate) (cu.m/s)	Flow Direction
SW1	Okulu River - Agbonchia section (Near Bridge)	4°48'26.82"	7° 07'27.75"	6.50	-	-	-	SW	-	-	-	NE	0.6	0.057	0.17248	SW
SW2	Okulu River - Aleto section	4°48'27.91"	7° 06'58.91"	309.00	5.8	0.056	115.130	W	5.4	0.0514	99.133	E	-	-	-	-
SW3	Okulu River - Aleto section (Near Pipeline)	4°48'27.33"	7° 06'39.19"	161.00	5.9	0.100	79.012	W	5.5	0.095	69.417	E	-	-	-	-
SW4	Okulu River – Aleto section (Outfall Area)	4°48'38.46"	7° 06'30.80"	54.00	2.1	0.025	2.466	W	1.8	0.021	1.743	E	-	-	-	-
SW5	Okulu River - Aleto section (Near E-W Bridge)	4°48'26.05"	7° 06'08.12"	83.00	6.2	0.062	25.393	W	5.8	0.0588	22.316	E	-	-	-	-
SW6	Okulu River - Aleto section (Near NNPC housing)	4°48'24.55"	7° 05'40.93"	574.00	6.3	0.153	496.923	NW	5.9	0.1483	423.027	SE	-	-	-	-
SW7	Okulu River – D/S of NNPC housing	4°48'45.87"	7° 05'06.86"	392.00	6.9	0.163	375.226	NW	6.1	0.1567	312.538	SE	-	-	-	-
SWC1	Woji/Elenwo Stream Upstream	4°49'12.15"	7° 04'17.66"	201.00	7.2	0.384	0.384	SE	6.8	0.379	1.458	NW	-	-	-	-
SWC2	Bonny Estuary at George/Kalo Ama Area	4°47'35.75"	7°03'59.19"	357.00	7.9	0.157	0.157	SE	6.9	0.1504	343.120	NW	-	-	-	-
SWC3	Upstream of SW1	4°48'28.56"	7°08'39.89"	42.00	-	-	-	-	-	-	-	-	0.7	0.0166	0.28552	SW
SWC4	Imo River (Near Imo Gate)	4°53'17.68"	7°08'43.77"	73.00	-	-	-	-	-	-	-	-	1.5	0.177	15.8176	SE

7.4.9.12 LABORATORY QUALITY RESULTS

Surface water Quality characteristics

Surface water quality reflects strong spatial and seasonal variability. The system ranges from freshwater upstream to saline tidal conditions downstream refer to Table 7-46 and Table 7-47 for results.

pH values remain within a stable range of 6.42–7.38, indicating neutral to slightly alkaline conditions. Electrical conductivity and total dissolved solids vary widely from 138–34,687 µS/cm and 83–23,934 mg/L, respectively, reflecting the influence of saline intrusion in downstream areas. Salinity increases from near freshwater conditions (≤0.43 ppt) upstream to 21.58 ppt in tidal zones.

Major ions such as chloride (26.9–5,426 mg/L) and sulphate (10–786 mg/L) are significantly elevated in tidal sections, confirming marine influence. Nutrient concentrations indicate moderate enrichment, with nitrate ranging from 1.98–6.18 mg/L, phosphate from 0.09–0.65 mg/L, and ammonium from 0.40–1.70 mg/L, while total nitrogen reaches up to 8.69 mg/L.

Dissolved oxygen concentrations (5.0–5.4 mg/L) are above the applicable NESREA minimum of 4.0 mg/L (for fisheries/aquatic life and discharge-receiving waters), while BOD (8.8–20.8 mg/L) and COD (26.8–60.6 mg/L) indicate moderate to high organic loading. Hydrocarbons are largely absent, with oil and grease, BTEX, and phenols below detection limits, while TPH (≤0.745 mg/L) and PAHs (≤0.095 mg/L) occur at low concentrations.

Metal concentrations show mixed patterns. Most metals remain low; however, cadmium (up to 0.095 mg/L) exceeds guideline limits, while chromium and nickel show localised exceedances. Other metals such as lead, mercury, and arsenic are below detection limits.

Microbiological quality is poor, with total coliforms ranging from 160 to ≥2,400 MPN/100 ml and faecal coliforms from 48 to ≥2,400 MPN/100 ml, indicating significant faecal contamination.

The surface water quality assessment indicates that most physicochemical parameters are within the applicable FMEnv, NESREA, and IFC guideline limits, reflecting generally acceptable baseline conditions. However, localized deviations, particularly in parameters such as nutrients, suggest areas of moderate ecological stress. The nutrient enrichment may contribute to reduced aquatic habitat quality and increased susceptibility to eutrophication in sensitive zones.

TABLE 7-46: OCTOBER 2025 WET SEASON SURFACE WATER RESULTS

Parameters	Guideline Standards			High Tide								Low Tide								No Tide (Fresh Waterbody)		
	FMEnv Limit (Aquatic Life)	NESREA	IFC (EHS/GIIP)	SW2	SW3	SW4	SW5	SW6	SW7	SWC 1	SWC 2	SW2	SW3	SW4	SW5	SW6	SW7	SWC 1	SWC 2	SW1	SWC 3 Far U/S	SWC4 Imo River
Water/Shoreline Elevation (m) - E	-	-	-	5.8	3.9	2.4	3.8	4.2	16.2	8.2	3.7	~	~	~	~	~	~	~	~	7.2	2.0	6.2
Water/Shoreline Elevation (m) - W	-	-	-	12.5	4.7	4.4	5.3	3.9	3.1	12.7	5.9	~	~	~	~	~	~	~	~	4.6	2.2	5.6
Distance from shoreline (m)	-	-	-	46.1	59.9	96.0	25.7	89.1	149.5	120.2	161.2	46.1	59.9	96.0	25.7	89.1	149.5	120.2	161.2	3.0	2.8	26.3
*Flow (m/s) (Surface, measured using traditional method)	-	-	-	0.36	0.46	0.20	0.50	0.49	0.45	0.50	0.52	0.34	0.42	0.18	0.47	0.43	0.41	0.46	0.46	0.72	0.63	0.12
Flow Direction	-	-	-	S to E	S to E	S to E	S to E	S to E	S to E	S to E	S to E	E to S	E to S	E to S	E to S	E to S	E to S	E to S	E to S	E to S	E to S	N to E
Depth at sampling point (m)	-	-	-	5.3	5.6	1.8	5.8	5.9	6.6	6.9	7.7	5.0	5.2	1.5	5.3	5.3	5.7	6.4	6.2	0.5	0.8	1.2
pH	6.0 – 9.0	6.5-8.5	6.0–9.0	6.42	6.52	6.42	6.54	7.11	6.99	7.21	7.31	6.40	6.61	6.72	6.74	6.84	6.78	7.01	7.19	6.81	6.20	6.70
Appearance			NS	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Temperature (oC)	20 - 33	NS	+3°C above ambient	25.6	25.5	25.8	25.9	27.2	27.1	27.1	27.4	25.1	25.8	25.5	25.9	26.4	26.5	26.8	26.9	24.6	27.8	27.9
Elect. Cond. (µs/cm)	NS	NS	NS	12,430	16,980	14,550	18,750	19,610	19,890	23,840	33,650	10,630	12,290	12,600	14,220	14,490	15,390	14,998	27,500	687	149	138
TDS (mg/l)	NS	NS	NS	8017	10952	9385	12094	12649	12829	15377	21704	6856	7927	8127	9172	9346	9927	9674	17737	433	89	83
Salinity (ppt)			NS	7.74	10.58	9.13	11.69	12.18	12.36	14.81	20.89	6.61	7.64	7.87	8.86	8.95	9.57	9.32	17.14	0.14	0.08	0.08
Turbidity (NTU)	NS	NS	NS	6.4	6.2	6.4	7.3	8.3	7.6	6.9	8.9	4.6	4.4	5.2	5.3	5.5	5.9	5.8	6.9	5.7	4.6	6.1
TSS (mg/l)	NS	0.25	50	5.2	5.1	5.6	5.9	6.8	6.5	5.7	7.4	3.7	3.3	4.1	4.4	4.7	4.8	5.1	5.6	4.8	3.9	5.3
Total Hardness, as CaCO3 (mg/l)	NS	NS	NS	1840	2210	2020	2380	2460	2540	2830	3120	1520	1740	1810	2080	2160	2210	2090	2780	32.0	12.0	10.0
T. Alkalinity as CaCO3(mg/l)	NS	NS	NS	60.0	70.0	65.0	65.0	80.0	75.0	85.0	90.0	55.0	60.0	60.0	65.0	65.0	60.0	70.0	75.0	35.0	25.0	30.0
Chloride, Cl-(mg/l)	NS	300	NS	2780	3270	2980	3450	3680	3720	3960	4450	2360	2530	2670	2890	2970	3150	2860	4150	32.0	22.0	16.0
Sulphate, SO42-(mg/l)	NS	100	NS	502	548	518	597	634	651	732	825	461	512	537	589	608	622	609	756	12.0	10.0	8.0
Nitrate, NO3-(mg/l)	NS	9.1	50	4.62	4.78	4.56	4.94	5.17	5.39	5.51	5.85	4.47	4.59	4.45	4.66	5.02	5.08	5.54	5.58	3.24	1.85	2.37
Phosphate, PO43- (mg/l)	NS	3.5	NS	0.67	0.56	0.59	0.74	0.69	0.78	0.89	0.73	0.56	0.51	0.65	0.64	0.64	0.82	0.98	0.75	0.45	0.49	0.63

Parameters	Guideline Standards			High Tide								Low Tide								No Tide (Fresh Waterbody)		
	FMEnv Limit (Aquatic Life)	NESREA	IFC (EHS/GIIP)	SW2	SW3	SW4	SW5	SW6	SW7	SWC 1	SWC 2	SW2	SW3	SW4	SW5	SW6	SW7	SWC 1	SWC 2	SW1	SWC 3 Far U/S	SWC4 Imo River
Cyanide, CN- (mg/l)	0.005	NS	NS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ammonium, NH3 (mg/l)	NS	0.05	10	0.50	0.80	0.70	0.80	0.90	1.10	1.00	0.80	0.60	0.70	0.90	0.80	0.75	0.90	1.10	0.90	0.60	0.50	0.90
Total Nitrogen as N (mg/l)	NS	NS	10	6.74	6.58	6.19	6.94	7.33	7.85	8.32	7.28	6.35	6.27	5.81	6.87	7.29	7.58	9.26	7.39	5.12	4.45	6.87
Urea (mg/l)	NS	NS	NS	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Formaldehyde (mg/l)	NS	NS	NS	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
DO (mg/l)	6.8	6		5.10	5.40	5.20	5.10	5.40	5.30	5.20	5.20	5.30	5.20	5.10	5.20	5.20	5.00	5.20	5.10	5.20	5.10	5.00
BOD (mg/l)	4	NS	30	12.80	14.40	11.40	15.80	15.40	18.60	17.20	16.40	11.80	12.60	12.40	14.60	19.40	18.60	20.80	16.00	10.40	9.80	14.60
COD (mg/l)	40	NS	125	46.20	48.60	43.80	48.40	50.20	58.60	54.00	51.60	44.00	48.00	42.40	44.60	49.80	46.80	60.60	47.40	36.80	28.20	41.60
O & G (mg/l)	NS	NS	10	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
TPH	NS	NS	NS	0.278	0.245	0.205	0.265	0.298	0.315	0.459	0.325	0.235	0.226	0.185	0.255	0.305	0.282	0.475	0.294	0.154	0.102	0.235
PAH	NS	NS	NS	0.005	0.008	0.003	0.009	0.005	0.008	0.014	0.009	0.003	0.004	0.002	0.006	0.004	0.007	0.017	0.008	0.003	0.002	0.006
BTEX	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phenol	NS	NS	NS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium, Na (mg/l)	NS	120	NS	1186.0	1329.0	1209.0	1365.0	1488.0	1506.0	1557.0	1734.0	1016.0	1075.0	1109.0	1179.0	1195.0	1289.0	1095.0	1697.0	25.40	23.10	20.20
Potassium, K (mg/l)	NA	50	NS	155.0	193.0	165.0	214.0	229.0	244.0	264.0	290.0	129.0	147.0	157.0	176.0	172.0	183.0	185.0	229.0	3.90	3.60	4.20
Iron, Fe (mg/l)	1	0.05	NS	0.18	0.23	0.21	0.24	0.22	0.27	0.29	0.23	0.21	0.18	0.19	0.24	0.23	0.25	0.34	0.25	0.21	0.19	0.25
Calcium, Ca (mg/l)	NS	180	NS	458.0	565.0	528.0	612.0	629.0	645.0	705.0	837.0	406.0	452.0	471.0	517.0	541.0	572.0	559.0	757.0	11.20	3.60	3.07
Magnesium, Mg (mg/l)	NS	40	NS	138.0	165.0	153.0	183.0	192.0	197.0	223.0	237.0	107.0	136.0	129.0	157.0	165.0	161.0	159.0	187.0	0.89	0.58	0.53
Zinc, Zn (mg/l)	0.03	0.01	NS	0.25	0.22	0.21	0.25	0.23	0.27	0.26	0.24	0.21	0.19	0.20	0.24	0.23	0.27	0.29	0.26	0.11	0.09	0.18
Copper, Cu (mg/l)	NS	0.01	NS	0.17	0.12	0.11	0.13	0.14	0.19	0.18	0.15	0.16	0.19	0.18	0.18	0.22	0.24	0.31	0.25	0.10	0.09	0.15

Parameters	Guideline Standards			High Tide								Low Tide								No Tide (Fresh Waterbody)		
	FMEnv Limit (Aquatic Life)	NESREA	IFC (EHS/GIIP)	SW2	SW3	SW4	SW5	SW6	SW7	SWC 1	SWC 2	SW2	SW3	SW4	SW5	SW6	SW7	SWC 1	SWC 2	SW1	SWC 3 Far U/S	SWC4 Imo River
Manganese, Mn (mg/l)	NS	NS	NS	0.14	0.14	0.15	0.13	0.14	0.13	0.14	0.13	0.14	0.15	0.14	0.13	0.14	0.14	0.13	0.15	0.13	0.11	0.11
Total Chromium, Cr (mg/l)	0.00002 – 0.002	0.001	NS	<0.001	<0.001	<0.001	<0.001	<0.001	0.007	0.016	0.008	<0.001	<0.001	<0.001	<0.001	<0.001	0.011	0.025	0.009	<0.001	<0.001	0.006
Silver, Ag (mg/l)	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead, Pb (mg/l)	0.0017	0.01	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury, Hg (mg/l)	0.001	0.001	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, Cd (mg/l)	0.0002 – 0.0018	0.005	NS	0.037	0.034	0.022	0.045	0.047	0.059	0.046	0.055	0.032	0.023	0.019	0.027	0.034	0.042	0.048	0.047	0.007	0.004	0.009
Nickel, Ni (mg/l)	0.025 – 0.15	0.01	NS	<0.001	<0.001	<0.001	0.004	0.005	0.031	0.057	0.038	<0.001	<0.001	<0.001	0.03	0.004	0.025	0.031	0.036	0.004	0.012	0.026
Cobalt, CO (mg/l)	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium, V (mg/l)	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, As (mg/l)	NS	0.05	NS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Coliform (MPN/100ml)	NS	NS	100	440	560	390	600	540	840	≥2,400	520	240	380	410	360	400	960	≥2,400	400	350	260	460
Fecal Coliform (MPN/100ml)	NS	NS	NS	80	106	88	120	100	140	≥2,400	148	48	66	52	86	70	180	≥2,400	220	72	98	106
Total Plate Count (cfu/ml) x 10^2	NS	NS	NS	2.1	1.9	1.8	1.8	2.3	5.2	1.9	2.4	1.2	2.4	2.1	1.6	2.8	3.2	2.6	2.4	2.7	6.8	5.2
HUB (CFU/ml) x10^2	NS	NS	NS	0.5	1.0	1.0	0.7	1.0	2.0	2.0	19.0	0.7	1.2	0.4	0.4	0.5	0.9	0.3	0.3	1.0	1.9	2.4
HUF (CFU/ml) x 10^2	NS	NS	NS	0.3	0.5	0.4	0.4	0.6	0.5	0.5	2.3	0.2	0.3	0.2	0.2	0.3	0.4	0.1	0.2	0.3	1.0	0.4
THB (CFU/ml) x 10^2	NS	NS	NS	3.0	5.2	8.0	1.6	7.0	15.0	12.0	18.0	1.5	1.9	1.6	1.5	1.6	1.4	1.4	1.5	7.0	8.8	5.1
THF (CFU/ml) x 10^2	NS	NS	NS	1.8	1.7	1.5	1.3	1.6	4.3	1.0	1.7	0.4	1.6	0.6	0.6	1.6	1.7	1.5	1.5	1.5	5.0	3.3

TABLE 7-47: FEBRUARY 2026 DRY SEASON SURFACE WATER RESULT

Parameters	Guideline Standards			High Tide								Low Tide								No Tide (Fresh Waterbody)		
	FMEnv Limit (Aquatic Life)	NESREA	IFC (EHS/GIIP)	SW2	SW3	SW4	SW5	SW6	SW7	SWC 1	SWC 2	SW2	SW3	SW4	SW5	SW6	SW7	SWC 1	SWC 2	SW1	SWC3 Far U/S	SWC 4 Imo River
Water/Shoreline Elevation (m) - E	-	-	-	5.2	4.3	3.2	3.6	4.6	15.9	7.8	4.2	~	~	~	~	~	~	~	~	7.6	2.1	7.9
Water/Shoreline Elevation (m) - W	-	-	-	13.4	5.1	4.3	5.9	4.2	3.6	13.2	6.2	~	~	~	~	~	~	~	~	4.8	2.4	5.8
Distance from shoreline (m)	-	-	-	52.3	58.5	88.7	28.5	90.4	138.9	124.6	158.4	48.9	61.2	98.3	26.8	88.3	138.9	119.4	158.4	2.9	3.2	27.8
*Flow (m/s) (Surface, measured using traditional method)	-	-	-	0.0564	0.1000	0.0250	0.0618	0.1528	0.1627	0.3840	0.1574	0.0514	0.0950	0.0210	0.0588	0.1483	0.1567	0.3790	0.1504	0.0570	0.0166	0.1770
Flow Direction	-	-	-	W	W	W	W	NW	NW	SE	SE	E	E	E	E	SE	SE	NW	NW	SW	SW	SE
Depth at sampling point (m)	-	-	-	5.8	5.9	2.1	6.2	6.3	6.9	7.2	7.9	5.4	5.5	1.8	5.8	5.9	6.1	6.8	6.9	0.6	0.7	1.5
pH	6.0 – 9.0	6.5-8.5	6.0–9.0	6.76	6.84	6.68	6.74	7.06	6.84	7.38	7.12	6.52	6.62	6.46	6.82	6.75	6.65	7.26	7.04	6.76	6.42	6.59
Appearance			NS	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Temperature (oC)	20 - 33	NS	+3°C above ambient	29.3	29.6	29.1	29.9	29.6	29.8	29.7	29.8	31.7	30	31.4	30.7	29.8	29.9	30.1	30.2	27.2	27.8	27.9
Elect. Cond. (µs/cm)	NS	NS	NS	14,543	18,654	16,426	17,984	20,423	21,675	20,864	34,687	12,654	16,429	15,875	16,276	19,865	20,876	18,674	30,764	1,092	168	143
TDS (mg/l)	NS	NS	NS	10034	12871	11333	12408	14091	14955	14396	23934	8731	11336	10953	11230	13706	14404	12885	21227	748	115	98
Salinity (ppt)			NS	9.06	11.64	10.26	11.22	12.76	13.49	15.49	21.58	7.86	10.26	9.86	9.87	12.38	12.40	11.68	19.21	0.43	0.10	0.09
Turbidity (NTU)	NS	NS	NS	6.7	5.4	6.8	5.9	6.4	5.6	6.1	6.4	5.6	5.1	6.2	5.5	5.8	5.9	6.3	5.9	4.3	3.9	7.8
TSS (mg/l)	NS	0.25	50	5.5	4.6	5.5	4.7	5.1	4.4	4.9	5.2	4.4	3.9	5.1	4.3	4.6	4.9	5.1	4.8	3.4	3.1	6.5
Total Hardness, as CaCO3 (mg/l)	NS	NS	NS	1736.0	2108.0	1890.0	2004.0	2224.0	2392.0	2092.0	2816.0	1470.0	1880.0	1840.0	1880.0	2126.0	2234.0	2042.0	2334.0	60.0	14.0	16.0
T. Alkalinity as CaCO3(mg/l)	NS	NS	NS	36.0	40.0	34.0	48.0	56.0	50.0	60.0	54.0	32.0	38.0	40.0	52.0	50.0	46.0	68.0	62.0	28.0	22.0	30.0
Chloride, Cl-(mg/l)	NS	300	NS	3,258	3,748	3,529	3,672	4,235	4,358	4,282	5,426	2,784	3,325	3,174	3,295	3,918	4,141	3,768	4,908	137.5	34.6	26.9
Sulphate, SO42-(mg/l)	NS	100	NS	496	562	532	548	581	598	642	786	458	524	509	547	580	561	625	708	28.0	14.0	10.0
Nitrate, NO3-(mg/l)	NS	9.1	50	4.92	5.06	4.68	4.81	5.45	5.83	5.96	6.05	4.65	4.74	4.32	4.52	5.03	5.66	6.18	5.89	2.82	1.98	2.75
Phosphate, PO43- (mg/l)	NS	3.5	NS	0.34	0.42	0.33	0.49	0.55	0.58	0.46	0.54	0.32	0.26	0.46	0.37	0.31	0.55	0.65	0.52	0.18	0.25	0.28

Parameters	Guideline Standards			High Tide								Low Tide								No Tide (Fresh Waterbody)		
	FMEnv Limit (Aquatic Life)	NESREA	IFC (EHS/GIIP)	SW2	SW3	SW4	SW5	SW6	SW7	SWC 1	SWC 2	SW2	SW3	SW4	SW5	SW6	SW7	SWC 1	SWC 2	SW1	SWC3 Far U/S	SWC 4 Imo River
Cyanide, CN- (mg/l)	0.005	NS	NS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ammonium, NH3 (mg/l)	NS	0.05	10	0.75	0.80	0.95	0.90	1.00	1.10	1.30	0.90	0.60	0.70	1.10	0.85	0.95	1.30	1.70	0.95	0.80	0.40	1.30
Total Nitrogen as N (mg/l)	NS	NS	10	6.92	6.67	6.28	6.58	7.36	7.85	7.69	7.05	6.74	6.29	6.14	6.47	7.26	7.83	8.69	7.21	5.71	3.98	7.55
Urea (mg/l)	NS	NS	NS	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Formaldehyde (mg/l)	NS	NS	NS	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
DO (mg/l)	6.8	6		5.20	5.30	5.40	5.30	5.30	5.40	5.30	5.40	5.20	5.30	5.20	5.30	5.40	5.20	5.30	5.20	5.10	5.20	5.20
BOD (mg/l)	4	NS	30	12.30	14.60	12.40	14.80	16.40	15.80	19.60	13.80	11.60	18.30	12.40	16.00	15.20	16.40	17.80	12.60	12.80	8.80	16.40
COD (mg/l)	40	NS	125	43.20	46.80	44.20	45.80	51.20	49.40	56.40	50.80	44.80	48.20	45.40	46.60	49.40	53.20	59.40	52.40	34.60	26.80	48.60
O & G (mg/l)	NS	NS	10	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
TPH	NS	NS	NS	0.163	0.187	0.175	0.192	0.285	0.324	0.535	0.275	0.146	0.168	0.125	0.159	0.253	0.295	0.745	0.264	0.132	0.117	0.425
PAH	NS	NS	NS	0.005	0.007	0.004	0.006	0.013	0.045	0.069	0.032	0.004	0.005	0.005	0.019	0.015	0.026	0.095	0.037	0.003	0.002	0.085
BTEX	NS	NS	NS	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	<0.001	<0.001
Phenol	NS	NS	NS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium, Na (mg/l)	NS	120	NS	1285.0	1518.0	1425.0	1475.0	1746.0	1824.0	1788.0	2218.0	1096.0	1456.0	1366.0	1422.0	1669.0	1748.0	1583.0	2098.0	57.80	29.50	22.80
Potassium, K (mg/l)	NA	50	NS	178.0	216.0	192.0	204.0	242.0	263.0	257.0	382.0	138.0	175.0	164.0	169.0	218.0	234.0	197.0	276.0	8.60	4.20	3.50
Iron, Fe (mg/l)	1	0.05	NS	0.24	0.21	0.18	0.25	0.29	0.25	0.31	0.27	0.21	0.17	0.23	0.25	0.22	0.29	0.35	0.28	0.12	0.17	0.24
Calcium, Ca (mg/l)	NS	180	NS	482.0	572.0	513.0	541.0	598.0	645.0	532.0	769.0	406	495	489	487	572	597	543	615	16.84	4.45	5.06
Magnesium, Mg (mg/l)	NS	40	NS	127.0	162.0	146.0	156.0	175.0	187.0	183.0	214.0	109.0	154.0	148.0	159.0	167.0	178.0	164.0	191.0	4.29	0.53	0.85
Zinc, Zn (mg/l)	0.03	0.01	NS	0.23	0.27	0.24	0.31	0.36	0.32	0.41	0.35	0.19	0.18	0.21	0.24	0.22	0.28	0.45	0.31	0.09	0.08	0.25
Copper, Cu (mg/l)	NS	0.01	NS	0.22	0.18	0.16	0.24	0.21	0.27	0.32	0.31	0.18	0.17	0.13	0.21	0.24	0.28	0.36	0.30	0.06	0.08	0.19
Manganese, Mn (mg/l)	NS	NS	NS	0.24	0.29	0.26	0.34	0.41	0.37	0.49	0.35	0.38	0.45	0.31	0.44	0.28	0.37	0.42	0.33	0.11	0.12	0.24

Parameters	Guideline Standards			High Tide								Low Tide								No Tide (Fresh Waterbody)		
	FMEnv Limit (Aquatic Life)	NESREA	IFC (EHS/GIIP)	SW2	SW3	SW4	SW5	SW6	SW7	SWC 1	SWC 2	SW2	SW3	SW4	SW5	SW6	SW7	SWC 1	SWC 2	SW1	SWC3 Far U/S	SWC 4 Imo River
Total Chromium, Cr (mg/l)	0.00002 – 0.002	0.001	NS	0.008	0.006	0.005	0.011	0.015	0.021	0.016	0.017	0.005	0.007	0.005	0.009	0.016	0.028	0.054	0.016	0.003	<0.001	0.011
Silver, Ag (mg/l)	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead, Pb (mg/l)	0.0017	0.01	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury, Hg (mg/l)	0.001	0.001	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, Cd (mg/l)	0.0002 – 0.0018	0.005	NS	0.037	0.056	0.037	0.049	0.068	0.082	0.064	0.061	0.023	0.046	0.031	0.039	0.048	0.072	0.095	0.058	0.007	0.004	0.012
Nickel, Ni (mg/l)	0.025 – 0.15	0.01	NS	0.041	0.028	0.053	0.034	0.047	0.026	0.058	0.033	0.044	0.027	0.051	0.037	0.046	0.039	0.055	0.048	0.019	0.009	0.037
Cobalt, CO (mg/l)	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium, V (mg/l)	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, As (mg/l)	NS	0.05	NS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Coliform (MPN/100ml)	NS	NS	100	380	720	480	520	660	740	≥2,400	680	280	440	360	400	540	920	≥2,400	520	160	200	720
Fecal Coliform (MPN/100ml)	NS	NS	NS	64	160	120	100	150	160	≥2,400	180	56	80	64	80	120	240	≥2,400	200	48	60	220
Total Plate Count (cfu/ml) x 10^2	NS	NS	NS	4.7	3.4	2.9	3.9	9.2	8.6	9.2	7.4	2.6	4.1	6.8	9.6	8.3	8.9	6.1	9.4	7.9	6.8	8.7
HUB (CFU/ml) x10^2	NS	NS	NS	1.4	0.9	2.1	1.4	7.8	2.5	3.2	2.7	3.1	1.4	1.8	2.5	3.9	1.9	1.5	3.1	6.7	3.4	2.1
HUF (CFU/ml) x 10^2	NS	NS	NS	1.5	0.9	1.6	0.8	3.0	2.0	1.0	2.0	1.0	1.3	2.0	2.0	1.0	1.2	1.0	1.0	2.0	4.0	1.0
THB (CFU/ml) x 10^2	NS	NS	NS	4.4	3.1	7.4	8.2	10.4	7.6	9.7	16.0	1.7	2.9	6.4	11.2	7.2	10.5	6.8	10.3	13.1	11.4	9.1
THF (CFU/ml) x 10^2	NS	NS	NS	2.4	2.6	2.0	2.4	3.5	2.0	4.0	3.0	1.1	1.3	4.0	7.0	4.0	5.0	5.0	2.0	7.0	7.0	3.0

Riverine Sediment Quality

Project Footprint sediment results for Wet season are presented in Table 7-48 and Dry season in Table 7-53. Sediments are predominantly sandy, with sand content ranging from 74.5–90.4% (wet season) and 79.8–86.9% (dry season). Seasonal increases in clay content (up to 15.2%) during the dry season indicate enhanced fine-particle retention.

Sediment pH ranges between 5.09 and 8.32, while sulphide concentrations remain below detection limits, indicating oxic conditions. Nutrient concentrations show moderate enrichment, with nitrate reaching up to 8.70 mg/kg and phosphate up to 0.84 mg/kg.

Organic carbon concentrations vary significantly, reaching up to 12.38% in the dry season, reflecting accumulation under reduced flow conditions. Hydrocarbon content (THC) ranges from 6.8–82.5 mg/kg, although TPH and PAHs are below detection limits.

Metal concentrations are generally consistent with background conditions, although iron shows elevated values (up to 2,863 mg/kg) during the dry season. Other metals remain low and within expected ranges.

Microbial activity is present across all locations, with total heterotrophic bacteria ranging up to 21.6 $\times 10^5$ CFU/g, reflecting active sediment biological processes.

Sediment analysis results were screened against exist known benchmarks standards for compliance purposes. The sediment quality results indicate a mixed environmental condition, with several key parameters exceeding benchmark standards. Elevated concentrations of cadmium (wet season) exceeded the CCME screening benchmark. The screening values, indicate a moderate ecological risk, particularly to benthic organisms due to toxicity and potential bioaccumulation.

Additionally, elevated sodium and potassium levels suggest salinity influences that may alter sediment chemistry and biological functioning. While hydrocarbons are present at moderate levels, the absence of TPH and PAHs reduces long-term persistence concerns. However, the presence of these heavy toxic elements might be due to natural conditions as they were observed in all samples except for control samples. The presence of some of the detected heavy metals may result in sediment toxicity, ecological stress, and potential transfer of contaminants to the aquatic food chain, particularly in depositional zones.

TABLE 7-48: WET SEASON OCTOBER 2025 SEDIMENT RESULTS

Parameters	Benchmark Standards			Sediment Samples							Control Samples			
	FMEnv Limit (Aquatic Life)	CCME (ISQG / PEL)	IFC (EHS/GIIP)	SD1	SD2	SD3	SD4	SD5	SD6	SD7	SDC1	SDC2	SDC3	SDC4
Sand (%)	-	-	-	86.3	86.3	74.5	81.3	88.4	76.7	90.4	78.1	89.3	78.3	82.1
Clay (%)	-	-	-	3.5	1.5	4.9	6.3	1.9	7.9	1.9	5.7	1.8	6	2
Silt (%)	-	-	-	10.2	12.3	20.6	12.5	9.7	15.4	7.7	16.2	8.9	15.8	15.9
Texture	-	-	-	LS	LS	SCL	LS	SS	SL	SS	SL	SS	SL	SL
Colour	-	-	-	Brown	Gray	Gray	Gray	Gray	Gray	Gray	Gray	Gray	Black	Dark Brown
Permeability (cm/sec)	-	-	-	0.14	0.18	0.13	0.16	0.12	0.18	0.13	0.17	0.15	0.18	0.15
Moisture Content (%)	-	-	-	21.03	24.34	35.5	34.03	22.11	10.75	33.22	12.44	14.9	35.05	31.3
Bulk Density (g/cm3)	-	-	-	1.24	1.21	1.26	1.23	1.26	1.32	1.29	1.32	1.34	1.23	1.42
Porosity	-	-	-	51.56	52.73	50.78	51.95	50.78	48.44	49.61	48.44	47.66	51.95	44.53
pH	6.0 – 9.0	NS	6.0–9.0	7.57	7.22	5.45	5.66	6.5	7.11	7.46	7.05	6.35	7.84	7.63
Sulphide, S2- (mg/kg)		NS	NS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sulphate, SO42- (mg/kg)	NS	NS	NS	12	16	25	8	11	19	12	25	18	2	4
Nitrate, NO3- (mg/kg)	NS	NS	50	1.17	3.95	2.86	3.07	4.09	3.71	4.86	4.58	4.76	1.42	1.69
Phosphate, PO43- (mg/kg)	NS	NS	NS	0.13	0.28	0.41	0.26	0.49	0.76	0.84	0.82	0.94	0.11	0.23
THC (mg/kg)	NS-	NS	NS-	14.5	45.2	41.5	32.7	43.8	49.3	45.6	69.7	48.8	17.4	32.6
Ammonia-Nitrogen (mg/kg)	NS	NS	10	0.13	0.63	0.83	0.47	0.54	0.84	0.69	0.93	0.84	0.1	0.21
TOC (%)	NS-	NS	NS	1.68	3.56	2.69	2.53	2.79	3.29	3.98	5.44	3.93	1.24	2.57
Total Nitrogen (%)	NS	NS	10	3.99	4.39	3.91	5.79	4.89	4.59	3.83	4.29	3.71	2.89	3.25
Calcium (cmol/kg)	NS	NS	NS	79.35	169.9	178.6	135.77	149.58	166.08	145.71	179.08	186.17	51.95	63.35
Magnesium (cmol/kg)	NS	NS	NS	49.15	161.88	152.78	113.71	132.22	144.41	132.08	155.1	162.17	33.82	51.17
Potassium (cmol/kg)	NA	NS	NS	235.11	351.7	471.57	381.93	521.14	599.75	531.36	612.37	576.4	185.17	150.03
Sodium (cmol/kg)	NS	NS	NS	325.48	504.42	657.14	526.7	710.16	754.38	712.2	854.43	823.2	214.42	292.45
TPH (mg/kg)	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PAH (mg/kg)	NS	1.68	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Parameters	Benchmark Standards			Sediment Samples							Control Samples			
	FMEnv Limit (Aquatic Life)	CCME (ISQG / PEL)	IFC (EHS/GIIP)	SD1	SD2	SD3	SD4	SD5	SD6	SD7	SDC1	SDC2	SDC3	SDC4
Manganese, Mn (mg/kg)	NS	NS	NS	0.58	1.47	1.54	1.66	1.74	2.82	2.67	2.89	2.97	0.29	0.88
Nickel, Ni (mg/kg)	0.025 – 0.15	18	NS	0.39	0.62	0.78	0.8	0.81	0.94	0.79	0.96	0.92	0.29	0.72
Iron, Fe (mg/kg)	1	NS	NS	239.87	540.67	542.53	538.65	542.34	536.45	564.76	621.35	548.23	153.23	262.34
Lead, Pb (mg/kg)	0.0017	35	NS	1.76	1.98	2.34	2.21	2.86	2.17	2.64	2.74	2.84	1.36	1.35
Copper, Cu (mg/kg)	NS	35.7	NS	6.29	12.44	12.66	10.82	13.91	14.11	13.47	15.16	13.49	3.62	4.83
Zinc, Zn (mg/kg)	0.03	123	NS	1.06	2.08	2.22	1.45	2.92	2.45	3.5	3.53	2.79	0.95	2.07
Cadmium, Cd (mg/kg)	0.0002 – 0.0018	0.6	NS	0.15	0.65	0.92	0.48	0.76	0.95	0.82	0.65	0.79	0.44	0.12
Mercury, Hg (mg/kg)	0.001	0.17	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, As (mg/kg)	NS	5.9	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium, V (mg/kg)	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt, Co (mg/kg)	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium, Cr (mg/kg)	0.00002 – 0.002	37.3	NS	0.87	1.56	3.65	2.54	2.96	3.82	5.56	7.45	4.46	0.62	1.14
THB (CFU/g) $x10^5$	NS	NS	NS	8	8.5	8.6	2.63	3.34	6.1	11.3	3.33	13.2	2.65	3.12
THF (CFU/g) $x10^3$	NS	NS	NS	2.45	3.12	2.89	3.78	2.67	3.34	2.99	3.56	4.05	7.83	9.04
HUB (CFU/g) x 10^4	NS	NS	NS	1.23	1.45	1.62	1.31	1.78	1.54	1.36	1.68	1.49	1.86	1.75
HUF (CFU/g) x 10^3	NS	NS	NS	2.25	1.32	1.44	1.51	1.08	1.57	1.62	1.47	1.36	1.1	1.33

TABLE 7-49: DRY SEASON FEBRUARY 2026 SEDIMENT RESULTS

Parameters	Benchmark Standards			Sediment Samples							Control Samples			
	FMEnv Limit (Aquatic Life)	CCME (ISQG / PEL)	IFC (EHS/GIIP)	SD1	SD2	SD3	SD4	SD5	SD6	SD7	SDC1	SDC2	SDC3	SDC4
Sand (%)	-	-	-	83.3	82.3	80.5	81.3	84.4	79.8	86.9	80.1	84.3	76.3	80.9
Clay (%)	-	-	-	3.5	2.5	4.9	4.3	4.6	6.9	1.4	5.7	1.8	8.0	4.0
Silt (%)	-	-	-	13.2	15.2	14.6	14.5	11.0	13.3	11.7	14.2	13.9	15.8	15.1
Texture	-	-	-	LS	LS	SCL	LS	SS	SL	SS	SL	SS	SL	SL
Colour	-	-	-	Brown	Gray	Gray	Gray	Gray	Gray	Gray	Gray	Gray	Black	Dark Brown
Permeability (cm/sec)	-	-	-	0.16	0.14	0.15	0.14	0.14	0.15	0.14	0.16	0.14	0.160	0.18
Moisture Content (%)	-	-	-	23.47	31.86	34.71	11.93	25.68	33.54	15.37	22.84	12.61	34.18	24.95
Bulk Density (g/cm3)	-	-	-	1.32	1.38	1.29	1.30	1.29	1.30	1.34	1.30	1.32	1.28	1.39
Porosity	-	-	-	48.44	46.09	49.61	49.22	49.61	49.22	47.66	49.22	48.44	50.00	45.70
pH	6.5-8.5	NS	6.0–9.0	7.34	6.39	7.79	5.09	8.32	6.57	5.51	7.05	6.35	6.81	6.54
Sulphide, S2- (mg/kg)		NS	NS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sulphate, SO42- (mg/kg)	100	NS	NS	5.20	4.30	15.10	4.24	7.55	14.14	13.80	15.30	14.10	4.80	3.50
Nitrate, NO3- (mg/kg)	9.1	NS	50	1.12	2.73	1.29	6.40	8.70	2.71	3.18	5.60	9.30	0.78	1.36
Phosphate, PO43- (mg/kg)	3.5	NS	NS	0.37	0.24	0.31	0.38	0.46	0.27	0.39	0.22	0.44	0.09	0.21
THC (mg/kg)		NS	NS	9.75	33.65	27.90	23.60	51.80	42.80	36.80	82.50	45.20	6.80	25.80
Ammonia-Nitrogen (mg/kg)	0.05	NS	10	0.11	0.44	0.65	0.55	0.39	0.72	0.53	0.79	0.64	0.13	0.18
TOC (%)		NS	NS	12.38	4.65	2.74	2.27	1.59	2.46	4.87	4.34	2.72	1.19	1.96
Total Nitrogen (%)	NS	NS	10	4.17	2.74	3.65	2.87	4.48	3.29	5.72	2.96	4.13	3.84	2.78
Calcium (cmol/kg)	180	NS	NS	84.10	162.34	177.63	168.47	157.21	179.12	164.13	167.40	198.36	69.58	75.27
Magnesium (cmol/kg)	40	NS	NS	28.34	35.17	31.42	24.78	36.81	23.87	32.54	21.76	34.23	26.41	29.18
Potassium (cmol/kg)	50	NS	NS	187.24	284.30	512.54	296.10	434.51	478.50	572.40	419.00	893.00	153.00	125.37
Sodium (cmol/kg)	120	NS	NS	263.40	387.30	624.70	378.10	732.40	587.50	746.30	918.00	1264.70	329.10	257.40
TPH (mg/kg)	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PAH (mg/kg)	NS	1.68	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese, Mn (mg/kg)	NS	NS	NS	0.29	0.51	0.63	0.38	0.24	1.06	1.43	1.31	1.48	0.19	0.44

Parameters	Benchmark Standards			Sediment Samples							Control Samples			
	FMEnv Limit (Aquatic Life)	CCME (ISQG / PEL)	IFC (EHS/GIIP)	SD1	SD2	SD3	SD4	SD5	SD6	SD7	SDC1	SDC2	SDC3	SDC4
Nickel, Ni (mg/kg)	0.01	18	NS	0.47	0.73	0.68	0.34	0.81	0.58	0.92	0.76	1.04	0.16	0.28
Iron, Fe (mg/kg)	0.05	NS	NS	631.0	876.0	1234.0	2863.0	2474.0	2517.0	2329.0	1985.0	2674.0	432.0	229.0
Lead, Pb (mg/kg)	0.01	35	NS	0.12	0.23	0.18	0.31	0.25	0.27	0.47	0.42	0.39	0.11	0.18
Copper, Cu (mg/kg)	0.01	35.7	NS	4.21	6.73	5.31	7.98	4.47	6.12	3.69	7.54	4.93	2.18	3.81
Zinc, Zn (mg/kg)	0.01	123	NS	0.87	1.31	1.12	1.18	1.53	2.71	1.93	1.39	1.64	0.83	1.85
Cadmium, Cd (mg/kg)	0.005	0.6	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury, Hg (mg/kg)	0.001	0.17	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, As (mg/kg)	0.05	5.9	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium, V (mg/kg)	NS	NS	NS	0.16	0.34	0.31	0.47	0.29	0.33	0.41	0.35	0.44	0.110	0.170
Cobalt, Co (mg/kg)	NS	NS	NS	0.12	0.45	0.76	0.58	0.89	0.81	0.97	0.57	0.68	0.110	0.140
Chromium, Cr (mg/kg)	0.001	37.3	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
THB (CFU/g) $x10^5$	NS	NS	NS	21.60	4.10	13.70	9.70	6.50	3.50	7.30	6.30	6.40	12.20	2.10
THF (CFU/g) $x10^3$	NS	NS	NS	0.23	0.04	0.13	0.07	0.13	0.05	0.16	0.07	0.11	0.17	0.09
HUB (CFU/g) x 10^4	NS	NS	NS	18.60	0.20	5.20	1.50	1.30	0.70	0.60	1.70	2.20	4.90	0.30
HUF (CFU/g) x 10^3	NS	NS	NS	1.20	0.50	0.10	0.70	0.10	0.10	0.14	0.30	0.12	0.12	0.50

Sediment TCLP leachability Assessment

The TCLP results were evaluated to determine the potential for metals contained within the sediments to become mobilised and migrate into surrounding surface water or groundwater systems. As there are currently no Nigerian sediment leachate-specific assessment criteria, the results were screened against available FMEnv aquatic-life limits and supplemented with relevant international guideline standards (CCME and IFC).

Overall, the results indicate that the sediments have a low potential to release metals under the leaching conditions simulated by the TCLP test. Iron (Fe), manganese (Mn), copper (Cu) and nickel (Ni) were detected in both the wet and dry seasons across the study area; however, concentrations were generally low and exhibited limited spatial variability. Iron concentrations remained below the applicable FMEnv aquatic-life guideline value of 1 mg/L at all locations, suggesting minimal risk associated with iron mobility from the sediments.

Of the metals analysed, zinc (Zn) was the only parameter that consistently exceeded the FMEnv aquatic-life guideline value of 0.03 mg/L. Zinc concentrations ranged from 0.073 to 0.745 mg/L during the dry season and from 0.028 to 0.558 mg/L during the wet season, with the highest concentrations recorded at control sample locations SDC1 and SDC2. The presence of elevated zinc concentrations in both sampling seasons indicates that zinc is the most mobile metal within the sediment matrix. Although the observed concentrations exceed the screening criterion, the pattern was relatively consistent between seasons, suggesting that the elevated levels may be associated with local geochemical conditions or historical anthropogenic influences rather than a recent contamination event.

Nickel was detected at low concentrations, ranging from 0.009 to 0.044 mg/L, and generally fell within the FMEnv guideline range of 0.025–0.15 mg/L. Copper was also detected at low concentrations throughout the study area and did not indicate significant leaching potential. In contrast, vanadium, chromium, lead, mercury, arsenic, cobalt and cadmium were below the analytical detection limit (<0.001 mg/L) in all samples collected during both the wet- and dry-season sampling campaigns, indicating negligible mobility of these potentially toxic metals.

Overall, the TCLP assessment suggests that the sediments are not a significant source of leachable metal contamination and are unlikely to adversely affect surrounding water resources under current conditions. With the exception of zinc, which demonstrated elevated mobility relative to the FMEnv aquatic-life guideline, all analysed metals exhibited low leaching potential or were not detected. Consequently, the sediments are considered to pose a low risk of contaminant release to adjacent aquatic and groundwater environments, although zinc should be considered during future environmental monitoring and impact assessment activities.

TABLE 7-50: DRY SEASON FEBRUARY 2026 SEDIMENT LEACHATE RESULTS

Parameters	Benchmark Standards			Sediment Leachate Samples							Control Samples			
	FMEnv Limit (Aquatic Life)	CCME (ISQG / PEL)	IFC (EHS/GIIP)	SD1	SD2	SD3	SD4	SD5	SD6	SD7	SDC1	SDC2	SDC3	SDC4
Iron, Fe (mg/l)	1	NS	NS	0.128	0.341	0.127	0.482	0.313	0.654	0.417	0.432	0.873	0.095	0.182
Manganese, Mn (mg/l)	NS	NS	NS	0.051	0.078	0.091	0.063	0.085	0.047	0.093	0.071	0.058	0.088	0.067
Zinc, Zn (mg/l)	0.03	123	NS	0.073	0.213	0.163	0.119	0.212	0.348	0.187	0.745	0.563	0.079	0.096
Nickel, Ni (mg/l)	0.025 – 0.15	18	NS	0.031	0.043	0.037	0.018	0.041	0.026	0.039	0.023	0.044	0.028	0.033
Copper, Cu (mg/l)	NS	35.7	NS	0.042	0.069	0.035	0.062	0.084	0.051	0.073	0.118	0.104	0.075	0.082
Vanadium, V (mg/l)	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium, Cr (mg/l)	0.00002 – 0.002	37.3	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead, Pb (mg/l)	0.0017	35	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury, Hg (mg/l)	0.001	0.17	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, As (mg/l)	NS	5.9	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt, Co (mg/l)	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, Cd (mg/l)	0.0002 – 0.0018	0.6	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

TABLE 7-51: WET SEASON OCTOBER 2025 SEDIMENT LEACHATE RESULTS

Parameters	Benchmark Standards			Sediment Leachate Samples							Control Samples			
	FMEnv Limit (Aquatic Life)	CCME (ISQG / PEL)	IFC (EHS/GIIP)	SD1	SD2	SD3	SD4	SD5	SD6	SD7	SDC1	SDC2	SDC3	SDC4
Iron, Fe (mg/l)	1	NS	NS	0.095	0.240	0.220	0.120	0.160	0.190	0.207	0.282	0.250	0.038	0.145
Manganese, Mn (mg/l)	NS	NS	NS	0.045	0.042	0.069	0.050	0.087	0.066	0.082	0.089	0.095	0.041	0.023
Zinc, Zn (mg/l)	0.03	123	NS	0.060	0.160	0.390	0.128	0.150	0.188	0.282	0.558	0.434	0.028	0.082
Nickel, Ni (mg/l)	0.025 – 0.15	18	NS	0.015	0.024	0.028	0.021	0.018	0.020	0.031	0.019	0.022	0.009	0.013
Copper, Cu (mg/l)	NS	35.7	NS	0.034	0.185	0.215	0.076	0.085	0.063	0.098	0.181	0.167	0.073	0.052
Vanadium, V (mg/l)	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium, Cr (mg/l)	0.00002 – 0.002	37.3	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead, Pb (mg/l)	0.0017	35	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury, Hg (mg/l)	0.001	0.17	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, As (mg/l)	NS	5.9	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt, Co (mg/l)	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, Cd (mg/l)	0.0002 – 0.0018	0.6	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Effluent Water Quality characteristics

Wastewater analytical results are presented in Table 7-52 and Table 7-53. The analytical data presented in the tables above represent wastewater quality samples collected within the Indorama wastewater treatment facility and demonstrate progressive reduction in contaminant concentrations across the various treatment stages prior to final discharge into the receiving environment. Treated effluent is discharged at a single point sampled at RPGV (Final Discharge), from where it flows into the discharge channel, where a downstream sample was collected. The interpretation presented below focuses on the final discharge sample and the discharge channel sample only; the remaining sampling points are internal to the treatment system and are included to illustrate treatment performance.

At the point of discharge, the effluent is near-neutral (pH 7.3–7.6), moderately mineralised (TDS 982–1,089 mg/L), and low in suspended solids (4.8–8.7 mg/L), indicating effective treatment performance. Residual organic and nutrient loading remains, with BOD ranging from 9.2–9.8 mg/L, COD from 37.6–39.8 mg/L, total nitrogen from 6.0–7.2 mg/L, and ammonium between 0.3–1.2 mg/L, with slightly higher concentrations observed in the discharge channel. Hydrocarbons are not detected (oil and grease <1 mg/L), while most trace metals are below detection limits (<0.001 mg/L). Zinc (0.28–0.35 mg/L) and copper (0.06–0.08 mg/L) are the only metals detected with trace concentrations.

Effluent results were screened against the Project Applicable Limits, NESREA guidelines, and IFC/WBG EHS Guidelines. Comparison of the Final Discharge Area and Discharge Channel results indicated that most parameters complied with the applicable screening criteria. While DO, TSS, Cu and Zn exceeded the prescribed NESREA guideline values.

DO concentrations were recorded at approximately 5.0–5.1 mg/L, exceeding the NESREA minimum criterion of 4 mg/L. This exceedance is considered positive, as higher dissolved oxygen concentrations generally indicate better water quality and greater capacity to support aquatic life. Therefore, the elevated DO concentrations do not represent an adverse environmental impact.

TSS concentrations exceeded the NESREA guideline value of 0.75 mg/L; however, all results remained well below the Project Applicable Limit of 30 mg/L and the IFC/WBG EHS Guideline value of 50 mg/L. The observed exceedances are therefore considered minor and are unlikely to result in significant impacts on the receiving environment.

Similarly, Zn and Cu concentrations exceeded the NESREA guideline value of 0.2 and 0.01 mg/L. In addition, Zn and Cu are essential trace element and the concentrations detected were low relative to commonly applied industrial effluent discharge limits. The exceedances are therefore considered of low environmental significance and do not indicate a material risk to the receiving surface water body.

Overall, although DO, TSS, Cu and Zn exceeded the conservative NESREA screening values, compliance with the Project and IFC/WBG EHS guideline limits, together with the generally good effluent quality observed, suggests that the discharged effluent is unlikely to affect the receiving environment.

TABLE 7-52: INDORAMA EFFLUENT LABORATORY RESULTS FOR WET SEASON (OCTOBER 2025)

Parameter	Benchmark Standard			Effluent Sampling Points within Indorama Wastewater Facility											Final Discharge Area	Discharge Channel
	FMEnv Limit (Aquatic Life)	NESREA	IFC (EHS/GIIP)	ISBL Line1	ISBL Line2	CT BD	SSF Pit	DM-1 Npit	DM-2 Npit	Eq Basin -A	Eq Basin-B	HP-A	HP-B	IFZ-HP Dis	IPL-HP	RPGV (Final Discharge)	Discharge Channel
pH	6.0 – 9.0	6.5-8.5	6.0–9.0	7.10	7.60	7.20	6.90	6.60	6.80	7.50	7.30	7.30	7.20	7.30	7.70	7.20	7.30
Appearance			NS	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Turbid
Temperature, (°C)	20 - 33	NS	+3°C above ambient	28.1	27.9	24.6	26.8	26.5	25.9	27.9	28.1	27.6	27.5	27.6	28.1	27.5	27.9
Elect. Cond. (µs/cm)	NS	NS	NS	1216	1712	2545	3240	3780	3650	1645	1870	1950	1650	1780	2260	1430	1510
TDS (mg/l)	NS	NS	NS	790	1113	1654	2106	2457	2373	1069	1216	1268	1073	1157	1469	930	982
Turbidity (NTU)	NS	NS	NS	5.7	4.3	6.7	18.5	6.5	7.2	4.3	4.9	4.4	5.1	4.6	7.6	8.5	9.8
TSS (mg/l)	NS	0.75	50	4.2	3.8	5.5	17.1	5.3	5.9	3.6	4.1	3.7	4.0	3.8	6.5	7.2	8.7
Total Hardness (mg/l)	NS	NS	NS	6.0	8.0	45.0	52.0	15.0	12.0	36.0	29.0	32.0	30.0	32.0	14.0	18.0	20.0
Alkalinity (mg/l)	NS	NS	NS	32.0	36.0	25.0	20.0	16.0	18.0	26.0	32.0	28.0	34.0	30.0	45.0	40.0	45.0
Chloride, Cl-(mg/l)	NS	350	NS	10.0	12.0	58.0	76.0	16.0	20.0	32.0	48.0	44.0	34.0	38.0	28.0	32.0	36.0
Sulphate, SO42-(mg/l)	NS	500	NS	52.0	87.0	22.0	34.0	128.0	120.0	67.0	53.0	74.0	46.0	52.0	68.0	62.0	65.0
Nitrate, NO3-(mg/l)	NS	40	50	0.83	0.95	1.38	2.85	0.92	0.85	2.36	1.92	2.21	2.08	2.13	2.67	2.45	2.59
Phosphate, PO43-(mg/l)	NS	3.5	NS	0.11	0.13	4.85	5.35	0.04	0.06	1.57	1.29	1.38	1.22	1.28	0.85	0.70	0.75
Cyanide (mg/l)	0.005	NS	NS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silica (mg/l)	NS	NS	NS	5.8	7.6	125.5	116.8	158.5	178.2	85.6	83.8	88.9	85.6	87.5	96.5	55.2	61.5
Ammonium (mg/l)	NS	2.0	10	0.90	1.40	<0.10	0.20	<0.10	<0.10	0.70	0.95	0.85	0.80	0.80	0.20	0.60	0.70
Urea (mg/l)	NS	NS	NS	0.20	0.30	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Formaldehyde (mg/l)	NS	NS	NS	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Total Nitrogen (mg/l)	NS	NS	10	4.88	5.65	4.60	6.90	3.20	2.90	5.06	5.78	5.52	5.67	5.55	5.16	5.85	6.02
DO (mg/l)	6.8	4		5.10	5.00	5.40	4.80	4.60	4.50	5.00	5.10	5.10	5.20	5.10	4.90	5.00	5.10
BOD (mg/l)	4	6	30	7.40	8.80	10.40	14.50	6.50	5.40	9.20	7.40	8.60	8.00	8.60	9.40	9.20	9.80
COD (mg/l)	40	30	125	28.60	30.40	36.80	46.60	24.60	22.00	36.80	27.60	32.60	29.20	32.80	39.20	38.00	39.80
O & G (mg/l)	NS	0.1	10	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00

Parameter	Benchmark Standard			Effluent Sampling Points within Indorama Wastewater Facility											Final Discharge Area	Discharge Channel
	FMEnv Limit (Aquatic Life)	NESREA	IFC (EHS/GIIP)	ISBL Line1	ISBL Line2	CT BD	SSF Pit	DM-1 Npit	DM-2 Npit	Eq Basin -A	Eq Basin-B	HP-A	HP-B	IFZ-HP Dis	IPL-HP	RPGV (Final Discharge)	Discharge Channel
Sodium, Na (mg/l)	NS	120	NS	38.6	52.55	34.54	48.24	61.55	59.45	39.62	46.87	51.23	38.96	42.76	56.43	51.48	57.89
Potassium, K (mg/l)	NA	50	NS	6.55	12.25	11.65	8.66	17.62	19.48	14.65	16.73	14.12	11.45	12.43	14.59	12.87	13.69
Iron, Fe (mg/l)	1	0.5	NS	0.12	0.14	0.19	0.35	0.11	0.16	0.13	0.15	0.15	0.17	0.15	0.25	0.14	0.17
Calcium, Ca (mg/l)	NS	180	NS	2.23	2.96	12.21	14.26	5.59	4.37	12.45	10.22	11.35	10.65	10.75	4.85	6.24	6.48
Magnesium, Mg (mg/l)	NS	40	NS	0.05	0.07	3.10	3.80	0.18	0.24	0.85	0.72	0.78	0.75	0.81	0.45	0.54	0.63
Zinc, Zn (mg/l)	0.03	0.2	NS	0.09	0.11	1.08	1.39	0.08	0.07	0.26	0.32	0.25	0.27	0.26	0.39	0.28	0.30
Copper, Cu (mg/l)	NS	0.01	NS	0.07	0.04	0.09	0.13	0.08	0.07	0.06	0.04	0.05	0.06	0.05	0.09	0.06	0.07
Manganese, Mn (mg/l)	NS	NS	NS	0.03	0.04	0.07	0.09	0.05	0.08	0.05	0.06	0.05	0.05	0.05	0.08	0.07	0.07
Chromium, Cr (mg/l)	0.00002 – 0.002	0.5	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Silver, Ag (mg/l)	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead, Pb (mg/l)	0.0017	0.1	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury, Hg (mg/l)	0.001	0.005	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, Cd (mg/l)	0.0002 – 0.0018	0.01	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel, Ni (mg/l)	0.025 – 0.15	0.1	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, As (mg/l)	NS	0.05	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Note: The Project Applicable Limits were based on project-specific benchmark limits approved by the Federal Ministry of Environment (FMEnv) for Indorama in March 2018 (FMEnv, 2018).

TABLE 7-53: INDORAMA EFFLUENT LABORATORY RESULTS FOR DRY SEASON (FEBRUARY 2026)

Parameter	Benchmark Standard			Effluent Sampling Points within Indorama Wastewater Facility											Final Discharge Area	Discharge Channel
	FMEnv Limit (Aquatic Life)	NESREA	IFC (EHS/GIIP)	ISBL Line1	ISBL Line2	CT BD	SSF Pit	DM-1 Npit	DM-2 Npit	Eq Basin - A	Eq Basin-B	HP-A	HP-B	IFZ-HP Dis	IPL-HP	RPGV (Final Discharge)	Discharge Channel
pH	6.0 – 9.0	6.5-8.5	6.0–9.0	7.2	7.5	7.4	6.9	6.6	6.7	7.4	7.2	7.4	7.3	7.1	7.5	7.4	7.55
Appearance			NS	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Temperature, (oC)	20 - 33	NS	+3°C above ambient	27.9	28.1	26.3	26.8	27.4	26.4	26.8	27.8	28.2	26.9	27.4	27.8	27.9	28.1
Elect. Cond. (µs/cm)	NS	NS	NS	1865	1094	2764	3070	4146	3843	1484	1584	1465	1523	1486	2344	1612	1675
TDS (mg/l)	NS	NS	NS	1212	711	1796	1996	2695	2498	965	1030	952	990	966	1524	1048	1089
Turbidity (NTU)	NS	NS	NS	4.7	4.4	7.6	15.4	5.2	6.1	4.9	5.6	4.5	4.9	4.6	6.7	5.6	6.4
TSS (mg/l)	NS	0.75	50	3.8	3.7	6.3	14.1	4.3	5	4.8	4.7	3.6	3.5	3.7	5.5	4.8	5.6
Total Hardness (mg/l)	NS	NS	NS	7	6	46	54	18	14	36	35	35	34	34	16	25	26
Alkalinity (mg/l)	NS	NS	NS	24	30	40	28	16	18	38	34	28	36	32	40	44	50
Chloride, Cl-(mg/l)	NS	350	NS	8.8	6.4	38.6	74.45	10.64	8	42.54	28.36	35.45	28.36	32.6	48.8	44.8	49.2
Sulphate, SO42-(mg/l)	NS	500	NS	76.4	38.2	19.1	23.5	145.6	130.7	83.2	72.8	82.4	68.7	78.3	85.6	69.5	64.2
Nitrate, NO3-(mg/l)	NS	40	50	1.31	0.98	3.78	4.76	1.27	1.48	2.55	1.98	3.67	2.83	3.51	4.22	3.98	4.39
Phosphate, PO43-(mg/l)	NS	3.5	NS	0.16	0.11	5.78	6.24	0.09	0.1	3.16	2.87	2.95	2.51	2.74	3.44	1.69	1.82
Cyanide (mg/l)	0.005	NS	NS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silica (mg/l)		NS		3.4	2.9	91.6	78.9	132.6	188.5	72.4	66.9	69.8	67.2	68.5	81.2	62.1	65.8
Ammonium (mg/l)	NS	2.0	10	1.8	2.6	<0.10	<0.10	<0.10	<0.10	1.4	1.1	1.2	0.9	0.9	0.3	1	1.2
Urea (mg/l)	NS	NS	NS	0.3	0.4	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Formaldehyde (mg/l)	NS	NS	NS	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Total Nitrogen (mg/l)	NS	NS	10	5.63	4.98	5.94	6.35	2.06	1.75	6.24	5.37	5.88	5.46	5.78	6.23	6.74	7.15
DO (mg/l)	6.8	4		5.2	5.3	5.3	4.8	4.5	4.6	5.4	5.2	5.2	5.5	5.4	5.1	5.4	5.4
BOD (mg/l)	4	6	30	8.6	7.6	12.2	17.4	5.2	4.8	9.2	8.6	8.4	7.8	8	9.8	8.8	9.2
COD (mg/l)	40	30	125	34.2	31.2	42.6	52.6	20.4	16.4	33.8	37.4	34.4	36.8	36.8	39.6	37.6	39
O & G (mg/l)	NS	0.1	10	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00

Parameter	Benchmark Standard			Effluent Sampling Points within Indorama Wastewater Facility											Final Discharge Area	Discharge Channel
	FMEnv Limit (Aquatic Life)	NESREA	IFC (EHS/GIIP)	ISBL Line1	ISBL Line2	CT BD	SSF Pit	DM-1 Npit	DM-2 Npit	Eq Basin - A	Eq Basin-B	HP-A	HP-B	IFZ-HP Dis	IPL-HP	RPGV (Final Discharge)	Discharge Channel
Sodium, Na (mg/l)	NS	120	NS	43.83	27.78	27.22	43.85	62.94	58.27	57.34	44.83	51.79	43.94	49.86	72.47	60.91	65.75
Potassium, K (mg/l)	NA	50	NS	4.12	3.17	9.88	9.13	18.25	15.47	14.92	11.65	12.98	11.89	12.42	19.75	15.98	13.14
Iron, Fe (mg/l)	1	0.5	NS	0.18	0.13	0.21	0.26	0.14	0.09	0.17	0.14	0.15	0.14	0.14	0.19	0.18	0.2
Calcium, Ca (mg/l)	NS	180	NS	2.56	2.23	13.65	15.12	6.94	5.46	13.18	12.35	12.83	12.27	12.45	5.24	9.25	9.52
Magnesium, Mg (mg/l)	NS	40	NS	0.08	0.1	2.86	3.94	0.15	0.19	0.78	0.93	0.73	0.85	0.82	0.47	0.39	0.41
Zinc, Zn (mg/l)	0.03	0.2	NS	0.06	0.05	0.65	0.81	0.04	0.05	0.47	0.39	0.44	0.33	0.37	0.43	0.32	0.35
Copper, Cu (mg/l)	NS	0.01	NS	0.04	0.05	0.09	0.13	0.04	0.03	0.07	0.08	0.06	0.07	0.06	0.09	0.08	0.08
Manganese, Mn (mg/l)	NS	NS	NS	0.03	0.04	0.09	0.08	0.03	0.03	0.06	0.05	0.04	0.05	0.04	0.08	0.07	0.08
Chromium, Cr (mg/l)	0.00002 – 0.002	0.5	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Silver, Ag (mg/l)	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead, Pb (mg/l)	0.0017	0.1	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury, Hg (mg/l)	0.001	0.005	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, Cd (mg/l)	0.0002 – 0.0018	0.01	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel, Ni (mg/l)	0.025 – 0.15	0.1	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, As (mg/l)	NS	0.05	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Note: The Project Applicable Limits were based on project-specific benchmark limits approved by the Federal Ministry of Environment (FMEnv) for Indorama in March 2018 (FMEnv, 2018).

7.4.9.13 FLOOD RISK

Flood risk associated with the Line 2 development has been assessed through two specialist studies: a stormwater drainage design prepared for the proposed fertiliser and petrochemicals complex (Toyo Engineering, 2021) and a hydraulic flood model of the wider Indorama site (JBA Consulting, 2024). Together they establish how surface water will be managed and confirm the level of flood risk under a range of rainfall events.

Surface water management

Surface water across the development is collected by a network of lined open channels and culverts that drain by gravity to a retention pond in the south east of the site. The pond attenuates runoff before releasing it to the existing canal, reducing the risk of flooding both on site and to surrounding land. The drainage network and pond have been sized for intense local rainfall, with an allowance for additional flows such as fire-fighting water. The IFF Line 2 drainage network is designed for a worst-case rainfall intensity of 99 mm per hour (Sections 4.4.12 and 7.4.2.3).

Flood risk findings

A hydraulic computer model was used to test the performance of the drainage system and retention pond across rainfall events up to and including the 1-in-1,000-year storm, for storm durations ranging from 30 minutes to 24 hours. The modelling found that:

- For shorter and less severe rainfall events, the drainage network and retention pond have sufficient capacity to manage runoff without flooding.
- For the largest, longest events, the pond's outflow capacity becomes critical. Operating the single primary outfall, the pond would overtop during a 1-in-200-year (24-hour) event and larger. Bringing the two standby outfall pipes into service provides enough additional capacity to prevent overtopping even in the extreme 1-in-1,000-year event.
- The model indicated some localised surface water ponding in the western part of the site, but this is considered to be overstated, reflecting gaps in the available drainage data rather than a genuine flood risk in that area.
- It should be noted that the hydraulic flood model (JBA Consulting, 2024) assessed the existing 360 ha development and did not directly model the proposed IFF Line 2 complex. Its findings nonetheless remain relevant to Line 2, as they establish the local design rainfall and catchment drainage behaviour and, in particular, demonstrate the performance and outflow capacity required of the retention pond and its discharge to the existing canal, the same approach adopted in the Line 2 drainage design. The model's conclusions on retention pond capacity and the importance of operating the full outfall capacity during extreme events are therefore directly applicable to the management of flood risk from Line 2.
- No floodline delineation currently exists for the Okulu River, and the flood extents associated with the river have therefore not been defined for the Line 2 development. As a result, it cannot presently be confirmed whether the development footprint, its

hazardous installations or the retention pond discharge point fall within, or remain protected above, the river's flood-prone area.

7.4.9.14 SUMMARY

The baseline assessment of surface water, riverine sediments, sediments leachability, and wastewater within the Project footprint indicates that the Okulu River system is a tidally influenced estuarine environment characterised by pronounced spatial and seasonal variability. Surface water quality reflects a transition from freshwater upstream to increasingly saline conditions downstream, driven by tidal mixing and marine intrusion. Key parameters such as electrical conductivity (138–34,687 µS/cm), total dissolved solids (83–23,934 mg/L), and salinity (up to 21.58 ppt) confirm this gradient, while pH remains relatively stable (6.42–7.38), indicating generally neutral conditions.

Nutrient concentrations, including nitrate (1.98–6.18 mg/L), phosphate (0.09–0.65 mg/L), and ammonium (0.40–1.70 mg/L), suggest moderate enrichment, with total nitrogen values of up to 8.69 mg/L indicating ongoing nutrient inputs. Elevated biochemical oxygen demand (8.8–20.8 mg/L) and chemical oxygen demand (26.8–60.6 mg/L), coupled with reduced dissolved oxygen levels (5.0–5.4 mg/L), provide evidence of organic loading within the system. While hydrocarbon contamination is minimal, microbiological indicators, including total and faecal coliform counts ≥2,400 MPN/100 mL, indicate significant faecal contamination, rendering the water unsuitable for domestic use without treatment. Overall, surface water quality is broadly compliant with applicable guidelines but reflects low to moderate ecological risk, with localized stress linked to nutrient enrichment and organic pollution. Collectively, the nutrient enrichment, organic loading and faecal contamination indicate that the receiving environment is already impacted by existing anthropogenic inputs prior to the Project. The nutrient and organic signals consistent with effluent from the existing industrial complex and surrounding land use, and the faecal contamination indicative of domestic/sewage sources within the catchment.

Riverine sediments are predominantly sandy, highly permeable, and consistent with an estuarine depositional environment. Sediment quality generally reflects natural background conditions, with low hydrocarbon contamination and no detectable TPH or PAHs during either season. Nutrient enrichment and elevated organic carbon concentrations indicate ongoing accumulation of organic matter within depositional zones. Cadmium exceeded the CCME Interim Sediment Quality Guideline during the wet season, indicating a potential moderate ecological risk to benthic organisms through toxicity and bioaccumulation mechanisms. Elevated sodium and potassium concentrations further reflect the influence of saline estuarine conditions. However, most metals occurred at relatively low concentrations, and the widespread occurrence of some metals in both sediment and control samples suggests that natural geochemical conditions and broader regional influences may contribute to the observed concentrations rather than a distinct Project-related source. Nevertheless, the presence of elevated metals within sediments may contribute to ecological stress in depositional areas where contaminants can accumulate over time.

The sediment TCLP leachability assessment demonstrates that contaminants retained within sediments exhibit low mobility and limited potential for release to surrounding surface water or groundwater systems. Although iron, manganese, zinc, nickel, and copper were detected in sediment leachates, concentrations were generally low and spatially consistent. Potentially toxic metals of greater environmental concern, including cadmium, chromium, lead, mercury, arsenic, cobalt, and vanadium, were below analytical detection limits in all leachate samples. The assessment therefore indicates that sediments are unlikely to act as a significant secondary source of contamination and currently pose a low risk of contaminant migration to adjacent aquatic environments.

The wastewater treatment facility demonstrates effective treatment performance, producing a final effluent that is generally compliant with the Project Applicable Limits and IFC/WBG EHS Guidelines. Final effluent was characterised by near-neutral pH, moderate dissolved solids concentrations, low suspended solids, and relatively low concentrations of nutrients and organic matter. Hydrocarbons were not detected, while most trace metals remained below analytical detection limits. Although dissolved oxygen, total suspended solids, copper, and zinc exceeded conservative NESREA screening values, the environmental significance of these exceedances is considered low. Dissolved oxygen concentrations exceeded the minimum criterion and are therefore considered environmentally beneficial, whereas TSS, copper, and zinc concentrations remained significantly below the Project-specific and IFC discharge limits. Overall, the results indicate effective treatment performance and suggest that current effluent discharges are unlikely to result in significant adverse impacts on the receiving environment.

Overall, the receiving environment can be classified as moderately impacted, with water and sediment quality influenced by both natural estuarine processes and a combination of existing anthropogenic sources. These include treated effluent discharges from the existing Indorama Complex, which contribute to nutrient and organic loading; extensive in-channel dredging and sand-mining activities, which modify channel morphology and disturb sediments; domestic and sewage inputs from surrounding communities, reflected by elevated faecal coliform concentrations; and diffuse runoff from industrial, commercial, and residential developments within the contributing catchment. Therefore, the observed baseline degradation cannot be attributed solely to the Indorama Complex but instead reflects cumulative pressures from multiple sources operating within the wider catchment. Although these pressures, the aquatic system remains functional and retains natural assimilative and attenuation capacity. Nevertheless, the environment is sensitive, and there remains a clear potential for further degradation should additional pollutant loading not be effectively controlled and managed during future development and operational activities.

7.4.9.15 DEVELOPMENT CONSIDERATIONS

Based on the findings of the surface water baseline study, the following development considerations are noted to inform the subsequent design and impact assessment phases:

- **Proximity to defined watercourses.** The site lies within a low-lying deltaic setting with a network of natural drainage channels feeding the wider Bonny estuary system. Layout planning should respect the position of identified watercourses relative to the proposed IFF Line 2 footprint, with appropriate setbacks maintained.
- **Flood risk assessment.** It is recommended that formal floodline delineation be undertaken for the Okulu River to establish, as a minimum:
    - the 1:100-year flood extent, incorporating an allowance for climate change, as the primary floodline for assessing the development platform, drainage and the retention pond discharge point; and
    - a more extreme flood extent (1:200-year or greater) for siting and protecting hazardous and critical infrastructure. This recommendation protects the company from infrastructure damage and protects from environmental water quality impact due to flood event.
- **Low topographic gradient.** The baseline confirms a flat to very gently sloping terrain typical of the Niger Delta. This limits the natural conveyance of stormwater and increases reliance on engineered drainage to prevent ponding and waterlogging within the developed area.
- **High water table and shallow groundwater–surface water interaction.** The shallow water table observed during baseline characterisation means surface water and groundwater systems are closely connected. Any surface contamination has the potential to influence shallow groundwater, and excavation and foundation design will need to account for shallow saturated conditions.
- **Existing impervious surfaces within the Indorama complex.** The IFF Line 2 footprint sits adjacent to the existing IFF Line 1 plant where impervious cover and engineered drainage are already established. New development will add incrementally to the impervious area, and stormwater infrastructure will need to integrate with the existing complex-wide drainage system.
- **Sheet flow conditions at site boundaries.** Baseline observation of dispersed sheet flow at site margins indicates that post-development discharges should be designed to re-establish sheet flow at the outfall, with energy dissipation where concentrated flows are released to natural ground.
- **Sensitivity of receiving watercourses.** Baseline water quality results identify the receiving system as a sensitive brackish estuarine receptor. Although already heavily modified by sand mining and industrial discharge evidenced by depressed pH at some stations, elevated conductivity and raised heavy metal concentrations, the river continues to sustain artisanal fisheries and informal water-supply use for nearby communities, and it remains hydrologically connected to a downstream Okrika mangrove and Bonny Estuary system. Any future discharges from the IFF Line 2 facility will need to be managed to avoid degradation of the established baseline condition.
- **Wet/dry season variability.** Baseline data reflect strong seasonality in rainfall, runoff volumes, and surface water quality. Drainage and water management infrastructure will

need to be sized for the wet-season peak while remaining functional under dry-season low-flow conditions.

- **Existing baseline water quality signature.** Constituents already present in the receiving environment (including nutrients and parameters associated with the surrounding industrial complex and community discharges) establish the reference condition against which IFF Line 2 operations must be managed. Future monitoring should adopt the same parameter suite and sampling locations to allow direct comparison with the baseline.
- **Limited long-term hydrological records.** The baseline relies on short-duration sampling rather than long-term gauging records. Operational monitoring should extend the temporal coverage of the baseline to strengthen trend detection over the life of the project.

7.4.10 SUMMARY OF KEY PHYSICAL ENVIRONMENTAL SENSITIVITIES

The physical environment baseline indicates that the Project is located within a humid tropical coastal setting characterised by high rainfall, persistently high humidity, warm temperatures and seasonal rainfall variability. These climatic conditions influence runoff generation, recharge, flood behaviour, pollutant dispersion and the broader environmental sensitivity of the receiving environment. In addition, the climate-risk baseline indicates that the principal physical climate hazards applicable to the Project are extreme heat, extreme rainfall flooding, wildfires, and water stress and drought, with extreme heat representing the highest long-term materiality hazard.

Ambient air quality baseline conditions indicate that the receiving airshed is not degraded, with baseline concentrations of the principal pollutants used in the assessment remaining below the adopted air quality standards. Notwithstanding this, the setting remains sensitive because the Project is located within an already active industrial and community environment where cumulative emissions management remains important.

The acoustic baseline indicates that the surrounding environment is generally characterised by moderate baseline noise conditions, with daytime noise levels below the IFC daytime criterion at all monitored locations and one location showing elevated night-time conditions. Sensitive receptors are present within the wider area, and although the Project-related assessment predicts negligible impacts, the receiving environment remains sensitive to changes in industrial and traffic-related noise.

The geological and soil baseline shows that the Project is underlain by sandy coastal plain deposits characteristic of the Niger Delta. These soils are predominantly permeable, weakly cohesive and well drained, which is favourable for infiltration but also makes them susceptible to erosion, leaching and contamination migration if not properly managed. The same sandy geologic framework underpins a hydrogeologically sensitive environment in which shallow groundwater is relatively vulnerable to surface-derived contamination.

Groundwater is a particularly important physical receptor because it supports both industrial abstraction and community water use. The baseline indicates that the hydrogeological system comprises shallow, intermediate and deep aquifer units, with a degree of hydraulic connectivity across the system. Groundwater quality is generally suitable at baseline, but the shallow

aquifer remains sensitive due to its vulnerability to infiltration from the ground surface and the strategic importance of deeper aquifers for water supply.

Surface water is also a key sensitivity because runoff and drainage from the site ultimately discharge to the Okulu River and associated tidally influenced receiving waters. The wider hydrological setting is shaped by low relief, strong seasonal rainfall, tidally influenced channels and existing drainage infrastructure. Surface-water sensitivity is therefore linked not only to water quality, but also to sediment transport, drainage continuity, flood behaviour and the broader condition of the receiving riverine system.

The main physical environmental sensitivities identified for the Project are summarised in Table 7-54.

TABLE 7-54: SUMMARY OF KEY PHYSICAL ENVIRONMENTAL SENSITIVITIES

Receptor / topic	Key sensitivity
Meteorology and climate	Warm, humid tropical coastal climate with high rainfall, high relative humidity and seasonal rainfall variability influencing runoff, recharge and dispersion.
Climate risks	Extreme heat is the most material long-term climate hazard; extreme rainfall flooding is also important, while wildfires and water stress / drought remain relevant but of lower materiality.
Air quality	Baseline airshed is not degraded, but the Project is located within a mixed industrial and community setting where cumulative emissions management remains important.
Noise	Sensitive receptors are present in the wider area and one monitored location showed elevated night-time baseline conditions, indicating some existing acoustic sensitivity.
Geology and soils	Sandy coastal plain deposits and permeable soils create sensitivity to erosion, leaching and contaminant migration under disturbance.
Groundwater	Shallow groundwater is vulnerable to contamination and deeper aquifers are strategically important for industrial and community water supply.
Surface water	Tidally influenced receiving environment linked to the Okulu River, sensitive to runoff quality, sediment transport, drainage disruption and flood behaviour.

7.5 BIOPHYSICAL ENVIRONMENT

7.5.1 INTRODUCTION

This section of the report provides a detailed overview of the ecological baseline established for the proposed IFF Line 2 Fertilizer Project, which is to be developed by Indorama Fertilizer FZE within the Indorama Free Zone, Eleme, Rivers State. The ecological assessment has been rigorously designed and executed in alignment with internationally recognized standards for biodiversity impact evaluations, with a primary focus on the guidelines outlined in IFC PS6. This ensures that the evaluation not only meets regulatory requirements but also reflects best practices in biodiversity conservation and management.

To accurately characterize the biodiversity present in the project area, a multifaceted approach was adopted. Desktop research formed the foundation of the initial assessment, leveraging

resources such as the Integrated Biodiversity Assessment Tool (IBAT), high-resolution aerial imagery, pertinent scientific literature, and comprehensive national aquatic databases. These sources provided critical contextual information and informed the scope of subsequent fieldwork. Building upon this foundation, extensive infield baseline studies were conducted by SRL specialists, who were specifically engaged by IFF for this purpose. These field investigations took place in three distinct phases, October 2025, January 2026, and February 2026, allowing for seasonal variations and ensuring a robust dataset. The fieldwork was complemented by detailed herbarium research, which facilitated the precise identification and verification of plant species encountered during the surveys, thereby enhancing the scientific accuracy of the baseline data.

A diverse array of sampling methods was systematically employed to capture the full spectrum of terrestrial biodiversity within the study area (Figure 1-1). These methodologies were selected to ensure comprehensive coverage and to address the unique ecological characteristics of the site. The study area itself was carefully delineated, encompassing the immediate project footprint as well as an additional 4 km buffer zone. This extended buffer was incorporated to include the wider receiving environment, thereby enabling a holistic evaluation of local biodiversity and potential project impacts.

Data collection was undertaken during the wet and dry season. Characterisations of the vegetation and wildlife species in the Project Area were carried out initially by general surveillance to determine the natural stratification of the plant community. The vegetation distribution, composition, abundance, and diversity were then determined. A summary of the methods used in vegetation and wildlife surveys are as presented in Table 7-55.

TABLE 7-55: SUMMARY OF METHODS USED IN VEGETATION AND WILDLIFE SURVEY

Field Activity	Method used
Plants	Transects and quadrats
Reptiles	Field observations and interviews with the hunters
Birds	Field observations and interviews with the hunters
Mammals	Field observations and interviews with the hunters

Vegetation sampling was undertaken using a systematic transect–quadrat approach. A total of twenty-seven (27) transects, each 100 m long, were established across the study area. Along each transect, four quadrats were positioned at 20 m intervals. Quadrat sizes varied by vegetation stratum: 10 m × 10 m for trees, 5 m × 5 m for shrubs, and 1 m × 1 m for herbs. Plant species were identified in-situ where possible, while unknown specimens were collected and authenticated at the University of Port Harcourt Herbarium. Ethnobotanical information was obtained through interviews with residents.

Faunal surveys employed a combination of direct observations, indirect evidence (tracks, calls, droppings, nests), opportunistic encounters, and structured interviews with hunters, farmers, and forest product collectors. Avifaunal surveys were conducted during peak activity periods, amphibians were sampled acoustically and through larval evidence, and insects were sampled

using both active and passive methods. Data analysis relied on descriptive statistics, relative abundance indices, spatial interpretation using satellite imagery, and photographic documentation.

This ecological assessment examined the vegetation structure, biodiversity composition, and ecosystem services within the study area and its surrounding environments. The results show that the landscape is predominantly composed of modified ecosystems, including bush fallow vegetation, residential or homestead vegetation, farmlands, riparian forests, mangrove swamps, freshwater swamp forests, and open grassland areas. These habitats support a diverse assemblage of plant and animal species, reflecting the ecological heterogeneity of the area, although human activities have significantly influenced vegetation composition and ecosystem structure.

7.5.2 HABITATS OF THE PROJECT AREA OF INFLUENCE

The study area comprised mainly of modified ecosystems predominated by bush fallow and residential/homestead vegetation, farmlands, and patches of secondary forests including seasonal floodplains. Other vegetation types in study areas include riverine (riparian/mangrove) forests. The vegetation types are stratified into three distinct canopy layers. The topmost canopy is formed by tree species such as oil palm (*Elaeis guineensis*), *Mandifera indica*, *Pterocarpus sp*., *Anthocleista spp*., *Rhizophora spp*., and *Cleistopholis patens*. The second (middle) canopy consists mainly of shrubs including *Baphia nitida*, *Alchornea cordifolia*, and *Nypa fruticans*, while the herbaceous species form the lowest canopy.

7.5.2.1 BUSH FALLOW

Bush fallows (Figure 7-28) in the study area are generally shrubby in nature and consist of young regenerating trees, a wide variety of weeds and forbs, as well as remnants of previously harvested crops. The bush fallows observed in the study area originated from farmlands that had been harvested one or more years prior to the survey. They are typically found outside the perimeter fences of the facility, farmlands and along the fringes of secondary forests.

The species composition of these fallow lands is characterised by a mixture of re-growing cultivated crops such as plantain and banana (*Musa spp*.), cassava (*Manihot esculenta*), and cocoyam (*Xanthosoma spp*. and *Colocasia spp*.), alongside numerous other plant species at varying stages of ecological succession. Dominant shrub and herbaceous species associated with the fallow lands include *Harungana madagascariensis*, *Elaeis guineensis*, *Anthonatha macrophylla*, *Spondias monbin*, *Baphia nitida*, *Alchornea cordifolia*, *Ficus exasperata*, *Chromolaena odorata*, *Aspilia africana*, *Mimosa pudica*, *Senna sp*., *Amaranthus sp*., *Ageratum conyzoides*, *Synedrella sp*., *Costus afer*, *Anthocleista vogelii*, *Psidium guajava*, *Amorphophallus sp*., *Funtumia sp*., and *Calopogonium sp*.

Herbs, grasses, and sedges form the dominant life forms within the bush fallows. These include species belonging to the families Asteraceae (e.g. *Ageratum conyzoides*, *Synedrella sp*., *Emilia spp*.), Poaceae (e.g. *Panicum maximum*, *Panicum laxum*, *Axonopus compressus*, *Paspalum sp*., and *Digitaria horizontalis*), Cyperaceae (e.g. *Kyllinga spp*., *Cyperus spp*., and *Mariscus spp*.), and Commelinaceae (e.g. *Commelina spp*. *and Aneilema spp*.).



FIGURE 7-28: BUSH FALLOW

7.5.2.2 HOMESTEAD/RESIDENTIAL/BUILT-UP AREA

Homestead vegetation (Figure 7-29) within the study area is characterised by cultivated crops such as plantain, banana (*Musa spp*.) and cassava (*Manihot esculenta*), as well as economically important trees including oil palm (*Elaeis guineensis*), pawpaw (*Carica papaya*), african pear (*Dacryodes edulis*), and soursop (*Annona muricata*), Avocardo pear (*Persea americana*)*, Fluted pumpkin* (*Telfairia occidentalis*).

Within the residential areas, other dominant plant species recorded include *Chromolaena odorata*, *Combretum bracteatum*, *Newbouldia laevis*, *Tridax procumbens*, *Aspilia africana*, *Asystasia gangetica*, *Alchornea cordifolia*, *Anthocleista vogelii*, *Gmelina arborea*, *Mangifera indica*, *Maniphyton fulvum*, *Bambusa vulgaris*, *Albizia zygia, Talinum triangulare*, *Mangifera indica*, *Vernonia sp*., *Ocimum gratissimum*, *Luffa cylindrica*, and *Xanthosoma sp*. Grasses and sedges commonly observed include *Panicum maximum*, *Cyperus spp*., *Fimbristylis spp*., and *Kyllinga spp*.



FIGURE 7-29: HOMESTEAD/RESIDENTIAL VEGETATION/ BUILD-UP AREA

7.5.2.3 FARMLANDS

These areas are primarily cultivated farmlands (Figure 7-30) dominated by crop species such as cassava (*Manihot esculenta*), yams (*Dioscorea spp*.), fluted pumpkin (*Telfairia occidentalis*), pawpaw (*Carica papaya*), and plantain and banana (*Musa spp*.). Other plant species commonly found in these farms include oil palm (*Elaeis guineensis*; Figure 7-31), *Emilia spp*., *Euphorbia hirta*, *Tridax procumbens*, *Indigofera spicata*, *Momordica charantia*, *Oldenlandia corymbosa*, *Desmodium sp*., *Passiflora foetida*, *Lindernia sp*., *Eclipta alba*, *Ipomoea triloba*, *Phyllanthus amarus*, *Euphorbia hyssopifolia*, *Commelina spp*., *Ageratum conyzoides*, *Axonopus compressus*, *Fimbristylis spp*., *Paspalum scrobiculatum*, *Sporobolus pyramidalis*, *Kyllinga spp*., *Echinochloa sp*., *Bolbostylis sp*., *Cyperus iria*, *Cyperus spp*., *Andropogon sp*., *Mariscus alternifolius*, *Alchornea cordifolia*, *Alchornea laxiflora*, *Macaranga sp*., and *Ficus sp*. These species occur across farmlands, wetlands, and built-up areas, reflecting both cultivated and opportunistic plant communities.



FIGURE 7-30: CASSAVA FARM



FIGURE 7-31: OIL PALM PLANTATION AT IMO RIVER, ACROSS OKULU RIVER AND AGBONCHIA

7.5.2.4 RIVERINE VEGETATION

The riverine vegetation type occurs along the brackish water bodies of the upper Bonny Estuary (Akpajo/Aboloma) and the Okulu River. It can be classified into mangrove and freshwater swamp forests and is composed mainly of hydromorphic and lowland plant species.

7.5.2.5 MANGROVE SWAMP VEGETATION

This area comprises patches of secondary and modified mangrove ecosystems (Figure 7-32). The vegetation is made up of rainforest and mangrove species. Mangrove vegetation was recorded in Woji, Okrika, Abuloma, and Azubie areas, as well as in parts of Aleto and Akpajo. This vegetation type is composed mainly of members of the Rhizophoraceae, including *Rhizophora racemosa*, *R. harrisonii*, and *R. mangle*; Avicenniaceae (*Avicennia africana*); and Combretaceae (*Laguncularia racemosa* and *Conocarpus erectus*). Other characteristic species include *Nypa fruticans*, *Acrostichum sp*., *Dalbergia sp*., and *Pongamia sp*., alongside associated freshwater or upland species such as *Ficus sp*., *Terminalia catappa*, *Lagenaria breviflora*, *Sida acuta*, *Solanum torvum*, *Paspalum conjugatum*, *Triumfetta cordifolia*, *Cyperus spp*., *Cyanthula prostrata*, *Cyperus spp*., *Harungana madagascariensis*, and *Macaranga sp*.



FIGURE 7-32: MANGROVE VEGETATION (A) RHIZOPHORA SPECIES AND *NYPA FRUTICANS* AND (B) *NYPA FRUTICANS*

7.5.2.6 FRESH WATER SWAMP FOREST

This vegetation type occurs along the Okulu River at the Aleto and Agbonchia sections. The plant species recorded in this vegetation type include trees such as *Raphia sp*., *Elaeis guineensis*, *Pterocarpus spp*., *Spondias mombin*, *Ficus racemosa*, and *Ficus exasperata*; shrubs and small trees including *Alchornea cordifolia*, *Baphia nitida*, *Rauvolfia vomitoria*; climbers and creepers such as *Calamus sp*., *Dioscorea bulbifera*, *Cissus gracilis*, and *Zehneria scabra*; herbs and grasses including *Selaginella myosurus*, *Sacciolepis africana*, *Acanthus sp*., and *Thaumatococcus daniellii*, *Ipomoea aquatica*, *Chromolaena odorata*, *Ludwigia spp*., *Eclipta alba*, *Acroceras zizanioides*, *Kyllinga sp*., and *Cyperus spp*.; and ferns such as *Pteridium aquilinum*.

7.5.2.7 AQUATIC MACROPHYTE

In the wet season, aggregations of aquatic macrophytes along waterways provide habitats and breeding sites for various aquatic organisms. Within the study area, only a few aquatic macrophytes—*Sacciolepis africana*, *Ipomoea aquatica*, and *Ipomoea pes-caprae*—were observed, occurring in patches mainly along some sections of the Okulu River at Agbonchia (Figure 7-33), behind the NNPC Residential Estate and within the Azuabie Creek and also the Imo river (Figure 7-34). *Sacciolepis africana* formed mats along the banks of the Okulu River, while *Ipomoea pes-caprae* occurred in small patches along the margins of the Azuabie Creek.

These species were recorded primarily in areas that were either un-dredged or in recovery stages following dredging activities.



FIGURE 7-33: AGGREGATION OF AQUATIC MACROPHYTES AT OKULU RIVER (AGBONCHIA AREA)



FIGURE 7-34: AGGREGATION OF AQUATIC MACROPHYTES AT IMO RIVER

7.5.2.8 RIPARIAN/SECONDARY FORESTS

This vegetation type, observed at Agbonchia (along Okulu river) and the opposite NNPC Refinery, represents fringe or relics of relatively undisturbed forest (Figure 7-35). It is dominated by *Raphia* species and a few tall *Rhizophora* species. Other associated plant species include trees and palms such as *Elaeis guineensis*, *Anthocleista vogelii*, *Napoleonaea sp*.,

Macaranga heterophylla, *Funtumia sp*., *Musanga sp*., *Cleistopholis patens*, *Combretum racemosum*, and *Albizia sp*.; shrubs and climbers such as *Alchornea cordifolia*, *Chromolaena odorata*, and *Smilax anceps*; herbs and forbs including *Ipomoea spp*., *Icacina mannii*, *Urena lobata*, *Emilia spp*., and *Phyllanthus amarus*; and ferns such as *Pteridium aquilinum*. *Ficus exasperata* occurs as an emergent tree within this vegetation type.



FIGURE 7-35: RELICS OF (A) SECONDARY FOREST AND (B) RIPARIAN FOREST

7.5.2.9 GREEN VEGETATED AREAS WITHIN INDORAMA COMPLEX

This section of the Indorama complex is predominantly covered by a diverse assemblage of trees and shrubs (Figure 7-36). Within the green vegetated area, a total of twenty-two (22) tree and shrub species were recorded, representing 21 genera and 14 families. *Mangifera indica* and *Azadirachta indica* were the most abundant species, followed by *Ixora coccinea*, *Acacia auriculiformis*, *Chrysalidocarpus lutescens*, and *Khaya senegalensis*. The exotic species dominate the landscape, comprising over 50% of the trees and shrubs, compared to the indigenous species.



FIGURE 7-36: OVERVIEW OF GREEN VEGETATED AREAS WITHIN THE COMPLEX

7.5.2.10 VEGETATION WITHIN THE PERIMETER FENCE & OPEN AREAS WITHIN PROPOSED PROJECT SITE

The open grassland areas (Figure 7-37) are dominated by grass, sedges, and herbaceous species. Common grasses recorded include *Megathyrsus maximus*, *Panicum laxum*, *Axonopus compressus*, *Paspalum conjugatum*, and *Cynodon dactylon*, while sedges such as *Cyperus rotundus*, *Kyllinga erecta*, and *Mariscus alternifolius* were also present. Herbaceous and forb species observed include *Chromolaena odorata*, *Ipomoea aquatica*, *Tridax procumbens*, *Ageratum houstonianum*, *Desmodium triflorum*, and *Phyllanthus amarus*. Ferns and aquatic herbs such as *Nephrolepis cordifolia* and *Hymenocallis littoralis* were occasional but contributed to the structural diversity of the grassland. These species reflect a mixture of native and opportunistic plants.



FIGURE 7-37: VEGETATION WITHIN THE PERIMETER FENCE AND OPEN AREAS OF THE PROPOSED SITE

7.5.3 TERRESTRIAL BIODIVERSITY

7.5.3.1 TERRESTRIAL FLORA

Tree Community

The tree species identified during the wet season in the study comprised 94 species (Table 7-56). The Fabaceae family (legumes) was the most dominant, represented by species such as *Acacia auriculiformis*, *Albizia zygia*, *Leucaena leucocephala*, *Pterocarpus soyauxii*, and *Dalbergia latifolia*. Other notable families included Arecaceae (palms), Moraceae (figs and jackfruit), Apocynaceae (rubber trees), and Euphorbiaceae (sandbox tree and related species). Most species were classified as Least Concern (LC), indicating they are not currently threatened. However, some species exhibited conservation concern: *Khaya senegalensis*,

Terminalia ivorensis, and *Triplochiton scleroxylon* were Vulnerable (VU), while *Cycas circinalis* and *Pterocarpus soyauxii* were Endangered (EN). Several species, including *Bougainvillea pachyphylla*, *Dalbergia latifolia*, and *Funtumia africana*, have Not Evaluated (NE) status, highlighting gaps in conservation assessment. Many of these species are planted within the Indorama facility as part of their green vegetation program.

During the dry season, 67 tree species were recorded, showing distinct patterns of family dominance. The most abundant family was Arecaceae (palms) with 9 species, accounting for approximately 13.4% of the total. This was followed by Moraceae (fig family) with 8 species (11.9%) and Fabaceae (legume family) with 6 species (9.0%). Anacardiaceae and Combretaceae each contributed 4 species (6.0%), while Meliaceae included 3 species (4.5%). Several other families, such as Apocynaceae, Annonaceae, Acanthaceae, Myrtaceae, Lamiaceae, and Malvaceae, were represented by 1–2 species each (1.5–3%). Most species were classified as Least Concern (LC), though *Khaya senegalensis*, *Terminalia ivorensis*, and *Triplochiton scleroxylon* were Vulnerable (VU), and *Cycas circinalis* and *Pterocarpus soyauxii* were Endangered (EN). Overall, the tree composition reflects a diverse mixture of native, exotic, and cultivated species, with palms, figs, and legumes dominating the relative abundance among families.

TABLE 7-56: TREE SPECIES IN THE STUDY AREA (WET AND DRY SEASONS)

Scientific Name	Family	Common Name	IUCN Status
Acacia auriculiformis	Fabaceae	Earleaf acacia	LC
Adonidia merrillii	Arecaceae	Christmas palm	LC
Albizia zygia	Fabaceae	West African albizia	LC
Alstonia boonei	Apocynaceae	Stool wood	LC
Anacardium occidentale	Anacardiaceae	Cashew	LC
Annona muricata	Annonaceae	Soursop	LC
Anthocleista vogelii	Gentianaceae	Cabbage tree	LC
Artocarpus heterophyllus	Moraceae	Jackfruit	LC
Artocarpus altilis	Moraceae	Breadfruit	LC
Avicennia africana	Acanthaceae	Black mangrove	LC
Azadirachta indica	Meliaceae	Neem	LC
Barteria nigritana	Passifloraceae	Barteria tree	LC
Bridelia ferruginea	Phyllanthaceae	Bridelia	LC
Bridelia micrantha	Phyllanthaceae	Coast goldleaf	LC
Caryota mitis	Arecaceae	Fishtail palm	LC
Chrysophyllum albidum	Sapotaceae	African star apple	LC
Citrus sinensis	Rutaceae	Sweet orange	LC
Cleistopholis patens	Annonaceae	Salt-and-oil tree	LC
Cocos nucifera	Arecaceae	Coconut	LC
Conocarpus erectus	Combretaceae	Buttonwood	LC
Cycas circinalis	Cycadaceae	Queen sago	EN
Dacryodes edulis	Burseraceae	African pear	LC
Delonix regia	Fabaceae	Royal poinciana	LC
Dypsis lutescens	Arecaceae	Areca palm	LC
Elaeis guineensis	Arecaceae	Oil palm	LC
Eucalyptus globulus	Myrtaceae	Blue gum	LC

Euphorbia kamerunica	Euphorbiaceae	Candelabra tree	LC
Ficus benjamina	Moraceae	Weeping fig	LC
Ficus elastica	Moraceae	Rubber fig	LC
Ficus exasperata	Moraceae	Sandpaper tree	LC
Ficus microcarpa	Moraceae	Chinese banyan	LC
Ficus religiosa	Moraceae	Sacred fig	LC
Ficus sur	Moraceae	Cape fig	LC
Gmelina arborea	Lamiaceae	Gmelina	LC
Harungana madagascariensis	Hypericaceae	Dragon's blood tree	LC
Hura crepitans	Euphorbiaceae	Sandbox tree	LC
Irvingia gabonensis	Irvingiaceae	Bush mango	LC
Khaya senegalensis	Meliaceae	African mahogany	VU
Lagerstroemia speciosa	Lythraceae	Queen of flowers	LC
Leucaena leucocephala	Fabaceae	Lead tree	LC
Mangifera indica	Anacardiaceae	Mango	LC
Musanga cecropioides	Urticaceae	Umbrella tree	LC
Newbouldia laevis	Bignoniaceae	Boundary tree	LC
Nypa fruticans	Arecaceae	Nipa palm	LC
Persea americana	Lauraceae	Avocado	LC
Pinus caribaea	Pinaceae	Caribbean pine	LC
Polyalthia longifolia	Annonaceae	Masquerade tree	LC
Pongamia pinnata	Fabaceae	Indian beech	LC
Psidium guajava	Myrtaceae	Guava	LC
Pterocarpus soyauxii	Fabaceae	African padauk	EN
Raphia hookeri	Arecaceae	Raffia palm	LC
Rhizophora harrisonii	Rhizophoraceae	Red mangrove	LC
Rhizophora mangle	Rhizophoraceae	Red mangrove	LC
Rhizophora racemosa	Rhizophoraceae	Red mangrove	LC
Roystonea regia	Arecaceae	Royal palm	LC
Spondias dulcis	Anacardiaceae	Golden apple	LC
Spondias mombin	Anacardiaceae	Hog plum	LC
Syzygium guineense	Myrtaceae	Water pear	LC
Tectona grandis	Lamiaceae	Teak	LC
Terminalia catappa	Combretaceae	Tropical almond	LC
Terminalia ivorensis	Combretaceae	Black afara	VU
Terminalia mantaly	Combretaceae	Madagascar almond	LC
Thuja occidentalis	Cupressaceae	Arborvitae	LC
Trema orientalis	Cannabaceae	Charcoal tree	LC
Trichilia monadelpha	Meliaceae	Trichilia	LC
Triplochiton scleroxylon	Malvaceae	Obeche	VU
Wodyetia bifurcata	Arecaceae	Foxtail palm	LC

Shrubs

The shrubby species documented comprises 25 species distributed across 14 families, reflecting a moderately diverse shrub and ornamental tree community (Table 7-57). The species list includes a mixture of ornamental, indigenous, and naturalized taxa, commonly associated with landscaped, peri-urban, or semi-managed environments. The Apocynaceae and Euphorbiaceae families are the most represented, each contributing five species (20%

each) to the total shrubs. Apocynaceae species such as *Allamanda cathartica*, *Holarrhena floribunda*, *Rauvolfia vomitoria*, and *Tabernaemontana* spp. are well known for their ornamental, medicinal, and ecological importance, particularly in tropical Africa. Euphorbiaceae members, including *Acalypha wilkesiana*, *Alchornea cordifolia*, and *Macaranga* spp., are typical of disturbed or secondary habitats and often play significant roles in vegetation regeneration and ground cover stabilization. Assessment of the IUCN conservation categories of the shrubs shows that it is overwhelmingly composed of species classified as Least Concern (LC). Specifically, 21 out of 25 species (84%) fall under the LC category, suggesting that the majority of the species are not currently facing significant global extinction risks.

TABLE 7-57: CHECKLIST OF SHRUBS

Scientific name	Family	Common name	IUCN status
Acalypha wilkesiana	Euphorbiaceae	Copperleaf	LC
Alchornea cordifolia	Euphorbiaceae	Christmas bush	LC
Allamanda cathartica	Apocynaceae	Golden trumpet	LC
Bougainvillea pachyphylla	Nyctaginaceae	Bougainvillea	NE
Byrsocarpus coccineus	Connaraceae	Crimson combretum	LC
Calliandra surinamensis	Fabaceae	Pink powderpuff	LC
Dracaena afromontana	Asparagaceae	Dragon tree	NE
Dracaena fragrans	Asparagaceae	Corn plant	LC
Funtumia africana	Apocynaceae	Silk rubber tree	NE
Heptapleurum arboricola	Araliaceae	Dwarf umbrella tree	LC
Hibiscus rosa-sinensis	Malvaceae	China rose	LC
Holarrhena floribunda	Apocynaceae	False rubber tree	LC
Ixora coccinea	Rubiaceae	Jungle flame	LC
Jatropha integerrima	Euphorbiaceae	Peregrina	LC
Macaranga barteri	Euphorbiaceae	Macaranga	LC
Macaranga heterophylla	Euphorbiaceae	Macaranga	LC
Morinda citrifolia	Rubiaceae	Noni	LC
Murraya paniculata	Rutaceae	Orange jasmine	LC
Mussaenda philippica	Rubiaceae	Flag bush	LC
Napoleonaea imperialis	Lecythidaceae	Napoleon’s hat	LC
Plumbago auriculata	Plumbaginaceae	Cape leadwort	LC
Rauvolfia vomitoria	Apocynaceae	Serpent wood	LC
Tabernaemontana divaricata	Apocynaceae	Crape jasmine	LC
Tabernaemontana elegans	Apocynaceae	Toad tree	LC
Tecoma stans	Bignoniaceae	Yellow bells	LC

Herbs, Grasses, and Sedges

Table 7-58 shows a diverse community of herbs, grasses, sedges, climbers, and ferns, dominated by species characteristic of disturbed habitats, fallow lands, farmlands, and secondary vegetation in the humid tropics. A total of 78 plant species belonging to 27 families were identified in the study area. Poaceae (grasses) was the most abundant family, with 11

species (14.1%), reflecting strong adaptation to open and disturbed environments. This was followed by Asteraceae and Fabaceae, each contributing 10 species (12.8%), highlighting the prominence of composite weeds and legumes. Cyperaceae was also well represented with 8 species (10.3%), indicating the presence of moist or seasonally waterlogged microhabitats. Together, these four families accounted for about 50% of all species, underscoring their ecological importance in structuring the vegetation. The remaining families—including Euphorbiaceae, Amaranthaceae, Commelinaceae, Malvaceae, Rubiaceae, Convolvulaceae, and others—were represented by one to four species each, individually contributing less than 6% of the total composition.

Most species are classified as Least Concern (LC), with a few Not Evaluated (NE) taxa. This pattern is typical of widespread tropical weeds and ruderal species, suggesting low immediate conservation risk while highlighting their role in soil cover, nutrient cycling, and early successional recovery. Seasonal patterns show that perennial herbs and grasses dominate the herbaceous community. In the wet season (Table 7-58), 78 species were recorded, including dominant Poaceae grasses (*Panicum laxum, Cynodon dactylon, Megathyrsus maximus*) and Cyperaceae sedges (*Cyperus rotundus, Fimbristylis* spp.), alongside fast-growing annuals (*Ageratum houstonianum, Emilia sonchifolia*) and persistent perennials (*Aspilia africana, Ipomoea aquatica*). In the dry season (Table 7-59), 50 species were documented, reflecting seasonal declines in annual herbs dependent on soil moisture. Grasses and sedges remained relatively stable, indicating resilience, while many core perennials persisted across seasons, with some wet-season annuals absent, illustrating seasonal turnover in the herbaceous species.

TABLE 7-58: CHECKLIST OF HERBS, GRASSES, AND SEDGES (WET SEASON)

Scientific name	Family	Common name	Life cycle	IUCN status
Abrus precatorius	Fabaceae	Rosary pea	Perennial	LC
Acrostichum sp.	Pteridaceae	Mangrove fern	Perennial	NE
Ageratum houstonianum	Asteraceae	Floss flower	Annual	LC
Alternanthera sessilis	Amaranthaceae	Sessile joyweed	Perennial	LC
Aneilema sp.	Commelinaceae	Aneilema	Perennial	NE
Aspilia africana	Asteraceae	Haemorrhage plant	Perennial	LC
Avena madagascariensis	Poaceae	Oat grass	Annual	LC
Axonopus compressus	Poaceae	Carpet grass	Perennial	LC
Bulbostylis barbata	Cyperaceae	Hairy sedge	Annual	LC
Callisia fragrans	Commelinaceae	Basket plant	Perennial	LC
Centrosema pubescens	Fabaceae	Centro	Perennial	LC
Chromolaena odorata	Asteraceae	Siam weed	Perennial	LC
Chrysopogon aciculatus	Poaceae	Love grass	Perennial	LC
Cleome ciliata	Cleomaceae	Spider flower	Annual	LC
Cleome rotundisperma	Cleomaceae	Spider flower	Annual	LC
Cleome viscosa	Cleomaceae	Tickweed	Annual	LC
Commelina diffusa	Commelinaceae	Spreading dayflower	Perennial	LC
Coreopsis lanceolata	Asteraceae	Tickseed	Perennial	LC

Cyathula prostrata	Amaranthaceae	Pasture weed	Perennial	LC
Cynodon dactylon	Poaceae	Bermuda grass	Perennial	LC
Cyperus esculentus	Cyperaceae	Tiger nut sedge	Perennial	LC
Cyperus rotundus	Cyperaceae	Purple nut sedge	Perennial	LC
Desmodium scorpiurus	Fabaceae	Scorpion tail	Annual	LC
Desmodium triflorum	Fabaceae	Tick clover	Perennial	LC
Digitaria horizontalis	Poaceae	Crab grass	Annual	LC
Diodia sarmentosa	Rubiaceae	False buttonweed	Perennial	LC
Eclipta prostrata	Asteraceae	False daisy	Annual	LC
Eleutheranthera ruderalis	Asteraceae	Eleutheranthera	Annual	LC
Emilia sonchifolia	Asteraceae	Lilac tasselflower	Annual	LC
Euphorbia heterophylla	Euphorbiaceae	Mexican fireplant	Annual	LC
Euphorbia hirta	Euphorbiaceae	Asthma weed	Annual	LC
Euphorbia hyssopifolia	Euphorbiaceae	Eyebane	Annual	LC
Euphorbia thymifolia	Euphorbiaceae	Thyme-leaf spurge	Annual	LC
Fimbristylis dichotoma	Cyperaceae	Fimbry sedge	Annual	LC
Fimbristylis ferruginea	Cyperaceae	Fimbry sedge	Perennial	LC
Fimbristylis littoralis	Cyperaceae	Fimbry sedge	Annual	LC
Gomphrena celosioides	Amaranthaceae	Soft khaki weed	Annual	LC
Hymenocallis littoralis	Amaryllidaceae	Spider lily	Perennial	LC
Indigofera spicata	Fabaceae	Creeping indigo	Perennial	LC
Ipomoea aquatica	Convolvulaceae	Water spinach	Perennial	LC
Ipomoea involucrata	Convolvulaceae	Morning glory	Annual	LC
Ipomoea triloba	Convolvulaceae	Morning glory	Annual	LC
Kyllinga erecta	Cyperaceae	Kyllinga sedge	Perennial	LC
Lindernia crustacea	Linderniaceae	Lindernia	Annual	LC
Ludwigia hyssopifolia	Onagraceae	Water primrose	Annual	LC
Luffa cylindrica	Cucurbitaceae	Sponge gourd	Annual	LC
Malvastrum coromandelianum	Malvaceae	False mallow	Perennial	LC
Mariscus alternifolius	Cyperaceae	Umbrella sedge	Perennial	LC
Megathyrsus maximus	Poaceae	Guinea grass	Perennial	LC
Melochia corchorifolia	Malvaceae	Chocolate weed	Annual	LC
Mimosa invisa	Fabaceae	Giant sensitive plant	Annual	LC
Mimosa pudica	Fabaceae	Sensitive plant	Perennial	LC
Nelsonia canescens	Acanthaceae	Nelsonia	Perennial	LC
Nephrolepis cordifolia	Nephrolepidaceae	Sword fern	Perennial	LC
Ocimum gratissimum	Lamiaceae	Scent leaf	Perennial	LC
Oldenlandia corymbosa	Rubiaceae	Diamond flower	Annual	LC
Panicum laxum	Poaceae	Panicum grass	Annual	LC
Passiflora foetida	Passifloraceae	Stinking passionflower	Perennial	LC
Paspalum conjugatum	Poaceae	Sour grass	Perennial	LC
Pennisetum polystachion	Poaceae	Mission grass	Annual	LC

Phyllanthus amarus	Phyllanthaceae	Stonebreaker	Annual	LC
Phyllanthus niruri	Phyllanthaceae	Stonebreaker	Annual	LC
Piper guineense	Piperaceae	West African pepper	Perennial	LC
Portulaca oleracea	Portulacaceae	Purslane	Annual	LC
Pteridium aquilinum	Dennstaedtiaceae	Bracken fern	Perennial	LC
Pueraria phaseoloides	Fabaceae	Tropical kudzu	Perennial	LC
Sacciolepis africana	Poaceae	Cupscale grass	Perennial	LC
Schwenckia americana	Solanaceae	Chaffweed	Annual	LC
Senna alata	Fabaceae	Wild senna	Perennial	NE
Sida acuta	Malvaceae	Wire weed	Perennial	LC
Spermacoce ocymoides	Rubiaceae	Buttonweed	Annual	LC
Sphagneticola trilobata	Asteraceae	Singapore daisy	Perennial	LC
Sporobolus pyramidalis	Poaceae	Dropseed grass	Perennial	LC
Talinum triangulare	Talinaceae	Waterleaf	Perennial	LC
Tridax procumbens	Asteraceae	Coat buttons	Perennial	LC
Vernonia cinerea	Asteraceae	Purple fleabane	Annual	LC
Vigna spp.	Fabaceae	Wild cowpea	Annual	NE
Xanthosoma sagittifolium	Araceae	Cocoyam	Perennial	LC

TABLE 7-59: CHECKLIST OF HERBS, GRASSES, AND SEDGES (DRY SEASON)

Species Name	Family	Common Name	Life Span	IUCN Status
Pueraria phaseoloides	Fabaceae	Tropical kudzu	Perennial	NE
Centrosema pubescens	Fabaceae	Centro	Perennial	NE
Desmodium sp.	Fabaceae	Beggarweed	Perennial	NE
Vigna unguiculata	Fabaceae	Cowpea	Annual	NE
Ipomoea involucrata	Convolvulaceae	Morning glory	Annual/Perennial	NE
Panicum maximum	Poaceae	Guinea grass	Perennial	NE
Triumfetta cordifolia	Malvaceae	Burr bush	Perennial	NE
Sida acuta	Malvaceae	Wireweed	Perennial	NE
Euphorbia hyssopifolia	Euphorbiaceae	Hyssop spurge	Annual	NE
Mimosa invisa	Fabaceae	Giant sensitive plant	Perennial	NE
Sacciolepis africana	Poaceae	African cupscale grass	Perennial	NE
Eleusine indica	Poaceae	Goose grass	Annual/Perennial	NE
Eclipta alba	Asteraceae	False daisy	Annual	NE
Physalis sp.	Solanaceae	Ground cherry	Annual	NE
Amaranthus sp.	Amaranthaceae	Amaranth	Annual	NE
Eleutheranthera ruderalis	Asteraceae	Cinderella weed	Annual	NE
Ageratum conyzoides	Asteraceae	Goat weed	Annual	NE
Elaeis guineensis	Arecaceae	Oil palm	Perennial	NE
Vernonia cinerea	Asteraceae	Little ironweed	Annual	NE
Ludwigia sp.	Onagraceae	Water primrose	Annual	NE
Chromolaena odorata	Asteraceae	Siam weed	Perennial	NE
Emilia sonchifolia	Asteraceae	Lilac tasselflower	Annual	NE
Phyllanthus amarus	Phyllanthaceae	Stonebreaker	Annual	NE
Brachiaria sp.	Poaceae	Signal grass	Perennial	NE

Setaria sp.	Poaceae	Foxtail grass	Annual/Perennial	NE
Lagenaria breviflora	Cucurbitaceae	Wild bottle gourd	Annual	NE
Cyperus brevifolius	Cyperaceae	Shortleaf flatsedge	Perennial	NE
Urena lobata	Malvaceae	Caesar weed	Perennial	NE
Cynodon dactylon	Poaceae	Bermuda grass	Perennial	LC
Sporobolus sp.	Poaceae	Dropseed grass	Perennial	NE
Aeschynomene sp.	Fabaceae	Jointvetch	Annual/Perennial	NE
Alternanthera sessilis	Amaranthaceae	Sessile joyweed	Perennial	NE
Commelina diffusa	Commelinaceae	Spreading dayflower	Perennial	NE
Cleome sp.	Cleomaceae	Spider flower	Annual	NE
Aspilia africana	Asteraceae	Hemorrhage plant	Perennial	NE
Talinum triangulare	Talinaceae	Waterleaf	Perennial	NE
Panicum laxum	Poaceae	Lax panic grass	Perennial	NE
Musa sp.	Musaceae	Banana/Plantain	Perennial	NE
Axonopus compressus	Poaceae	Carpet grass	Perennial	NE
Hibiscus sabdariffa	Malvaceae	Roselle	Annual/Perennial	NE
Gomphrena sp.	Amaranthaceae	Globe amaranth	Annual	NE
Asystasia gangetica	Acanthaceae	Chinese violet	Perennial	NE
Oldenlandia corymbosa	Rubiaceae	Diamond flower	Annual	NE
Cyperus iria	Cyperaceae	Rice flatsedge	Annual	NE
Chrysopogon aciculatus	Poaceae	Golden beard grass	Perennial	NE
Alopecurus sp.	Poaceae	Foxtail grass	Annual/Perennial	NE
Bidens pilosa	Asteraceae	Blackjack	Annual	NE
Ipomoea aquatica	Convolvulaceae	Water spinach	Annual	NE
Tridax procumbens	Asteraceae	Coat buttons	Perennial	NE
Cyperus rotundus	Cyperaceae	Purple nutsedge	Perennial	LC

Relative Abundance of Herbs, Grasses, and Sedges

The relative abundance of herbs, grasses, and sedges in the wet season showed that herbs were the predominant group, representing 62.32% of the species, followed by grasses (20.29%) and sedges (17.39%; Figure 7-38). Among the families in this group, Poaceae is the most abundant at 14.29%, followed by Asteraceae and Fabaceae (12.99% each), Cyperaceae (10.39%), Amaranthaceae, Cleomaceae, Commelinaceae, Convolvulaceae, Euphorbiaceae, Malvaceae, Rubiaceae (3.90% each), Phyllanthaceae (2.60%), and others at 1.30% each. In the dry season, the herbaceous component remains dominant, with herbs comprising 62.5%, grasses 27.5%, and sedges 10% of the species (Figure 7-38). This pattern reflects the resilience of perennial and fast-growing non-woody plants in disturbed or secondary habitats. Grasses, largely from Poaceae, contribute significantly to turf and ground cover, while sedges occupy wetter or marginal microsites.

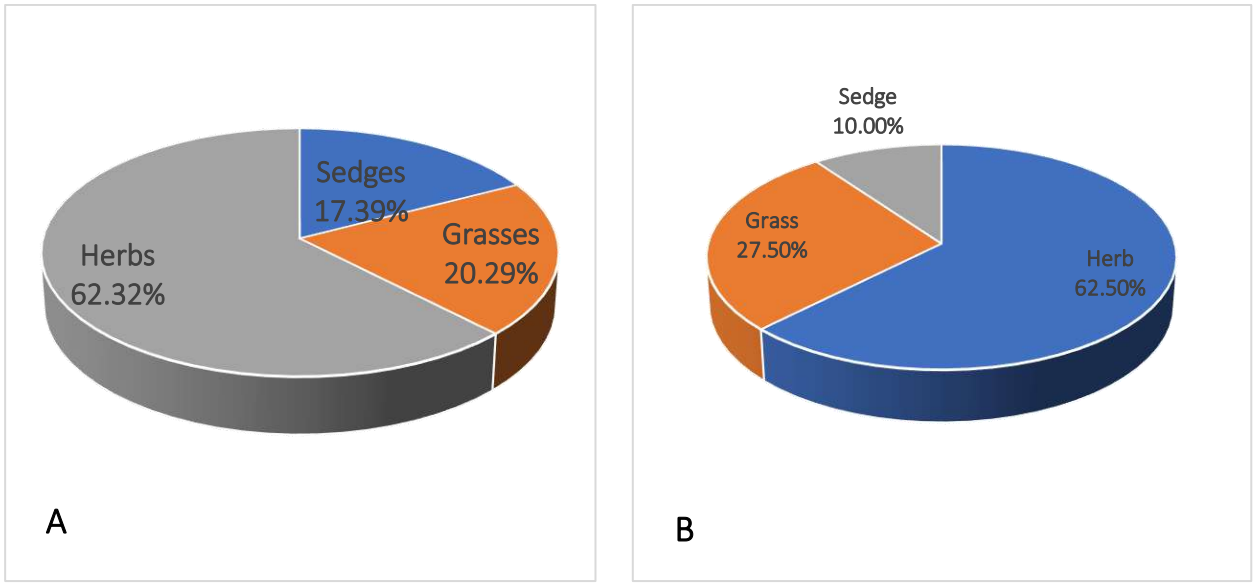


FIGURE 7-38: RELATIVE ABUNDANCE OF HERBS, GRASSES, SEDGES (A) WET SEASON AND (B) DRY SEASON

Non-Native and Invasive Plant Species

The activities within the study area (dredging/sand mining) have caused collapse of the riverbanks. Dredging activities have broken down barriers and enhanced the intrusion of salt water and in turn changed the chemistry of the water bodies and encouraged the establishment of non-native or invasive or salt tolerant species such as *Acrostichum aureum, Ipomoea pes-caprae, Nypa fructicans,* and *Sesuvium portulacastrum*. These species are gradually establishing themselves on the banks of the river and are gradually replacing the original or native plant species (Table 7-60). It is worth noting that where natural habitats are altered or destroyed, the species that once occupied the areas are forced to adapt or become extinct. The species' composition may change substantially in modified landscapes, as some species especially adaptable will thrive in modified environments, while others particularly sensitive species decline. This often has the effect of subsequently altering general ecosystem structure and function. For example, alien species introduced into altered landscapes disrupt the native ecosystem further by outcompeting species native for resources and, hence altering habitat conditions. Changes in land use disrupt species distribution by creating obstacles to the movement of species to resources and hence causing imbalances in ecological interaction and reducing resilience to an ecosystem. There is no difference in the species' composition in both wet and dry seasons.

TABLE 7-60: RELATIVE ABUNDANCE OF PLANT SPECIES

S/N	Family	Species	% Composition	S/N	Family	Species	% Composition
1	Asteraceae	12	7.7	**24**	Commelinaceae	3	1.9
2	Talinaceae	1	0.6	**25**	Portulacaceae	1	0.6
3	Lamiaceae	3	1.9	**26**	Amaranthaceae	3	1.9
4	Phyllanthaceae	4	2.6	**27**	Poaceae	12	7.7

S/N	Family	Species	% Composition	S/N	Family	Species	% Composition
5	Cucurbitaceae	1	0.6	**28**	Arecaceae	5	3.2
6	Araceae	1	0.6	**29**	Apocynaceae	6	3.9
7	Cyperaceae	9	5.8	**30**	Anacardiaceae	3	1.9
8	Pteridaceae	1	0.6	**31**	Annonaceae	2	1.3
9	Dennstaedtiaceae	1	0.6	**32**	Gentianaceae	1	0.6
10	Convolvulaceae	4	2.6	**33**	Moraceae	5	3.2
11	Passifloraceae	2	1.3	**34**	Meliaceae	3	1.9
12	Fabaceae	14	9.0	**35**	Myrtaceae	3	1.9
13	Cleomaceae	3	1.9	**36**	Hypericaceae	1	0.6
14	Linderniaceae	1	0.6	**37**	Araliaceae	1	0.6
15	Rubiaceae	6	3.9	**38**	Lythraceae	1	0.6
16	Onagraceae	1	0.6	**39**	Combretaceae	3	1.9
17	Euphorbiaceae	9	5.8	**40**	Cupressaceae	1	0.6
18	Acanthaceae	2	1.3	**41**	Cannabaceae	1	0.6
19	Solanaceae	1	0.6	**42**	Cycadaceae	1	0.6
20	Malvaceae	5	3.2	**43**	Lauraceae	1	0.6
21	Nephrolepidaceae	1	0.6	**44**	Pinaceae	1	0.6
22	Amaryllidaceae	1	0.6	**45**	Plumbaginaceae	1	0.6
23	Piperaceae	1	0.6	**46**	Caricaceae	1	0.6

Exotic/Invasive Species

During survey, a total of 169 plant species were identified in the study area (Table 7-61). Native plant species constitute the majority of the flora. Although native species dominated the vegetation (123, 72.8%), a considerable proportion of the flora comprised exotic species (18.9%), while invasive taxa accounted for 8.3%. There is no seasonal difference in these species of plants. The presence of aggressive invaders such as *Chromolaena odorata*, *Nypa fruticans*, and *Leucaena leucocephala* indicates ongoing ecological pressure and potential threats to native plant communities. This reflects significant anthropogenic influence on vegetation composition.

TABLE 7-61: CHECKLIST EXOTIC/INVASIVE SPECIES

Scientific name	Family	Common name	Growth form	IUCN status	Status
Acacia auriculiformis	Fabaceae	Earleaf acacia	Tree	LC	Exotic
Adonidia merrillii	Arecaceae	Christmas palm	Tree	LC	Exotic
Ageratum houstonianum	Asteraceae	Floss flower	Herb	LC	Invasive
Allamanda cathartica	Apocynaceae	Golden trumpet	Shrub	LC	Exotic

Alternanthera sessilis	Amaranthaceae	Sessile joyweed	Herb	LC	Invasive
Anacardium occidentale	Anacardiaceae	Cashew	Tree	LC	Exotic
Annona muricata	Annonaceae	Soursop	Tree	LC	Exotic
Artocarpus heterophyllus	Moraceae	Jackfruit	Tree	LC	Exotic
Avena madagascariensis	Poaceae	Oat grass	Grass	LC	Exotic
Azadirachta indica	Meliaceae	Neem	Tree	LC	Exotic
Bougainvillea pachyphylla	Nyctaginaceae	Bougainvillea	Shrub	NE	Exotic
Calliandra surinamensis	Fabaceae	Pink powderpuff	Shrub	LC	Exotic
Chromolaena odorata	Asteraceae	Siam weed	Shrub	LC	Invasive
Cocos nucifera	Arecaceae	Coconut	Tree	LC	Exotic
Coreopsis lanceolata	Asteraceae	Tickseed	Herb	LC	Exotic
Delonix regia	Fabaceae	Flamboyant	Tree	LC	Exotic
Digitaria horizontalis	Poaceae	Crab grass	Grass	LC	Invasive
Dracaena fragrans	Asparagaceae	Corn plant	Shrub	LC	Exotic
Dypsis lutescens	Arecaceae	Areca palm	Tree	LC	Exotic
Eucalyptus globulus	Myrtaceae	Blue gum	Tree	LC	Exotic
Euphorbia heterophylla	Euphorbiaceae	Mexican fireplant	Herb	LC	Invasive
Gmelina arborea	Lamiaceae	Gmelina	Tree	LC	Exotic
Hibiscus rosa-sinensis	Malvaceae	China rose	Shrub	LC	Exotic
Ipomoea aquatica	Convolvulaceae	Water spinach	Climber	LC	Exotic
Ipomoea triloba	Convolvulaceae	Morning glory	Climber	LC	Invasive
Lagerstroemia speciosa	Lythraceae	Queen of flowers	Tree	LC	Exotic
Leucaena leucocephala	Fabaceae	Lead tree	Tree	LC	Invasive
Mangifera indica	Anacardiaceae	Mango	Tree	LC	Exotic
Megathyrsus maximus	Poaceae	Guinea grass	Grass	LC	Exotic
Mimosa invisa	Fabaceae	Giant sensitive plant	Herb	LC	Invasive
Mimosa pudica	Fabaceae	Sensitive plant	Herb	LC	Invasive
Murraya paniculata	Rutaceae	Orange jasmine	Shrub	LC	Exotic
Nypa fruticans	Arecaceae	Nipa palm	Palm	LC	Invasive
Passiflora foetida	Passifloraceae	Stinking passionflower	Climber	LC	Invasive
Pennisetum polystachion	Poaceae	Mission grass	Grass	LC	Invasive
Persea americana	Lauraceae	Avocado	Tree	LC	Exotic
Pinus caribaea	Pinaceae	Caribbean pine	Tree	LC	Exotic
Polyalthia longifolia	Annonaceae	Masquerade tree	Tree	LC	Exotic
Psidium guajava	Myrtaceae	Guava	Tree	LC	Exotic
Senna alata	Fabaceae	Wild senna	Shrub	NE	Exotic
Sphagneticola trilobata	Asteraceae	Singapore daisy	Herb	LC	Invasive
Tectona grandis	Lamiaceae	Teak	Tree	LC	Exotic
Terminalia catappa	Combretaceae	Tropical almond	Tree	LC	Exotic
Thuja occidentalis	Cupressaceae	Arborvitae	Tree	LC	Exotic
Tridax procumbens	Asteraceae	Coat buttons	Herb	LC	Invasive
Wodyetia bifurcata	Arecaceae	Foxtail palm	Tree	LC	Exotic

7.5.4 TERRESTRIAL FAUNA

7.5.4.1 MAMMALS

The mammalian composition of the study area showed notable seasonal variation in species richness and family representation. During the wet season (Table 7-62), 27 species across 13 families were recorded, while the dry season (Table 7-63) yielded 36 species representing 16 families, reflecting higher richness and diversity during the dry season. In both seasons, Sciuridae (squirrels) and Muridae (rats and mice) were the most dominant families, accounting for 18.52% each in the wet season and 25.0% and 16.67%, respectively, in the dry season. Their dominance reflects the ecological prevalence of arboreal and terrestrial rodents and squirrels (Figure 7-39), which occupy a wide range of habitats and play important roles in seed dispersal and prey dynamics. Other well-represented families include Soricidae, Bovidae, Pteropodidae, and Viverridae, each contributing between 5.0% and 8.3% of the total species in the dry season, demonstrating the contribution of small mammals, duikers, bats, and civets to overall diversity.

The assemblage also included rare or vulnerable species, such as *Phataginus tetradactyla* (Vulnerable) which is reported by hunters and *Cercopithecus mona* (Near Threatened), observed in the dry season at outer fringe of study area, highlighting the conservation importance of the study area. Most other species are classified as Least Concern, indicating relatively stable populations. The mammalian community comprised a mixture of arboreal, terrestrial, and semi-aquatic species, reflecting the ecological heterogeneity of the study area, which includes forests, wetlands, and open habitats. The higher species richness and increased representation of squirrels and rodents during the dry season suggest seasonal changes in detectability, activity, and resource availability, emphasizing the importance of year-round surveys to capture the full diversity of mammals.

TABLE 7-62: CHECKLIST OF MAMMALS (WET SEASON)

Scientific Name	Common Name	Family	Means of Identification	IUCN Status
Cypsiurus sp.	African palm swift	Apodidae	DO	LC
Philantomba maxwellii	Maxwell's duiker	Bovidae	DO	LC
Epomops sp.	Bat	Pteropodidae	DO	LC
Galago moholi	Bush baby	Galagidae	PR	LC
Atherurus africanus	Brush-tailed porcupine	Hystricidae	PR	LC
Ctenosaura sp.	Iguana	Iguanidae	PR	LC
Phataginus tetradactyla	African, black-bellied pangolin	Manidae	HR	VU
Rattus fuscipes	Bush rat	Muridae	DO	LC
Arvicanthis niloticus	Nile grass rat	Muridae	PR	LC
Lemniscomys striatus	Spotted grass mouse	Muridae	DO	LC
Rattus rattus	Common rat	Muridae	DO	LC

Cricetomys gambianus	Gambian pouched rat	Nesomyidae	DO	LC
Epomophorus spp.	Fruit bat	Pteropodidae	DO	LC
Epixerus wilsoni	Biafran palm squirrel	Sciuridae	DO	LC
Funisciurus pyrrhopus	African striped tree squirrel	Sciuridae	DO	LC
Geosciurus inauris	African ground squirrel	Sciuridae	DO	LC
Protoxerus stangeri	Forest giant squirrel	Sciuridae	DO	LC
Xerus erythropus	Striped ground squirrel	Sciuridae	DO	LC
Crocidura sp.	Shrew	Soricidae	DO	LC
Potamochoerus larvatus	Bush pig	Suidae	PR	LC
Thryonomys swinderianus	Cane rat	Thryonomyidae	DO	LC
Scotophilus dinganii	African yellow bat	Vespertilionidae	PR	LC
Civettictis civetta	African civet	Viverridae	PR	LC
Galeopterus variegatus	Colugo (flying lemur)	Cynocephalidae	HR	LC
Cercopithecus mona	Mona monkey	Cercopithecidae	PR	NT
Crocidura dsineumi	Shrew	Soricidae	DO	LC
Rattus rattus	Common rat	Muridae	DO	LC

DO – Direct observation, PR – Previous report, HR - Hunters report, LC = Least Concern, NT = Near Threatened, VU = Vulnerable

TABLE 7-63: CHECKLIST OF MAMMALS (DRY SEASON)

Scientific Name	Common Name	Family	Means of Identification	IUCN Status
Cypsiurus sp.	African palm swift	Apodidae	DO	LC
Philantomba maxwellii	Maxwell's duiker	Bovidae	DO	LC
Epomops sp.	Bat	Pteropodidae	DO	LC
Galago moholi	Bush baby	Galagidae	PR	LC
Atherurus africanus	Brush-tailed porcupine	Hystricidae	PR	LC
Ctenosaura sp.	Iguana	Iguanidae	PR	LC
Phataginus tetradactyla	African, black-bellied pangolin	Manidae	HR	VU
Rattus fuscipes	Bush rat	Muridae	DO	LC
Arvicanthis niloticus	Nile grass rat	Muridae	PR	LC
Lemniscomys striatus	Spotted grass mouse	Muridae	DO	LC
Rattus rattus	Common rat	Muridae	DO	LC
Cricetomys gambianus	Gambian pouched rat	Nesomyidae	DO / BM	LC
Epomophorus sp.	Fruit bat	Pteropodidae	DO	LC
Epixerus wilsoni	Biafran palm squirrel	Sciuridae	DO	LC
Funisciurus pyrrhopus	African striped tree squirrel	Sciuridae	DO	LC

Funisciurus anerythrus	–	Sciuridae	DO	LC
Funisciurus leucogenys	–	Sciuridae	DO	LC
Heliosciurus rufobrachium	–	Sciuridae	DO	LC
Heliosciurus gambianus	–	Sciuridae	DO	LC
Geosciurus inauris	African ground squirrel	Sciuridae	DO	LC
Protoxerus stangeri	Forest giant squirrel	Sciuridae	DO	LC
Xerus erythropus	Striped ground squirrel	Sciuridae	DO	LC
Crocidura sp.	Shrew	Soricidae	DO	LC
Crocidura dsineumi	Shrew	Soricidae	DO	LC
Crocidura poensis	–	Soricidae	DO	LC
Potamochoerus larvatus	Bush pig	Suidae	PR	LC
Thryonomys swinderianus	Cane rat	Thryonomyidae	DO	LC
Scotophilus dinganii	African yellow bat	Vespertilionidae	PR	LC
Civettictis civetta	African civet	Viverridae	PR / BM	LC
Galeopterus variegatus	Colugo (flying lemur)	Cynocephalidae	HR	LC
Cercopithecus mona	Mona monkey	Cercopithecidae	PR / DO	NT
Genetta sp.	Genet	Viverridae	BM / DO	LC
Hyemoschus aquaticus	Water chevrotain	Tragulidae	BM / DO	LC
Philantomba monticola	Blue duiker	Bovidae	BM / DO	LC
Tragelaphus spekii	Sitatunga	Bovidae	BM / DO	LC
Mus minutoides	Pygmy mouse	Muridae	DO	LC

DO – Direct observation, PR – Previous report, HR - Hunters report, LC = Least Concern, NT = Near Threatened, VU = Vulnerable



FIGURE 7-39: SOME MAMMALS AND REPTILE OBSERVED IN THE STUDY AREA (A) SHREW, (B) COMMON RAT, (C) AFRICAN GROUND SQUIRREL (D) *TRACHYLEPIS*

QUINQUETAENIATA (E) LIZARD, (F) BROWN SNAKE (G) GREEN SNAKE, AND (H & I) PYTHON

7.5.4.2 AVIFAUNA

The checklist of birds recorded in the study area revealed a high level of species diversity during both seasons. A total of 65 species were recorded during the wet season (Table 7-64), while 68 species were observed in the dry season (Table 7-65), indicating a slightly higher species richness during the dry period. Several species were common to both seasons, suggesting that the study area supports a stable population of resident birds throughout the year. Examples of species recorded in both seasons include *Accipiter nisus*, *Accipiter tachiro*, *Ardea cinerea*, *Bubulcus ibis*, *Halcyon senegalensis*, and *Milvus migrans* (Figure 7-40). The presence of these species across both seasons suggests that the habitat provides adequate food resources, nesting sites, and ecological stability for many resident bird species. Despite these similarities, some differences in species composition were observed between the two seasons. Certain species were recorded only during the wet season, while others appeared exclusively in the dry season. This seasonal variation may be attributed to changes in environmental conditions such as water availability, vegetation structure, and food resources. The slightly higher number of species recorded in the dry season may also reflect seasonal movements or increased detectability of birds during periods of reduced vegetation density.

The avian community in the study area exhibited clear seasonal patterns. During the wet season, 65 species across 30 families were recorded, with Accipitridae the most dominant (nine species, ≈13.8%), reflecting the abundance of raptors. Ardeidae contributed eight species (≈12.3%), associated with wetlands and open water, while Nectariniidae accounted for six species (≈9.2%), highlighting the role of flowering plants in supporting nectar-feeding birds. Families such as Bucerotidae, Charadriidae, Columbidae, Scolopacidae, and Strigidae had three to four species each, and the remaining families contributed one or two species, indicating broad but uneven representation. Some species bred locally, evidenced by adults with chicks (Figure 7-42), while others formed large congregations (>400 individuals) along the Okulu River and retention pond (Figure 7-41). During the dry season, 68 species across 33 families were recorded. Ardeidae (17.6%) and Accipitridae (10.3%) remained dominant, reflecting wetland and hunting habitats, while moderately represented families included Bucerotidae, Alcedinidae, Charadriidae, and Strigidae (4–6%). Families such as Psittacidae, Turdidae, and Rallidae were represented by only one species (<2%). The prevalence of waders and raptors indicates diverse ecological niches.

Most species in both seasons belong to similar families, including Accipitridae, Ardeidae, Alcedinidae, Nectariniidae, and Charadriidae, suggesting that the overall structure of the bird community remains relatively stable. The majority of species are classified as Least Concern (LC), although threatened species such as the Hooded Vulture (CR) and African Grey Parrot (EN) were reported in previous studies, they were not observed during this survey.

TABLE 7-64: CHECKLIST OF BIRDS IN THE STUDY AREA (WET SEASON)

Scientific Name	Family	Common Name	Means of Identification	IUCN Status
Accipiter nisus	Accipitridae	Eurasian sparrowhawk	DO	LC

Accipiter tachiro	Accipitridae	African goshawk	DO	LC
Circus macrourus	Accipitridae	Pallid harrier	DO	LC
Circus pygargus	Accipitridae	Montagu's harrier	DO	LC
Gypohierax angolensis	Accipitridae	Palm-nut vulture	DO	LC
Haliaeetus vocifer	Accipitridae	African fish eagle	DO	LC
Milvus migrans	Accipitridae	Black kite	DO	LC
Polyboroides radiatus	Accipitridae	Harrier-hawk	DO	LC
Tachyspiza minulla	Accipitridae	Little sparrowhawk	DO	LC
Apus barbatus	Apodidae	African black swift	DO	LC
Apus caffer	Apodidae	White-rumped swift	DO	LC
Ardea cinerea	Ardeidae	Grey heron	DO	LC
Ardea melanocephala	Ardeidae	Black-headed heron	DO	LC
Ardeola ibis	Ardeidae	Cattle egret	DO	LC
Bubulcus ibis	Ardeidae	Cattle egret	DO	LC
Butorides striata	Ardeidae	Green-backed heron	DO	LC
Egretta alba	Ardeidae	Great egret	DO	LC
Egretta ardesiaca	Ardeidae	Black heron	DO	LC
Egretta garzetta	Ardeidae	Little egret	DO	LC
Ceyx picta	Alcedinidae	African pygmy kingfisher	DO	LC
Corythornis cristatus	Alcedinidae	Malachite kingfisher	DO	LC
Halcyon senegalensis	Alcedinidae	Woodland kingfisher	DO	LC
Dendrocygna viduata	Anatidae	White-faced whistling duck	DO	LC
Bycanistes brevis	Bucerotidae	Silvery-cheeked hornbill	DO	LC
Bycanistes buccinator	Bucerotidae	Trumpeter hornbill	DO	LC
Lophoceros semifasciatus	Bucerotidae	African pied hornbill	DO	LC
Burhinus vermiculatus	Burhinidae	Water thick-knee	DO	LC
Anarhynchus marginatus	Charadriidae	White-fronted plover	DO	LC
Charadrius hiaticula	Charadriidae	Ringed plover	DO	LC
Vanellus spinosus	Charadriidae	Spur-winged lapwing	DO	LC
Anastomus lamelligerus	Ciconiidae	African openbill stork	DO	LC
Spilopelia senegalensis	Columbidae	Laughing dove	DO	LC
Streptopelia semitorquata	Columbidae	Red-eyed dove	DO	LC
Corvus albus	Corvidae	Pied crow	DO	LC
Lagonosticta senegala	Estrildidae	Red-billed firefinch	DO	LC
Falco ardosiaceus	Falconidae	Grey kestrel	DO	LC
Hirundo albigularis	Hirundinidae	White-throated swallow	DO	LC
Gelochelidon nilotica	Laridae	Gull-billed tern	DO	LC
Laniarius ferrugineus	Malaconotidae	Tropical boubou	DO	LC
Merops nubicus	Meropidae	Carmine bee-eater	DO	LC
Anthus novaeseelandiae	Motacillidae	Richard's pipit	DO	LC
Myrmecocichla aethiops	Muscicapidae	Northern anteater-chat	DO	LC
Chalcomitra senegalensis	Nectariniidae	Scarlet-chested sunbird	DO	LC

Cinnyris cupreus	Nectariniidae	Copper sunbird	DO	LC
Cinnyris pulchellus	Nectariniidae	Beautiful sunbird	DO	LC
Cinnyris venustus	Nectariniidae	Variable sunbird	DO	LC
Cyanomitra verticalis	Nectariniidae	Green-headed sunbird	DO	LC
Nectarinia venusta	Nectariniidae	Variable sunbird	DO	LC
Numida meleagris	Numididae	Helmeted guineafowl	DO	LC
Gymnoris dentata	Passeridae	Bush sparrow	DO	LC
Microcarbo africanus	Phalacrocoracidae	Long-tailed cormorant	DO	LC
Francolinus bicalcaratus	Phasianidae	Double-spurred francolin	DO	LC
Ploceus ocularis	Ploceidae	Spectacled weaver	DO	LC
Ploceus cucullatus	Ploceidae	Village weaver	DO	LC
Psittacus erithacus	Psittacidae	African grey parrot	DO	LC
Pycnonotus barbatus	Pycnonotidae	Common bulbul	DO	LC
Gallinula chloropus	Rallidae	Common moorhen	DO	LC
Actitis hypoleucos	Scolopacidae	Common sandpiper	DO	LC
Numenius phaeopus	Scolopacidae	Whimbrel	DO	LC
Tringa nebularia	Scolopacidae	Common greenshank	DO	LC
Scopus umbretta	Scopidae	Hamerkop	PR	LC
Bubo africanus	Strigidae	Spotted eagle-owl	PR	LC
Otus senegalensis	Strigidae	African scops owl	DO	LC
Ptilopsis leucotis	Strigidae	Northern white-faced owl	PR	LC
Turdus olivaceus	Turdidae	Olive thrush	DO	LC

Direct Observation (DO); Previous Report (PR); Least Concern (LC); Critically Endangered (CR); Endangered (EN)

TABLE 7-65: CHECKLIST OF BIRDS IN THE STUDY AREA (DRY SEASON)

Scientific Name	Family	Common Name	Means of Identification	IUCN Status
Accipiter nisus	Accipitridae	Eurasian Sparrowhawk	DO	LC
Accipiter tachiro	Accipitridae	African Goshawk	DO	LC
Actitis hypoleucos	Scolopacidae	Common Sandpiper	DO	LC
Actophilornis africanus	Jacanidae	African Jacana	DO	LC
Alopochen aegyptiaca	Anatidae	Egyptian Goose	DO	LC
Anarhynchus marginatus	Charadriidae	White-fronted Plover	DO	LC
Anastomus lamelligerus	Ciconiidae	African Openbill	DO	LC
Anthus novaeseelandiae	Motacillidae	Richard's Pipit	DO	LC
Apus barbatus	Apodidae	Alpine Swift	DO	LC
Apus caffer	Apodidae	White-rumped Swift	DO	LC
Ardea alba	Ardeidae	Great Egret	DO	LC
Ardea cinerea	Ardeidae	Grey Heron	DO	LC
Ardea intermedia	Ardeidae	Intermediate Egret	DO	LC
Ardea melanocephala	Ardeidae	Black-headed Heron	DO	LC
Ardeola ibis	Ardeidae	Squacco Heron	DO	LC
Ardeola ralloides	Ardeidae	Squacco Heron	DO	LC

Butorides striata	Ardeidae	Striated Heron	DO	LC
Bubo africanus	Strigidae	Spotted Eagle-Owl	DO	LC
Bubulcus ibis	Ardeidae	Cattle Egret	DO	LC
Burhinus vermiculatus	Burhinidae	Water Thick-knee	DO	LC
Bycanistes bucinator	Bucerotidae	Trumpeter Hornbill	DO	LC
Ceratogymna brevis	Bucerotidae	Silvery-cheeked Hornbill	DO	LC
Ceryle rudis	Alcedinidae	Pied Kingfisher	DO	LC
Ceyx pictus	Alcedinidae	African Pygmy Kingfisher	DO	LC
Chalcomitra senegalensis	Nectariniidae	Scarlet-chested Sunbird	DO	LC
Charadrius hiaticula	Charadriidae	Common Ringed Plover	DO	LC
Charadrius tricollaris	Charadriidae	Three-banded Plover	DO	LC
Cinnyris cupreus	Nectariniidae	Copper Sunbird	DO	LC
Cinnyris pulchellus	Nectariniidae	Beautiful Sunbird	DO	LC
Corvus albus	Corvidae	Pied Crow	DO	LC
Corythornis cristatus	Alcedinidae	Malachite Kingfisher	DO	LC
Cyanomitra verticalis	Nectariniidae	Green-headed Sunbird	DO	LC
Dendrocygna viduata	Anatidae	White-faced Whistling Duck	DO	LC
Egretta ardesiaca	Ardeidae	Black Heron	DO	LC
Egretta garzetta	Ardeidae	Little Egret	DO	LC
Egretta thula	Ardeidae	Snowy Egret	DO	LC
Euplectes orix	Ploceidae	Southern Red Bishop	DO	LC
Francolinus bicalcaratus	Phasianidae	Double-spurred Francolin	DO	LC
Gallinula chloropus	Rallidae	Common Moorhen	DO	LC
Gelochelidon nilotica	Laridae	Gull-billed Tern	DO	LC
Gymnoris dentata	Passeridae	Bush Petronia	DO	LC
Gypohierax angolensis	Accipitridae	Palm-nut Vulture	DO	LC
Halcyon senegalensis	Alcedinidae	Woodland Kingfisher	DO	LC
Haliaeetus vocifer	Accipitridae	African Fish Eagle	DO	LC
Hirundo albigularis	Hirundinidae	White-throated Swallow	DO	LC
Ixobrychus minutus	Ardeidae	Little Bittern	DO	LC
Lagonosticta senegala	Estrildidae	Red-billed Firefinch	DO	LC
Laniarius ferrugineus	Malaconotidae	Tropical Boubou	DO	LC
Lophoceros semifasciatus	Bucerotidae	Piping Hornbill	DO	LC
Merops nubicus	Meropidae	Northern Carmine Bee-eater	DO	LC
Microcarbo africanus	Phalacrocoracidae	Reed Cormorant	DO	LC
Milvus migrans	Accipitridae	Black Kite	DO	LC
Myrmecocichla aethiops	Muscicapidae	Anteater Chat	DO	LC
Necrosyrtes monachus	Accipitridae	Hooded Vulture	PR	CR
Numenius phaeopus	Scolopacidae	Whimbrel	DO	LC
Numida meleagris	Numididae	Helmeted Guineafowl	DO	LC
Otus senegalensis	Strigidae	African Scops Owl	DO	LC
Phalacrocorax africanus	Phalacrocoracidae	Long-tailed Cormorant	DO	LC
Ploceus cucullatus	Ploceidae	Village Weaver	DO	LC
Polyboroides radiatus	Accipitridae	Madagascar Harrier-hawk	DO	LC
Psittacus erithacus	Psittacidae	African Grey Parrot	PR	EN
Ptilopsis leucotis	Strigidae	Northern White-faced Owl	DO	LC
Pycnonotus barbatus	Pycnonotidae	Yellow-vented Bulbul	DO	LC
Scopus umbretta	Scopidae	Hamerkop	DO	LC

Spilopelia senegalensis	Columbidae	Laughing Dove	DO	LC
Streptopelia semitorquata	Columbidae	Red-eyed Dove	DO	LC
Turdus olivaceus	Turdidae	Olive Thrush	DO	LC
Vanellus spinosus	Charadriidae	Spur-winged Lapwing	DO	LC



FIGURE 7-40: SOME AVIAN SPECIES OBSERVED DURING THE FIELD WORK; (A) BLACK-WINGED KITE, (B) COMMON MOORHEN, (C) COMMON SANDPIPER (D) FORBES'S PLOVER, (E) WOODLAND KINGFISHER, (F) BLUE-HEADED COUCAL (G) WATER THICK-KNEE, ADULTS WITH CHICKS (INDICATED BY ARROW), (H) PIED KINGFISHER



FIGURE 7-41: AGGREGATION OF AQUATIC BIRDS (A) OKULU RIVER AND (B) RETENTION POND



FIGURE 7-42: JUVENILE OF MICROCA*RBO AFRICANUS* OBSERVED IN THE STUDY AREA

7.5.4.3 AMPHIBIANS

A total of 11 amphibian species belonging to six families were recorded in the study area during the wet season (Table 7-66), while 14 species representing nine families were documented during the dry season (Table 7-67), indicating higher species richness and family diversity in the dry season. During the wet season, the family Hyperoliidae was the most dominant, contributing four species (*Heterixalus sp*., *Afrixalus sp*., *Afrixalus nigeriensis*, and *Hyperolius riggenbachi*), accounting for 36.36% of the total species recorded. The family Bufonidae contributed to two species (18.18%), while Ranidae, Pipidae, Rhacophoridae, and Ptychadenidae were each represented by one species (9.09%).

In the dry season, Hyperoliidae remained the dominant family with four species, representing 28.57% of the amphibian assemblage. Bufonidae followed with two species (14.29%), while Ranidae, Pipidae, Rhacophoridae, Ptychadenidae, Arthroleptidae, Pyxicephalidae, and Microhylidae each contributed one species (7.14%). Generally, both seasons were dominated by Hyperoliidae, indicating that reed frogs are the most common amphibians in the study area, likely due to the availability of wetlands and vegetated breeding habitats. Most recorded species were classified as Least Concern (LC).

TABLE 7-66: AMPHIBIANS SPECIES OF THE STUDY AREA (WET SEASON)

Scientific Name	Common Name	Family	Means of Identification	IUCN Status
Sclerophrys regularis	Common African toad	Bufonidae	DO	LC
Bufo latiformis	African giant toad	Bufonidae	DO	LC
Rana temporaria	True green frog	Ranidae	DO	LC
Xenopus tropicalis	Western clawed frog	Pipidae	DO	LC
Xenopus laevis	African clawed frog	Pipidae	DO	LC
Heterixalus sp.	Tree frog	Hyperoliidae	PR	LC
Afrixalus sp.	Tree frog	Hyperoliidae	PR	LC
Afrixalus nigeriensis	Nigeria banana frog	Hyperoliidae	DO	LC
Hyperolius riggenbachi	Riggenbach's reed frog	Hyperoliidae	DO	LC
Chirixalus sp.	Tree frog	Rhacophoridae	DO	LC
Ptychadena mascareniensis	Mascarene ridged frog	Ptychadenidae	DO	LC

Note: LC - Least concern, DO – Direct Observation, PR- Previous Report (Source: Fieldwork, 2025)

TABLE 7-67: AMPHIBIANS SPECIES OF THE STUDY AREA (DRY SEASON)

Scientific Name	Common Name	Family	Means of Identification	IUCN Status
Sclerophrys regularis	African common toad	Bufonidae	DO	LC
***Sclerophrys latifrons* (syn. *Bufo latifrons*)**	African giant toad	Bufonidae	DO	LC
Rana temporaria	Common frog	Ranidae	DO	LC
Xenopus tropicalis	Western clawed frog	Pipidae	DO	LC
Xenopus laevis	African clawed frog	Pipidae	DO	LC
Heterixalus sp.	Tree frog	Hyperoliidae	PR	NE

Afrixalus sp.	Banana frog /leaf-folding frog	Hyperoliidae	PR	NE
Afrixalus nigeriensis	Nigerian banana frog	Hyperoliidae	DO	LC
Hyperolius riggenbachi	Riggenbach's reed frog	Hyperoliidae	DO	LC
Chiromantis sp. (formerly *Chirixalus*)	Foam-nest tree frog	Rhacophoridae	DO	NE
Ptychadena mascareniensis	Mascarene grass frog	Ptychadenidae	DO	LC
Leptopelis sp.	Forest tree frog	Arthroleptidae	DO	NE
Pyxicephalus adspersus	African bullfrog	Pyxicephalidae	DO	LC
Phrynomantis sp.	Rubber frog	Microhylidae	DO	NE

Note: LC - Least concern, NE – Not Evaluated, DO – Direct Observation, PR- Previous Report (Source: Fieldwork, 2026)

7.5.4.4 REPTILES

Table 7-68 presents the checklist of reptiles recorded in the study area during both wet and dry seasons. A total of 27 species belonging to 13 families were identified, indicating considerable reptile diversity within the area. Among the recorded families, Elapidae was the most dominant, contributing five species (*Dendroaspis jamesoni*, *Hapsidophrys smaragdinus*, *Naja nigricincta*, *Naja nigrocollis*, and *Dendroaspis polylepis*), representing 18.52% of the total reptile species. The family Scincidae followed with four species (14.81%), including *Lampropholis guichenoti* and three species of *Trachylepis*. The families Colubridae, Crocodylidae, Gekkonidae, Pythonidae, Bufonidae, Chamaeleonidae, and Varanidae each contributed two species (7.41% each). The remaining families—Agamidae, Lamprophiidae, Testudinidae, and Viperidae—were each represented by one species (3.70%).

The reptiles recorded represent a mixture of lizards, snakes, crocodilians, and tortoises, reflecting diverse habitat conditions in the study area, including wetlands, forest patches, and open terrestrial environments. Species such as *Agama agama*, *Hemidactylus skyaboboensis*, and *Trachylepis spp*. are typical of terrestrial and human-modified habitats, while *Crocodylus niloticus* and *Osteolaemus tetraspis* indicate the presence of aquatic ecosystems. Most of the recorded species are categorized as Least Concern (LC) on the International Union for Conservation of Nature (IUCN) Red List, suggesting relatively stable global populations. However, the Osteolaemus tetraspis is listed as Vulnerable (VU), while Python sebae and Python regius which are reported by hunters and found at outer fringe of study area are classified as Near Threatened (NT), highlighting the need for monitoring and conservation attention for these species in the study area. The hunters in the area cut and killed Python regius in the Ebubu-Agbonchia riparian forest two weeks before the dry season data gathering. The reptile composition demonstrates significant biodiversity and ecological heterogeneity within the surveyed habitats.

TABLE 7-68: CHECKLIST OF REPTILES IN THE STUDY AREA (WET AND DRY SEASON)

Scientific Name	Common Name	Family	Means of Identification	IUCN Status
Agama agama	West African rainbow lizard	Agamidae	DO	LC

Chamaeleo africanus	African chameleon	Chamaeleonidae	DO	LC
Chamaeleo gracilis	Graceful chameleon	Chamaeleonidae	HR	LC
Amietophrynus superciliaris	African giant toad	Bufonidae	DO	LC
Sclerophrys regularis	Common African toad	Bufonidae	DO	LC
Graya smithii	Smith's African water snake	Colubridae	DO	LC
Crotaphopeltis sp.	Herald snake	Colubridae	DO	LC
Crocodylus niloticus	Nile crocodile	Crocodylidae	DO	LC
Osteolaemus tetraspis	Dwarf crocodile	Crocodylidae	HR	VU
Dendroaspis jamesoni	Green mamba	Elapidae	DO	LC
Hapsidophrys smaragdinus	Emerald, green snake	Elapidae	DO	LC
Naja nigricincta	Spitting cobra	Elapidae	DO	LC
Naja nigrocollis	Black-necked spitting cobra	Elapidae	DO	LC
Dendroaspis polylepis	Black mamba	Elapidae	DO	LC
Hemidactylus skyaboboensis	Forest gecko	Gekkonidae	DO	LC
Tarentola gomerensis	Wall gecko	Gekkonidae	DO	LC
Lycodonomorphus inornatus	Olive house snake	Lamprophiidae	DO	LC
Python sebae	African rock python	Pythonidae	HR	NT
Python regius	Royal python	Pythonidae	HR	NT
Lampropholis guichenoti	Skink	Scincidae	DO	LC
Trachylepis quinquetaeniata	Five-lined mabuya	Scincidae	DO	LC
Trachylepis affinis	Skink	Scincidae	DO	LC
Trachylepis sp.	Striped skink	Scincidae	DO	LC
Kinixys belliana	Bell's hinge-back tortoise	Testudinidae	HR	LC
Varanus niloticus	Nile monitor lizard	Varanidae	HR	LC
Varanus varius	Monitor lizard	Varanidae	HR	LC
Bitis arietans	Puff adder	Viperidae	HR	LC

7.5.4.5 MOLLUSK AND ARTHROPODS

Table 7-69 and Table 7-70 show the composition of mollusk and arthropod species recorded in the study area during the wet and dry seasons. In the wet season (Table 7-69), six species belonging to three families were recorded. The family Achatinidae was dominant with four species, representing about 66.7% of the total species composition. The remaining families, Sesarmidae and Potamonautidae, were represented by one species each, accounting for 16.7% respectively. All molluscan species recorded were terrestrial snails, while the arthropods were represented by two crab species (Figure 7-43).

In contrast, the dry season (Table 7-70) recorded fifteen species distributed across eight families, indicating higher taxonomic diversity. Achatinidae still contributed four species (26.7%), but its relative dominance decreased compared to the wet season. Planorbidae was the next most represented family with three species (20.0%), followed by Ampullariidae and Potamonautidae with two species each (13.3% respectively). Other families, including Sesarmidae, Gecarcinidae, Ocypodidae, and Bulinidae, were each represented by one species (6.7%). The wet season community was dominated by Achatinidae, whereas the dry season assemblage showed a more even distribution among several families, particularly freshwater snail families. This indicates that aquatic mollusks and additional crab species became more detectable or abundant during the dry season, increasing both species' richness and family-level diversity in the study area.

TABLE 7-69: MOLLUSKS AND ARTHROPODS SPECIES OF THE STUDY AREA (WET SEASON)

Scientific Name	Family	Common Name	Group	Means of Identification	IUCN Status
Achatina achatina	Achatinidae	Giant African snail	Mollusc	DO	LC
Limicolaria aurora	Achatinidae	Land snail	Mollusc	DO	LC
Lissachatina fulica	Achatinidae	Land snail	Mollusc	DO	LC
Archachatina marginata	Achatinidae	Banana rasp snail	Mollusc	DO	LC
Sesarma leptosoma	Sesarmidae	Mangrove crab	Crustacean	DO	NE
Liberonautes latidactylus	Potamonautidae	Freshwater crab	Crustacean	DO	NE

Note: LC - Least concern, NE – Not Evaluated, DO – Direct Observation, (Source: Fieldwork, 2025)

TABLE 7-70: MOLLUSKS AND ARTHROPODS SPECIES OF THE STUDY AREA (DRY SEASON)

Scientific Name	Common Name	Major Group	Family	Means of Identification	IUCN Status
Achatina achatina	Giant African snail	Mollusc	Achatinidae	DO	LC
Limicolaria aurora	Land snail	Mollusc	Achatinidae	DO	LC
Lissachatina fulica	Giant African land snail	Mollusc	Achatinidae	DO	LC
Archachatina marginata	Banana rasp snail	Mollusc	Achatinidae	DO	LC
Sesarma leptosoma	Mangrove crab	Arthropod	Sesarmidae	DO	NE
Liberonautes latidactylus	Freshwater crab	Arthropod	Potamonautidae	DO	NE
Cardisoma armatum	West African rainbow land crab	Arthropod	Gecarcinidae	DO	NE
Ucides cordatus	Mangrove crab	Arthropod	Ocypodidae	DO	NE
Potamonautes niloticus	Nile freshwater crab	Arthropod	Potamonautidae	DO	NE
Bulinus globosus	Freshwater snail	Mollusc	Bulinidae	DO	LC
Pila sp.	Apple snail	Mollusc	Ampullariidae	DO	NE
Biomphalaria pfeifferi	Freshwater snail	Mollusc	Planorbidae	DO	LC
Lanistes lybicus	Freshwater apple snail	Mollusc	Ampullariidae	DO	NE
Gyraulus costulatus	Ramshorn snail	Mollusc	Planorbidae	DO	NE
Ferrissia sp.	Freshwater limpet	Mollusc	Planorbidae	DO	NE

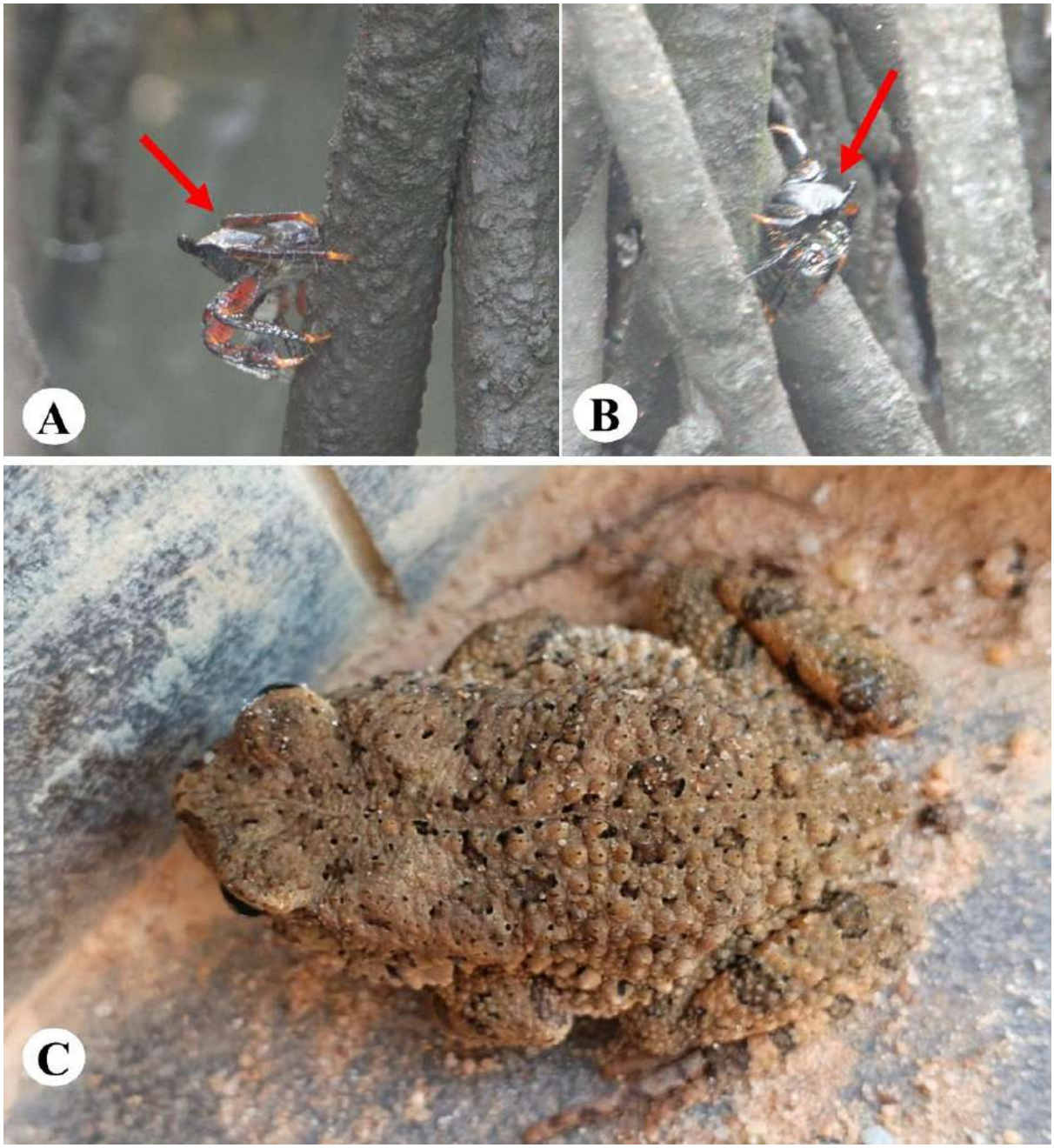


FIGURE 7-43: (A AND B) CRAB (*SESARMA LEPTOSOME*); (C) TOAD

7.5.4.6 INSECTS

Table 7-71 and Table 7-72 present the checklist of insect groups recorded in the study area during the wet and dry seasons. In the wet season (Table 7-71), a total of 41 species belonging to 21 families were recorded. In contrast, the dry season (Table 7-72) showed a higher diversity with 57 species distributed across 23 families. Most of the species recorded during the wet season were also present in the dry season, indicating relatively stable insect assemblages throughout the seasons.

During the wet season, Lepidoptera families dominated the assemblage. The family Nymphalidae had the highest representation with 5 species (≈12.2%), followed by Hesperiidae

(4 species; ≈9.8%), Pieridae (3 species; ≈7.3%), and Lycaenidae (3 species; ≈7.3%), while Papilionidae was represented by one species (≈2.4%). Other families such as Tenebrionidae, Pentatomidae, Carabidae, Scarabaeidae, Muscidae, Gryllidae, Gryllotalpidae, Mantidae, Formicidae, Apidae, Thomisidae, Salticidae, Araneidae, Libellulidae, Aeshnidae, Sphecidae, and Pelecinidae were each represented by one or two species (Figure 7-44 and Figure 7-45).

In the dry season, species richness increased with the addition of 16 species and two additional families (Vespidae and Scoliidae). Lepidoptera diversity increased markedly, with Nymphalidae increasing to 9 species (≈15.8%), Papilionidae to 5 species (≈8.8%), Pieridae to 5 species (≈8.8%), Lycaenidae to 5 species (≈8.8%), and Hesperiidae to 5 species (≈8.8%). The dry season exhibited more species richness and family representation (23 families) compared to the wet season (21 families), suggesting increased insect visibility, and detectability during drier environmental conditions in the study area.

TABLE 7-71: CHECKLIST OF INSECT GROUPS (WET SEASON)

Scientific Name	Family	Common Name	IUCN Status
Strongylium purpuripenne	Tenebrionidae	Darkling beetle	NE
Chlorochroa ligata	Pentatomidae	Green shield bug	NE
Pheropsophus africanus	Carabidae	African bombardier beetle	NE
Copris lunaris	Scarabaeidae	Dung beetle	NE
Cacyreus lingeus	Lycaenidae	Common bush blue butterfly	NE
Papilio sp.	Papilionidae	Swallowtail butterfly	NE
Appias sp.	Pieridae	Albatross butterfly	NE
Leptosia alcesta alcesta	Pieridae	African wood white	NE
Mylothris chloris chloris	Pieridae	Common dotted border	NE
Leptotes pirithous	Lycaenidae	Pea blue	LC
Acraea serena serena	Nymphalidae	Dancer acraea	NE
Acraea bonasia bonasia	Nymphalidae	Bonasia acraea	NE
Junonia sophia sophia	Nymphalidae	Blue pansy	NE
Junonia chorimene	Nymphalidae	Variable pansy	NE
Junonia terea terea	Nymphalidae	Brown pansy	NE
Coeliades forestan forestan	Hesperiidae	Forest swift	NE
Platylesches moritili	Hesperiidae	Moritili hopper	NE
Borbo borbonica borbonica	Hesperiidae	African grass skipper	NE
Borbo gemella	Hesperiidae	Twin grass skipper	NE
Zizula hylax	Lycaenidae	Tiny grass blue	LC
Musca domestica	Muscidae	House fly	NE
Xysticus sp.	Thomisidae	Crab spider	NE
Spider	Araneae	Large spider	NE

Scientific Name	Family	Common Name	IUCN Status
Epocilla calcarata	Salticidae	Jumping spider	NE
Austracantha sp.	Araneidae	Spiny orb-weaver spider	NE
Allonemobius sp.	Gryllidae	Ground cricket	NE
Sphodromantis gracilicollis	Mantidae	African praying mantis	NE
Dorylus labiatus	Formicidae	Driver ant	NE
Gryllotalpa gryllotalpa	Gryllotalpidae	Mole cricket	NE
Tholymis tillarga	Libellulidae	Coromandel marsh hawk	NE
Sympetrum sp.	Libellulidae	Darter dragonfly	NE
Orthetrum sp.	Libellulidae	Skimmer dragonfly	NE
Anisoptera sp.	Odonata	Dragonfly	NE
Anax sp.	Aeshnidae	Emperor dragonfly	NE
Odonata sp.	Odonata	Dragonfly	NE
Pelecinus sp.	Pelecinidae	Pelecinid wasp	NE
Sceliphron sp.	Sphecidae	Mud-dauber wasp	NE
Chlorion sp.	Sphecidae	Blue mud wasp	NE
Prionyx sp.	Sphecidae	Sand wasp	NE
Apis mellifera	Apidae	Western honey bee	LC
Ceratina sp.	Apidae	Small carpenter bee	NE

TABLE 7-72: CHECKLIST OF INSECT GROUPS (DRY SEASON)

Scientific Name	Family	Common Name	IUCN Status
Strongylium purpuripenne	Tenebrionidae	Darkling beetle	NE
Chlorochroa ligata	Pentatomidae	Green shield bug	NE
Pheropsophus africanus	Carabidae	African bombardier beetle	NE
Copris lunaris	Scarabaeidae	Dung beetle	NE
Cacyreus lingeus	Lycaenidae	Common bush blue	NE
Papilio sp.	Papilionidae	Swallowtail butterfly	NE
Appias sp.	Pieridae	Albatross butterfly	NE
Leptosia alcesta alcesta	Pieridae	African wood white	NE
Mylothris chloris chloris	Pieridae	Common dotted border	NE
Leptotes pirithous	Lycaenidae	Pea blue	LC
Acraea serena serena	Nymphalidae	Dancer acraea	NE
Acraea bonasia bonasia	Nymphalidae	Bonasia acraea	NE
Junonia sophia sophia	Nymphalidae	Blue pansy	NE
Junonia chorimene	Nymphalidae	Variable pansy	NE
Junonia terea terea	Nymphalidae	Brown pansy	NE
Coeliades forestan forestan	Hesperiidae	Forest swift	NE
Platylesches moritili	Hesperiidae	Moritili hopper	NE
Borbo borbonica borbonica	Hesperiidae	African grass skipper	NE

Borbo gemella	Hesperiidae	Twin grass skipper	NE
Zizula hylax	Lycaenidae	Tiny grass blue	LC
Musca domestica	Muscidae	House fly	NE
Xysticus sp.	Thomisidae	Crab spider	NE
Spider sp.	Araneae	Large spider	NE
Epocilla calcarata	Salticidae	Jumping spider	NE
Austracantha sp.	Araneidae	Spiny orb-weaver spider	NE
Allonemobius sp.	Gryllidae	Ground cricket	NE
Sphodromantis gracilicollis	Mantidae	African praying mantis	NE
Dorylus labiatus	Formicidae	Driver ant	NE
Gryllotalpa gryllotalpa	Gryllotalpidae	Mole cricket	NE
Tholymis tillarga	Libellulidae	Coromandel marsh hawk	NE
Sympetrum sp.	Libellulidae	Darter dragonfly	NE
Orthetrum sp.	Libellulidae	Skimmer dragonfly	NE
Anisoptera sp.	Odonata	Dragonfly	NE
Anax sp.	Aeshnidae	Emperor dragonfly	NE
Odonata sp.	Odonata	Dragonfly	NE
Pelecinus sp.	Pelecinidae	Pelecinid wasp	NE
Sceliphron sp.	Sphecidae	Mud-dauber wasp	NE
Chlorion sp.	Sphecidae	Blue mud wasp	NE
Prionyx sp.	Sphecidae	Sand wasp	NE
Apis mellifera	Apidae	Western honey bee	LC
Ceratina sp.	Apidae	Small carpenter bee	NE
Papilio antimachus	Papilionidae	African giant swallowtail	NE
Papilio nireus	Papilionidae	Green-banded swallowtail	NE
Papilio demodocus	Papilionidae	Citrus swallowtail	NE
Graphium leonidas	Papilionidae	Veined jay	NE
Danaus chrysippus	Nymphalidae	African monarch	NE
Junonia oenone	Nymphalidae	Lemon pansy	NE
Hypolimnas misippus	Nymphalidae	Danaid eggfly	NE
Bicyclus dorathea	Nymphalidae	Dorathea bush brown	NE
Catopsilia florella	Pieridae	African emigrant	NE
Eurema hecabe	Pieridae	Common grass yellow	NE
Anthene amarah	Lycaenidae	Amarah ciliate blue	NE
Deudorix antalus	Lycaenidae	Common guava blue	NE
Borbo barbonica	Hesperiidae	Grass skipper	NE
Polistes africanus	Vespidae	African paper wasp	NE
Polistes marginalis	Vespidae	Paper wasp	NE
Cyphonomyx bretonii	Scoliidae	Flower wasp	NE
Rhynchophorus phoenicis	Curculionidae	African Palm weevil	NE

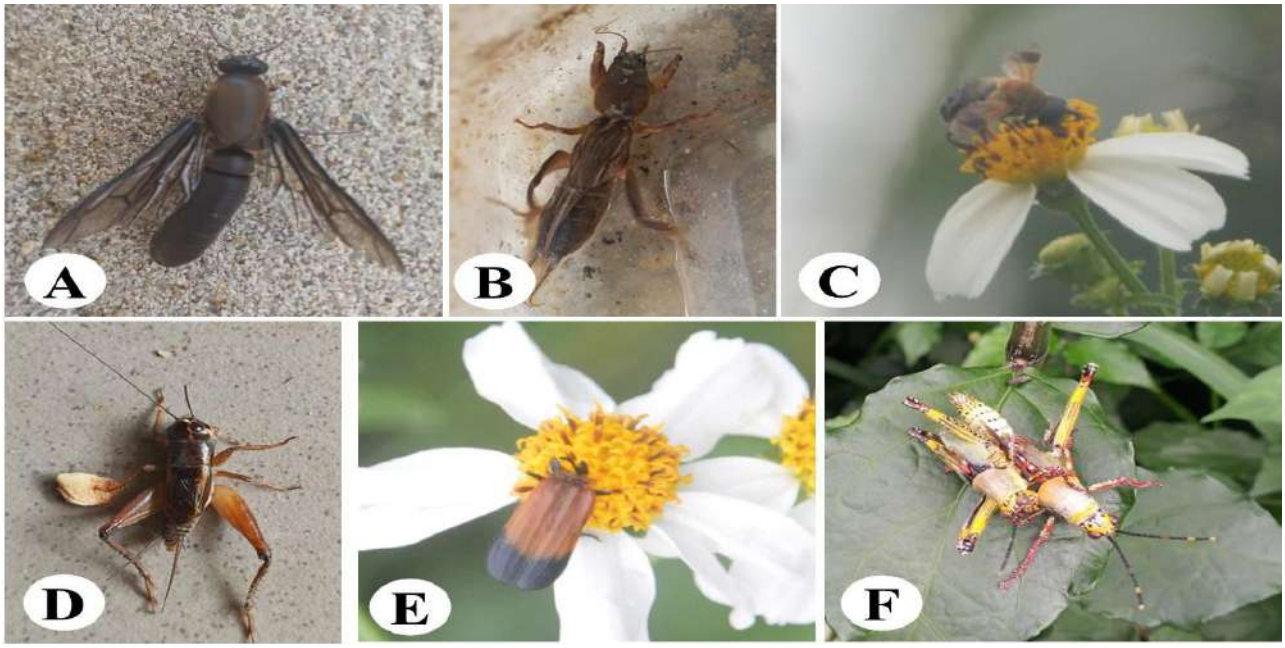


FIGURE 7-44: INSECT COMMUNITY IN THE STUDY AREA, (A) DIPTERA, (B) ORTHOPTERA (GRYLLOTALPIDAE), (C) HYMENOPTERA, (D) ORTHOPTERA (GRYLLIDAE), (E) COLEOPTERA, (F) ORTHOPTERA (ACRIDIDAE).

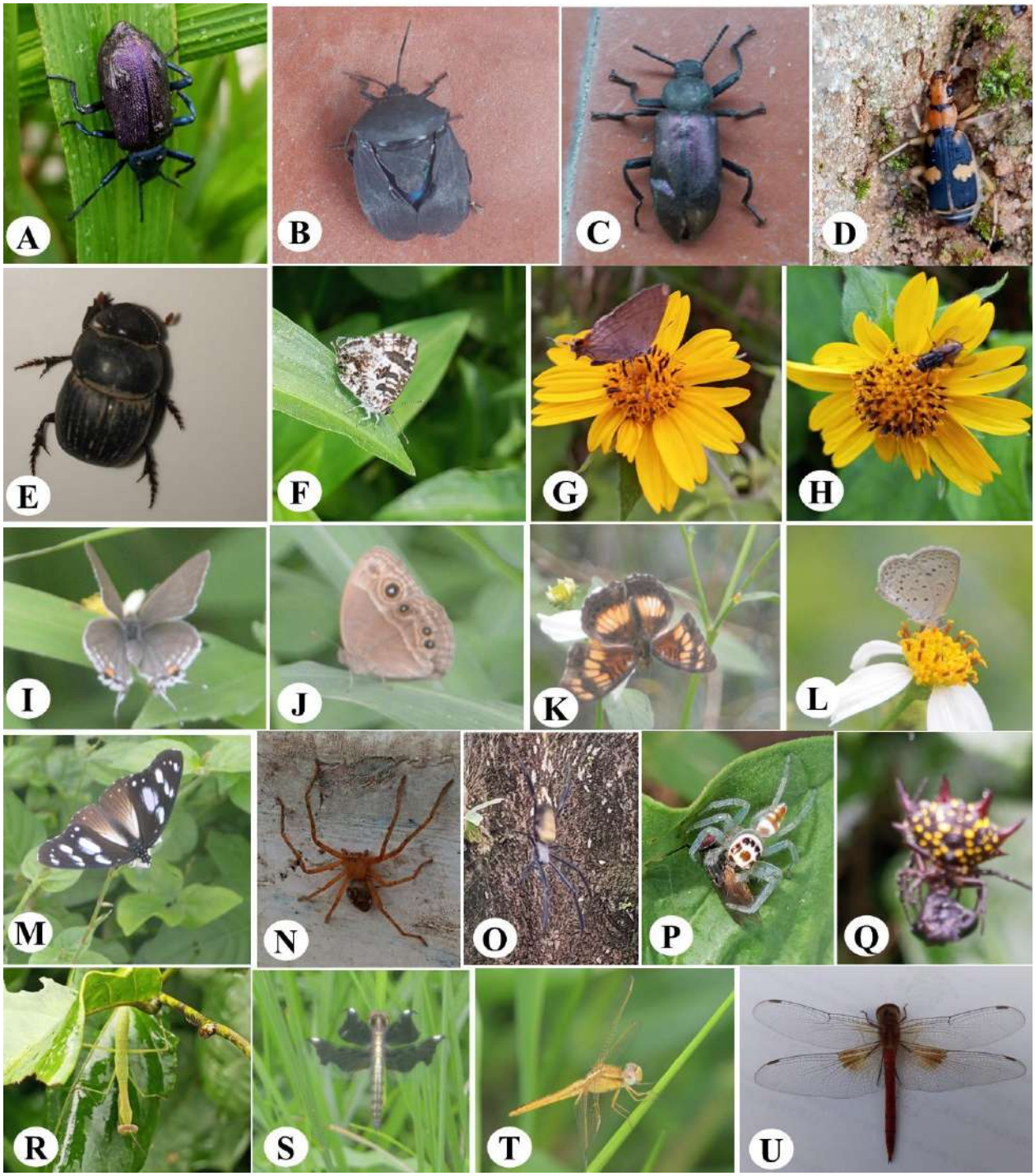


FIGURE 7-45: INSECT SPECIES; (A) *STRONGYLIUM PURPURIPENNE*, (B) *CHLOROCHROA LIGATA*, (C) *PHEROPSOPHUS AFRICANUS*, (D) *COPRIS LUNARIS*, (E) *CACYREUS LINGEUS*, (F) BUTTERFLY, (G) HOUSE FLY, (H) *XYSTICUS SP.*, (I) LARGE SPIDER, (J) *JUNONIA SOPHIA*, (K) *EPOCILLA CALCARATA*, (L) *AUSTRACANTHA SP.*, (M) *ALLONEMOBIUS SP.*, (O) PRAYING MANTIS, (P)

DORYLUS LABIATUS, (Q) *GRYLLOTALPA GRYLLOTALPA*, AND (R) *THOLYMIS TILLARGA*

7.5.5 AQUATIC BIODIVERSITY

The field survey and sample collection for aquatic biodiversity was done from 16th to 18th October 2025 for Wet Season, and from 17th to 19th February 2026 for Dry Season. The sampling stations (Table 7-73) considered for this study are the same as for surface water and sediment studies, and were chosen based on hydrological connectivity, project footprint and potential upstream/downstream impacts. Okulu River is the surface water body within the influence zone of proposed project. The Okulu River runs from the Agbonchia end (where it is non-tidal freshwater) to Aleto area (now tidal); runs into the Akpajo/Woji creek before meeting the Amadi creek and finally discharge into Bonny channel which receives Atlantic Ocean water. One sampling station (SW1) was located in the non-tidal freshwater Agbonchia area, while six (SW2 to SW7) were located in the tidal Aleto area up to the NNPC housing. Control stations were established outside the area of influence. Two freshwater control stations were chosen (one upstream of SW1 and one in the Imo River), while two brackish water control stations were located downstream. The sampling stations/codes and their coordinates recorded during the fieldwork are presented in Table 7-73 and plotted in Figure 7-46. Triplicate samples were obtained from each station. Sampling in the tidal stations was conducted in triplicate at both low tide and high tide.

TABLE 7-73: SAMPLING STATIONS FOR SURFACE WATER/SEDIMENT/AQUATIC BIODIVERSITY

Station	Description	GPS Co-ordinates	
		North (N)	East (E)
SW1	Okulu River - Agbonchia section (Near Bridge)	N04°48'34.69"	E007° 7'31.67"
SW2	Okulu River - Aleto section	N04^0 48’ 32.8”	E007^0 06’ 57.2”
SW3	Okulu River - Aleto section (Near Pipeline)	N04^0 48’ 28.8”	E007^0 06’ 39.7”
SW4	Okulu River – Aleto section (Outfall Area)	N04^0 48’ 38.2”	E007^0 06’ 39.9”
SW5	Okulu River - Aleto section (Near E-W Bridge)	N04^0 48’ 25.2”	E007^0 06’ 07.3”
SW6	Okulu River - Aleto section (Near NNPC housing)	N04°48'59.17”	E007° 4'56.90"
SW7	Okulu River – D/S of NNPC housing	N04°48'54.47"	E007° 5'6.63"
SWC1	Woji/Elenwo Creek Upstream	N04^0 49’ 06.5”	E007^0 04’ 20.2”
SWC2	Bonny Estuary at George/Kalo Ama Area	N04^0 45’ 16.6”	E007^0 04’ 08.8”
SWC3	Upstream of SW1	N04°48'28.56"	E007° 8'39.89"
SWC4	Imo River (Near Imo Gate)	N0 4°53'17.68"	E00 7° 8'43.77"

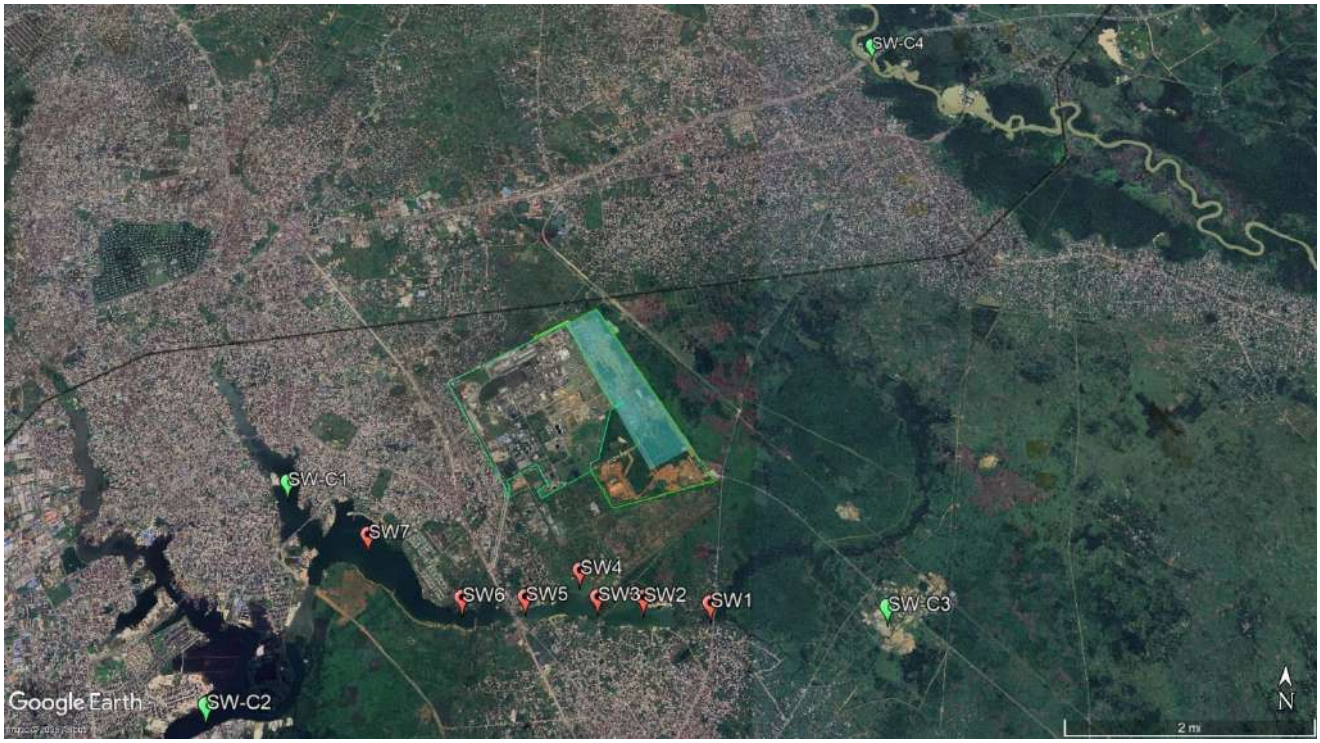


FIGURE 7-46: STUDY SAMPLING MAP

7.5.5.1 FRESH WATER AND ESTUARINE AQUATIC FLORA

Aquatic Macrophytes

Aquatic macrophytes were studied by visual assessment in the field and photographed. No floating aquatic macrophytes were observed in much of the stretch of the brackish water stations and controls (Figure 7-47); SW2, SW3, SW4, SW5 and SW6 had relics of riparian forest. The macrophytes at SWC2 were *Nypa fruticans*, alongside native mangrove species including the red mangrove (*Rhizophora racemosa, R. harrisonii* and *R. mangle*) and the white mangrove (*Laguncularia racemosa*). Mangrove vegetation Rhizophora with *Nypa fruticans*, and a few stands of *Acrosticum* were observed at SWC1. The freshwater stations had riparian vegetation at SW1 and SWC3. Aquatic plants such as *Saciolepsis africana, Nymphaea lotus* and *Paspalium* sp. were found at SW1 while SWC3 (Figure 7-48) had ferns, *Cyphostemma* sp. and SWC4 had aquatic plants such as *Ipomea aquatic* and *Saciolepsis africana.*

Wet Season	Dry Season
	
SW2	
	
SW3	
	
SW4	
	
SW5	

Wet Season	Dry Season
	
SW6	
	
SW7	
	
SWC1	
	
SWC2	

FIGURE 7-47: TIDAL BRACKISH WATER STATIONS



FIGURE 7-48: NON-TIDAL FRESHWATER STATIONS

Phytoplankton

The phytoplankton composition from the study area is presented in Table 7-74 and Table 7-75. In the wet season (Table 7-74), the phytoplankton consisted of seven (7) genera of bacillariophyeae (diatoms) and two genera of chlorophyceae (green algae). The relative abundance (Figure 7-49) showed that bacillariphyceae accounted for 90 % in two stations to 100 % in six of the brackish water stations, and 80% to 85% in the freshwater stations. *Synedra* and *Nitzschia* were the most widely distributed diatoms. The green algae *Spyrogyra* was found only in the freshwater stations and SW2 the brackish water station with the lowest salinity values (data in surface water chemistry report). The dominance of diatoms is

consistent with some other studies in the Niger Delta (Akpan 2006, Davies & Nwosu, 2019, George *et al*., 2021). The ranges of phytoplankton community indices were: Margalef (0.327 to 0.906); Shannon-Weiner (0.995 to 1.696); Pielou (0.847 to 0.962); and Simpson- 0.200 to 0.405). No phytoplankton was recovered from the samples at SW1 because of the high throughput of water from high velocity as indicated in the surface water chemistry report.

In the dry season (Table 7-75), phytoplankton consisted of ten (10) genera of bacilariophyceae, and one genus each of Chlorophyceae and chrysophyceae. Baciillariophyceae accounted for 60% at SW5 to 100% in four brackish water stations, and also 50% at SWC2 to 100% at SW1 amongst the freshwater stations (Figure 7-50). SW1 from which no phytoplankton was observed in the wet season because of the high-water velocity now had some standing stock as the water velocity had substantially reduced.

TABLE 7-74: COMPOSITION AND DISTRIBUTION OF PHYTOPLANKTON IN THE STUDY (WET SEASON)

Taxa	**Brackish Water**								**Fresh Water**		
	SW2	**SW3**	**SW4**	**SW5**	**SW6**	**SW7**	**SWC1**	**SWC2**	**SW1**	**SWC3**	**SWC4**
BACILLARIOPHYCEAE											
Synedra spp	50	225	75	75	100	50	125	125	0	175	150
Nitzschia spp	50	125	75	50	100	50	75	150	0	75	75
Coscinodiscus spp	75	125	0	0	25	0	25	25	0	0	0
Gyrosigma spp	0	0	0	0	0	0	50	50	0	0	0
Navicula spp	0	0	25	25	25	0	0	25	0	0	0
Cyclotella sp	25	0	0	0	0	25	25	0	0	150	0
Fragillaria sp	25	0	0	0	0	0	0	0	0	75	0
CHLOROPHYTCEA**E**											
Spirugyra spp	25	0	0	0	0	0	0	0	0	75	50
Chaetophora sp	0	0	0	0	0	0	25	0	0	0	0
No of Genera	6	3	3	3	4	3	6	5	5		3
Abundance (N): cells/L	250	475	175	150	250	125	325	375	550		275
Margalef Richness (d)	0.906	0.325	0.387	0.399	0.543	0.414	0.865	0.675	0.634		0.356
Pielou Evenness (J')	0.946	0.962	0.914	0.921	0.861	0.960	0.885	0.847	0.953		0.906
Shannon-Weiner Diversity (H')	1.696	1.057	1.004	1.011	1.194	1.055	1.586	1.362	1.534		0.995
Simpson Dominance (λ)	0.200	0.363	0.388	0.389	0.34	0.36	0.243	0.298	0.231		0.405

TABLE 7-75: COMPOSITION AND DISTRIBUTION OF PHYTOPLANKTON IN THE STUDY (DRY SEASON)

Taxa	Brackish Water								Freshwater		
	SW2	SW3	SW4	SW5	SW6	SW7	SWC1	SWC2	SW1	SWC3	SWC4
BACILLARIOPHYCEAE											
Synedra spp	50	25	125	75	25	50	25	150	100	0	0
Nitzschia spp	150	125	100	0	125	75	150	225	150	75	75
Coscinodiscus spp	225	200	450	0	50	325	25	0	0	75	0
Gyrosigma spp	0	0	75	0	25	0	0	125	0	0	0
Thalassiosira spp	0	0	25	0	25	100	25	100	0	0	0
Navicula spp	0	25	50	75	25	0	25	50	0	0	0
Cyclotella spp	0	0	200	0	0	0	0	25	0	0	0
*Asterionell*a spp	0	0	0	0	0	0	0	25	0	0	50
Skeletonema costatum	0	0	0	0	0	0	0	25	0	0	0
Thalassiosira decipiens	0	0	0	0	0	0	0	50	0	0	0
CHLOROPHYCEAE											
Spirogyra spp	0	0	0	0	0	0	0	175	0	75	125
CHRYSOPHYCEAE											
Synura spp	0	0	300	100	0	0	0		0	0	0
No of Genera	3	4	8	3	6	4	5	10	2	3	3
Abundance (N): cells/L	425	375	1325	250	275	550	250	950	250	225	250
Margalef Richness (d)	0.331	0.506	0.974	0.362	0.890	0.475	0.724	1.313	0.181	0.369	0.362
Pielou Evenness (J')	0.870	0.767	0.850	0.991	0.860	0.801	0.763	0.888	0.971	1.000	0.937
Shannon-Weiner Diversity (H')	0.956	1.063	1.767	1.089	1.540	1.111	1.228	2.045	0.673	1.099	1.030
Simpson Dominance (λ)	0.419	0.404	0.209	0.340	0.273	0.409	0.400	0.151	0.520	0.333	0.380

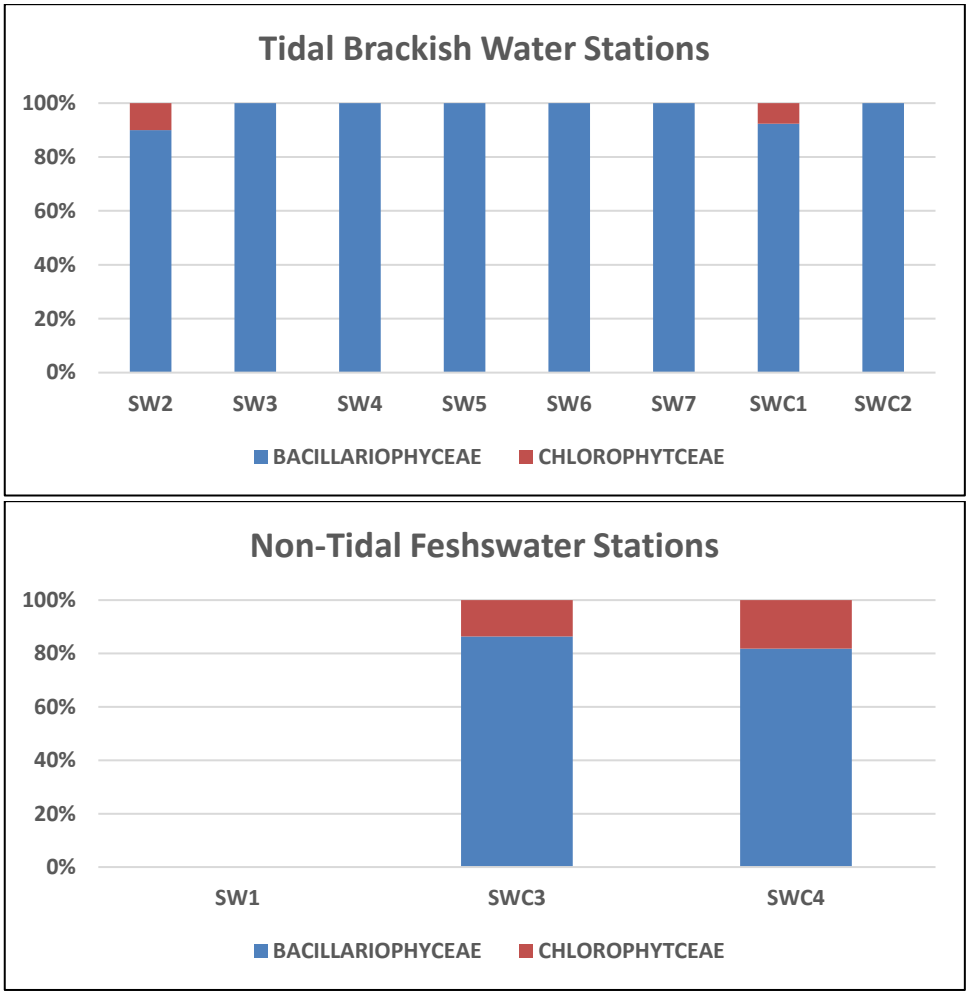


FIGURE 7-49: RELATIVE ABUNDANCE OF PHYTOPLANKTON (WET SEASON)

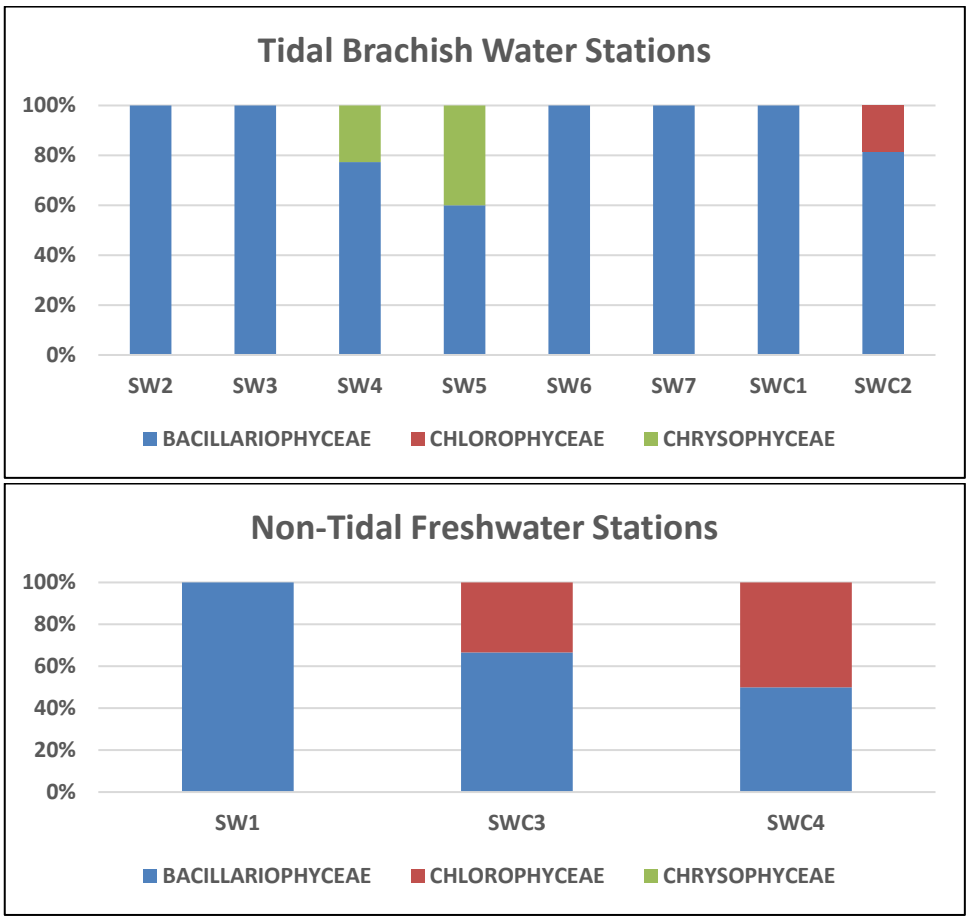


FIGURE 7-50: RELATIVE ABUNDANCE OF PHYTOPLANKTON (DRY SEASON)

7.5.5.2 FRESH WATER AND ESTUARINE AQUATIC FAUNA

Fish and Fisheries

Fishing activities were observed in the study area but mostly at the subsistence level. During the fieldwork periods, some fishers were observed in dug-out canoes using cast nets, seine or hooks and occasionally casting nets or lunching hooks from the banks. No fishing activity was observed in the freshwater station at Agbonchia section of the river (SW1) or the upstream Control station (SWC3). Also, no fishing activity was observed in the freshwater control at the Imo River (SWC4), but some catfish (*Chrisichthys nigrodigitatus*) were found on display for sale.

Thirteen species of fish were found during the biodiversity study of Okulu River and its upper Bonny Estuary environs in October 2025 (Figure 7-51 and Table 7-76). The black-chin tilapia *Sarotherodon melanotheron* and *Sardinella maderensis* were dominant. The other species caught during the October 2025 sampling were *Coptodon guineensis*, *Neochelon falcipinnis*, *Mugil cephalus*, *Lutjanus agennes*, *Eucinostomus melanopterus*, *Monodactylus sebae*, *Pomadasys jubelini*, *Brycinus nurse*, *Sardinella aurita*, *Elops lacerta* and *Chrysichthys nigrodigitatus*. Eleven species of fish were caught in the dry season (January 2026) samples (Table 7-77), and species not recorded during the wet season (*Liza grandisquamis*, *Caranx*

hippos and *Epinephelus aeneus*) are shown in Figure 7-52. *Sarotherodon melanotheron* and *Sardinella maderensis* were also dominant in the dry season. length-frequency distributions are presented in Figure 7-53 for *Sarotherodon melanotheron* and *Sardinella maderensis*. In the wet season, the modal length of *S. melanotheron* was 14.9 to 16.66 cm while that of *S. maderensis* was 10.0 to 11.4 cm (Figure 7-53). The modal lengths were lower in the dry season for both species (Figure 7-54). In the wet season, the modal weight class of *S. melanotheron* was 48.9 to 64.4g while *S. maderensis* was 10.5 to 14.3 g (Figure 7-55). Dry season values were lower than wet season (Figure 7-56).

In the wet season, the equation derived was LogWeight = -1.406 + 2.689LogLength for *Sarotherodon* and LogWeight = -1.964 + 2.868LogLength for *Sardinella*. The regression showed that both *Sarotherodon melanotheron* and *Sardinella maderensis* exhibited negative allometric growth patterns with "b" value which is the weight at unit length of the fish of was < 3. Similarly, regression equation for *Sarotherodon melanotheron* showed negative allometric growth pattern. However, *Sardinella maderensis* exhibited negative allometric growth patterns with "b" value >3 and this can be attributed to the predominantly small sizes. The Fulton's condition factors of the *S. melanotheron* ranged from 0.94 to 2.47 with a mean value of 1.76 while the condition factors of the *S. maderensis* ranged from 0.54 to 1.07 with a mean value of 0.80 (Table 7-78). 1.73 and 0.87 for *S. melanotheron* and *S. maderensis* respectively (Table 7-79). According to Bennet (1970), Fulton's condition factor of 0.56 is considered as well-being benchmark value of a fish; hence fishes with condition factor values above the well-being benchmark were considered to be in good condition.

TABLE 7-76: COMPOSITION AND ABUNDANCE OF FISH SPECIES (WET SEASON)

Scientific Name	Comon Name	Abundance Score	IUCN Status	CITES
Sarotherodon melanotheron	(Black-chin tilapia	Dominant	Least Concern	Not Evaluated
Sardinella mederensis	Madeiran sardinella	Dominant	Vulnerable	Not Evaluated
Sardinella aurita	(Round sardinella	Abundant	Least Concern	Not Evaluated
Eucinostomus melanopterus	Flagfin mojarra	Abundant	Least Concern	Not Evaluated
Coptodon guineensis	Guinean tilapia	Abundant	Least Concern	Not Evaluated
Monodactylus sebae	African moony	Abundant	Least Concern	Not Evaluated
Pomadasys jubelini	Sompat grunt	Abundant	Least Concern	Not Evaluated
Neochelon falcipinnis	Sickle-fin mullet	Common	Data Deficient	Not Evaluated
Mugil cephalus	Flathead grey mullet	Common	Least Concern	Not Evaluated
Lutjanus agennes	African red snapper	Common	Data Deficient	Not Evaluated
Chrysichthys nigrodigitatus	Bagrid catfish	Common	Least Concern	Not Evaluated
Brycinus nurse	Nurse tetra	Common	Least Concern	Not Evaluated
Elops lacerta	West African ladyfish	Common	Least Concern	Not Evaluated

TABLE 7-77: COMPOSITION AND ABUNDANCE OF FISH SPECIES (DRY SEASON)

Scientific Name	Comon Name	Abundance Score	IUCN Status	CITES
Sarotherodon melanotheron	Black-chin tilapia	Dominant	Least Concern	Not Evaluated
Sardinella mederensis	Madeiran sardinella	Dominant	Vulnerable	Not Evaluated

Scientific Name	Comon Name	Abundance Score	IUCN Status	CITES
Eucinostomus melanopterus	Flagfin mojarra	Abundant	Least Concern	Not Evaluated
Coptodon guineensis	Guinean tilapia	Abundant	Least Concern	Not Evaluated
Monodactylus sebae	African moony	Abundant	Least Concern	Not Evaluated
Pomadasys jubelini	Sompat grunt	Abundant	Least Concern	Not Evaluated
Neochelon falcipinnis	Sickle-fin mullet	Common	Data Deficient	Not Evaluated
Lutjanus agennes	African red snapper	Common	Data Deficient	Not Evaluated
Caranx hippos	Creville jack	Common	Least Concern	Not Evaluated
Epinephelus aeneus	White grouper	Common	Near Threatened	Not Evaluated
Liza grandisquamis	large-scaled mullet	Common	Data Deficient	Not Evaluated

The spatial boundaries of the study where the Okulu River at Aleto and Agbonchia are located do not fall within any national legally protected area or an internationally recognized area. Nigeria presently has 11 sites designated as Wetlands of International Importance (Ramsar Sites), with a surface area of 1,076,728 hectares spreading across the six geopolitical regions in Nigeria. (https://www.ramsar.org/news/nine-new-ramsar-sites-in-nigeria). The study area is not an aquatic critical or sensitive fish habitat. There are no endemic species, and the IUCN status of the fish were mostly Least Concern or Data Deficient. Only the mandarin sardinella, *Sardinella maderensis* is listed as vulnerable globally and *Epinephelus aeneus* as near threatened (caught at a control location – SWC2 in the dry season). All the species fall in the Not Evaluated category in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).



Sarotherodon melanotheron (Black-chin tilapia)



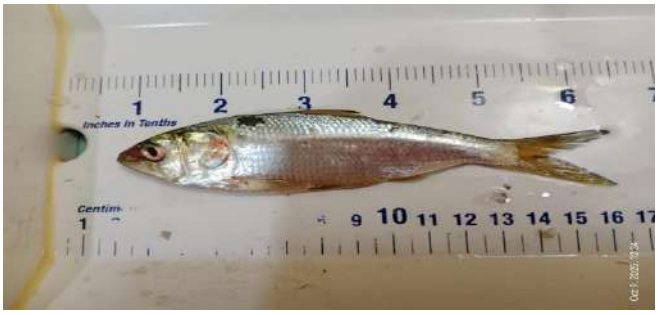
Coptodon guineensis (Guinean tilapia)



Neochelon falcipinnis (Sickle-fin mullet)



Mugil cephalus (Flathead grey mullet)



Sardinella maderensis (Madeiran sardinella)



Sardinella aurita (Round sardinella)



Lutjanus agennes (African red snapper)



Eucinostomus melanopterus (Flagfin mojarra)



Monodactylus sebae (African moony)



Pomadasys jubelini (Sompat grunt)

FIGURE 7-51: EXAMPLE OF FISH SPECIES SAMPLED IN THE STUDY AREA



Chrysichthys nigrodigitatus (Bagrid catfish)



Brycinus nurse (Nurse tetra)



Elops lacerta (West African ladyfish)



Liza grandisquamis (large-scaled mullet)

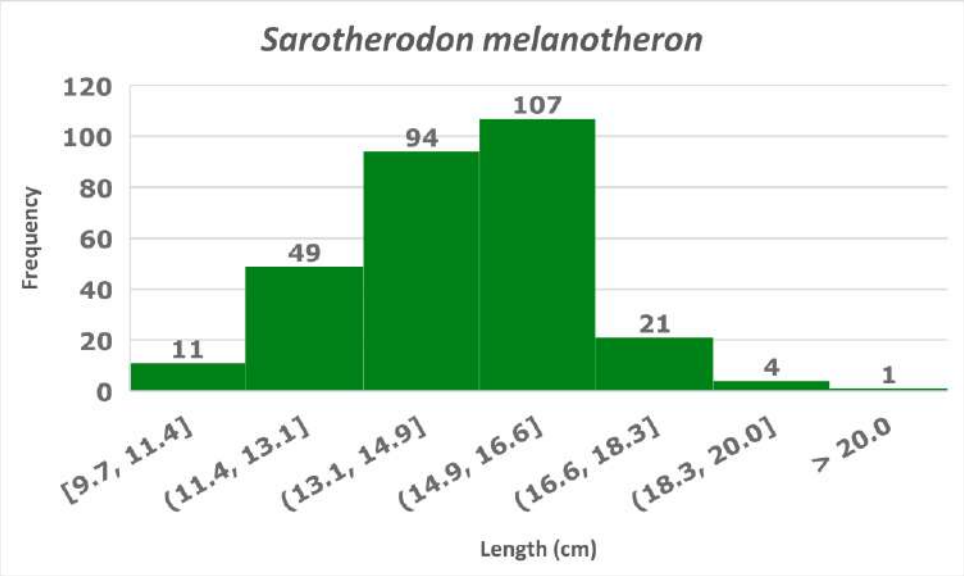


Caranx hippos (Creville jack)



Epinephelus aeneus (White grouper)

FIGURE 7-52: EXAMPLE OF FISH SPECIES SAMPLED IN THE STUDY AREA



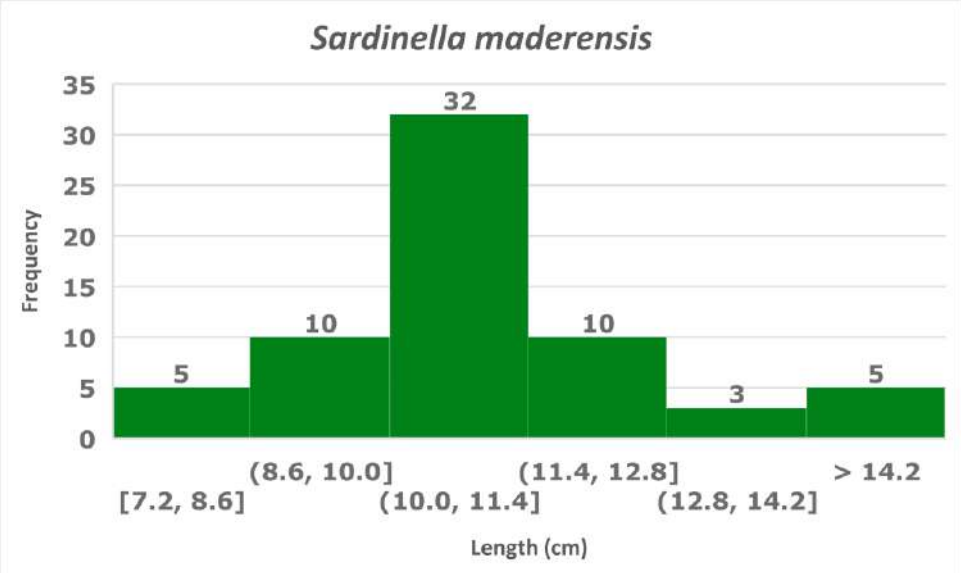
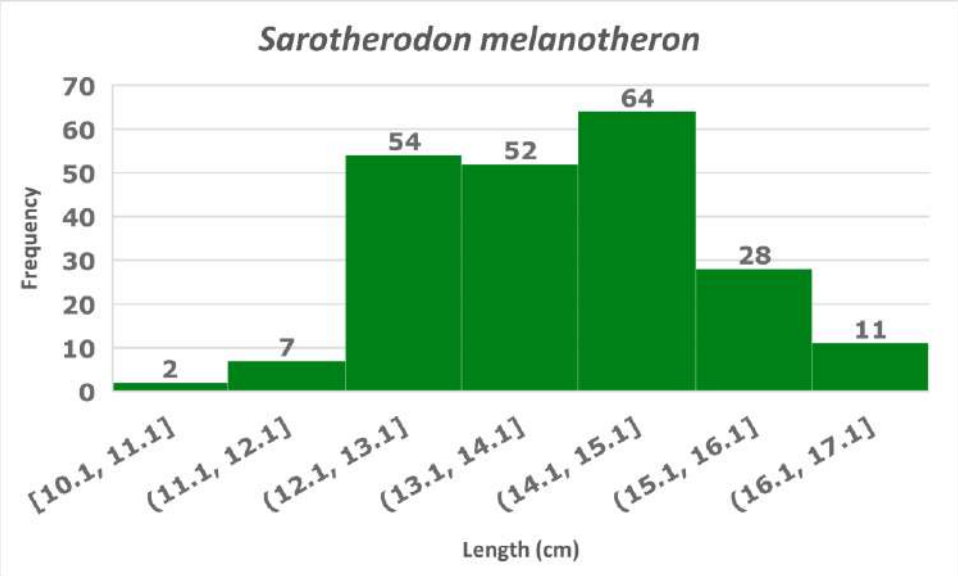


FIGURE 7-53: LENGTH - FREQUENCY HISTOGRAMS OF SOME FISH IN THE STUDY AREA (WET SEASON - OCTOBER 2025)


Sarotherodon melanotheron
Frequency
70
60
50
40
30
20
10
0
2
7
54
52
64
28
11
[10.1, 11.1]
(11.1, 12.1]
(12.1, 13.1]
(13.1, 14.1]
(14.1, 15.1]
(15.1, 16.1]
(16.1, 17.1]
Length (cm)

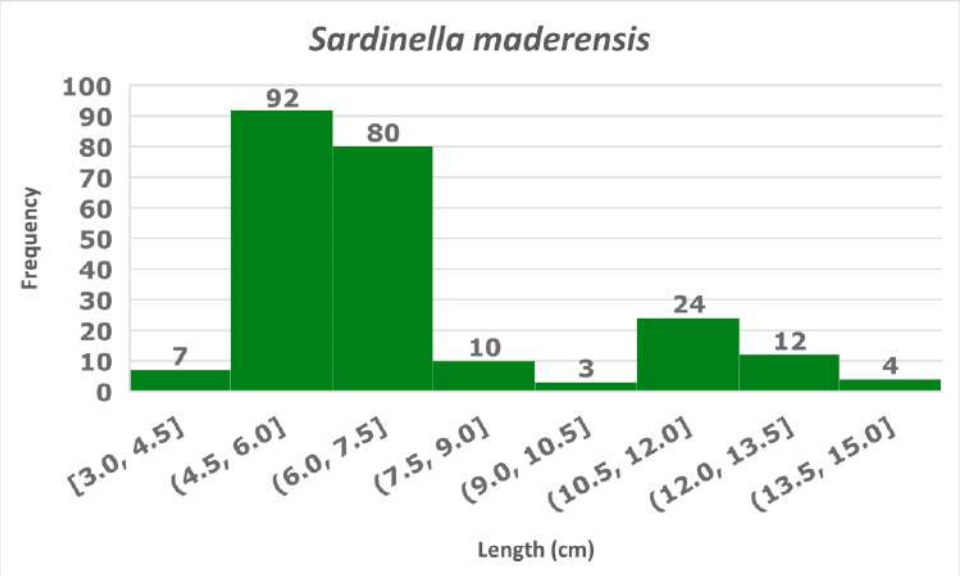
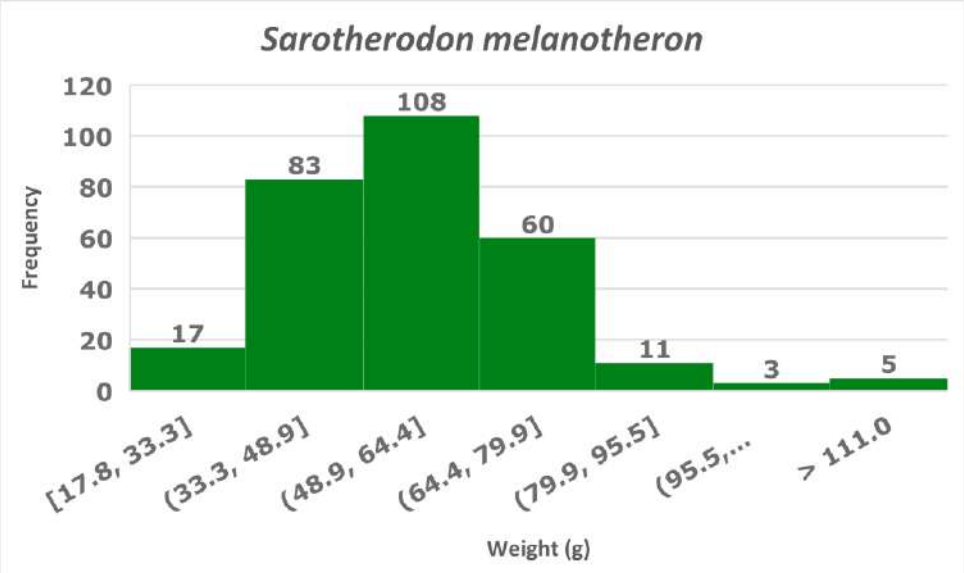


FIGURE 7-54: LENGTH - FREQUENCY HISTOGRAMS OF SOME FISH IN THE STUDY AREA (DRY SEASON - JANUARY 2026)



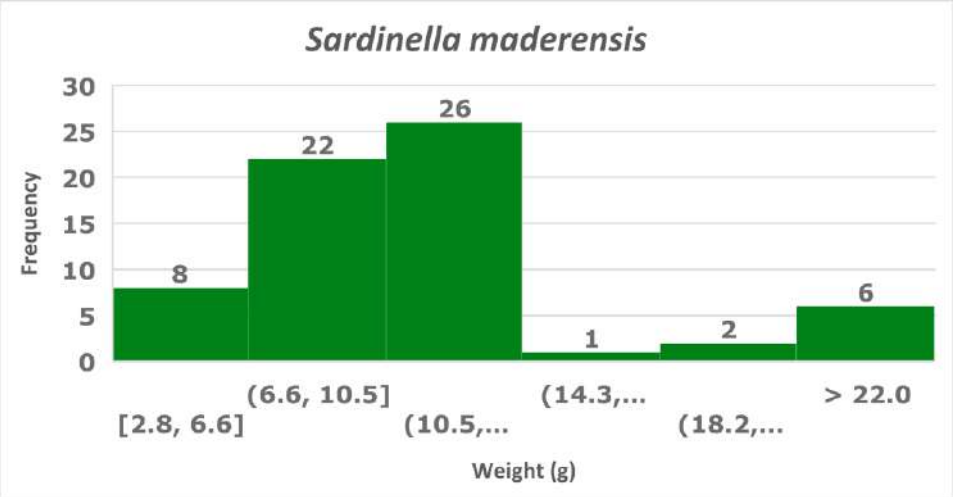
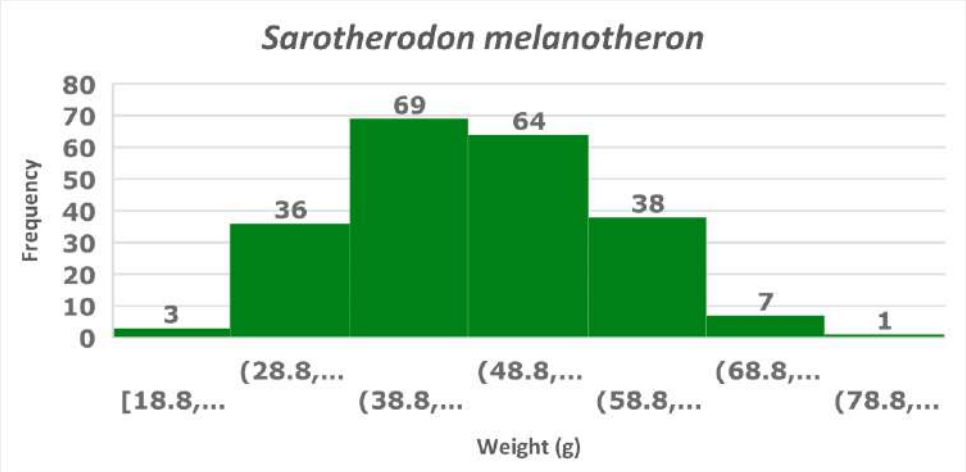


FIGURE 7-55: WEIGHT - FREQUENCY HISTOGRAMS OF SOME FISH IN THE STUDY AREA (WET SEASON - OCTOBER 2025)



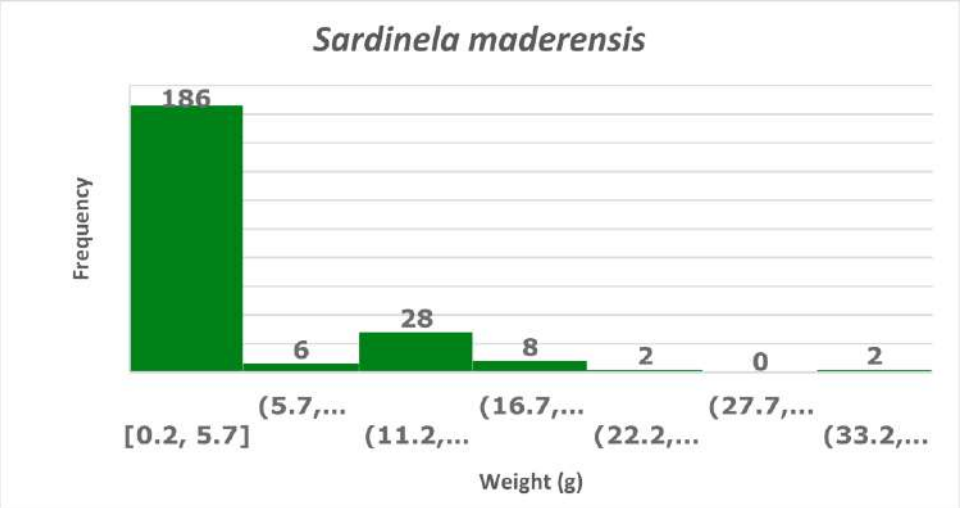


FIGURE 7-56: WEIGHT - FREQUENCY HISTOGRAMS OF SOME FISH IN THE STUDY AREA (DRY SEASON - JANUARY 2026)

TABLE 7-78: STATISTICAL SUMMARY OF CONDITION FACTORS OF MOST DOMINANT FISH CAUGHT (WET SEASON)

	Sarotherodon melanotheron	***Sardinella maderensis***
Minimum	0.94	0.54
Maximum	2.47	1.07
Mean	1.76	0.80
Standard Deviation	0.16	0.13
Count	287	65

TABLE 7-79: STATISTICAL SUMMARY OF CONDITION FACTORS OF MOST DOMINANT FISH CAUGHT (DRY SEASON)

	Sarotherodon melanotheron	***Sardinella maderensis***
Minimum	1.36	0.16
Maximum	2.15	2.87
Mean	1.73	0.87
Standard Deviation	0.13	0.21
Count	218	232

Benthos

The composition and abundance of benthic organisms in the study area are presented in Table 7-80 and Table 7-81. Five major taxa namely Polychaeta (10 genera), Oligochaeta (2 genera), Mollusca (3 genera) and Crustacea (2 genera) and Insecta (1 genus) were recorded.

Polychaeta were observed in all the brackish water stations (except SW2), accounting for 35% at SW4 (with oligochaetes 75%) to 100% at SW3. Mollusca (5% at SWC5 to 100% at SW2) was also observed five brackish water stations (Table 7-80). In the freshwater stations, only Oligochaeta (57% in SWC3, 50% in SWC4) and Insecta (43% in SWC3 and 50% in SWC4) were recorded. *Nereis* and *Nephtys* were the most widely distributed polychaete genera (4 stations) followed by Capitella (3 stations) and *Lumbrineris* in 2 stations. The oligochaete *Eiseniella tetraedra* was found in the freshwater stations (SWC3 and SWC4) and SW2 while *Ophidonais serpentina* was found only at SWC3 (Figure 7-57). The ranges of community indices of benthic organisms (not calculated for SW2 with only 1 genus) were: Margalef- 0.217 to 1.418; Shannon-Weiner- 0.641 to 1.837; Pielou- 0.667 to 0.925 and Simpson- 0.205 to 0.551. No benthic organism was recorded in the sample from SW1 probably due to alteration to the sediment via removal and concrete placement at recently reconstructed bridge crossing. Benthic organisms were also not observed from SW1 in the dry season in tandem with wet season; In addition, no benthos was found in the other freshwater stations (SWC3 and SWC4) (Table 7-81) ostensibly due to the intensive sand dredging activities at these stations. While polychaetes and molluscs contribute equally to the benthos at SW7, they account for a higher proportion of the relative abundance at 4 stations and 2 stations respectively (Figure 7-58).

TABLE 7-80: COMPOSITION AND DISTRIBUTION OF BENTHOS IN THE STUDY AREA (WET SEASON)

TAXA	Brackish Water								Fresh Water		
	SW2	SW3	SW4	SW5	SW6	SW7	SWC1	SWC2	SW1	SWC3	SWC4
POLYCHAETA											
Nereis spp	0	100	0	0	317	100	25	0	0	0	0
Nephtys sp	0	8	0	8	50	0	0	8	0	0	0
Eunice spp	0	0	0	0	50	0	0	0	0	0	0
Lumbrineris spp	0	17	0	0	0	0	0	33	0	0	0
Glycera spp	0	0	0	0	25	0	8	0	0	0	0
Polydora spp	0	0	0	17	0	0	8	0	0	0	0
Streblospio spp	0	25	0	0	0	0	0	0	0	0	0
Capitella sp	0	0	17	0	0	0	8	33	0	0	0
Ophelina sp	0	0	0	0	0	0	0	17	0	0	0
Marphysa sanquinea	0	0	0	0	0	0	0	100	0	0	0
OLIGOCHAETA											
Eiseniella tetraedra	0	0	33	0	0	0	0	0	0	75	50
Ophidonais serpentina	0	0	0	0	0	0	0	0	0	25	0
MOLLUSCA											
Loripinus subfragilis	0	0	0	25	75	0	0	8	0	0	0
Tympanotonus fuscatus	50	0	0	0	0	33	0	0	0	0	0
Tellina sp	0	0	0	0	8	8	8	8	0	0	0

CRUSTACEA											
Penaeus sp	0	0	0	0	8	25	8	0	0	0	0
Lysiosquilla hoevenii	0	0	0	0	0	0	0	17	0	0	0
	0	0	0	0	8	25	8	17	0	0	0
INSECTA											
Chironomus ablabiesmia	0	0	0	0	0	50	0	58	0	75	50
No of Genera	1	4	2	3	7	5	6	9		3	2
Abundance (N): Num/m²	50	150	50	50	533	216	65	282		175	100
Margalef Richness (d)	0	0.599	0.256	0.511	0.956	0.744	1.198	1.418		0.387	0.217
Pielou Evenness (J')		0.701	0.925	0.916	0.667	0.841	0.925	0.836		0.914	1
Shannon-Weiner Diversity (H')	0	0.972	0.641	1.007	1.299	1.354	1.657	1.837		1.004	0.693
Simpson Dominance (λ)	1	0.488	0.551	0.391	0.394	0.306	0.224	0.205		0.388	0.5

TABLE 7-81: COMPOSITION AND DISTRIBUTION OF BENTHOS IN THE STUDY AREA (DRY SEASON)

Taxa	Brackish Water								Freshwater		
	SW2	SW3	SW4	SW5	SW6	SW7	SWC1	SWC2	SW1	SWC3	SWC4
POLYCHAETA											
Nereis spp	67	550	0	33	300	25	13	75	0	0	0
Nephtys spp	100	0	0	0	0	0	0	0	0	0	0
Lumbrineris spp	0	133	13	0	133	0	13	13	0	0	0
Marphysa sanquinea	0	0	0	17	367	0	0	0	0	0	0
Glycera spp	0	0	0	0	17	0	0	13	0	0	0
Streblospio spp	117	0	25	0	0	0	675	0	0	0	0
Polydora spp	0	0	25	0	0	0	1025	0	0	0	0
OLIGOCHAETA											
Ophidonais serpentine	50	0	200	0	0	0	0	0	0	0	0
Einseniella tetrahedron	0	0	125	0	0	0	0	0	0	0	0
INSECTA											
Chironomus ablabiesmia	0	0	0	0	0	0	13	13	0	0	0
CRUSTACEA											
Penaeus spp	0	0	0	17	17	0	0	0	0	0	0
MOLLUSCA											
Loripinus subfragilis	17	1217	13	167	0	0	13	50	0	0	0
Tellina spp	17	0	0	0	17	0	0	0	0	0	0
Tympanotonus fuscatus	0	0	0	0	0	25	0	0	0	0	0
PISCES	33	1217	13	167	17	25	13	50	0	0	0
Fish	0	0	0	33	0	0	0	0	0	0	0

No of Genera	6	3	6	5	6	2	6	5
Abundance (N): cells/L	368	1900	401	267	851	50	1752	164
Margalef Richness (d)	0.846	0.265	0.834	0.716	0.741	0.256	0.670	0.784
Pielou Evenness (J')	0.884	0.756	0.714	0.721	0.700	1.000	0.461	0.822
Shannon-Weiner Diversity (H')	1.584	0.830	1.279	1.161	1.255	0.693	0.827	1.323
Simpson Dominance (λ)	0.231	0.499	0.356	0.430	0.336	0.500	0.491	0.321

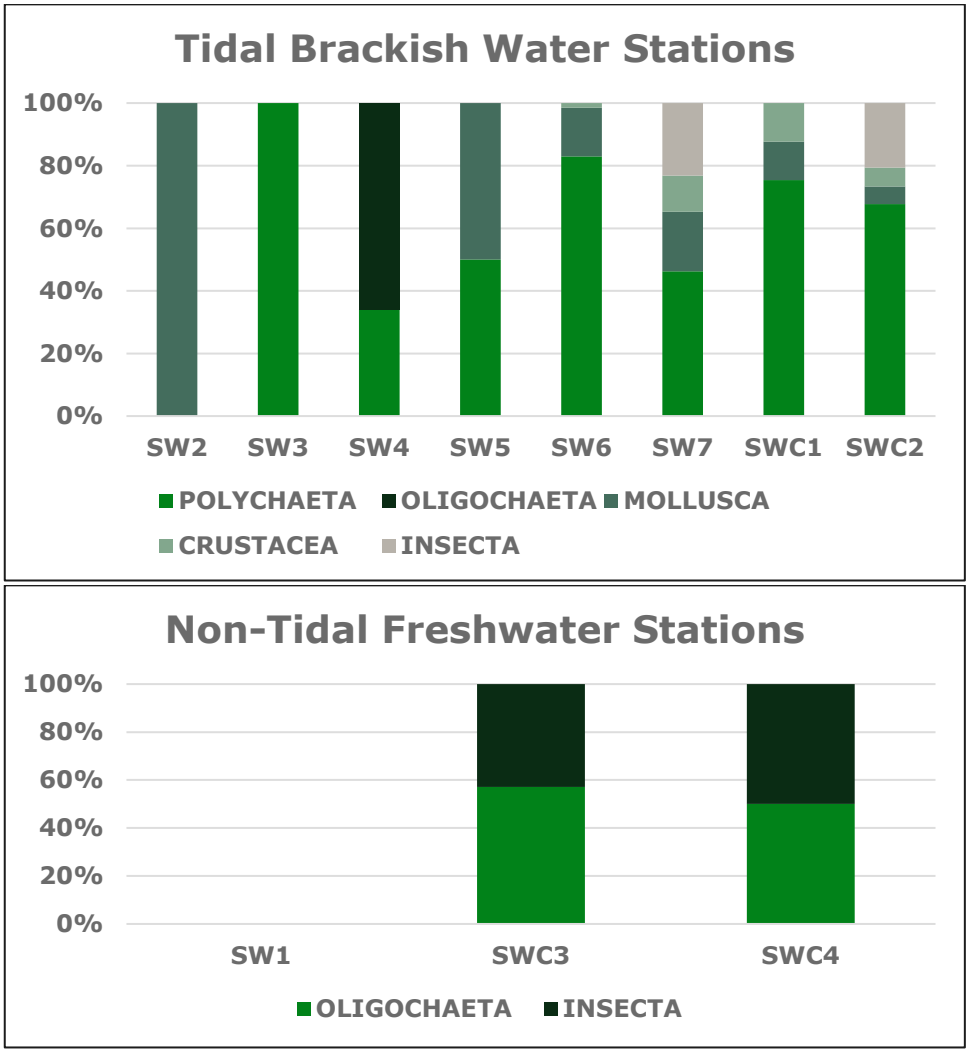


FIGURE 7-57: RELATIVE ABUNDANCE OF MAJOR TAXA IN THE BENTHOS (WET SEASON)

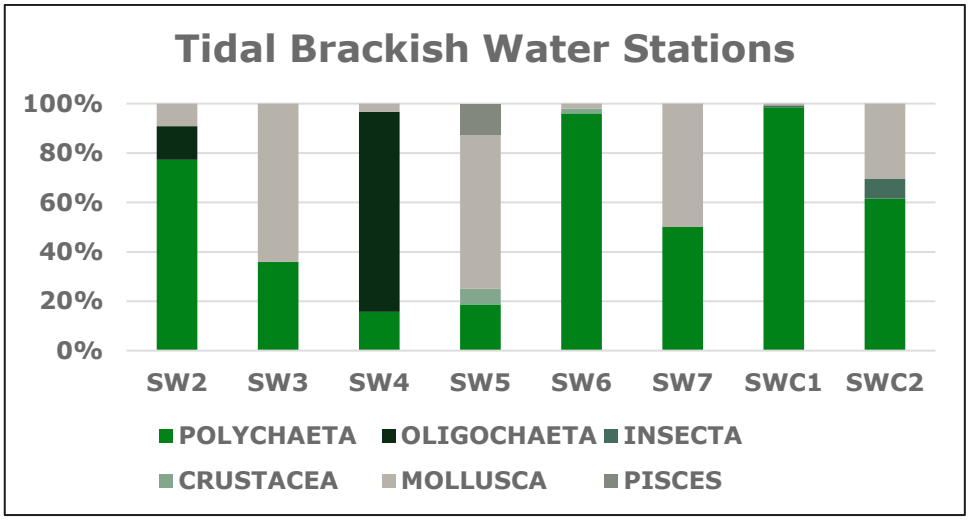


FIGURE 7-58: RELATIVE ABUNDANCE OF MAJOR TAXA IN THE BENTHOS (DRY SEASON)

zooplankton

The relative abundance of major taxa in the zooplankton is presented in Table 7-82 and Table 7-83. In the wet season (Table 7-82), copepods were the most dominant, accounting for between 90% to 100% of the relative abundance in the brackish water stations, and 75% to 80% in the freshwater stations (Figure 7-59). Cladocera were recorded from SW2 (the brackish water station with the lowest salinity (representing 10%) and 2 freshwater stations where they contributed between 20% to 25% Polychaete larva was observed in one station (SWC2) where it accounted for 6%. Thirteen putative genera comprising eleven copepod, one cladocera and one polychaeta were recorded. Copepod naupli were the most widely distributed amongst being found in all stations except SWC4. *Paracalanus* was recorded in all brackish water stations except SW4, *Diaptomus siciloides* was found in five brackish water and one freshwater station respectively while *Canthocampus* was observed from only one freshwater station. For cladocera, *Daphnia rosea* was recoded from the freshwater stations and the least saline brackish water station. The ranges of zooplankton community indices were: Margalef- 0.374 to 1.157; Shannon-Weiner- 1.040 to 1.871; Pielou- 0.843 to 0.968and Simpson- 0.183 to 0.375. As observed for phytoplankton, no zooplankton was recovered from the samples at SW1 for the condition adduced.

In the dry season, zooplankton fauna was observed in all stations (Table 7-83). Copepods accounted for 100% in all the brackish water stations, except SWC1 where a hydrozoan genus was found, and in abundance. In the freshwater stations, copepods were 100% at SWC2, but cladocera accounted for 35% and 45% respectively at SW1 and SWC3 (Figure 7-60).

TABLE 7-82: COMPARISON AND DISTRIBUTION OF ZOOPLANKTON IN THE STUDY AREA (WET SEASON)

TAXA	Brackish Water								Fresh Water		
	SW2	SW3	SW4	SW5	SW6	SW7	SWC1	SWC2	SW1	SWC3	SWC4

COPEPODA											
Nauplius	100	125	50	25	50	25	75	50	0	150	0
Paracalanus spp	50	25	0	50	25	100	50	125	0	0	0
Tortanus spp	0	0	0	0	0	0	50	50	0	0	0
Limnocalanus spp	0	50	0	0	0	50	0	100	0	0	0
Epischura lacustris	25	0	25	0	0	25	50	25	0	50	0
Parvocalanus spp	0	0	0	0	0	0	0	0	0	0	0
Pseudocalanus spp	25	0	0	50	0	0	0	25	0	0	0
Scenecella calanoides	25	25	25	25	0	0	0	0	0	0	100
Pseudodiaptomus pelagicus	0	0	0	0	0	0	0	0	0	0	0
Diaptomus siciloides	25	0	25	0	25	0	25	25	0	25	0
Canthocampus sp	0	0	0	0	0	0	0	0	0	0	50
CLADOCERA											
Daphnia rosea	25	0	0	0	0	0	0	0	0	50	50
POLYCHAETA											
Polychaete larva	0	0	0	0	0	0	0	25	0	0	0
No of Genera	7	5	4	4	3	4	5	8		4	3
Abundance (N): num/L	275	275	125	150	100	200	250	425		275	200
Margalef Richness (d)	1.068	0.712	0.621	0.599	0.434	0.566	0.724	1.157		0.534	0.378
Pielou Evenness (J')	0.908	0.879	0.961	0.959	0.946	0.875	0.968	0.9		0.843	0.946
Shannon-Weiner Diversity (H')	1.768	1.414	1.332	1.33	1.04	1.213	1.557	1.871		1.169	1.04
Simpson Dominance (λ)	0.207	0.289	0.28	0.278	0.375	0.344	0.22	0.183		0.372	0.375

TABLE 7-83: COMPARISON AND DISTRIBUTION OF ZOOPLANKTON IN THE STUDY AREA (DRY SEASON)

TAXA	**Brackish Water**								**Freshwater**		
	SW2	**SW3**	**SW4**	**SW5**	**SW6**	**SW7**	**SWC1**	**SWC2**	**SW1**	**SWC3**	**SWC4**
COPEPODA											
Nauplius	225	125	200	175	175	325	225	200	50	150	125
Paracalanus spp	225	125	225	100	25	200	75	100	0	100	0
Limnocalanus spp	0	0	0	0	0	0	0	0	200	0	50
Epischura lacustris	0	0	0	0	0	0	0	0	225	75	0
Tortanus spp	50	0	100	50	225	100	0	75	0	0	0
Parvocalanus spp	0	0	0	0	75	75	25	25	0	100	0
Pseudocalanus spp	150	100	225	50	0	50	0	25	0	75	0
Calanus finmachicus	0	100	75	0	75	0	0	75	0	0	0
Acartia spp	25	75	125	25	100	0	0	25	0	0	0
CLADOCERA											
Bosmina longirostris	0	0	0	0	0	0	0	0	225	100	0
Daphnia rosea	0	0	0	0	0	0	0	0	0	100	0

Ceriodaphnia lacustris	0	0	0	0	0	0	0	0	0	150	0
Moina spp	0	0	0	0	0	0	0	0	0	75	0
	0	0	0	0	0	0	0	0	225	425	0
HYDROZOA											
Rathkea octopunctata	0	0	0	0	0	0	25	0	0	0	0
No of Genera	5	5	6	5	6	5	4	7	4	9	2
Abundance (N): num/L	675	525	950	400	675	750	350	525	700	925	175
Margalef Richness (d)	0.614	0.639	0.729	0.668	0.768	0.604	0.512	0.958	0.458	1.171	0.194
Pielou Evenness (J')	0.858	0.990	0.957	0.871	0.898	0.866	0.715	0.861	0.921	0.985	0.863
Shannon-Weiner Diversity (H')	1.382	1.593	1.715	1.401	1.609	1.394	0.991	1.674	1.276	2.163	0.598
Simpson Dominance (λ)	0.279	0.206	0.191	0.289	0.226	0.291	0.469	0.229	0.293	0.119	0.592

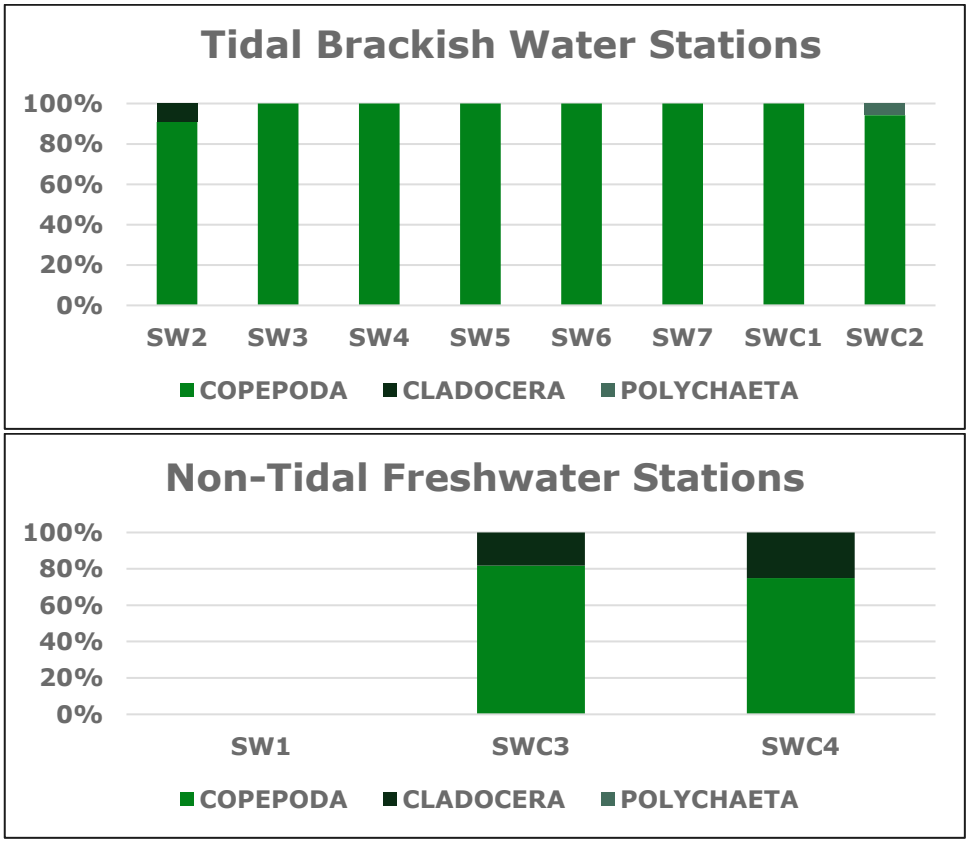


FIGURE 7-59: RELATIVE ABUNDANCE OF ZOOPLANKTON (WET SEASON)

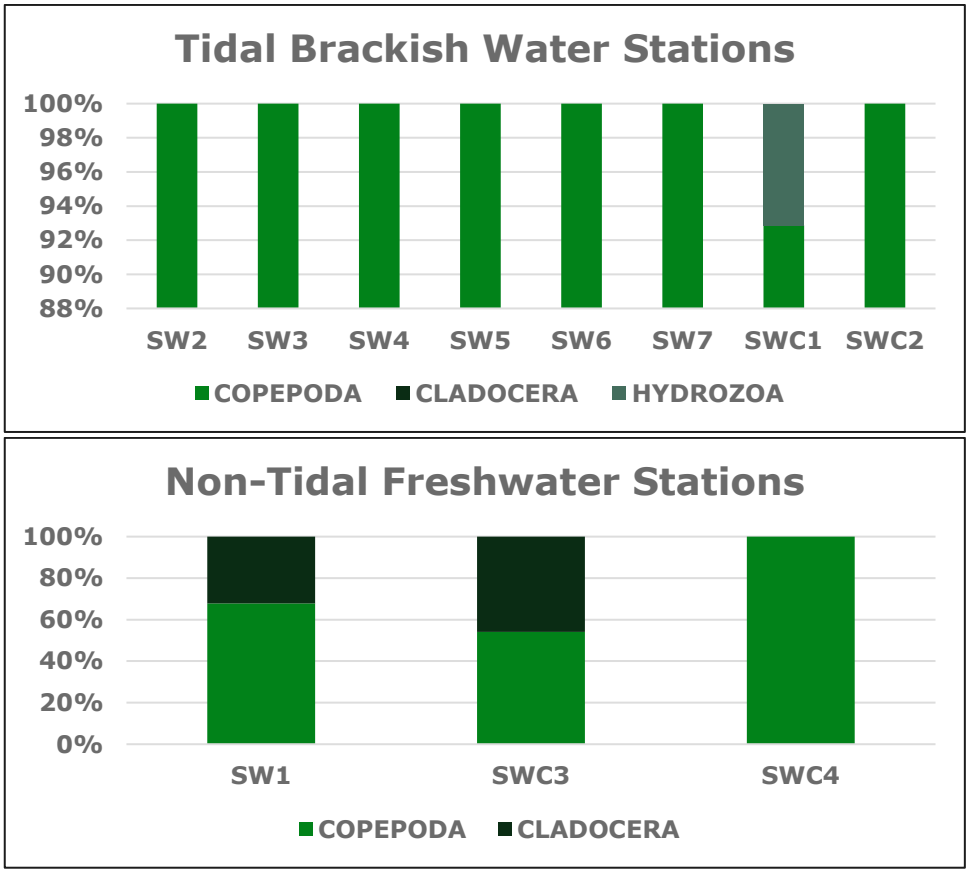


FIGURE 7-60: RELATIVE ABUNDANCE OF ZOOPLANKTON (DRY SEASON)

7.5.6 ECOSYSTEM SERVICES

Fisheries provisioning services is one of the most important ecosystem services provided by rivers and streams. Fishing in Okulu River is minimal and of subsistence value. There are no species that support recreational fisheries, or culturally important fisheries. The ecosystem services of plankton are supporting service premised on their ecological role in the ecosystem. Sand mining is a major activity in the Okulu River and adjoined downstream estuarine creeks. Tamunobereton-ari & Omubo-Pepple (2011) reported that sand mining unusual extent of excavated depth and width of the rivers compared to the original channel depth and width of the river (the original dimension of the stream channel was very narrow, but the mining activities have widened and deepen the channel). They also observed that the ecosystem was highly disturbed, bank erosion was severe, and degree of water turbidity was high that posed risk to the benthic fauna and primary producers, and the burial fauna by the deposition of the suspended sediments. The sand mining/dredging intensity have increased over the years, further widened the Okulu river, which in addition to dredging and land reclamation downstream has now become a tidal water body. This has also resulted in the progressive increase in the salinity of the water from saltwater intrusion from the upper Bonny estuary, which is modifying the biological assemblages. Treated effluent from the Indorama manufacturing complex and runoffs from other land-based activities such as petroleum filling stations, abattoir; and waste from domestic and commercial activities also enters the stream. A pipeline transporting crude across the river also recently ruptured and spilled crude oil into

the river with ecological impacts. There are downstream tidal inputs from the high-density populations and the Trans-Amadi industrial area.

Plant and animal species recorded in the study area are utilized for various economic purposes and collectively provide a broad range of ecosystem services that sustain ecological processes (Table 7-84). A large proportion of the plant species contribute mainly to provisioning services, particularly food, medicine, timber, and fuelwood (Table 7-85). Fruit-bearing (Figure 7-61) plants such as *Mangifera indica*, *Citrus sinensis*, and *Irvingia gabonensis* supply edible fruits, while leafy vegetables like Talinum *triangulare*, *Ocimum graticimum*, *Telfiaria occidentalis*, *Amaranthus sp*, etc. provide important dietary nutrients. Several plants are also widely used in traditional medicine, including *Azadirachta indica*, *Rauvolfia vomitoria*, and *Phyllanthus a*marus, emphasizing the role of vegetation as a source of primary healthcare for rural communities. Timber and fuelwood resources are also important, with species such as *Tectona grandis* and *Triplochiton scleroxylon* supporting construction activities and domestic energy needs. In addition, many plant species provide cultural and aesthetic services, particularly ornamental plants used for landscaping and environmental beautification. Some plants also perform regulating ecological functions, such as soil fertility improvement through nitrogen fixation by *Acacia auriculiformis* and shoreline protection by mangrove species such as *Rhizophora racemosa*.

Similarly, the faunal species recorded in the study area contribute to several ecosystem services that support ecosystem functioning and human well-being (Table 7-86). The most prominent among these are provisioning services, especially food supply through bushmeat and edible invertebrates. Mammals such as *Thryonomys swinderianus*, *Atherurus africanus*, and *Philantomba monticola* serve as sources of animal protein, while invertebrates including *Archachatina marginata* and *Rhynchophorus phoenicis* also provide edible protein. Some animals also supply material resources, such as skins used in traditional drum production and shells used in local construction. In addition, several species contribute to regulating services, particularly pollination and pest control. Pollinators such as *Apis mellifera* and butterflies including *Papilio demodocus* and *Danaus chrysippus* play important roles in plant reproduction and crop productivity. Predatory birds and reptiles, such as *Milvus migrans* and *Naja nigrocollis*, help regulate pest and rodent populations, thereby maintaining ecological balance. Faunal species also provide cultural ecosystem services, as some species, including *Civettictis civetta*, *Tragelaphus spekii*, and *Gypohierax angolensis*, are used in traditional ceremonies and coronation rituals. Overall, the diversity of plant and animal use highlights their ecological, economic, and socio-cultural importance to the sustainability of the ecosystem and the well-being of local communities.

TABLE 7-84: SUMMARY OF ECOSYSTEM SERVICES FROM DIFFERENT ECOSYSTEM TYPES

Ecosystem Type	Ecosystem Service Category	Specific Ecosystem Services	Evidence from Study Area	Beneficiaries / Relevance to Project
Bush fallow & secondary vegetation	Provisioning	Food crops (cassava, plantain, banana, cocoyam); medicinal plants; fuelwood	Presence of *Manihot esculenta*, *Musa* spp., *Xanthosoma* spp., *Alchornea cordifolia*, *Rauvolfia vomitoria*	Local communities, subsistence farmers
	Regulating	Soil stabilization; erosion control; microclimate regulation	Dense herb–grass cover (Poaceae, Asteraceae, Cyperaceae); regenerating shrubs	Reduces land degradation around facility and farmlands

	Supporting	Natural regeneration; habitat for insects, rodents, birds	Early successional species; high insect and bird diversity	Maintains ecological resilience
	Cultural	Traditional knowledge and ethnobotanical use	Information obtained from local inhabitants	Cultural heritage, livelihoods
Homestead / Residential vegetation	Provisioning	Fruits, vegetables, spices, medicinal plants	*Mangifera indica*, *Carica papaya*, *Ocimum gratissimum*, *Talinum triangulare*	Food security, household income
	Regulating	Shade, air quality improvement, dust suppression	Trees and shrub cover around settlements	Human health and comfort
	Cultural	Aesthetic and recreational value	Landscaped vegetation, ornamental plants	Community well-being
Farmlands	Provisioning	Crop production (cassava, yam, pumpkin, banana, Plantain, maize)	Dominance of cultivated crops	Local economy, food supply
	Regulating	Pest control; pollination	Presence of birds, insects (bees, butterflies)	Agricultural productivity
	Supporting	Nutrient cycling; soil formation	Legumes (Fabaceae), organic litter input	Sustains long-term soil fertility
Mangrove swamp forests	Provisioning	Fish and shellfish nursery support; fuelwood	*Rhizophora*, *Avicennia*, crabs (Sesarmidae)	Fisheries, local livelihoods
	Regulating	Shoreline stabilization; erosion and flood control; carbon sequestration	Mangrove root systems; estuarine setting	Coastal protection; climate regulation
	Supporting	Breeding and nursing habitat for birds, reptiles, fish, invertebrates	High avifaunal diversity and mollusk presence	Regional biodiversity conservation
Freshwater swamp forests	Provisioning	Non-timber forest products; medicinal plants	*Raphia* spp., *Thaumatococcus daniellii,*	Community livelihoods
	Regulating	Water purification; flood attenuation	Hydromorphic vegetation along Okulu River	Downstream water quality
	Supporting	Amphibian breeding habitat; nutrient retention	Frogs (Hyperoliidae, Bufonidae); macrophytes	Ecosystem stability
Riverine & riparian forests	Provisioning	Bank stabilization; sediment trapping	Tree and palm dominance along river margins	Reduced erosion from dredging
	Regulating			
	Supporting	Wildlife corridors; nesting and feeding sites	Birds, reptiles, mammals recorded	Landscape connectivity
Aquatic macrophyte communities	Provisioning	Edible plants (*Ipomoea aquatica*)	Harvested locally	Subsistence use
	Regulating	Water filtration; nutrient uptake	Macrophyte mats	Improves water quality
	Supporting	Breeding habitat for fish and amphibians	*Sacciolepis africana*, *Ipomoea aquatica*	Aquatic biodiversity
Green vegetated areas (landscaped)	Regulating	Carbon sequestration; temperature moderation	Tree cover (*Azadirachta indica*, *Khaya senegalensis*)	Climate resilience within facility
	Supporting	Refuge habitat for birds and insects	High avian and pollinator presence	Urban biodiversity
	Cultural	Aesthetic, recreational, corporate environmental value	Managed green spaces	Worker well-being; corporate ESG compliance
Open grasslands & disturbed areas	Regulating	Runoff reduction; erosion control	Dense herbaceous cover	Site stability
	Supporting	Early successional habitat; ground cover	Dominance of grasses and sedges	Preventing soil exposure
Faunal assemblages (all habitats)	Regulating	Pollination; pest control	Bees (Apidae), butterflies, insectivorous birds	Agriculture, vegetation regeneration
	Supporting	Food web maintenance; seed dispersal	Birds, mammals, reptiles	Ecosystem functioning
	Cultural	Educational and conservation value	High species richness; IUCN-listed species	Biodiversity awareness

TABLE 7-85: ECOSYSTEM SERVICES ASSOCIATED WITH FLORAL SPECIES

Ecosystem Service Category	Specific Service	Examples of Plant Uses	Representative Species
Provisioning Services	Food supply	Edible fruits, edible leaves, vegetables	*Mangifera indica, Persea americana, Citrus sinensis, Talinum triangulare*
	Medicinal resources	Traditional medicine, herbal remedies, wound treatment	*Azadirachta indica, Rauvolfia vomitoria, Phyllanthus amarus*
	Timber and wood products	Construction timber, carpentry wood	*Tectona grandis, Triplochiton scleroxylon, Terminalia ivorensis*
	Fuelwood	Firewood for domestic energy	*Khaya senegalensis, Bridelia ferruginea*
	Non-timber forest products	Palm wine, mats, thatching, fish traps	*Raphia hookeri, Nypa fruticans*
Regulating Services	Soil fertility improvement	Nitrogen fixation, soil amendment	*Acacia auriculiformis, Pueraria phaseoloides*
	Erosion and shoreline protection	Soil stabilization and coastal protection	*Rhizophora racemosa, Axonopus compressus*
	Climate and microclimate regulation	Carbon storage and shade	*Gmelina arborea, Ficus religiosa*
Cultural Services	Ornamental and aesthetic value	Landscaping, beautification	*Bougainvillea pachyphylla, Hibiscus rosa-sinensis, Polyalthia longifolia*
	Cultural and traditional uses	Cultural trees, traditional practices	*Newbouldia laevis*
Supporting Services	Habitat provision	Nesting sites and wildlife habitat	*Barteria nigritana, Eleias guineensis*
	Fodder for livestock	Grazing and livestock feed	*Panicum maximum, Cynodon dactylon*
	Nutrient cycling and primary productivity	Biomass production and ecosystem functioning	Various grass, herbs, and trees

TABLE 7-86: ECOSYSTEM SERVICES ASSOCIATED WITH FAUNAL SPECIES

Ecosystem Service Category	Type of Service	Examples of Uses in Data	Representative Species
Provisioning Services	Food (protein source)	Bushmeat, edible insects, snails, crabs	*Thryonomys swinderianus*, *Atherurus africanus*, *Archachatina marginata*, *Apis mellifera*, *Rhynchophorus phoenicis*
	Animal products	Skins used for drums, shells for construction	*Civettictis civetta*, *Philantomba monticola*, *Kinixys belliana*, *Ferrissia* sp.
	Traditional medicine and cultural materials	Species used in rituals or cultural ceremonies	*Python regius*, *Bitis arietans*, *Chamaeleo africanus*
Regulating Services	Pollination	Pollination of crops and wild plants	*Apis mellifera*, *Papilio demodocus*, *Danaus chrysippus*, *Ceratina* sp.
	Pest regulation / predation	Predation on pests and rodents	*Corvus albus*, *Milvus migrans*, *Cyphonomyx bretonii*
	Population regulation	Natural control of insect and rodent populations	snakes such as *Naja nigrocollis*, birds of prey such as *Haliaeetus vocifer*
Cultural Services	Cultural and ceremonial uses	Animals used in coronation rituals, traditional drums	*Civettictis civetta*, *Tragelaphus spekii*, *Gypohierax angolensis*
	Traditional beliefs and symbolism	Species associated with folklore or spiritual beliefs	*Python sebae*, *Bubo africanus*, *Otus senegalensis*

Supporting Services	Pollinator diversity	Butterflies, bees, flies, wasps aiding plant reproduction	*Papilio nireus*, *Graphium leonidas*, *Catopsilia florella*, *Musca domestica*
	Nutrient cycling	Detritivores and soil organisms improving ecosystem productivity	crabs (*Sesarma leptosoma*), insects (Scarabaeidae)
	Habitat and food web support	Species forming part of ecological food chains	birds, rodents, reptiles, amphibians



FIGURE 7-61: (A) BIRDS NESTING ON A TREE AND (B) PALM FRUITS

7.5.7 CRITICAL HABITATS (IFC PS6)

The dataset indicates that the project area does not support Critical Habitat classification under IFC PS6 criteria. However, the presence of modified natural habitats, invasive species, riverine and mangrove ecosystems, and a small number of IUCN-listed species highlights ecological sensitivity. Anthropogenic activities such as sand dredging and land modification have altered habitat structure, facilitated invasive species establishment, and changed hydrological conditions.

7.5.8 SUMMARY OF KEY ECOLOGICAL SENSETIVITIES

The following potential Critical Habitat triggering species were observed or recorded during interviews:

Plants: *Cycas circinalis* (Queen sago, EN), *Terminalia ivorensis* (Black afara, VU)

Mammals: *Phataginus tetradactyla* (Long-tailed pangolin, VU)

Reptiles: *Osteolaemus tetraspis* (Dwarf Crocodile, VU)

Birds: *Psittacus erithacus* (African grey parrot, EN), *Necrosyrtes monachus* (Hooded vulture, CR)

Fish: *Sardinella maderensis* (VU)

Potential critical habitat triggering species appear to be associated with wetland/stream habitats (including seasonally flooded areas), and denser forest/thicket vegetation which are reported by hunters.

Terrestrial Biodiversity:

The terrestrial biodiversity of the site has been impacted upon by anthropogenic disturbances, but still retains both plants and animals that form an integral part of the community's ecosystem services. The loss of the area to be cleared for the proposed IFF Line 2 Fertilizer Project could directly affect the surrounding ecosystem through siltation and pollutants, alien invasive species introduction, and changes to the functionality of the systems.

Aquatic Biodiversity:

While little to no direct impact is predicted to occur to the aquatic biodiversity of the site, the possibility exists that effluent discharge could lead to contamination of these systems is thus a reduction in aquatic biodiversity, which is already under threat from a number of anthropogenic impacts. Among the fish species recorded, only one is considered threatened.

Ecosystem Services:

The ecosystem services of the study area are most likely to be affected by the direct removal of natural systems from the footprint of the Project, as well as the loss of functionality that accompanies the loss of biodiversity noted above.

7.6 SOCIO-ECONOMIC ENVIRONMENT AND HEALTH

7.6.1 INTRODUCTION

This section describes the socio-economic and health baseline of the Project AoI, as informed by the Social Impact Assessment (SIA) undertaken for the proposed IFF Line 2 Fertilizer Project. The baseline has been developed using a combination of primary and secondary data sources to characterise the demographic profile, settlement pattern, livelihoods, access to services, community health context, vulnerability, and broader socio-economic conditions of communities within the AoI. Primary data collection was undertaken in Project-affected communities and was supported by stakeholder engagement processes to facilitate informed access to communities and participation in the study. The assessment applied a mixed-method approach, combining quantitative and qualitative data collection techniques, including household surveys, Focus Group Discussions (FGDs), Key Informant Interviews (KIIs), and participatory appraisal methods. Primary findings were triangulated with secondary information from official statistics, published literature, and other credible desktop sources in order to validate and contextualise the baseline within the wider socio-economic environment. The methodology adopted for the SIA provides a sufficiently robust basis for identifying key receptors, understanding existing community conditions, and assessing the potential socio-economic and health impacts associated with the construction and operation of the Project.

Key methodological elements include:

- Primary field surveys conducted across affected communities with a 400-respondent sample
- Stakeholder engagement facilitated through local gatekeepers and Indorama's community liaison structures
- Use of mixed methods: quantitative surveys, FGDs, KIIs, and participatory techniques

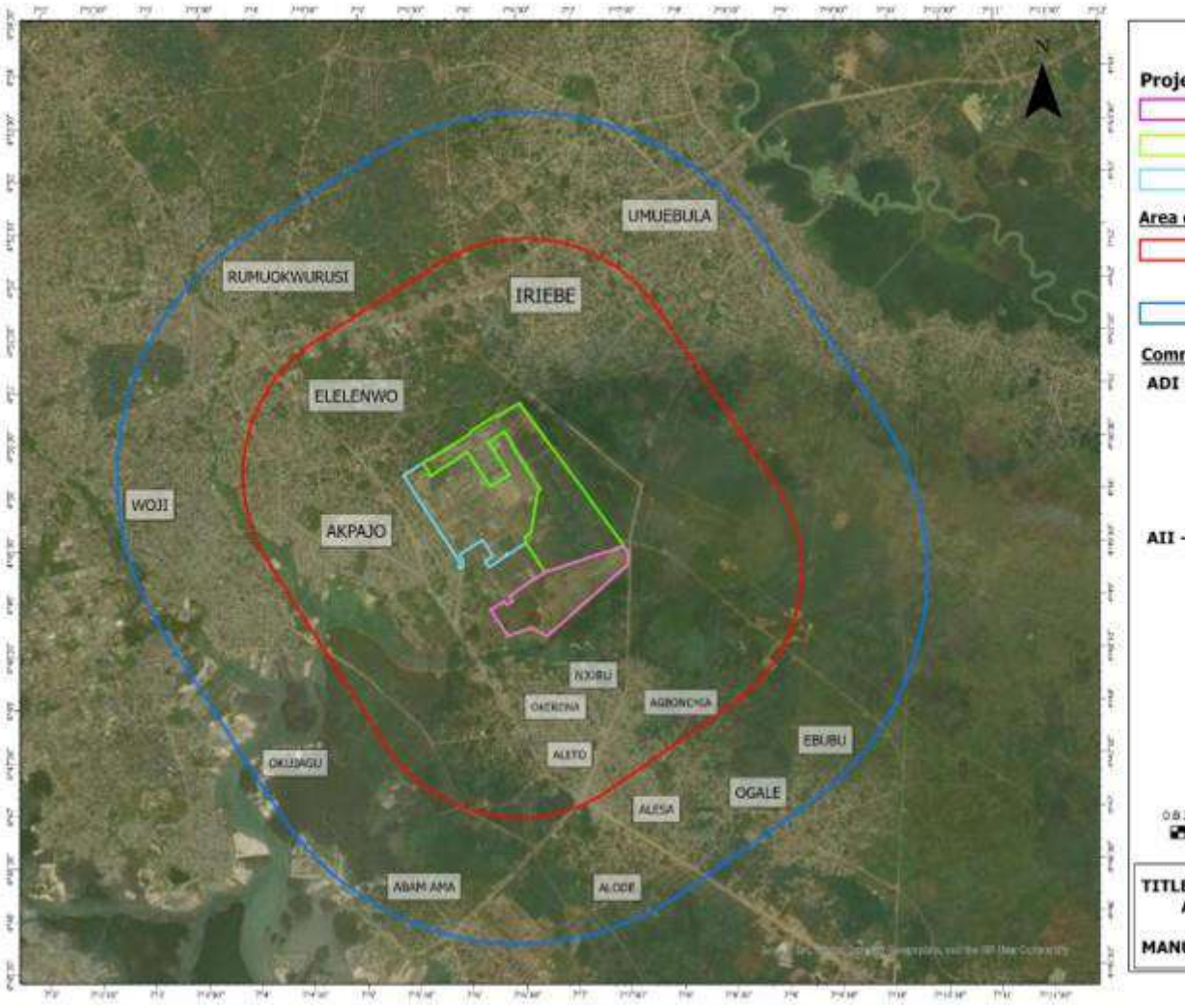
- Statistical analysis undertaken using recognised tools (e.g. SPSS), with defined estimation approaches
- Triangulation of findings through secondary data from official national statistics and reputable sources

7.6.2 STUDY AREA

The study area is situated within Rivers State, in the Niger Delta region of Nigeria, and forms part of the wider Port Harcourt metropolitan area. Eleme LGA, in particular, is characterized by a high concentration of industrial activities, including petrochemical, fertilizer and port-related operations, while Obio/Akpor LGA represents a rapidly urbanizing area influenced by the expansion of Port Harcourt city.

THE SOCIO-ECONOMIC PROJECT AREA FOR THE PROPOSED IFF LINE 2 FERTILIZER PROJECT COMPRISES COMMUNITIES LOCATED WITHIN THE DEFINED PROJECT AREA OF INFLUENCE (AOI), WHICH EXTENDS APPROXIMATELY 3 KM FROM THE EXISTING INDORAMA FERTILIZER COMPLEX. THE STUDY AREA INCLUDES SEVEN COMMUNITIES, NAMELY AKPAJO, ALETO, AGBONCHIA, OKEREWA AND NJURU IN ELEME LOCAL GOVERNMENT AREA (LGA), AND ELELENWO AND IRIEBE IN OBIO/AKPOR LGA. THE SPATIAL EXTENT OF THE STUDY AREA IN RELATION TO THE PROJECT SITE AND SURROUNDING

COMMUNITIES IS ILLUSTRATED IN



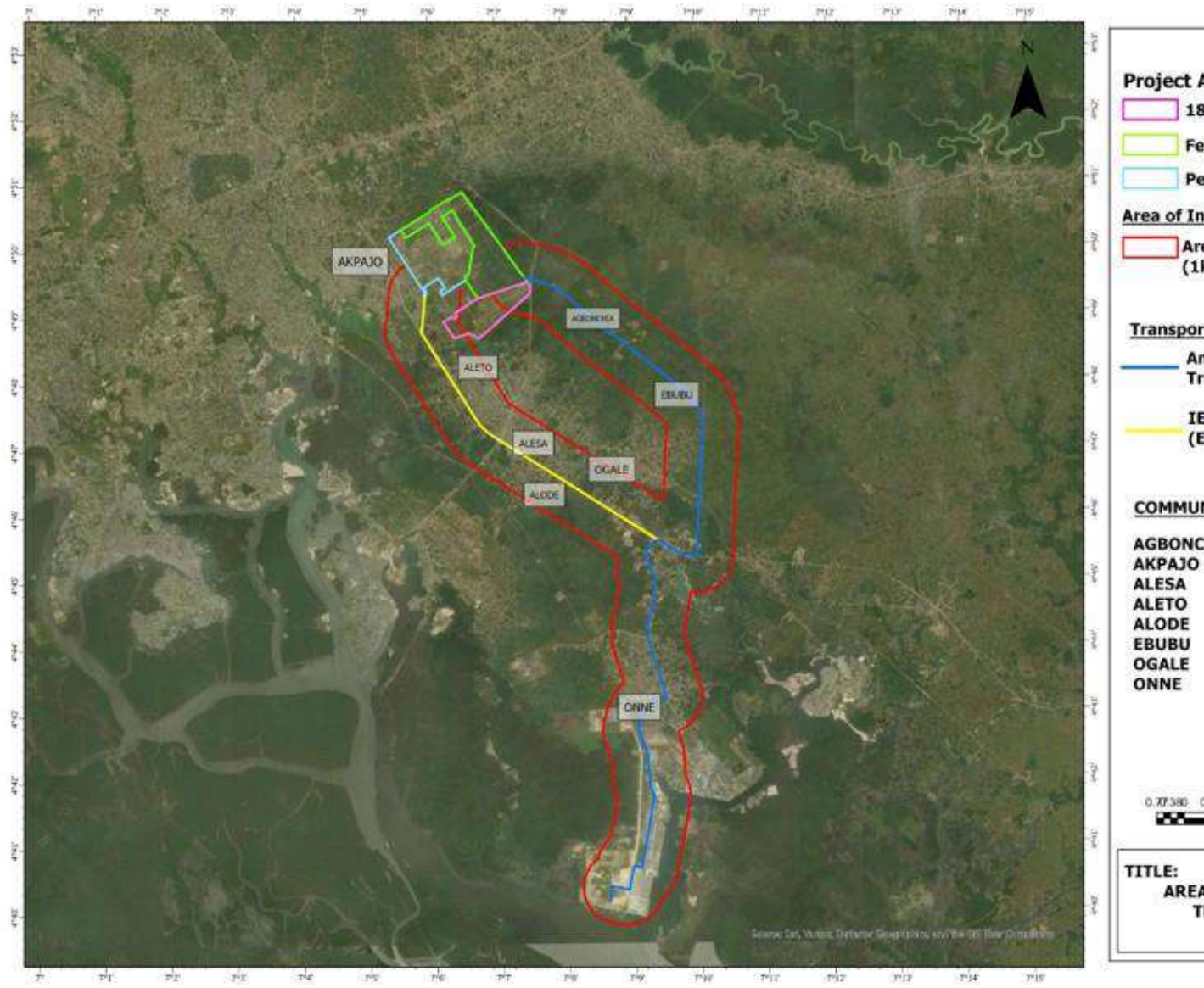
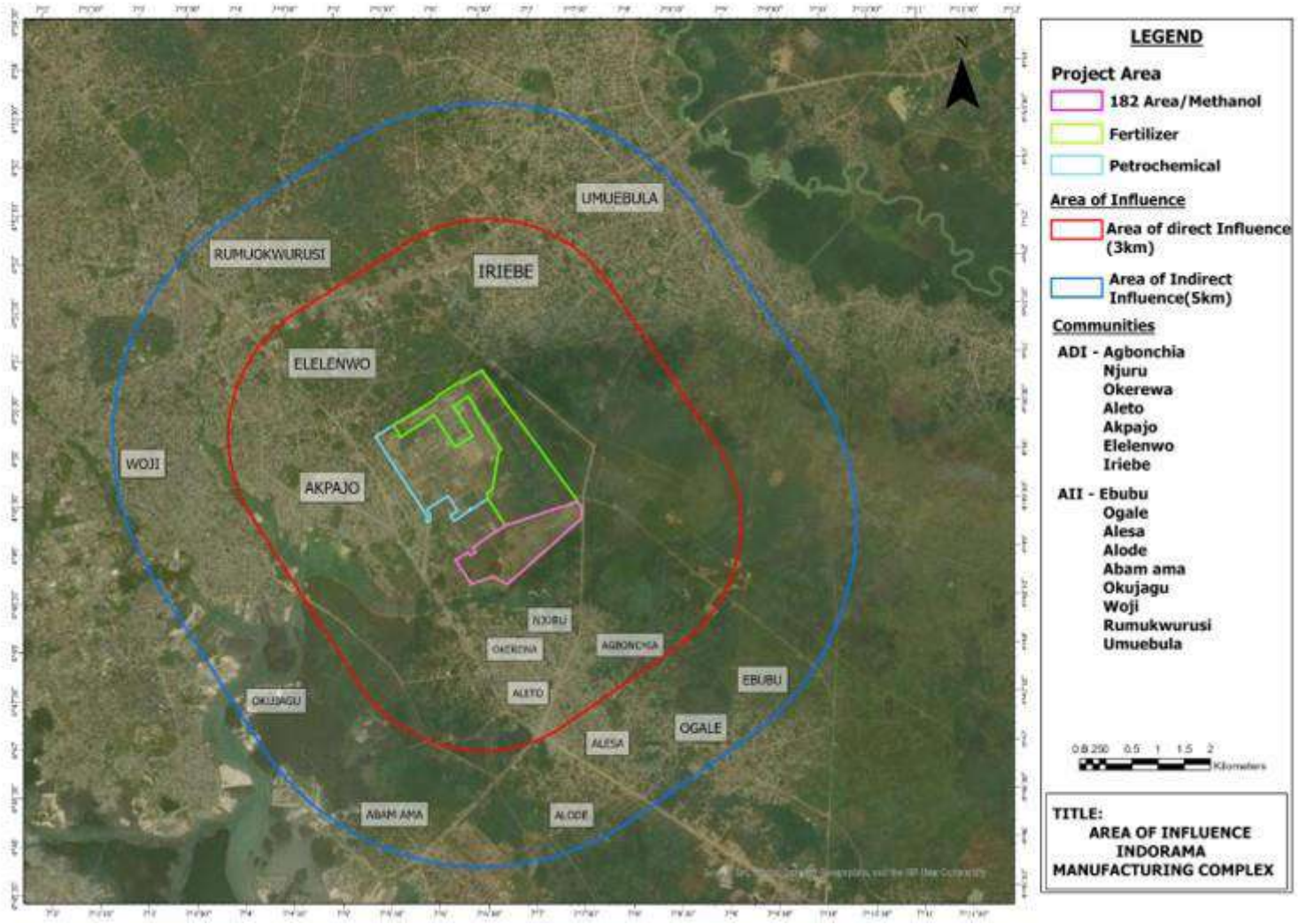


Figure 7-62 below.


UMUEBULA
RUMUOKWURUSI
IRIEBE
ELELENWO
WOJI
AKPAJO
NJURU
OKEREWA
AGBONCHIA
ALETO
OKUJAGU
EBUBU
OGALE
ALESA
ABAM AMA
ALODE
LEGEND
Project Area
182 Area/Methanol
Fertilizer
Petrochemical
Area of Influence
Area of direct Influence (3km)
Area of Indirect Influence(5km)
Communities
ADI - Agbonchia
Njuru
Okerewa
Aleto
Akpajo
Elelenwo
Iriebe
AII - Ebubu
Ogale
Alesa
Alode
Abam ama
Okujagu
Woji
Rumukwurusi
Umuebula
0 0.25 0.5 1 1.5 2
Kilometers
TITLE:
AREA OF INFLUENCE
INDORAMA
MANUFACTURING COMPLEX

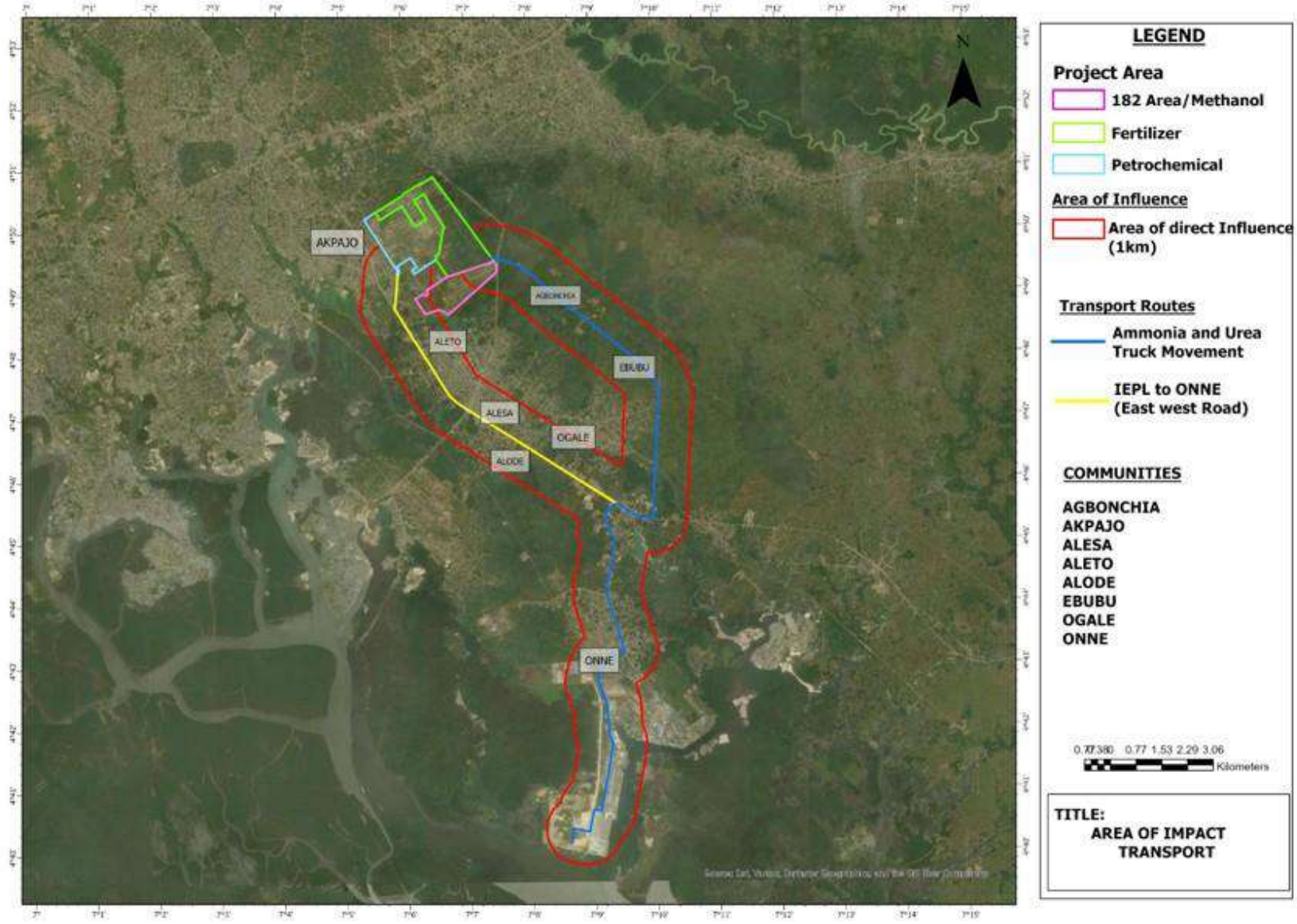

AKPAJO
AGBONCHIA
ALETO
EBUBU
ALESA
OGALE
ALODE
ONNE
N
LEGEND
Project Area
182 Area/Methanol
Fertilizer
Petrochemical
Area of Influence
Area of direct Influence (1km)
Transport Routes
Ammonia and Urea Truck Movement
IEPL to ONNE (East west Road)
COMMUNITIES
AGBONCHIA
AKPAJO
ALESA
ALETO
ALODE
EBUBU
OGALE
ONNE
0.77 1.53 2.29 3.06
Kilometers
TITLE:
AREA OF IMPACT TRANSPORT

FIGURE 7-62: Project Area of Influence and Study Communities

The proximity of the study communities to major industrial infrastructure, including the existing Indorama facilities, has influenced settlement patterns, economic activities and population dynamics. Communities within Eleme LGA exhibit a mix of traditional and industrial characteristics, while those within Obio/Akpor LGA display increasing urbanization and population density. The study area is accessible via key transport routes, including the East-West Road and the Port Harcourt–Aba Expressway, which connect the communities to major economic centers within the region. This accessibility has contributed to increased mobility, trade and migration within the AoI.

The assessment builds baseline information previously collected for the IEFCL Train 3 ESIA (2023), with the 2025 survey providing updated data on community characteristics and spatial distribution. While the structure of the study area remains largely consistent with the earlier assessment, population growth and urban expansion have resulted in increased settlement density and evolving land use patterns within the AoI.

7.6.3 GOVERNANCE AND ADMINISTRATION

Governance and administration within the study area are characterised by a structured and interrelated system comprising formal government institutions, traditional leadership frameworks and organised community-level structures. These systems operate concurrently and interact across multiple levels to regulate socio-economic activities, manage development processes and maintain social order.

The governance context is critical in shaping land ownership and access, stakeholder engagement dynamics, conflict resolution mechanisms and community decision-making processes within the AoI. The coexistence of statutory and customary governance systems remains a defining feature of the socio-economic environment.

7.6.3.1 NATIONAL CONTEXT

Nigeria, as the largest economy in Africa and a major oil-producing nation, operates within a governance environment characterised by institutional capacity constraints, variability in service delivery, and challenges in achieving consistent policy implementation across administrative levels. Governance processes are influenced by a range of socio-economic and regional dynamics, which may affect planning, prioritisation, and resource allocation. In addition, while efforts have been made to strengthen transparency and accountability frameworks, ongoing implementation challenges can affect administrative efficiency, investor confidence, and public trust, underscoring the continued importance of effective institutional coordination and governance systems. Nigeria’s macroeconomic structure is heavily influenced by its reliance on the oil and gas sector, which historically accounts for a significant share of export revenues and government income. This dependence has exposed the country to external shocks, particularly fluctuations in global oil prices, as demonstrated during the COVID-19 pandemic. The resulting economic pressures have reinforced the need for diversification into non-oil sectors such as manufacturing, agriculture, and services.

However, progress in economic diversification has been constrained by structural factors, including skills gaps, infrastructure deficits, and entrenched economic interests. Consequently, a substantial proportion of the population continues to depend on informal economic activities for livelihoods. This reliance on the informal economy is also evident within the study area,

where small-scale trade and service-based activities form a key component of the local economy.

From a governance perspective, these national-level dynamics have direct implications for project development. Constraints in institutional capacity, coupled with socio-economic pressures and reliance on natural resource revenues, can influence regulatory processes, stakeholder expectations and community responses to development projects. In addition, evolving socio-political context of resource-rich regions such as the Niger Delta further reinforce the importance of transparent governance, inclusive stakeholder engagement and effective benefit-sharing mechanisms. It is key for developments to adopt a risk-informed and structured approach to project implementation, with a strong emphasis on stakeholder engagement, institutional coordination and social performance.

7.6.3.2 ADMINISTRATIVE STRUCTURE

Nigeria operates as a federal presidential republic, characterised by the separation of executive, legislative, and judicial functions, a federal central government, and democratically elected leadership at national, state, and local levels. Rivers State, within which the study area is located, forms part of this administrative structure. At the state level, Rivers State is governed by an elected Governor, supported by a Deputy Governor and a State Executive Council. The State Government is responsible for coordinating development activities, infrastructure provision and public administration within its jurisdiction.

Rivers State comprises 23 LGAs, which represent the third tier of governance and provide the closest level of administrative interaction with communities.

The study area falls within two adjacent LGAs:

- Eleme LGA, with its administrative headquarters in Ogale (Nchia clan area); and
- Obio/Akpor LGA, with its headquarters in Rumuodomaya.

Local Government Authorities are responsible for a wide range of functions, including:

- Public health and sanitation services;
- Pre-school, primary and adult education;
- Local town planning and development control;
- Waste management and environmental sanitation;
- Local transportation systems; and
- Construction and maintenance of roads and public infrastructure.

These institutions therefore play a central role in service delivery, planning and local governance within the study area.

7.6.3.3 FORMAL GOVERNANCE

Formal governance within the study area is exercised through the framework of Federal, State and Local Government institutions. At the local level, both Eleme and Obio/Akpor LGAs are administered by Local Government Councils, each headed by an Executive Chairman and supported by elected councillors and appointed officials. These councils are responsible for

implementing government policies, managing local development initiatives and delivering essential services.

The study communities fall directly under these LGAs, which therefore represent the primary formal governance institutions within the AoI. Their functions include administrative oversight, infrastructure provision, regulation of local economic activities and coordination of development programmes. While formal governance structures provide the statutory and regulatory framework for administration, their effectiveness is often complemented by traditional governance systems, particularly in areas such as land management and community relations.

7.6.3.4 INFORMAL (TRADITIONAL) GOVERNANCE

Traditional governance systems are deeply embedded within the study area and operate alongside formal institutions, maintaining significant authority and legitimacy within local communities.

In the Eleme communities, traditional governance is structured under the authority of the Oneh Eh Eleme (Paramount Ruler), a government-recognised first-class traditional leader. The Paramount Ruler is supported by a Council of Chiefs and Elders, which functions as the principal decision-making body on matters relating to customary law, conflict resolution and cultural preservation.

Governance is hierarchical, with the Paramount Ruler at the apex, followed by chiefs (Emere), family heads and other traditional leaders. These structures collectively manage community affairs and uphold customary systems.

In the Ikwerre communities of Elelenwo and Iriebe, traditional governance is led by the Nye-we Eli (Paramount Chief), meaning “Owner of the Land.” Governance is organised along clan structures, typically consisting of multiple clans with leadership roles shared or rotated among them. In Elelenwo, for example, leadership rotates among three clans to ensure representation.

Traditional governance structures are further supported by:

- Community Development Committees (CDCs);
- Youth councils;
- Women’s associations; and
- Faith-based and community-based organisations.

These institutions play a vital role in day-to-day community life and are key mechanisms for participation, mobilisation and decision-making.

Traditional authorities perform several critical functions, including:

- Administration and allocation of land under customary tenure systems;
- Resolution of disputes and community-level conflicts;
- Enforcement of cultural norms and values;
- Oversight of community development initiatives; and

- Facilitation of engagement with external stakeholders, including project proponents.

They are widely recognised as the primary interface for stakeholder engagement and are essential to securing community acceptance of projects.

7.6.3.5 COMMUNITY-LEVEL GOVERNANCE AND SOCIAL ORGANISATION

Community governance within the study area is further reinforced by structured social systems, which complement both formal and traditional institutions.

Age-grade systems represent a key organisational structure, particularly among male community members. Individuals are grouped into age cohorts, each with defined leadership and responsibilities. These groups contribute to:

- Organisation of community development projects;
- Participation in cultural and traditional events;
- Provision of community security through vigilante activities; and
- Implementation of environmental sanitation initiatives.

Women's associations operate with elected leadership structures and play a significant role in governance and development. These groups often initiate and implement self-help projects and advocate for issues affecting women within the community.

Youth groups are similarly organised and contribute to governance through participation in development activities and maintenance of community order.

All of these structures operate under the authority of traditional leadership and contribute to strengthening local governance, participation and accountability.

7.6.3.6 SOCIAL CONTROL MECHANISMS

Social control within the study area is maintained through a combination of traditional and community-based mechanisms involving both rewards and sanctions.

Recognition is given to individuals who contribute positively to the community through the award of traditional titles and honours. Conversely, individuals who violate community norms may be subject to sanctions, including fines or referral to formal authorities in cases involving criminal offences.

Local security arrangements are often managed through youth-led vigilante groups, which play a role in maintaining order and ensuring community safety.

7.6.3.7 GOVERNANCE CONTEXT AND PROJECT RELEVANCE

The governance framework within the study area reflects a highly integrated system in which formal government institutions, traditional leadership and community-based structures coexist and function collectively.

While formal institutions provide statutory authority and administrative oversight, traditional governance structures retain significant influence over land, social organisation and stakeholder engagement processes. Community-level organisations further reinforce governance through participation and mobilisation.

This layered governance system is particularly relevant for the Project, as it directly influences:

- Stakeholder engagement and consultation processes;
- Land access and compensation arrangements;
- Conflict management and grievance mechanisms; and
- Community acceptance and social licence to operate.

Effective engagement with both formal and traditional governance systems will therefore be essential to ensuring successful project implementation and maintaining sustainable relationships with host communities.

7.6.4 PLANNING AND DEVELOPMENT

Planning and development within the study area are shaped by a combination of national economic priorities, state-level development strategies and localised industrial growth patterns. These factors collectively influence land use, population dynamics, infrastructure demand and economic activities within the AoI. Nigeria is the most populous country in Africa and one of the largest economies in Sub-Saharan Africa. The national economy is driven primarily by the oil and gas sector, which remains the dominant source of export earnings and government revenue. Although oil contributes a relatively small proportion to overall Gross Domestic Product (GDP), it accounts for a significant share of foreign exchange earnings and fiscal revenues.

In recent decades, the Nigerian economy has shown increasing diversification, with growth observed in sectors such as manufacturing, finance, telecommunications, technology, and services. However, despite this diversification, economic performance continues to be influenced by global oil market fluctuations. The country is considered an emerging market economy with a large and growing population. Rapid population growth has placed pressure on infrastructure, employment opportunities and public services, contributing to a high reliance on the informal economy for livelihoods. In response, government policy has increasingly emphasized economic diversification, industrialization and improved productivity, including efforts to enhance agricultural output and expand manufacturing capacity.

7.6.4.1 RIVERS STATE DEVELOPMENT

Rivers State plays a central role in Nigeria’s oil and gas industry and is one of the most economically significant states in the country. The State hosts extensive hydrocarbon reserves and associated infrastructure, including oil refineries, petrochemical facilities, and export terminals. It is estimated that Rivers State contributes a substantial proportion of Nigeria’s crude oil production.

The State is also characterised by a well-developed industrial base, including:

- Oil and gas processing facilities;
- Petrochemical and fertilizer plants; and
- Port infrastructure supporting domestic and international trade.

Key infrastructure within the State includes two major seaports, an international airport, and significant industrial estates. The presence of this infrastructure has positioned Rivers State as a major industrial and logistics hub within the Niger Delta region.

Within the vicinity of the study area, the Indorama Manufacturing Complex represents a significant industrial development. Originally established as a state-owned enterprise in 1996, the facility was privatised in 2006 and subsequently expanded. The existing fertilizer production lines (including IFZ Line 1 and Line 2) are among the largest single-train urea plants globally and represent a major component of Nigeria's industrial and export economy.

7.6.4.2 STRATEGIC PLANNING FRAMEWORKS

Development within the study area is further influenced by long-term strategic planning initiatives implemented by the Rivers State Government.

The Greater Port Harcourt City (GPHC) Development Plan, introduced in 2017 and implemented from 2018, provides a long-term framework for urban expansion and infrastructure development. The Plan aims to:

- Guide the development of new urban areas ("New City");
- Promote urban renewal and regeneration within the existing Port Harcourt metropolitan area ("Old City"); and
- Facilitate the integration of these areas into a consolidated urban system.

The development strategy focuses on planned urban expansion, improved infrastructure provision and decongestion of existing high-density areas. Key components of the GPHC Development Plan include:

- The Old Port Harcourt City;
- Onne Seaport (a major logistics and industrial hub); and
- Port Harcourt International Airport.

These elements form the backbone of regional economic development and spatial planning within the study area, reinforcing its role as a key industrial and logistics corridor.

7.6.4.3 LOCAL DEVELOPMENT AND ECONOMIC ACTIVITIES

At the local level, development within the project area is strongly influenced by the presence of industrial infrastructure and associated economic opportunities. The expansion of industrial facilities, particularly within Eleme LGA, has contributed to increased population growth, urbanisation and economic diversification.

Small-scale industrial and livelihood activities within the study area include:

- Welding and fabrication;
- Sand mining along river systems;
- Traditional food processing (including fish smoking); and
- Cassava processing and flour production.

Despite the presence of large-scale industrial developments, a significant proportion of the population relies on informal economic activities, including trading and service provision, for income generation. This reflects broader national trends and highlights the importance of the informal sector in supporting livelihoods.

The influx of migrant workers associated with industrial growth has contributed to increased economic activity, expansion of residential areas and diversification of local economies. However, this growth has also placed additional pressure on infrastructure, land availability and natural resources.

7.6.4.4 DEVELOPMENT PRESSURES AND CONSTRAINTS

Rapid industrialization and urban expansion within the study area have resulted in a number of development pressures, including:

- Increased demand for housing and land;
- Pressure on public infrastructure and services;
- Environmental stress on natural resources; and
- Changing socio-economic dynamics associated with migration.

These pressures are particularly evident in peri-urban and industrial-adjacent communities, where population growth and economic activity are expanding at a faster rate than infrastructure provisioning.

7.6.5 HUMAN RIGHTS

Human rights conditions within the project area of influence are shaped by national legal frameworks, regional socio-economic dynamics and local environmental and development contexts. Nigeria is a signatory to several international human rights instruments, including the Universal Declaration of Human Rights (UDHR) and the International Covenant on Civil and Political Rights (ICCPR), which establish the foundation for the protection of fundamental rights such as the right to life, equality, security and freedom from discrimination. At the national level, a legal and institutional framework exists to support these rights; however, the effectiveness of implementation and enforcement varies across the country.

Human rights conditions in Nigeria reflect a combination of established legal protections and ongoing governance challenges. In certain contexts, concerns have been reported relating to the conduct of security forces and limited access to legal recourse. While these issues are not uniformly experienced across all regions, they form part of the broader national human rights landscape. In addition, insecurity associated with conflict, although more prevalent in other regions of the country, highlights the variability in safety and stability across Nigeria.

Socio-economic inequalities also influence human rights conditions. Gender disparities persist in some areas, with women experiencing constraints in access to education, healthcare and employment opportunities. Gender-based violence, including domestic violence and other harmful practices, is reported in parts of the country, reflecting broader societal and structural challenges. Similarly, ethnic and religious diversity within Nigeria can be associated with varying levels of access to resources, participation in governance processes and representation in decision-making structures.

Rivers State has contributed significantly to national economic development (through the oil and gas industry) but has also been associated with environmental challenges. Oil spills, gas flaring and other forms of pollution have affected natural resources and surrounding communities. These environmental conditions are closely linked to human rights considerations, particularly in relation to environmental quality, community health and access to natural resource-based livelihoods.

Within the study area, human rights conditions are shaped by ongoing industrial and socio-economic development. The presence of major industrial facilities has contributed to employment opportunities and economic growth, while also influencing population dynamics through in-migration. These changes have increased demand for housing, infrastructure and social services within host communities. Livelihoods in the area include both formal and informal economic activities, with a significant proportion of the population engaged in small-scale trading, services and other informal sector activities. Access to opportunities and services may therefore vary across communities and households.

Community structures and stakeholder engagement processes play an important role in shaping local-level conditions. Traditional leadership systems, community-based organizations and other governance structures contribute to community organization, social cohesion and interaction with external stakeholders, including industrial operators. These structures form an integral part of how social and economic issues, including those related to human rights, are managed at the local level.

Overall, Nigeria has established a comprehensive framework for the protection of human rights, supported by its participation in international agreements. However, implementation remains variable across regions, and human rights conditions are influenced by governance capacity, socio-economic factors and environmental conditions. The study area reflects these broader dynamics, with human rights considerations shaped by the interaction between industrial development, environmental context and local socio-economic characteristics.

7.6.6 DEMOGRAPHICS

7.6.6.1 POPULATION

National overview

Nigeria has one of the largest and fastest-growing populations globally. According to the United Nations Population Fund (UNFPA), the total population was estimated at approximately 237.5 million in 2025, placing Nigeria among the most populous countries in the world. The population is relatively youthful, with a median age of approximately 18.3 years, and a large proportion of the population falling within younger age cohorts. In addition, approximately 55.8% of the population resides in urban areas, reflecting rapid urbanization trends across the country (UN DESA, 2024). The spatial distribution of population density across Nigeria is illustrated in Figure 7-63.

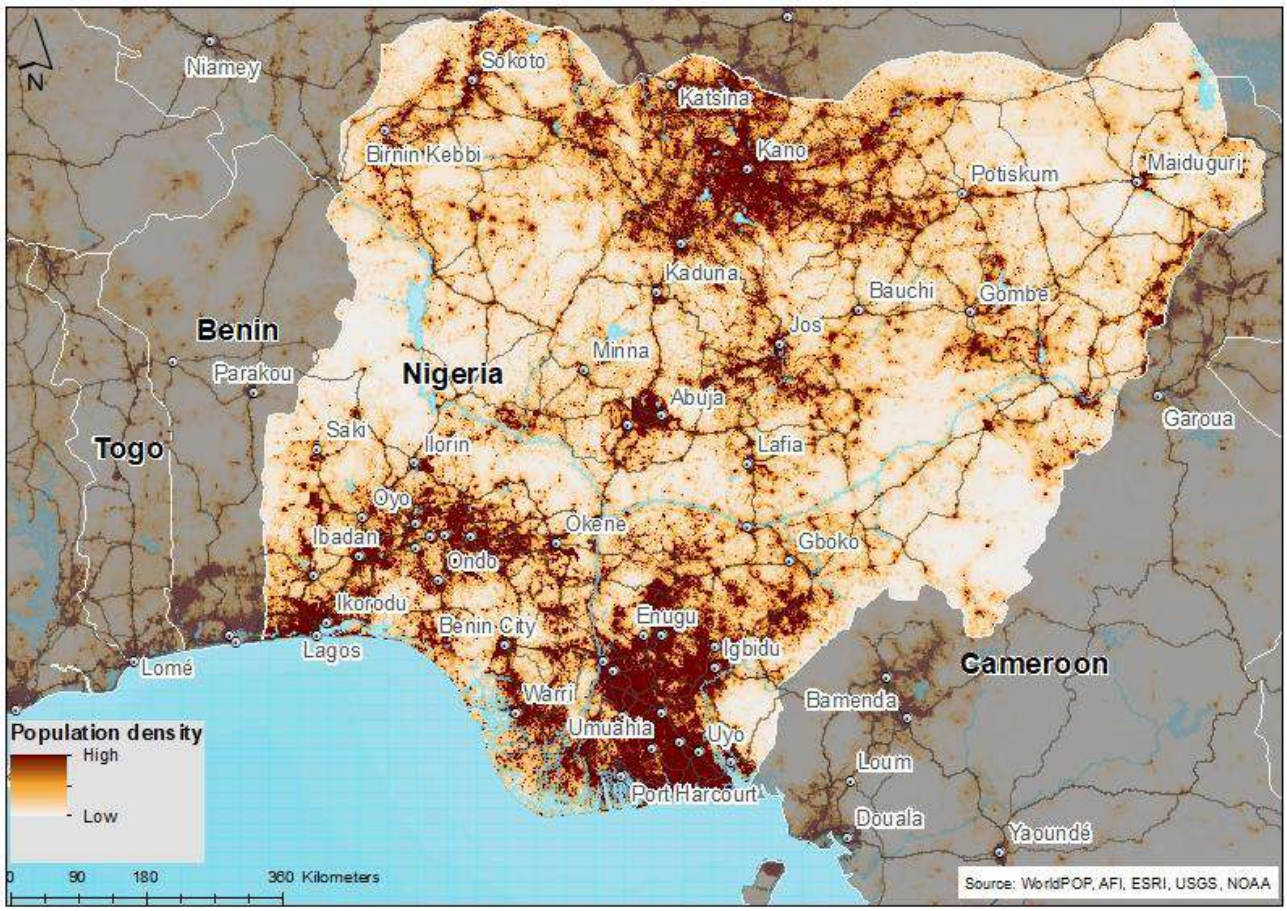


FIGURE 7-63: SPATIAL DISTRIBUTION OF POPULATION DENSITY IN NIGERIA

(Source Institute for Security Studies (ISS Africa). 2025)

Project Area

The demographic profile of the Project AoI is characterised by a young, expanding, and economically active population structure, reflecting broader national trends while demonstrating localised variations. As presented in Table 7-87 and illustrated in Figure 7-75 (Age–Sex Pyramid), the population exhibits a broad-based, pyramidal distribution, indicative of sustained population growth and a high proportion of younger age cohorts typical of developing regions. What is notable about the population with the study area, is the higher than expected (for developing context) of people in the age groups 20-40 years. This may be the result of in-migration of working-age individuals to the area as job-seekers.

TABLE 7-87: PERCENTAGE AGE-SEX DISTRIBUTION OF THE STUDY AREA

Age Cohorts (Years)	Male		Female		Total	
	N	%	N	%	N	%
0 to 4	169	4.4	137	3.6	306	8.0
5 to 9	136	3.5	165	4.3	301	7.8
10 to14	165	4.3	149	3.9	314	8.2

Age Cohorts (Years)	Male		Female		Total	
	N	%	N	%	N	%
15 to 19	125	3.3	173	4.5	298	7.8
20 to 24	194	5.0	180	4.7	374	9.7
25 to 29	124	3.2	128	3.3	252	6.6
30 to 34	191	5.0	221	5.8	412	10.7
35 to 39	188	4.9	126	3.3	314	8.2
40 to 44	139	3.6	107	2.8	246	6.4
45 to 49	137	3.5	136	3.5	273	7.1
50 to 54	103	2.7	114	3.0	217	5.6
55 to 59	92	2.4	78	2.0	170	4.4
60 to 64	88	2.3	93	2.4	181	4.7
65 – 69	63	1.6	58	1.5	121	3.1
70 and over	27	0.7	36	0.9	63	1.6
Total	1,941	50.5	1,901	49.5	3,842	100

(Source: Safespace Resources Limited, 2026*)*

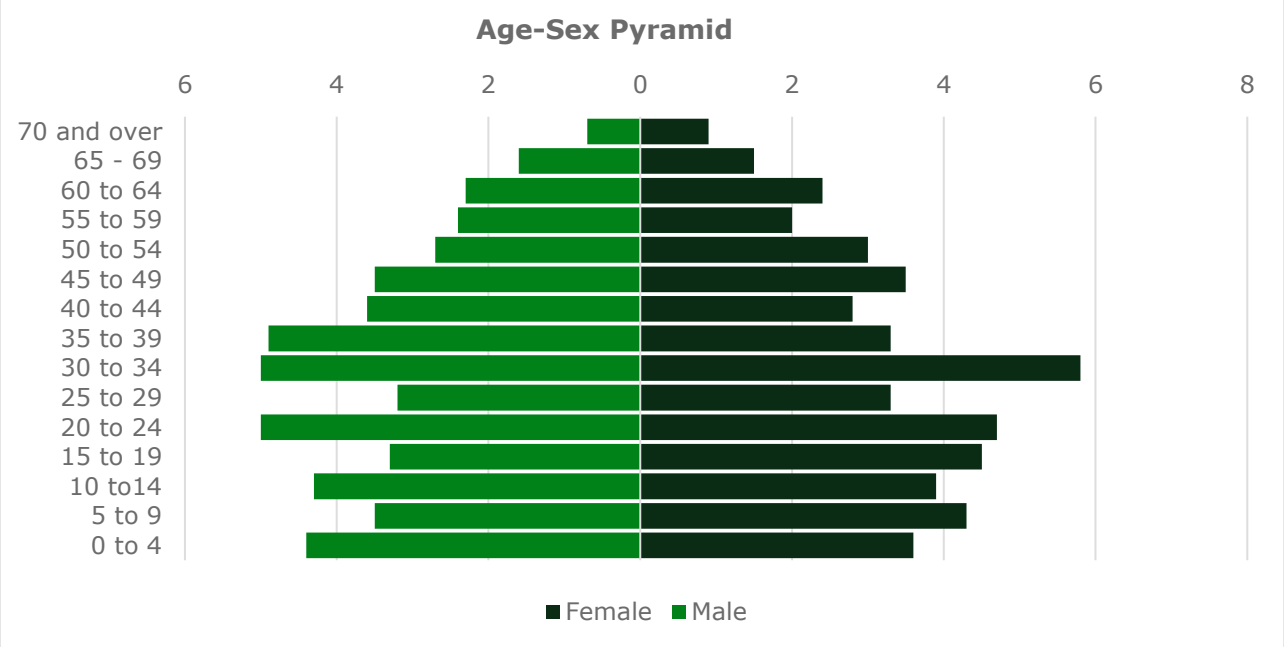


FIGURE 7-64: AGE-SEX PYRAMID OF THE PROJECT AREA

(Source: Safespace Resources Limited, 2026)

The working-age population (15–64 years) accounts for approximately 71% of the total population within the study area, compared to approximately 55% at the national level shown Figure 7-65 below. This further highlights the potential for the study area to be a focus of in-migration for people seeking work.

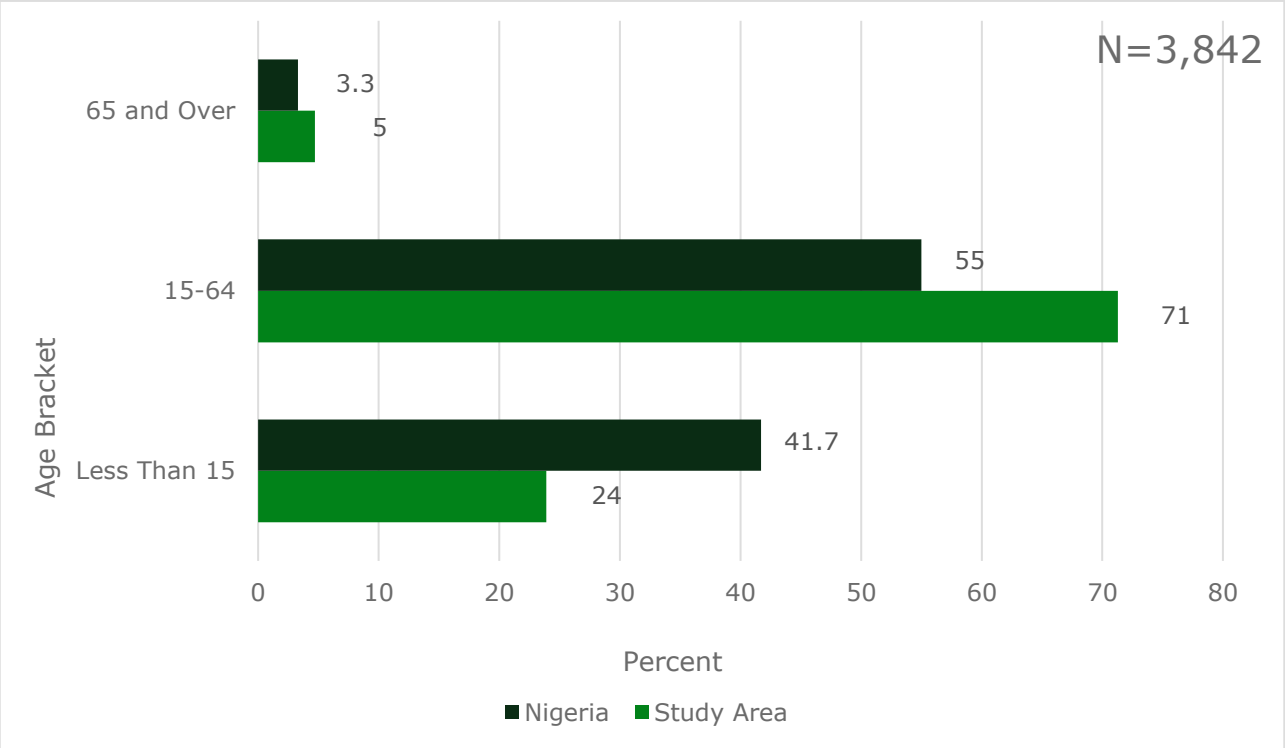


FIGURE 7-65: POPULATION STRUCTURE OF THE STUDY AREA COMPARED TO NATIONAL CONDITION

(Source: Safespace Resources Limited, 2026; World Fact Book, 2022)

The age structure is therefore skewed towards economically active age groups, with the largest population concentrations observed within the 30–34 years (10.7%), 20–24 years (9.7%), and 35–39 years (8.2%) cohorts. In contrast, the population aged 65 years and above accounts for approximately 4.7%, indicating a relatively low proportion of elderly dependents.

The dependency ratio is estimated at approximately 45:100, compared to the national average of 86:100, reflecting a lower dependency burden within the Project AoI. However, this dependency ratio may be somewhat distorted, as dependents may live in rural areas or other states. Gender distribution is relatively balanced, with males accounting for 50.5% (1,941 individuals) and females 49.5% (1,901 individuals), resulting in a sex ratio of approximately 102 males per 100 females, consistent with national demographic patterns.

Overall, the demographic structure of the Project AoI reflects a youthful, growing, and economically active population, with important implications for labour availability, economic participation, and increasing demand for infrastructure and social services.

7.6.6.2 POPULATION SIZE, GROWTH AND DISTRIBUTION

Population data for the Project AoI is based on the most recent available census (1991), supplemented by projections to 2026 using an assumed annual growth rate of 3.5% as illustrated in Table 7-88.

TABLE 7-88: POPULATION DATA

LGAs	Communities	1991			Projected Population @ 3.5% Growth Rate		% Change
		Male	Female	Total	2021	2026	
Eleme	Agbonchia[25]	4,869	4,458	9,327	30,923	35,970	19.5
	Akpajo	2,936	2,260	5,196	17,211	20,018	18.5
	Aleto[26]	3,211	3,165	6,376	21,122	24,566	19.5
Obio/Akpor	Elelenwo	1,656	2,714	3,275	29,028	33,665	19.5
	Iriebe	716	661	1,377[27]	3,930	4670	18.8
	Total	13,388	13,258	26,646	102,214	118,889	19.3

Source: ERM 2023[28]

The projected population indicates substantial growth across all communities, with higher population concentrations in Agbonchia, Elelenwo, and Akpajo, reflecting their proximity to industrial and economic centres. Some communities, including Njuru, Okerewa, and Iriebe, are based on estimated values due to limited historical data.

Overall, the population distribution reflects ongoing urban expansion and socio-economic development, resulting in increasing pressure on infrastructure, housing, and service delivery systems within the Project AoI.

7.6.6.3 MIGRATION PATTERNS

The Project Area exhibits moderate population mobility, characterised by both in-migration and out-migration driven primarily by economic activities, trade, and family-related factors. As illustrated in Figure 7-66, in-migration into the Project AoI is predominantly economically driven, with individuals relocating from neighbouring states and surrounding communities within Rivers State in search of employment and business opportunities. The presence of industrial and commercial activities has contributed to gradual settlement expansion and increasing demographic diversity within the area.

[25] Agbonchia population is inclusive of Njuru (Njuru is part of Agbonchia).
[26] Aleto population is inclusive of Okerewa (Okerewa is part of Aleto).
[27] 1991 population for Iriebe was derived by back-projecting the 2026 estimate using a 3.5% annual growth rate, consistent with the ESIA projection approach, due to lack of historical census data.
[28] ERM *(2023) Field Survey [2022] in: Social Impact Assessment Report for IEFCL-Train 3 project ESIA, ERM 2023*

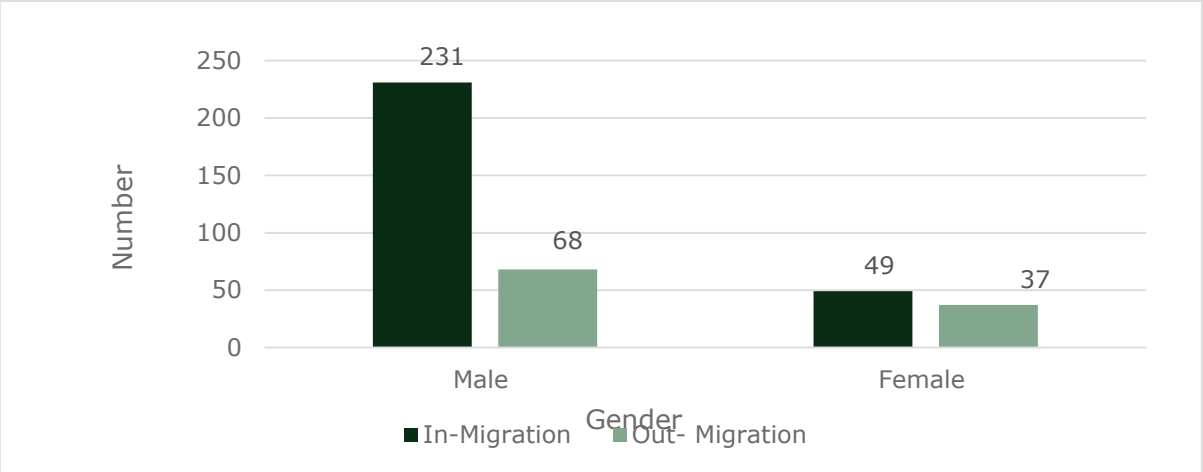


FIGURE 7-66: MIGRATION PATTERN OF THE STUDY AREA

(Source: Safespace Resources Limited, 2026)

The primary drivers of migration, as indicated by respondents and participatory research, include employment opportunities, business activities, and family considerations. These factors have strengthened the role of the Project AoI as an emerging economic hub within the region.

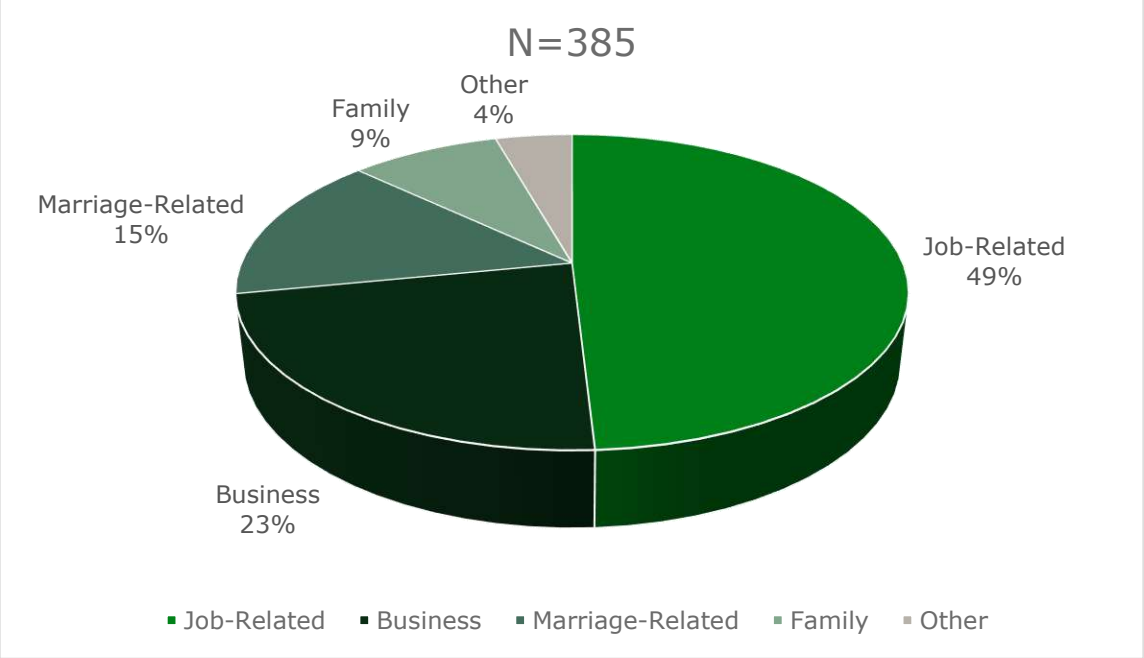


FIGURE 7-67: RESPONDENTS STATED PRIMARY REASON FOR IN-MIGRATION

(Source: Safespace Resources Limited, 2026)

While in-migration contributes to economic growth, labour availability, and market expansion, it also has the potential to increase pressure on infrastructure, housing, and public services. Additional risks associated with population inflow include rising cost of living, traffic congestion, communicable disease transmission, and potential for social tension if not adequately managed.

7.6.6.4 ETHNIC COMPOSITION

The Project AoI is predominantly inhabited by the Eleme and Ikwerre ethnic groups, who constitute the indigenous population.

In addition to the indigenous population, the presence of industrial and commercial activities has attracted individuals from diverse ethnic backgrounds, including Igbo, Ibibio, Hausa, Yoruba, and other neighbouring Niger Delta communities. This diversity is particularly evident in more urbanised settlements such as Akpajo, Elelenwo, and Iriebe, resulting in a multi-ethnic and cosmopolitan population structure.

Despite this diversity, interactions among residents are generally stable and shaped by economic relationships. Traditional leadership institutions remain important in community governance, conflict resolution, and maintaining social cohesion within the Project AoI.

7.6.6.5 RELIGIOUS COMPOSITION

The population within the Project AoI is predominantly Christian (approximately 82%), with smaller proportions practicing Islam (13%) and traditional beliefs (5%). Christianity is represented by multiple denominations, including Anglican, Catholic, Pentecostal, and evangelical churches. Islam is practiced primarily by migrant populations and non-indigenous residents, while traditional beliefs continue to be observed alongside Christianity in some communities. Overall, the religious composition reflects broader patterns observed in Rivers State, where Christianity is the dominant religion and plays an important role in community identity and social organisation.

7.6.7 EDUCATION AND LITERACY RATES

The project area has relatively high literacy and educational attainment levels compared with some communities in the Niger Delta region and Nigeria.

Table 7-89 below shows household educational attainment. The modal educational attainment for males, females and the population as a whole, was “Secondary Completed” accounting for 17.6%, 22.6% and 19.8%, respectively. Table 7-89 shows adult literacy levels for male, female and the general population at 72%, 75.1% and 73.5%, respectively. These figures compare favourably with national averages which stand 71.3%, 52.7% and 62%, respectively as at 2018 (CIA World Fact Book, 2023). School enrolment remains high in the study area. The average age of enrolment into nursery/primary school was found to be 3 years. The obvious implication is the availability different levels of workforce personnel who can service the formal sector, with the associated positive social impacts on the community and local economy. Information gathered from Key Informant Interviews (KII)s reveal that communities in the project AoI also benefits from corporate social investment initiatives, including scholarship programmes, technical training, and skills development schemes implemented by the proponent.

Albeit, despite the relatively favourable educational profile of the area, challenges such as inadequate educational infrastructure, overcrowding in public schools, limited teaching resources, shortage of trained teachers and many other issues continue to constrain the effectiveness of the educational system in the area. There are still some out-of-school children in the study area. It is important to state that the government educational facilities are

cheaper and tend to accommodate most of the students in the study area for the indigent households, while households that are more affluent enrol their wards in the private schools.

TABLE 7-89: PERCENTAGE DISTRIBUTION OF EDUCATIONAL ATTAINMENT BY HOUSEHOLD MEMBERS

Categories	Male		Female		Total	
	N	%	N	%	N	%
No Formal Education	66	5.0	44	4.2	110	4.7
Pre-primary Education	157	12.0	127	12.2	284	12.0
Primary Uncompleted	145	11.0	88	8.4	233	9.9
Primary Completed	226	17.2	193	18.5	419	17.8
Secondary Uncompleted	114	8.6	88	8.4	202	8.6
Secondary Completed	232	17.6	236	22.6	468	19.8
Tertiary Uncompleted	90	7.0	81	7.8	171	7.3
Tertiary Completed	229	17.4	130	12.5	359	15.2
Teachers Grade 2	22	1.6	44	4.1	66	2.8
Trade Test Certificate	34	2.6	12	1.2	46	2.0
City & Guilds Certificate	0	0	0	0	0	0.0
Total	1,315	100	1,043	100	2,358	100

(Source: Safespace Resources Limited, 2026)

TABLE 7-90: MALE AND FEMALE LITERACY LEVELS COMPARED WITH NATIONAL AVERAGES

Gender	Project Area	Nigeria
Male	72.0%	71.3%
Female	75.1%	52.7%
General Population	73.5%	62.0%

(Source: Safespace Resources Limited, 2026)

7.6.8 SOCIO-ECONOMIC CHARACTERISTICS

7.6.8.1 EMPLOYMENT STATUS

Employment patterns within the Project AoI indicate limited labour absorption capacity and high levels of unemployment across both male and female populations. Results from the survey illustrated in Figure 7-68 indicate that, unemployment among males is higher (33.2%) than among females (24.3%), although both groups experience significant employment constraints. The relatively high unemployment levels suggest limited availability of formal and sustainable livelihood opportunities within the local economy. A substantial proportion of females (44%) were identified as full-time homemakers, reflecting the continued influence of traditional domestic roles and limited participation of women in formal economic activities.

The proportion of employed household members was relatively low, accounting for 32% among males and 17% among females. This indicates a high intra-household dependency ratio despite low overall dependency ratios based on age groups, whereby a comparatively small economically active population supports a larger non-working population. Such conditions may place financial pressure on households and increase household vulnerability to poverty and food insecurity. Overall, the estimated unemployment rate within the Project AoI was approximately 26.3%, which is significantly higher than the national unemployment rate of approximately 5.0%[29] reported by the National Bureau of Statistics (2024). This disparity suggests that the local economy remains underdeveloped and lacks sufficient capacity to absorb the available labour force.

[29] Note: Nigeria rebased its economy and shifted its baseline indicators to align with international metrics in 2023 to include individuals who worked limited hours per week and were not formerly employed. Unemployment peaked historically at around 33.3% in 2020, the structural change in methodology dropped reported official figures to below 5%. (Ileogbu and Okolie, 2025).

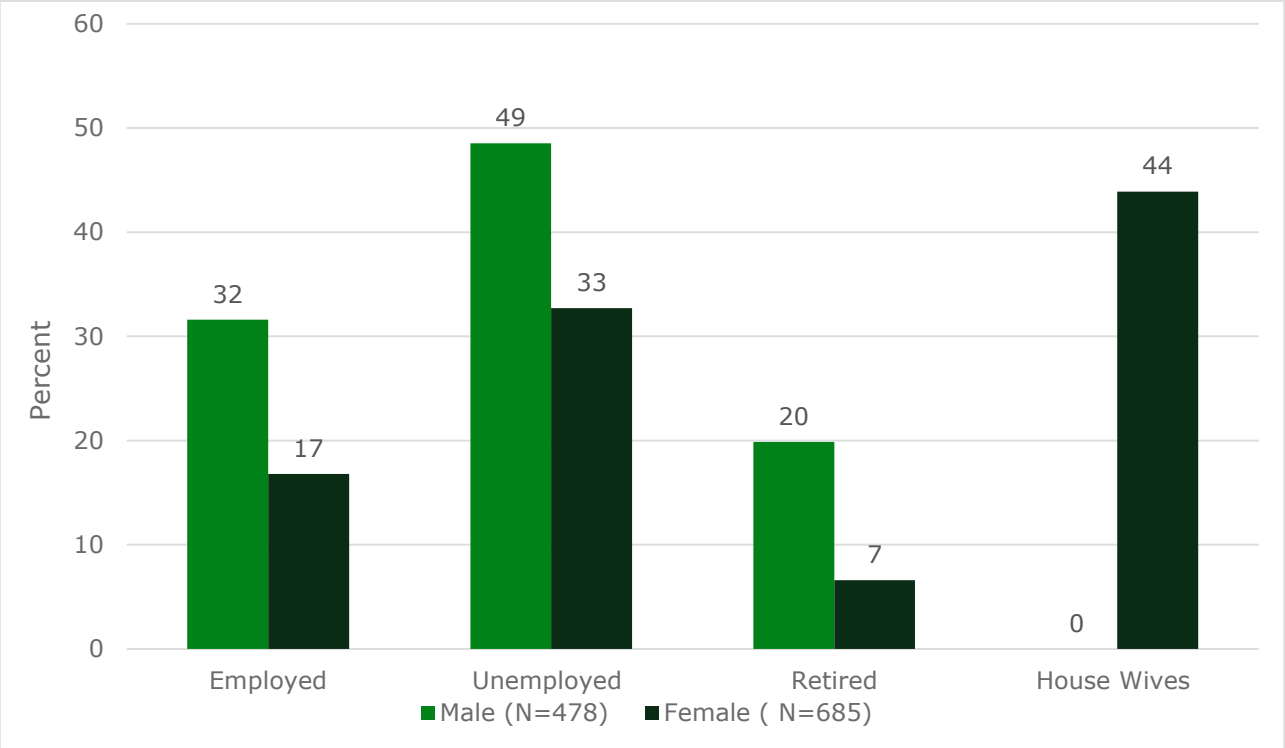


FIGURE 7-68: HOUSEHOLD EMPLOYMENT STATUS IN THE STUDY AREA
(Source: Field Survey, December, 2025)

Elevated unemployment levels within the Project AoI have important socio-economic implications, including reduced household income, increased reliance on informal or subsistence-based livelihood activities, and heightened socio-economic vulnerability. Prolonged unemployment may also contribute to broader social challenges such as rural–urban migration, youth disengagement, increased informal economic activity, and declining household welfare.

7.6.8.2 EMPLOYMENT TYPE

The occupational distribution of the population within the Project AoI, as presented in Table 7-91, indicates a strong reliance on informal and self-employed economic activities, with limited participation in formal employment sectors.

Farming represents the dominant economic activity, accounting for approximately 24.4% of respondents, and continues to serve as a key source of household subsistence and income. Participation in agricultural activities is higher among females (27.0%) than males (22.0%), indicating the significant role of women in sustaining household livelihoods through small-scale farming practices. Trading constitutes the second most prominent occupation, accounting for 20.5% of respondents, with notably higher female participation (27.8%) compared to males (13.9%). This reflects the importance of petty trading and informal commercial activities, particularly among women, as a means of household income generation within the local economy. Business-related activities account for approximately 19.8% of respondents, with slightly higher participation among males (21.5%) than females (17.9%). This suggests the presence of a moderately active entrepreneurial segment within the Project AoI, particularly among men, potentially influenced by comparatively greater access to capital, productive resources, and economic opportunities. Artisan occupations represent 11.7% of respondents,

with male participation (16.0%) significantly higher than female participation (7.0%). This distribution reflects the gendered nature of skilled manual trades such as carpentry, welding, masonry, and mechanical work, which are traditionally male-dominated occupations within the area.

In contrast, participation in the formal employment sector remains relatively limited. Public sector employment accounts for approximately 9.3% among junior civil servants and 6.1% among senior civil servants, while employment within private companies remains comparatively low, accounting for 3.6% and 3.3% among junior and senior private-sector employees, respectively. Overall, the occupational profile of the Project AoI is characterised by a high dependence on agriculture, trading, and small-scale business activities, coupled with limited access to formal salaried employment opportunities. This occupational structure is typical of a predominantly low-income and informal economy and contributes to the relatively high levels of unemployment and underemployment observed within the Project AoI.

TABLE 7-91: PERCENTAGE DISTRIBUTION OF OCCUPATION OF HOUSEHOLD MEMBERS WITHIN THE PROJECT AOI

S/No.	Categories	Male		Female		Total	
		N	%	N	%	N	%
1	Farmer	243	22.0	267	27.0	510	24.4
2	Fisher folk	0	0	0	0	0	0
3	Hunter	27	2.4	2	0.2	29	1.4
4	Artisan	177	16.0	69	7.0	246	11.7
5	Trader	154	13.9	275	27.8	429	20.5
6	Business	238	21.5	177	17.9	415	19.8
7	Junior civil servant	102	9.2	92	9.3	194	9.3
8	Senior civil servant	71	6.4	56	5.7	127	6.1
9	Junior worker in private companies	46	4.2	29	2.9	75	3.6
10	Senior worker in private companies	47	4.3	22	2.2	69	3.3
Total		1,105	100	989	100	2,094	100

(Source: Safespace Resources Limited, 2026)

7.6.9 INCOME LEVELS AND HOUSEHOLD ECONOMY

The distribution of monthly household income within the Project AoI presented in Table 7-92 indicates a high concentration of households within the lower income categories, reflecting generally low earning capacity across the area.

The mean monthly household income is estimated at approximately ₦51,374, while the modal income is approximately ₦50,000, indicating that the most common income levels are clustered within the lower income brackets. The majority of household heads reportedly earn below ₦71,000 per month, further highlighting the limited income-generating capacity of households within the Project AoI. Using an exchange rate of ₦1,350 to USD 1, the average household income is equivalent to approximately USD 1.3 per day, which falls significantly below the international extreme poverty threshold of USD 2.15 per day. This suggests that a substantial proportion of households within the Project AoI are likely living under conditions of extreme poverty and economic vulnerability.

Findings from participatory research corroborate the quantitative results, with respondents indicating difficulties in meeting basic household needs and limited capacity for savings. Household expenditure is primarily concentrated on essential items such as food, housing (rent), education, transportation, and energy-related costs, leaving minimal disposable income for investment, asset accumulation, or economic advancement. Overall, the household economy within the Project AoI is characterised by low- income levels, subsistence-oriented livelihoods, and limited financial resilience. These conditions increase household vulnerability to external economic shocks and may constrain access to essential services such as healthcare, education, and adequate nutrition.

TABLE 7-92: PERCENTAGE DISTRIBUTION OF MONTHLY HOUSEHOLD INCOME WITHIN THE PROJECT AOI

S/No.	Income Categories (₦)	N	%
1	Less than 8,000	0	0
2	8,000 – 17,999	83	23.7
3	18,000 - 27,999	44	12.6
4	28,000 - 37,999	23	6.6
5	38,000 - 47,999	75	21.4
6	48,000 - 57,999	45	12.9
7	58,000 - 67,999	24	6.9
8	68,000 - 77,999	22	6.3
9	78,000 - 87,999	0	0
10	88,000 - 97,999	0	0
11	98,000 - 107,999	34	9.7
12	108,000 – 117,999	0	0
13	118,000 – 127,999	0	0
14	128,000 and more	0	0
Total		350	100

(Source: Safespace Resources Limited, 2026)

7.6.10 LIVELIHOOD ACTIVITIES

Livelihoods within the Project Area are predominantly characterised by informal, small-scale, and subsistence-based economic activities, with limited participation in formal employment. The local economy is largely structured around non-basic[30] sectors, where economic activities are primarily oriented towards meeting local consumption needs rather than external markets. The basic sector comprises activities that generate income from outside the local area, including the export of goods and services. In contrast, the non-basic sector consists of economic activities that serve the local population and circulate income within the area. Within the Project AoI, the economy is predominantly non-basic, with most livelihood activities centred on subsistence production and small-scale trade. This reflects limited engagement with external markets and a high dependence on localised economic systems, where income generation and circulation occur mainly within community boundaries.

7.6.10.1 AGRICULTURE

Findings from primary data indicate that farming is the dominant livelihood activity, accounting for approximately 24.4% of respondents and serving as a primary source of household subsistence and income.

Crop Farming

Crop farming is the dominant agricultural activity and is undertaken using traditional tools, including hoes and machetes, with little to no mechanisation. Farm holdings are generally small, averaging approximately three plots per farmer, limiting productivity and commercial potential. Farming practices are based on the rotational bush fallow system, with mixed cropping widely practiced. Fallow periods have declined from historical levels of approximately seven years to about five years or less, due to population pressure, land scarcity, and urban expansion, particularly in more developed communities.

Key crops cultivated include cassava, yam, cocoyam, maize, and vegetables, primarily for household consumption, with surplus produce sold in local markets. Plantain and banana plantations illustrated in Figure 7-69 are frequently located close to residential areas, reflecting the integration of agricultural and settlement patterns.

[30] Basic sector: earns income from activities and transactions carried out with areas outside the region being studied. Examples include exporting goods or services to other regions or countries. 2. Non-basic sector: earns income from activities that occur within the local area itself, mainly serving the local population (Masser, 1972: 62 in: Safespace Resources Limited, 2026).

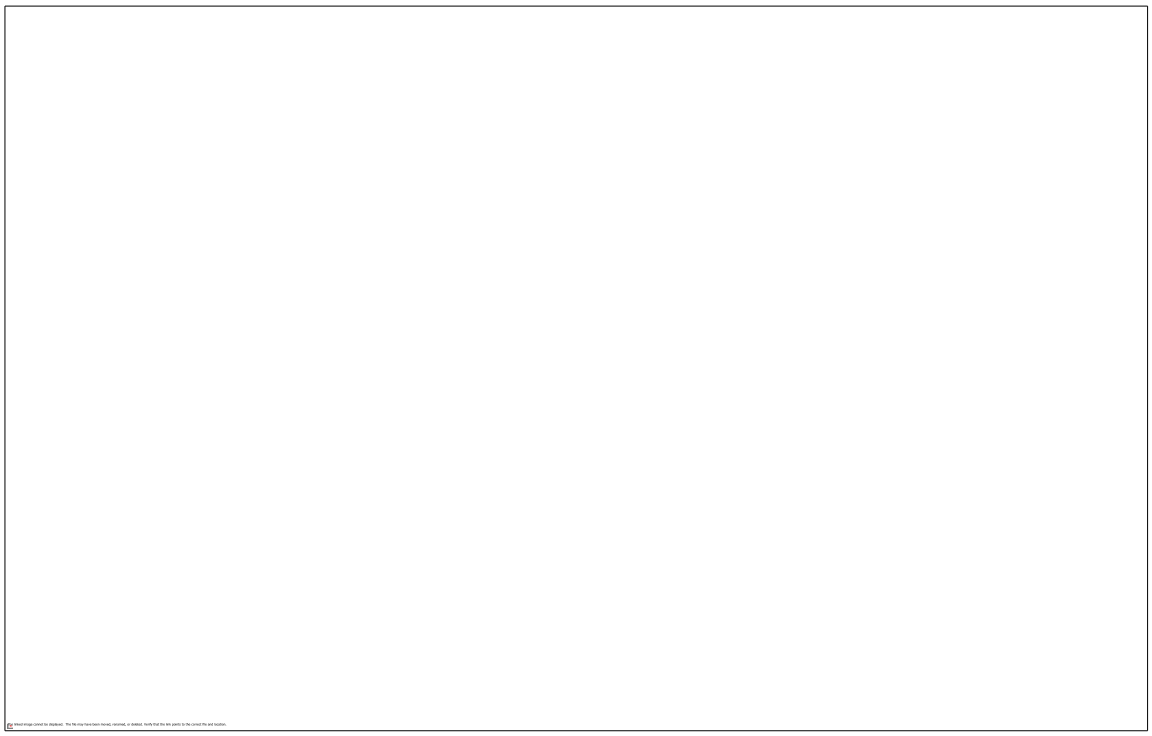


FIGURE 7-69: PLANTAIN PLANTATION IN THE PROJECT AREA
(Source: Safespace Resources Limited, 2026)

Agricultural activities follow a seasonal cycle, with land preparation typically commencing between January and February, followed by planting and harvesting at varying times throughout the year. Produce is processed locally, with cassava converted into garri and fufu, and other crops preserved using traditional methods.

Marketing of agricultural produce takes place within local and periodic markets, including Eleme and Elelenwo markets. However, the absence of cooperative institutions, extension services, and formal agricultural support systems constrains productivity and market efficiency.

Key constraints affecting crop farming include:

- Limited access to agricultural inputs (e.g., fertilisers);
- Poor access to finance; and
- Absence of agricultural extension services.

Income from farming is typically seasonal, with estimated earnings ranging between ₦150,000 and ₦350,000 per harvest period, which is generally insufficient to sustain households throughout the year.

Forestry and Lumbering

Lumbering activities occur within secondary forest areas of the Project AoI and involve the harvesting of timber species such as iroko, mahogany, and afara. Timber is used locally for construction and furniture production, with additional products marketed outside the communities. By-products from timber processing are utilised for firewood and charcoal production, contributing to household energy supply and supplementary income.

Fishing

Fishing activities are present but limited in scale and largely subsistence-based. The primary water body, the Okulu River, is subject to tidal influence and sand dredging activities, which constrain fishing productivity and limit long-term viability shown in Figure 7-70 below.



FIGURE 7-70: OKULU RIVER IN THE PROJECT AREA

(Source: Safespace Resources Limited, 2026)

Livestock Farming

Animals commonly kept in small quantities in the area are goats, sheep, and poultry, some of which are confined and others left to roam free. Animals are kept for food, commerce, and as gift items. Challenges associated with livestock farming in the area include livestock diseases, theft of livestock, scarcity of funds for the purchase of livestock feeds, and Absence of extension services from government agencies.

7.6.10.2 NON-TIMBER FOREST PRODUCTS EXPLOITATION

Hunting

Hunting is very limited activity in the area. Animals commonly caught include Grass-cutter, Duiker, Antelope and Bush Pig, which are sold as caught or roasted before sale. The activity is constrained by a number of factors, including occupational risks such as exposure to mosquito and snake bites, as well as the declining availability of wildlife.

The reduction in wildlife populations is primarily attributed to habitat loss and environmental pressures, including ongoing land use change, urban expansion, and deforestation associated with development activities.

Palm Oil Extraction

Palm oil extraction took place all year round. There were individually owned small mills for oil extraction; however, output depends on the season of exploitation. During the rainy season, yield is low, ranging from 22-35 bunches of palm fruit a week per exploiter. However, during

the dry season, yield soars to 120-310 bunches, at average earnings of ₦6 000 per bunch from the extracted oil and a further ₦1 000 worth of kernels per bunch.

There were challenges in the form of insufficient labour only few people were skilled in the art of climbing palm tree, and the number is dwindling steadily. There is a risk of death or serious injury from falling from the palm tree. As a result, youths are reluctant to engage in this type of business, thereby driving up the cost of labour. Inadequate funds and lack of government support hampers the effective operation of the business.

Gathering of Medicinal Herbs, Snails, Edible Leaves, and Fruits

The gathering of medicinal herbs, edible leaves (such as the popular Okasi), snails (regarded as a delicacy by some), and edible fruits (e.g., Ogbono) takes place in the rural parts of the project area.

Traditional healers gather medicinal herbs, as they alone can identify the plant species used to heal different kinds of ailments. Increasing loss of forests because of development and population pressure poses a challenge to this activity. Furthermore, the advent of modern medicine and Christianity has reduced the popularity of the village medicine man and, concurrently, the intensity of exploitation of such plants. Challenges associated with exploitation of these forms of Non-timber Forest Products (NTFPs) centre on snakebites and other forms of animal attack.

Rural Service-based Activity

Rural non-farm activity takes many forms. It may be classified, for convenience, into commercial and light industrial. Grocery stores, hair dressing/barber shops, and restaurants were the most abundant of the commercial activities, while tailoring, welding/fabrication and carpentry/furniture represented the primary light industrial activities. A characteristic feature of these businesses is that they are owned by individuals, small-scale in nature, and typically manned by a few persons, including apprentices. Table 7-93 below shows prices of common commodities in the area.

TABLE 7-93: PRICES OF SOME FOOD ITEMS IN THE PROJECT AREA

S/No.	Item	Price/Quantity(₦)
1a.	Garri	300 per cup
1b.	Garri	9,000 per basin
2.	Vegetable	200 per average bunch
3.	Plantain	6,000 per bunch
4.	Banana	6,000 per bunch
5.	Palm Oil	2,700 per bottle

(Source: Safespace Resources Limited, 2026)

7.6.11 LAND TENURE AND LAND USE

Land tenure within the Project Area is predominantly governed by customary ownership systems, under which land is owned and managed by extended families, communities, and

individuals through inheritance. These customary arrangements continue to play a central role in regulating access to land, while increasingly interacting with market-based land transactions driven by urbanisation and economic development.

7.6.11.1 LAND TENURE SYSTEM

Community land across the Project AoI is primarily held by extended family units, with inheritance representing the dominant mode of land acquisition for both agricultural and residential purposes. In many instances, individuals obtain residential land through family allocation, while land transactions such as sales and leases are mediated through customary authority structures.

In Ikwerre communities within the Project AoI, land ownership is vested in families, communities, and individuals by inheritance, with rights to mortgage, sell, or lease land generally restricted to indigenes. However, land transactions involving non-indigenes are permitted through purchase arrangements facilitated by indigenous landowners. For residential development, individuals may build on inherited land or acquire land through private transactions.

Similarly, within the Eleme axis, individuals and groups are permitted to sell or lease farmland, and both indigenes and non-indigenes can acquire land through market-based transactions. In Elelenwo, land ownership is shared between individuals and the wider community, with land allocation for residential purposes typically managed through family structures, while non-indigenes can acquire land through purchase from individuals or community authorities.

Overall, the land tenure system within the Project AoI reflects a hybrid structure, where traditional customary ownership coexists with increasing land commodification and private market transactions.

7.6.11.2 LAND USE PATTERNS

Historically, land use within the Project AoI has been dominated by subsistence agriculture, with farming serving as a primary livelihood activity. However, this pattern is undergoing a notable transition due to urbanisation, industrial expansion, and changing livelihood preferences.

Farming, although still present, is steadily declining in importance, primarily due to reduced availability of agricultural land, increased demand for residential and commercial development, and shifts toward non-agricultural economic activities.

As a result, land use within the Project AoI is increasingly characterised by a mixed system, incorporating:

- Residential expansion
- Commercial activities
- Industrial development
- Remaining agricultural land

This transition is particularly pronounced in areas closer to industrial facilities and transport corridors, where population influx and economic activity are highest.

7.6.11.3 LAND AVAILABILITY AND AGRICULTURAL PRESSURE

Land availability for agriculture within the Project AoI is under increasing pressure due to population growth, urban expansion, and competing land uses. This has led to a gradual reduction in farmland and more intensive land utilisation.

Traditional agricultural practices such as the rotational bush fallow system are still practiced; however, fallow periods have significantly declined. In Ikwerre communities, fallow periods have reduced to between 2–4 years, and in some cases as low as 2 years, compared to longer historical cycles. Similarly, in the Eleme axis, fallow periods that previously extended up to 7 years have declined considerably over the past decade due to increased land pressure driven by industrial activities and development.

The reduction in fallow periods reflects intensified land use, which may have implications for soil fertility, agricultural productivity, and long-term sustainability of farming systems.

7.6.11.4 LAND VALUE AND ACCESS

Land values within the Project AoI have increased significantly over recent years, reflecting rising demand associated with urbanisation and industrial growth. The cost of residential land varies depending on location, accessibility, and proximity to economic hubs.

In Ikwerre communities, the cost of a standard plot (100 ft × 50 ft or 30 m × 15 m) ranges between approximately ₦7,000,000 and ₦30,000,000, representing a substantial increase compared to values recorded five years prior (₦7,000,000 to ₦15,000,000).In the Eleme axis, land prices currently range between approximately ₦10,000,000 and ₦15,000,000, compared to ₦5,000,000 to ₦7,000,000 five years ago. In Elelenwo, land values have increased further, with plots currently valued at approximately ₦30,000,000, compared to ₦15,000,000 five years earlier.

These trends indicate a rapidly evolving land market, driven by increased demand for residential and commercial space within the Project AoI. While rising land values provide economic benefits to landowners, they also create barriers to land access, particularly for lower-income households and new settlers.

7.6.11.5 LAND USE TRANSITION AND URBANISATION

The Project AoI is experiencing a broader shift from rural and agriculture-based land use systems to more urbanized, commercially oriented, and industrial land uses. This transformation is driven by:

- Expansion of industrial operations
- Increased population inflow linked to economic opportunities
- Infrastructure development and improved connectivity

As agricultural land is increasingly converted to residential and commercial uses, the spatial character of communities is evolving into a peri-urban and industrial landscape.

7.6.12 INFRASTRUCTURE AND PUBLIC SERVICES

Infrastructure and public services within the Project Area reflect a moderately developed system, supported by proximity to Port Harcourt and associated industrial activities, but constrained by reliability, service quality, and institutional capacity limitations.

7.6.12.1 CLASSIFICATION OF INFRASTRUCTURE

Infrastructure within the Project Area is broadly classified into physical, social, and institutional components, to provide a useful framework for assessing the availability, accessibility, and functionality of infrastructure within the Project AoI.

- **Physical infrastructure** - comprises the foundational systems that support economic production and mobility. These include transportation networks such as roads, railways, bridges, ferry services, canals, and footpaths, as well as storage and processing facilities, including warehouses, silos, processing plants, and associated machinery and equipment. Additional elements of physical infrastructure include water resource development systems such as irrigation and flood control facilities, as well as soil conservation measures, which collectively support agricultural productivity and environmental management.
- **Social infrastructure** - refers to facilities and services that directly support human wellbeing and quality of life. Within this category are housing, health facilities (including hospitals, dispensaries, maternity centres, and primary healthcare facilities), and educational institutions, ranging from primary and secondary schools to technical, vocational, and adult education centres. Social infrastructure also includes utilities such as electricity supply, water provision, and sanitation systems, as well as leisure and recreational facilities that contribute to community cohesion and welfare.
- **Institutional infrastructure** - encompasses the organisations and systems that facilitate economic coordination, governance, and service delivery. These include cooperative societies, community-based organisations, farmers' groups, and community development initiatives. It also includes financial institutions, agricultural extension services, research and training centres, and communication systems such as postal services and telecommunications networks, all of which play a critical role in supporting economic activity and social development.

7.6.12.2 PHYSICAL INFRASTRUCTURE

The Project AoI is served by major federal transport corridors, including the East–West Road, which passes through the Eleme communities, and the Port Harcourt–Aba Expressway, which serves the Obio/Akpor communities, including Elelenwo and Iriebe. These routes provide critical regional connectivity and facilitate the movement of goods, services, and people within and beyond the Project AoI. At the local level, most intra- and inter-community roads are tarred and generally in good condition shown in

TABLE 7-94: IMPORTANT ACCESS ROADS IN THE STUDY AREA

S/No.	Access Road	Category	Estimated Length (km)	Tarred/ Un-tarred	Condition
1.	East-West Road	Trunk A	100>	Tarred	Undergoing Rehabilitation
2.	Port Harcourt – Aba Highway	Trunk A	100>	Tarred	Good
3.	Agbonchia - Oyigbo Road	Trunk B	20>	Tarred	Good
4.	Agbonchia - East West Road	Trunk B	10>	Tarred	Good
5.	Aleto - Agbonchia Road	Trunk B	20	Graded	Fair

7.6.12.3 SOCIAL INFRASTRUCTURE

Social infrastructure within the Project Area of Influence (AoI) comprises educational, healthcare, religious, and residential facilities, which collectively support community wellbeing and service delivery. Educational and healthcare facilities are present across the Project AoI, consisting of both public and privately owned institutions (Table 7-95). These facilities provide basic services to the population; however, their distribution and capacity vary across communities.

Religious infrastructure is widespread, with a high concentration of churches and a smaller number of mosques, reflecting the predominant religious composition of the area. These institutions also serve as important centres for community interaction and social cohesion.

Formal recreational facilities are largely absent within the Project AoI. In their place, informal recreational spaces such as community playgrounds, open fields, and areas associated with schools and religious centres are commonly used for social and leisure activities.

The distribution of social infrastructure across the study area is summarised in Table 7-95., with emphasis placed on infrastructure types that are present within the host communities. Infrastructure categories with no recorded facilities have been omitted for clarity.”

Several categories of social infrastructure are not present across the study communities, including higher and specialised educational facilities (e.g. teacher training colleges and colleges of education) and all social welfare facilities, such as orphanages and homes for vulnerable groups. There are also no teaching or specialist hospitals, and only very limited provision of certain religious facilities, indicating that infrastructure provision is largely restricted to basic education, places of worship, and primary healthcare services.

TABLE 7-95: DISTRIBUTION OF SOCIAL INFRASTRUCTURE ITEMS

Social Infrastructure Items	Community							Total
	Akpajo	Elelenwo	Aleto	Njuru	Okerewa	Agbonchia	Iriebe	
Educational								

Social Infrastructure Items	Community							Total
	Akpajo	Elelenwo	Aleto	Njuru	Okerewa	Agbonchia	Iriebe	
Nursery School	53	43	17	14	11	18	16	172
Primary School	51	25	18	13	8	15	19	149
Secondary School	8	4	4	3	3	4	12	38
Polytechnic	-	-	-	-	-	1	-	1
University	-	-	-	-	-	1	-	1
Religious								
Church	50	43	33	30	24	38	44	262
Mosque	2	-	-	-	-	1	2	5
Seminary/Christian Training Institute	1	-	-	-	2	-	-	3
Islamic School	-	-	-	-	1	-	-	1
Bethel	1	-	-	-	1	-	2	4
Spiritual Healing Home	8	-	-	-	1	-	2	11
Kingdom Hall	2	-	-	-	1	-	3	6
Healthcare								
Hospital	1	-	-	-	-	1	2	4
Maternity	3	2	2	-	-	4	6	17
Dispensary	-	-	1	-	-	-	-	1
Health Centre	1	-	-	-	1	1	-	2
Clinic	1	-	-	3	3	3	-	10
Patent Medicine Store	22	13	11	8	12	8	16	90
Traditional Healing Centre	6	4	3	5	5	2	3	28

Housing

Housing within the project area is generally characterised by permanent and structurally stable residential development, reflecting a moderately developed and established settlement pattern across the communities. The distribution, typology, and condition of housing are presented in Table 7-96 and provides a summary of key housing attributes within the Project AoI. The dominant housing type is single-family detached bungalows, constructed primarily using cement blocks for walling, corrugated iron sheets for roofing, and strip foundations. These construction materials are consistent with durable building practices and are typical of semi-urban and peri-urban environments. In terms of condition, the majority of residential structures are classified as being in "good" condition, requiring minimal or no repairs. This

indicates that housing within the Project AoI is generally adequate in meeting basic shelter requirements.

TABLE 7-96: DISTRIBUTION OF HOUSING ATTRIBUTES

Housing Attributes	Number	%
House Type		
Rooming House (Courtyard)	110	31.4
Bungalow	159	45.4
Storey Building	81	23.1
Total	350	100
No Block of Flats (Multi-family) or Rooming House (Wagon) were present		
Type of walling material		
Corrugated iron sheets	27	7.7
Blocks	323	92.3
Total	350	100
No houses made of "Wood "or "Mud" were present		
Roofing Material		
Corrugated iron sheets	228	65.1
Wood	24	6.9
Decking	98	28.0
Total	350	100
No roofing made "Slate", "Thatch" or Other materials were present		
Type of foundation		
Strip	350	100
Total	350	100
No "Raft" or "Pile" foundations, or houses with no foundations were present		
House Condition		
Good (needs no repair)	269	76.9
Fairly Good (needs minor repair)	81	23.1
Total	350	100
No houses were found to be in "Bad (needs major repair)" or "Very Bad (beyond repair)" condition.		



Figure 7-71 below illustrates a typical modern residential building within the Project Area, demonstrating the prevailing use of durable construction materials and established building practices characteristic of the area.



FIGURE 7-71: TYPICAL MODERN BUILDING IN THE STUDY AREA
(Source: Safespace Resources Limited, 2026)

Other Social Infrastructure

In addition to the primary facilities presented in Table 7-95, the Project Area is supported by a range of basic social infrastructure elements distributed across communities.

Educational facilities are present in both public and private forms, as illustrated in Figure 7-72 and Figure 7-73, which depict typical school infrastructure within the Project AoI. These facilities are generally integrated within community settlements and serve local populations.

Religious infrastructure is widely established, with a high concentration of churches and a smaller number of mosques distributed across the Project AoI, reflecting the dominant role of faith-based institutions within community structures. Notably, there is an absence of formal social welfare facilities within the Project AoI, including daycare centres, orphanages, and specialised support services for vulnerable groups.



FIGURE 7-72: GOVERNMENT SECONDARY SCHOOL, AKPAJO, ELEME LGA
(Source: *Field Survey, December, 2025*)



FIGURE 7-73: STATE SCHOOL I & 2, AKPAJO, ELEME LGA,
(Source: Safespace Resources Limited, 2026*)*

7.6.12.4 INSTITUTIONAL INFRASTRUCTURE

Based on the information from the baseline socio-economic study (Safespace Resources Limited, 2026), the institutional infrastructure within the Project AoI is extremely limited in scope. Formal institutions such as banks, post offices, courts (customary, magistrate, and high courts), agricultural extension services, research centres, and cooperative societies are absent across all surveyed communities. The only formal institutional facilities recorded within the Project AoI are police stations with three facilities distributed across Akpajo, Elelenwo, and

Agbonchia. These provide basic security services and represent the primary formal governance presence within the area.

7.6.13 UTILITIES AND BASIC SERVICES

Public utilities within the Project AoI are available but are characterised by reliability and service delivery constraints, particularly in relation to electricity and water supply.

Electricity infrastructure is present across most communities and is managed by the Port Harcourt Electricity Distribution Company (PHED). Despite widespread grid connectivity, supply is highly inconsistent, with frequent outages and, in some cases, prolonged periods without power due to administrative and infrastructure failures such as damaged transformers and fallen distribution lines. These challenges, combined with reported issues of overbilling and disconnection, have resulted in widespread reliance on private generators, with solar systems increasingly adopted as supplementary energy sources.

Water supply within the Project AoI is largely dependent on private and commercial boreholes, as well as water vendors. While communal water systems are present in some rural communities, these are generally non-functional or poorly maintained. In more urbanised areas, including Akpajo and Elelenwo, the absence of functional piped water systems has resulted in a near-complete reliance on privately sourced water.

Telecommunication services are widely available and relatively reliable, with all major network providers operating across the Project AoI. Mobile phone usage is high (approximately 95%), making telecommunications one of the more accessible and dependable public services within the area.

7.6.13.1 WASTE MANAGEMENT AND SANITATION

Waste management practices within the Project Area reflect a combination of formal disposal systems and informal practices, with varying levels of effectiveness across communities.

Solid Waste Management

The methods of household refuse disposal within the Project AoI are presented in Table 7-97 The predominant method of disposal is the use of government-designated temporary dumpsites, accounting for the majority of responses. This indicates some level of access to formal waste collection points within the area. Notwithstanding this, informal waste disposal practices remain prevalent, particularly in less urbanised communities. Disposal at family-designated dump sites constitutes a significant proportion of responses, while practices such as open burning are also observed, albeit at lower levels. The continued reliance on informal disposal methods highlights gaps in waste collection coverage and management efficiency, with potential implications for environmental quality and public health.

TABLE 7-97: METHODS OF DISPOSAL OF HOUSEHOLD REFUSE

S/No.	Method of Disposal	N	%
1.	Tipped at the nearest street corner	0	0
2.	Tipped at government-designated temporary dumpsite	191	54.6

S/No.	Method of Disposal	N	%
3.	Tipped at the marketplace	0	0
4.	Tipped into family designated dump site	76	21.7
5.	Tipped into stream /river	0	0
6.	Burned at designated site	10	2.9
7.	Disposed by Private Waste Collection Vendors	0	0
8.	By Burying	0	0
	Total	350	100

Sanitation and Human Waste Disposal

Sanitation practices within the Project AoI are characterised by a mix of improved and unimproved systems, as illustrated in Figure 7-74 below. The dominant method of human waste disposal is the use of water closet (WC) systems (or water-born sanitation), indicating a relatively improved level of sanitation infrastructure in parts of the Project AoI. However, alternative methods remain in use, particularly in rural communities, including pour-flush systems and open defecation.

The persistence of these practices reflects uneven access to improved sanitation facilities, with implications for hygiene conditions and community health outcomes.

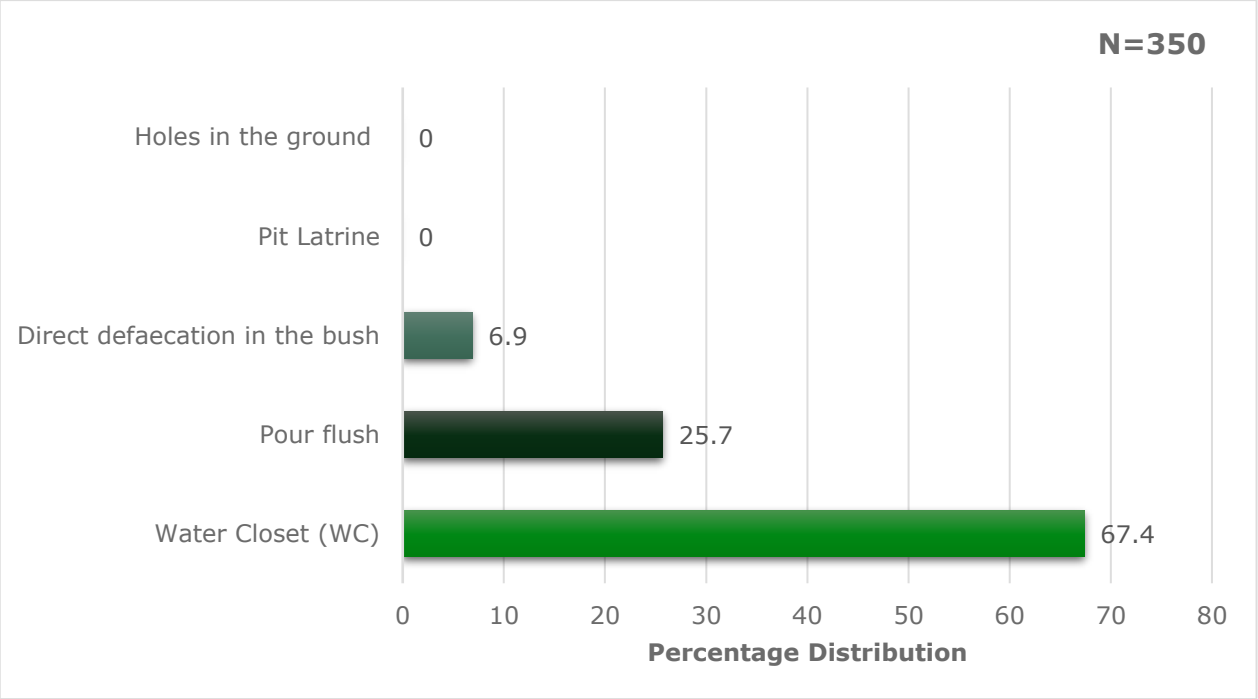


FIGURE 7-74: PERCENTAGE DISTRIBUTION OF HUMAN WASTE DISPOSAL METHODS

(Source: Safespace Resources Limited, 2026)

7.6.14 SUMMARY OF KEY SOCIO-ECONOMIC SENSITIVITIES

- **Livelihood dependence and economic vulnerability:** Households within the AoI rely heavily on subsistence agriculture, informal trading, and small-scale business activities. These livelihood systems are closely linked to access to land and natural resources, making them sensitive to changes in environmental conditions or resource availability. Low-income levels, coupled with limited savings, reduce household resilience and increase vulnerability to economic shocks and external disruptions.
- **Employment conditions and community expectations:** The AoI is characterised by high levels of unemployment and underemployment, particularly among youth and economically active populations. This context is likely to result in strong expectations around Project-related employment and procurement opportunities. Without clear communication and transparent processes, unmet expectations could lead to perceptions of inequitable benefit distribution.
- **Infrastructure and service constraints:** Existing infrastructure and social services, including water supply, electricity, sanitation, waste management, healthcare, and education, are already subject to capacity and reliability constraints. Additional demand associated with Project activities or population influx may place further pressure on these systems, increasing community sensitivity to perceived competition for limited resources.
- **Natural resource dependence:** Local livelihoods remain dependent on land, water, and surrounding natural resources for both subsistence and income generation. As a result, any reduction in resource availability or environmental quality may have direct implications for household income, food security, and overall wellbeing.
- **Health and community wellbeing:** Health services within the AoI are limited in capacity and resources, with communities relying on existing, often constrained facilities. These conditions increase sensitivity to potential public health risks, including communicable diseases and environmental health stressors, particularly during periods of increased activity such as construction.
- **Migration and influx sensitivity:** The AoI already experiences moderate levels of in-migration, driven by economic opportunities and urban expansion. Project-related labour influx may further increase demand for housing, services, and employment, with the potential to intensify competition for resources and contribute to social tension if not effectively managed.
- **Social cohesion and community stability**: While the study area is generally socially stable, it remains sensitive to perceived inequalities in access to benefits and opportunities. Uneven distribution of Project benefits or increased resource competition could affect social cohesion, particularly in contexts where traditional leadership structures play a central role in community governance and dispute resolution.
- **Gender and vulnerable groups:** Women, youth, and low-income households remain structurally vulnerable due to limited access to formal employment and economic opportunities. Youth unemployment is a particularly significant sensitivity, increasing exposure to socio-economic risks. Without targeted inclusion measures, these groups may be disproportionately excluded from Project benefits.

Overall sensitivity profile: Collectively, these factors indicate a moderate to high level of socio-economic sensitivity within the AoI. This is driven by high unemployment, low household income, reliance on informal livelihoods, and constrained infrastructure and services. These conditions highlight the importance of proactive stakeholder engagement, transparent communication, and inclusive strategies for employment and local participation throughout the Project lifecycle.

7.7 CULTURAL HERITAGE

7.7.1 INTRODUCTION

This chapter presents the baseline for cultural heritage and assesses the nature, distribution, and value (significance) of identified cultural heritage resources for the Indorama IFF Line 2 hereafter referred to as the Project, and it associated footprint referred to as the Site (Figure 4-2).

The Project comprises the design, construction and operation of the proposed IFF Line 2 Fertilizer Project in the Eleme Local Government Area, Rivers State, Nigeria. This includes the development of a new brownfield urea production line within the Indorama Free Zone, adjacent to the existing petrochemical complex and the IFF Line 1 facility (recently commissioned in June 2026).

The information presented in this baseline chapter draws on desk-based research, remote sensing, historic mapping and field survey of the Project AoI by Dr. Stanley Ifeanyi Okoroafor carried out in March 2026.

7.7.2 GEOGRAPHIC/TOPOGRAPHIC CONTEXT

The Site is located within Rivers State in southern Nigeria, forming part of the onshore Niger Delta Basin. The Niger Delta is a large sedimentary basin, comprising a thick sequence of clastic sediments deposited from the Eocene to the present through progradation of the delta system.[31]

The stratigraphy of the Niger Delta is typically divided into three principal formations: the Akata Formation (marine shales of prodelta origin); the Agbada Formation (interbedded sandstones and shales deposited in delta-front and delta-plain environments; and the Benin Formation (continental to coastal plain sands forming the uppermost unit). At the Site location, the shallow geology is dominated by the Benin Formation. The superficial and near-surface geology of the Site consists of unconsolidated to poorly consolidated sands, gravelly sands, and subordinate clay and silt horizons, derived from fluvial and deltaic deposition processes.

The Site is located within the low-lying deltaic plain of the Niger Delta, which is characterised by extremely low relief and very gentle gradients. Elevation across much of the region ranges

31 Aweto, K. E. (2018). Downhole geophysical investigation of lithological strata and water quality in the deltaic plain deposits and mangrove swamps of Niger Delta. Nigerian Journal of Pure and Applied Sciences, 31(2). https://njpas.com.ng/wp-content/uploads/2018/12/NJPAS-18-A30.pdf

from approximately sea level to only a few metres above sea level, reflecting the active depositional environment of the delta.

Across Rivers State, the terrain generally comprises flat plains with an extensive network of rivers and tributaries, and average elevations are low, with large areas lying close to sea level. Topographic gradients at the Site are therefore expected to be minimal, with limited natural variation in elevation.[32]

7.7.3 LITERATURE REVIEW OF ARCHAEOLOGICAL STUDIES TO DATE IN NIGERIA

The archaeological and historical development of the Study Area, located in the Rivers State within the eastern Niger Delta, forms part of one of the most culturally and historically significant landscapes in West Africa. The region reflects a long sequence of human occupation, technological development, trade interaction, and socio-political organisation from prehistoric periods through to the contemporary era.

Although the humid tropical environment of the Niger Delta is generally unfavourable for the preservation of organic archaeological materials, a combination of archaeological evidence, oral traditions, ethnographic records, and artefactual discoveries indicates that the region formed part of the wider network of prehistoric migration, riverine settlement, trade exchange, and resource exploitation. As such, the archaeological context of the Study Area must be understood within the broader cultural and historical framework of southern Nigeria and the Lower Niger region.

Archaeological research in south-eastern Nigeria developed relatively late, with the first systematic excavation undertaken in 1960. Earlier activity, beginning in 1910, consisted mainly of informal investigations by European scholars such as Frobenius, whose work focused on the recovery of artefacts rather than the recording of their archaeological context. The discovery of terracotta, copper, and bronze objects stimulated further interest, prompting and increase in archaeological surveys aimed largely at the collection of material culture. Up to the late 1930s, archaeological enquiry in Nigeria remained predominantly object-focused, with limited attention given to the broader interpretation of past societies in West Africa.

The establishment of the Nigerian Department of Antiquities (NDA) in 1943 marked a significant step in formalising archaeological research. By the late 1960s, systematic survey programmes were undertaken through collaboration between the NDA and academic institutions, including the University of Cape Town, the University of Ibadan, the University of Ile-Ife, and the University of Nigeria. These initiatives facilitated the emergence of Nigerian scholars in the study of their own archaeological heritage. Notable excavations, such as those at Igbo-Ukwu, produced substantial quantities of glass beads, finely crafted bronze artefacts,

32 Adizua, O. F., & Uzu, D. U. (2024). A petrophysical properties evaluation study of a Niger Delta field using well logs and core data. Oriental Journal of Physical Sciences, 9(1), 53–61. https://doi.org/10.13005/OJPS09.01.09

potsherds, and iron tools. These finds demonstrated the technological sophistication and cultural complexity of the Igbo Kingdom.

More recent archaeological research in south-eastern Nigeria has focused on understanding past technologies, particularly those associated with the extraction and processing of raw material for the production of stone and metal tools and pottery. Traditional practices relating to iron smelting, pottery production, and tin mining continue to be employed into the 21st century within the Igbo region.

7.7.4 ARCHAEOLOGICAL AND HISTORIC BACKGROUND

This section provides a period-by-period overview of the archaeology and history of the national, regional and AoI.

7.7.4.1 REGIONAL ARCHAEOLOGICAL AND HISTORIC CONTEXT (NIGER DELTA AND ELEME)

Archaeological evidence from across Nigeria demonstrates that human occupation extends back several millennia, with Early and Late Stone Age tools recovered from a range of ecological zones indicating long-term and widespread prehistoric settlement.

One of the most significant developments in West African archaeology is the emergence of the Nok culture in central Nigeria between approximately 500 BCE and 200 CE. This culture is characterised by early iron smelting technology, distinctive terracotta sculpture traditions, organised settlements, and increasing craft specialisation. Although geographically distant from the Niger Delta, the technological developments of the Nok culture, particularly in metallurgy, are considered to have influenced later societies across southern Nigeria through migration and long-distance interaction.

Within southern Nigeria, archaeological evidence from the Igbo-Ukwu complex (discussed above) demonstrates that advanced metallurgical technologies, ritual systems, and long-distance trade networks were established in the Lower Niger region by the 9th century CE.

The Niger Delta itself functioned as an important corridor of exchange and interaction, linking inland communities with coastal trade networks. Eleme, situated within the eastern Niger Delta and forming part of the Ogoni cultural region, occupies a strategically important position within this system. Historically, Eleme communities were connected to coastal trading settlements, inland Ogoni and Igbo hinterlands, riverine transport routes, and interior agricultural zones. This positioning facilitated the movement of goods, people, and ideas, contributing to the long-term socio-economic and cultural development of the region.

7.7.4.2 PREHISTORY

Available archaeological evidence indicates that hunter-gatherer groups occupied Igboland during the Middle to Late Stone Age (c. 8000-3000 BC), prior to wider population movements across sub-Saharan Africa between approximately 5000 and 4000 BCE. Oral traditions also retain references to this early period. For example, narratives associated with the Nri people suggest that their ancestral figure, Eri, arrived before the domestication of yams and other crops, implying a foraging economy.

Local traditions further contribute to an understanding of early settlement patterns. In the town of Aba, located approximately 40 km northeast of the Study Area, oral histories describe

migration routes from Ngwaland, with early settlers reportedly following elephant pathways to the Aza River. This association is reflected in the name 'enyi mba', meaning 'The Elephant Town'.

Evidence for long-distance interaction is suggested by the presence of beads of Indian origin recovered from an Igbo-Ukwu burial context, indicating trade connections with India as early as the 9th century AD.

7.7.4.3 HISTORIC ERA

Following the abolition of the transatlantic slave trade in 1807, new commercial networks were established by the British, including trade routes linking coastal settlements and focusing on palm oil production. Increased interaction between Igbo communities and neighbouring groups within the Niger River and Delta region accompanied this period, alongside the introduction and expansion of Christianity.

Christian missionary activity played a significant role in shaping social and cultural change within Igbo society, contributing to the adoption of European belief systems and the construction of churches. Some of these religious structures may remain within settlements surrounding the Study Area.

Nigeria gained independence from the United Kingdom in 1960, after which Igboland became largely confined to the southeastern region of the country. Political instability followed, culminating in a military coup in 1966, during which Igbo soldiers were involved in the overthrow of the central government. Subsequent tensions led to the establishment of the Republic of Biafra in the eastern region, marked by the adoption of a distinct national flag. Evidence of conflict associated with this period may still be present within the wider landscape, particularly around Aba.

The Biafran War concluded in 1970, when the region was reintegrated into Nigeria with external military support from the United Kingdom/ The methods employed during this process remain the subject of ongoing historical debate and controversy.

7.7.5 INTANGIBLE TRADITIONS

Intangible cultural heritage in the Study Area, including the Eleme, Elelenwo, and Iriebe communities, is expressed through oral traditions, rituals, festivals, and everyday social practices, which collectively sustain cultural identity and continuity. Knowledge is transmitted across generations through storytelling, proverbs, folklore, and communal gatherings, particularly during festivals and other social events.

Traditional belief systems remain centred on ancestral worship, with rituals undertaken at sacred sites such as shrines associated with specific communities or deities. However, many of these sites are under increasing pressure from development. For example, the Okala nsin of Okerewa has been lost due to land-use change, while the Otalloboni shrine in Akpajo has been relocated for preservation.

Seasonal festivals form a core component of cultural expression. The New Yam festival (*Ori Ijii* or *Ogbo Nja*), held between September and October, marks the harvest season and symbolises thanksgiving and renewal. Celebrations involve offerings to ancestors, alongside music, dance,

and communal feasting. Other events, including end-of-farming festivals and traditional wrestling competitions (e.g. *O'e Aka*), reinforce social cohesion and cultural identity.

Masquerade traditions (*Owu* or *Ekpo*) are also significant, representing ancestral presence and moral authority during ceremonies, funerals, and festivals. These performances combine ritual, music, and dance, and play an important role in maintaining cultural values.

Music, dance, and oral performance are integral to community life, serving as both entertainment and a means of transmitting history and shared values. Similarly, ritual practices linked to land, water, and spiritual wellbeing reinforce the strong relationship between cultural heritage and the natural environment.

Traditional governance systems, comprising kings, chiefs, elders, and family heads, regulate social conduct, oversee cultural practices, and resolve disputes according to customary law. Ceremonial events, such as the coronation of rulers, remain important expressions of authority and continuity.

Indigenous language and oral expression are central to cultural identity; however, they are increasingly under pressure from urbanisation, industrialisation, and in-migration. The growing dominance of English, Nigerian Pidgin, and other regional languages has contributed to a decline in local language use, particularly among younger generations.

Overall, intangible cultural heritage within the Study Area represents a dynamic and interconnected system of beliefs, practises, and social structures, which is increasingly vulnerable to socio-economic change and should be carefully considered within the context of development planning.

7.7.6 KEY BASELINE FINDINGS

The baseline study identified a total of 9 tangible cultural heritage resources within the 3 km Project AoI.

For the purposes of this study, each identified cultural heritage resource is assigned a unique identifier (for example IND_CH_001) and is presented below. Further details on each cultural heritage resource can be found in Table 7-98 and in Figure 7-75.

Key tangible cultural heritage resources within the Site AoI comprise shrines, sacred landscapes, water resources, and remnants of traditional land-use practices, reflecting long-standing religious beliefs and community organisation.

Community and compound shrines are present within nearby Eleme settlements, including Akpajo, Alesa, and Agbonchia. These may contain culturally significant artefacts, such as wooden slit gongs used historically for communication, ceremonial functions, and the exercise of traditional authority. Such resources are typically controlled by designated custodians and retain ritual significance. However, many shrine sites have been subject to encroachment, disturbance, or partial loss as a result of infrastructure development and urban expansion.

Sacred natural resources, including forests, trees, and water bodies, also form an important component of tangible heritage. Several of these have been degraded, relocated, or lost due to land-use change. For example, the former Ukala Nsin waterbody in Okerewa has been removed through development, while other sacred sites have been relocated for protection.

Watercourses such as the Okulu River (IND_CH_007 and IND_CH_008) hold both cultural and historical importance, having traditionally supported transport, subsistence activities, and ritual practices. However, activities such as sand mining have altered these resources and contributed to alterations in cultural sensitivity and/or value.

Other heritage elements, including historic trackways, farming sites, palm oil processing areas, and former trade routes, are now largely degraded or no longer visible due to modern development and changing economic practices.

Within the immediate Project Area, which comprises previously developed land, Dr. Stanley Ifeanyi Okoroafor maintains that as a result of fieldwork findings, no intact or significant tangible cultural heritage resources were identified during surveys or stakeholder engagement. Notwithstanding the above, further review of the baseline following receipt of Dr. Okoroafor's field report has identified the need for additional consideration of cultural heritage within the wider AoI.

TABLE 7-98: CULTURAL HERITAGE BASELINE GAZETTEER

Unique Identifier	Name	Type	Source	Description	Ground truthed?	Sensitivity	Latitude	Longitude
IND_CH_001	Onura Shrine, Alesa	Shrine	Indorama field survey	Relic of sacred forest, impacted vegetation, and commercial activity.	Yes - by subcontractor during field survey	High	4°47'9.42"N	7° 6'58.89"E
IND_CH_002	Sirariokulu Shrine, Agbonchia	Shrine	Indorama field survey	Relic of sacred forest, impacted vegetation, residential and farming activities.	Yes - by subcontractor during field survey	High	4°47'59.46"N	7° 7'19.11"E
IND_CH_003	Mukor Shrine, Agbonchia	Shrine	Indorama field survey	Relic of sacred forest, impacted vegetation, residential and farming activities.	Yes - by subcontractor during field survey	High	4°48'12.21"N	7° 7'35.23"E
IND_CH_004	Okulu Creek, Agbonchia	Creek and agricultural site	Indorama field survey	Riparian forest and wetland and site of residential and agricultural activity.	Yes - by subcontractor during field survey	Med?	4°48'27.17"N	7° 7'13.94"E
IND_CH_005	Akoroka Shrine	Shrine and agricultural site	Indorama field survey	Relic of sacred forest, agricultural activity.	Yes - by subcontractor	High	4°45'52.79"N	7° 7'9.41"E

Unique Identifier	Name	Type	Source	Description	Ground truthed?	Sensitivity	Latitude	Longitude
					during field survey			
IND_CH_006	Njuru Shrine	Relic and historic mining site	Indorama field survey	Relic of riparian forest and wetland, historic sand mining activity.	Yes - by subcontractor during field survey	High	4°48'33.19"N	7° 6'36.00"E
IND_CH_007	Aleto (Okulu River)	River and site of mining activity	Indorama field survey	Area of construction and sand mining activity.	Yes - by subcontractor during field survey	Low	4°48'25.00"N	7° 6'10.48"E
IND_CH_008	Okulu River 1	Relic, historic mining, and residential area	Indorama field survey	Relic of riparian forest and wetland, historic sand mining activity, and residential area.	Yes - by subcontractor during field survey	Med	4°48'33.11"N	7° 6'17.95"E
IND_CH_009	Okulu River 2	Relic, historic mining, and	Indorama field survey	Relic of riparian forest and wetland, historic sand mining activity, and residential area.	Yes - by subcontractor during field survey	Med	4°48'28.25"N	7° 6'40.96"E

Unique Identifier	Name	Type	Source	Description	Ground truthed?	Sensitivity	Latitude	Longitude
		residential area						

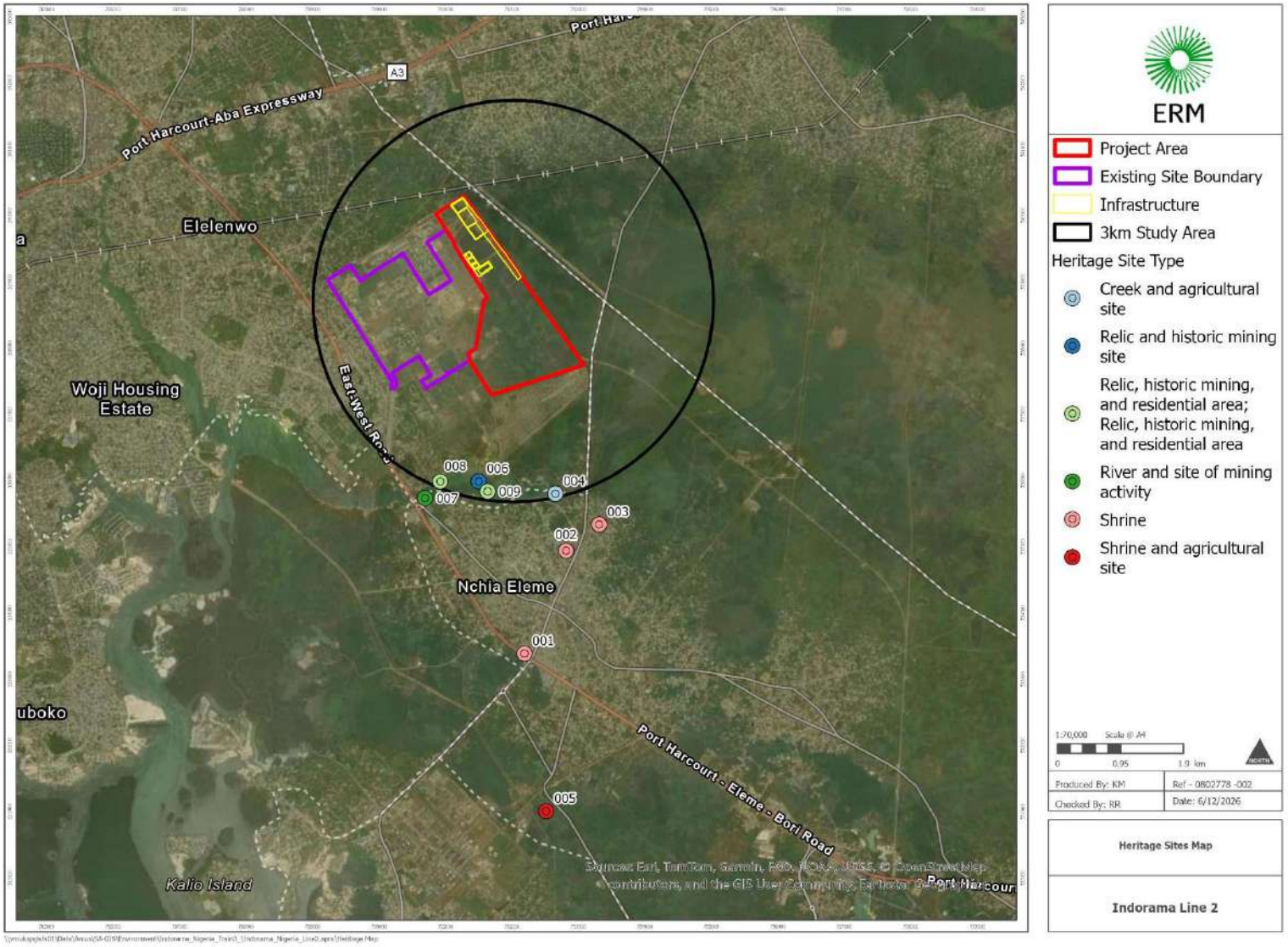

Port Harcourt-Aba Expressway
A3
Elelenwo
Woji Housing Estate
East West Road
Nchia Eleme
Port Harcourt - Eleme - Bori Road
Kalio Island
uboko
001
002
003
004
005
007
008
009
ERM
Project Area
Existing Site Boundary
Infrastructure
3km Study Area
Heritage Site Type
Creek and agricultural site
Relic and historic mining site
Relic, historic mining, and residential area; Relic, historic mining, and residential area
River and site of mining activity
Shrine
Shrine and agricultural site
1:70,000 Scale @ A4
0 0.95 1.9 km
Produced By: KM
Ref - 0802778 -002
Checked By: RR
Date: 6/12/2026
Heritage Sites Map
Indorama Line 2

FIGURE 7-75: CULTURAL HERITAGE MAPBOOK

7.7.7 SENSITIVITY/ VALUE OF RECEPTOR

Each identified tangible and intangible cultural heritage resource has been assigned a sensitivity/value. There are many factors to consider when assigning value to cultural heritage resources and key baseline findings are presented a sensitivity as a tangible or intangible cultural heritage resource.

Values are typically expressed as low, medium, high (and sometimes very high) and these can be equated to local, national, and international values.

The sensitivity/value of receptor for the cultural heritage resources identified in the baseline has been assigned based on ERM's internal Impact Assessment Standard criteria for Cultural Heritage Impact Significance, professional judgement, desk-based research, and the field survey on tangible and intangible cultural heritage.

ERM's internal Impact Assessment Standard Criteria for Cultural Heritage Impact Significance is aligned with the IFC PS8 guidance, and assigns a 'Low', 'Medium' and 'High' value to cultural heritage resources as set out in Table 7-99 below.

TABLE 7-99: CRITERIA FOR CULTURAL HERITAGE IMPACT SIGNIFICANCE (A GUIDE)[33]

Cultural Heritage Resource Sensitivity		
Low	**Medium**	**High**
Defining Characteristics: ▪ Site is not specifically protected under local, national or international laws or treaties; ▪ Site can be moved to another location or replaced by a similar site, or is a type of site that is common in the surrounding region; ▪ Site has limited or no cultural value to local, national or international stakeholders; and/or ▪ Site has limited scientific value or similar information can be obtained at numerous sites (Replicable Cultural Heritage)	**Defining Characteristics:** ▪ Site is specifically or generally protected by local or national laws, but laws allow for mitigated impacts; ▪ Site can be moved or replaced, or data and artefacts recovered in consultation with stakeholders; ▪ Site has considerable cultural value for the local and/or national stakeholders; and/or ▪ Site has substantial scientific value, but similar information can be obtained at a limited number of other sites. (Non-replicable Cultural Heritage)	**Defining Characteristics:** ▪ Site is protected by local, national and international laws or treaties; ▪ Site cannot be moved or replaced without a major loss of cultural value; ▪ Legal status specifically prohibits direct impacts or encroachment on site and/or protection zone; ▪ Site has substantial value to local, national and international stakeholders; and/or ▪ Site has exceptional scientific value and similar site types are rare or non-existent (Critical Cultural Heritage)

[33] Source: Annex to The ERM Impact Assessment Standard)

Cultural Heritage Resource Sensitivity		

7.7.7.1 TANGIBLE CULTURAL HERITAGE

Tangible cultural heritage refers to physical artefacts, objects or places produced, maintained and transmitted inter-generationally in a society. A fair amount of archaeological work has been undertaken in the area, with evidence detailed in the Archaeological and Historic Background (Section 7.7.4). The history of the area indicates the potential for further archaeological sites and buried remains to exist below the surface resulting in a risk of additional, previously unknown cultural heritage to be present within the Project AoI.

Tangible cultural heritage resources were assigned the following sensitivity:

High Sensitivity

The following five cultural heritage resources can be attributed a High sensitivity:

- Onura Shrine, Alesa (IND_CH_001);
- Sirariokulu Shrine, Agbonchia (IND_CH_002);
- Mukor Shrine, Agbonchia (IND_CH_003);
- Akoroka Shrine (IND_CH_005); and
- Njuru Shrine (IND_CH_006).

These resources comprise shrines and remnants of sacred forest landscapes, which are strongly associated with traditional belief systems and community identity within the local area. Although several sites show evidence of encroachment (e.g. vegetation clearance, agriculture, or residential use), their cultural significance is primarily derived from intangible spiritual associations rather than physical integrity.

In accordance with IFC Performance Standard 8, resources identified as shrines or associated with traditional belief systems have been classified as High sensitivity resources (critical cultural heritage), reflecting their likely ongoing cultural and spiritual importance to local communities. This classification has been applied irrespective of physical disturbance, recognising that cultural value may persist even where sites have been partially modified. For sites where cultural function is uncertain, a precautionary approach has been adopted.

Medium Sensitivity

The following three cultural heritage resources can be attributed a Medium sensitivity:

- Okulu Creek, Agbonchia (IND_CH_004);
- Okulu River 1 (IND_CH_008); and
- Okulu River 2 (IND_CH_009).

This grouping comprises riverine and wetland environments, areas of historic mining, agriculture, and settlement which form part of the broader cultural landscape of the Niger Delta. While not identified as sacred or formally protected, such environments often hold associative cultural value linked to traditional livelihoods, land use, settlement patterns, and historical activity.

Under IFC PS8, these resources are considered non-replicable cultural heritage, as they contribute to local cultural identity and environmental context, but are not rare or uniquely protected at national or international level. Comparable riverine systems are present within the region, although not necessarily identical in their combination of ecological and cultural characteristics.

Low Sensitivity

The following cultural heritage resource can be attributed a Low sensitivity:

- Aleto (Okulu River) (IND_CH_007).

This resource comprises a highly modified river system subject to active sand mining and construction activity, with no identified evidence of cultural, spiritual, or heritage significance beyond its economic function. The site exhibits low integrity and limited scientific or cultural value, and similar environments are widely distributed across the Niger Delta.

In line with IFC PS8, this type of resource is classified as replicable cultural heritage, where any residential value can be readily substituted by comparable sites, and impacts are unlikely to result in meaningful cultural loss.

7.7.7.2 INTANGIBLE CULTURAL HERITAGE

Due to the instrumental and artefactual nature of Intangible cultural heritage, it is common for cultural heritage to have both tangible and intangible value.[34] Intangible cultural heritage resources may be impacted by restricted access to, and use of these sites during construction and operation phase. Intangible cultural heritage resources were assigned the following sensitivity:

High Sensitivity

The following cultural heritage resources can be attributed a High sensitivity:

- Owu and Ekpo Masquerade traditions;
- New Yam Festival (Ori Ijii/Ogbo Nja) and other core seasonal festivals;
- Traditional belief systems and ancestral worship practices; and
- Rituals associated with shrines and sacred sites.

These resources represent living cultural heritage central to community identity, belief systems, and continuity, and are closely tied to specific locations (shrines, sacred landscapes) and ritual practices. Their significance is collective, intergenerational, and spiritual, with a strong dependence on authentic performance, setting, and community participation.

In line with IFC PS8, these are classed as critical cultural heritage, as they are non-replicable and cannot be substituted without loss of meaning or function. This aligns with UNESCO intangible cultural heritage (ICH) principles, which recognise rituals, festivals, and belief systems as core expressions of cultural identity requiring safeguarding, and with Nigerian customary systems that afford strong protection to sacred practices.

34 Intangible Cultural Heritage indicates 'the practices, representations, expressions, knowledge, skills – as well as the instruments, objects, artefacts and cultural spaces associated therewith – that communities, groups and, in some cases, individuals recognize as part of their Cultural Heritage' (UNESCO, 2003).

Medium Sensitivity

The following cultural heritage resources can be attributed a Medium sensitivity:

- Community festivals and social events (e.g. O'e Aka wrestling and end of farming celebrations);
- Traditional governance systems (chiefs, elders, customary law);
- Oral traditions, storytelling, proverbs, and folklore;
- Music, dance, and oral performance traditions; and
- Cultural practices linked to land and water use.

These resources represent important expressions of cultural identity and social cohesion, contributing to the transmission of knowledge, history, and community values. They are widely practised across communities and are not strictly tied to a single site, although they may be context-dependent (e.g. communal spaces and seasonal cycles).

Under IFC PS8, these are best characterised as non-replicable cultural heritage, as they retain significant cultural value, but may be sustained or adapted across different contexts if necessary. This aligns with UNESCO ICH recognition of dynamic and evolving cultural practices, which can persist even as conditions change.

Low Sensitivity

The following intangible cultural heritage resources can be attributed a Low sensitivity:

- Generalised cultural expressions not unique to the Study Area;
- Elements of daily social practices with broad regional/common occurrence; and
- Language use trends influenced by external factors (e.g. shift to English or Pidgin).

These resources comprise widely shared or adaptable cultural expressions that are not unique to specific communities or locations and can continue in modified or alternative forms. While still part of the broader cultural fabric, they are less dependent on specific settings or practices and are more resilient to change.

In IFC PS8 terms, these are considered replicable cultural heritage, where cultural expression may persist despite external pressures, and where impacts are unlikely to result in the loss of distinct cultural identity at a local scale.

7.8 TRAFFIC

This section describes existing conditions on public roads within the AoI for transportation.

7.8.1 ROAD NETWORK

Major roads that will be used by the Project include:

- **East-West Road:** This arterial (also referred to as the Eastwest Expressway, Ahoada Road, Deyor-Chara Eteo Road, and Rumukoroshe-Alese Road) connects southeastern Nigeria to Port Harcourt, and has an interchange with the A3 road, a national north-south highway, in Port Harcourt. In the vicinity of the Indorama Complex entrance/exit road, the East-West Road is a paved (asphalt) four-lane road with two travel lanes in each direction, approximate paved width of 24 meters (m), an intermittent low jersey barrier median, no

drainage or sidewalks, and unpaved shoulders. The pavement condition is degraded, although reconstruction to a concrete-surfaced roadway is ongoing.

- **Indorama Complex Entrance/Exit Road:** This is a concrete road with two dedicated lanes (one in each direction) for trucks. The designated road surface is 15 m wide, with 2 m wide walkways on either side. The entrance also includes a separate two-lane asphalt road (approximately 6 m wide) for personnel entry with paved shoulders, drainage, and a walkway along one side. The entrances to the Indorama Complex Road have security gates and guard posts at the East West Road. The intersection with the East West Road has no traffic signal. The Indorama Complex Road has a length of approximately 1.3 kms (km) from the East West Road to the Indorama Complex and becomes the perimeter road for the Indorama complex.
- **Onne Road:** This road links East West Road with Federal Ocean Terminal Roadway, a distance for approximately 4.7 km. The roadway is a paved (asphalt) two-lane road with one travel lane in each direction, approximate paved width of 16 m, a low concrete barrier approximately 3 m in width, no drainage or sidewalks, and unpaved shoulders. The intersection with the East-West Road has no traffic signal. The intersection with Federal Ocean Terminal Roadway is a roundabout.
- **Agbonchia New Road:** This newly constructed road provides dedicated access from the eastern corner of the Project site (where the Project site intersects the Uzaku–Alese Road) to a point on the East-West Road approximately 800 meters southeast of Onne Road. The Link Road is paved, with a typical width of 10 meters and provides one lane and a narrow shoulder in each direction.
- **Federal Ocean Terminal Roadway:** Project construction and operation will use terminal facilities at the port of Onne for the movement of materials and goods. Trucks hauling materials and goods would use the Federal Ocean Terminal roadway to connect to the East West Road. The Federal Ocean Terminal Roadway is an asphalt-paved, divided road with a paved width of about 8 m in each direction, a 5 m wide landscaped median with curbs, and intermittent unpaved shoulders. Although wide enough for multiple lanes, each direction of the road typically accommodates one lane of traffic, along with vehicles parked along the edge of the roadway.
- **Local road networks** that intersect the larger roadways are generally paved but narrower in width. Some include walkways and drainage, but shoulders are not typically present.

7.8.2 EXISTING TRAFFIC DATA

A traffic survey of the Study Area was conducted during the period 6 to 12 November 2025. The night traffic study was conducted manually over an 8-hour time period (20:00 to 06:00). Figure 7-76 identifies the locations where traffic data (including information on traffic origin and destination) were recorded. Traffic was grouped into four vehicle categories:

- 1: Motorcycles/Tricycles
- 2: Cars and Light Vans
- 3: Medium and Heavy Goods Vehicles (Lorries and Trucks)
- 4: Buses and Coaches

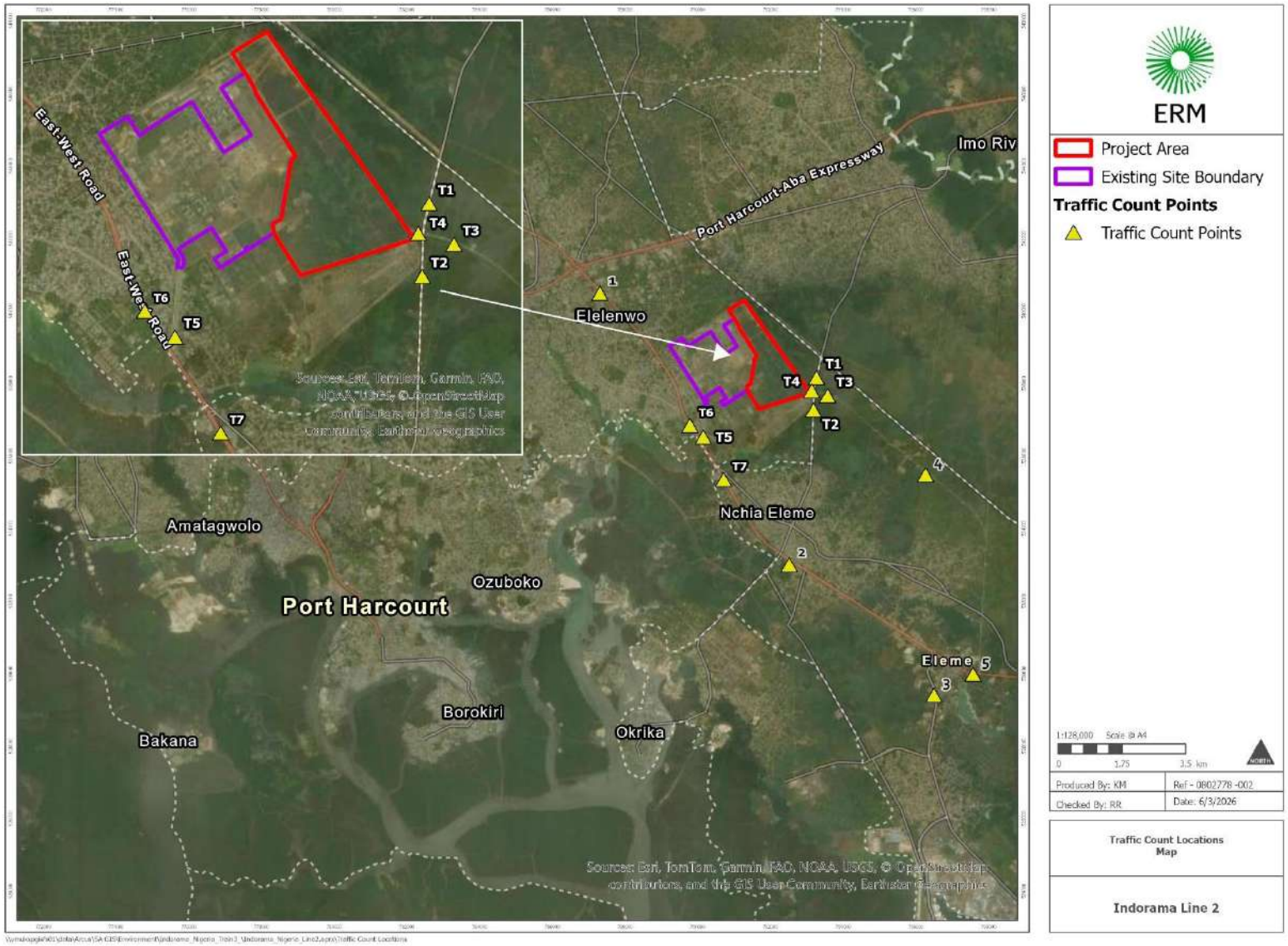

East-West Road
East-West Road
Port Harcourt-Aba Expressway
Imo Riv
T1
T2
T3
T4
T5
T6
T7
1
Elelenwo
Nchia Eleme
2
4
Amatagwolo
Ozuboko
Port Harcourt
Eleme
5
3
Borokiri
Okrika
Bakana
Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, Earthstar Geographics
ERM
Project Area
Existing Site Boundary
Traffic Count Points
Traffic Count Points
1:128,000 Scale @ A4
0 1.75 3.5 km
NORTH
Produced By: KM
Ref - 0802778 -002
Checked By: RR
Date: 6/3/2026
Traffic Count Locations Map
Indorama Line 2

FIGURE 7-76: LOCATION OF TRAFFIC DATA SURVEYS

Table 7-100 summarises daytime traffic volumes at the count locations. The highest levels of traffic occurred along the East West Road. Specific days of highest traffic volumes varied, but Sunday had the lowest traffic per day for all roads surveyed. Hours of peak traffic and lowest traffic varied. The sections below summarize traffic data trends and observations for each traffic data survey location. Overall, motorcycles comprised 30 % of all daytime traffic, cars and light vans comprised 38 %, and medium and heavy vehicles combined (lorries, trucks, buses, and coaches) comprised 32 %.

TABLE 7-100: AVERAGE DAYTIME (06:00 TO 20:00) TRAFFIC VOLUMES (6-12 NOVEMBER 2025)

Traffic Count Location	Motorcycle /Keke	Car and Light Vans	Lorries and Trucks	Buses and Coaches	Total
T1: Agbonchia–Oyigbo Road (Oyigbo End)	46	27	31	29	132
T2: Agbonchia–Oyigbo Road (Agbonchia End)	389	271	218	56	934
T3: Agbonchia New Road–East-West Road	162	327	225	88	802
T4: Indorama North East Gate Road	15	149	17	140	303
T5: Indorama Complex Road	4,625	3,311	1,010	275	9,221
T6: East-West Road, Akpajo Junction	12,579	16,070	6,109	6,769	41,528
T7: East-West Road, South of Okulu Bridge	7,487	9,556	5,065	5,789	27,898
1: Eleme Junction	3,824	5,618	1,682	1,955	13,078
2: East-West Road Refinery Junction	4,419	5,373	2,154	3,130	15,076
3: Trailer Park to Onne Port Road	3,008	4,190	1,730	2,063	10,991
4: Agbonchia New Road	34	211	374	76	694
5: Agbonchia New Road Junction	2,292	3,713	1,667	1,708	9,380

7.8.2.1 EAST WEST ROAD

As the primary traffic artery through the AoI, the East West Road carries large traffic volumes. At Akpajo Junction, north of the Indorama Complex Road, traffic volumes on the East-West Road averaged more than 41,500 vehicles per day, ranged from 33,214 vehicles on Sunday to 45,995 vehicles on Monday. Volumes south of the Oklulu Bridge were lower (17,595 on Sunday, 35,690 on Tuesday). Both count locations on the East-West Road experienced relatively steady traffic throughout the day, with notable morning (09:00 to 10:00) and afternoon (16:00 to 18:00) peaks. The average hourly traffic ranged from 2,749 to 3,362 vehicles at Akpajo Junction and from 1,606 to 2,227 vehicles south of the Okulu Bridge.

Motorcycles comprised more than one-quarter of total traffic, cars and light vans comprised more than one-third of total traffic, while medium and heavy vehicles combined (lorries, trucks, buses, and coaches) comprised nearly 40 % of total traffic.

7.8.2.2 AGBONCHIA NEW ROAD

Traffic on the New Road was relatively light, ranging from a peak of approximately 3,100 vehicles per day on Wednesday through Friday to a low of 1,262 on Sunday. Traffic was

relatively constant throughout the day, peaking at 68 between 17:00 to 18:00. Medium and heavy vehicles (lorries, trucks, buses, and coaches) comprised nearly half (49.4 %) of all traffic, likely reflecting the road's role in carrying heavy vehicle traffic between the Indorama Complex and Onne Port (among other destinations).

7.8.2.3 INDORAMA COMPLEX ACCESS ROAD

Weekday traffic on the Indorama Complex Road ranged from 9,788 vehicles on Thursday to 12,956 vehicles on Wednesday. Weekend traffic was lower, with 6,790 vehicles entering the complex on Saturday and 3,047 vehicles on Sunday. The morning and overall daily peak hour (1,024 vehicles) occurred from 07:00 to 08:00, part of a 3-hour peak (06:00 to 09:00) when more than 900 vehicles per hour used the road. The afternoon peak hour (occurred from 16:00 to 17:00 and had a substantially lower volume (688 vehicles). Half of vehicles using the access road were motorcycles, nearly 36 % were private cars and light vans, and the remaining 14 % were medium and heavy vehicles combined (lorries, trucks, buses, and coaches).

7.8.2.4 NIGHT-TIME TRAFFIC VOLUMES

Table 7-101 presents the total traffic volumes for each count location between the hours of 20:00 and 06:00. Night-time traffic volumes were substantially lower than daytime volumes. The mix of vehicle types at night differed from daytime traffic patterns. Motorcycles comprised approximately 24 % of traffic, cars and light vans approximately 31 %, and medium and heavy vehicles combined (lorries, trucks, buses, and coaches) comprised approximately 46 %.

TABLE 7-101: AVERAGE NIGHTTIME (20:00 TO 06:00) TRAFFIC VOLUMES (8–14 FEBRUARY 2026)

Traffic Count Location	Motorcycle /Keke	Car and Light Vans	Lorries and Trucks	Buses and Coaches	Total
T1: Agbonchia–Oyigbo Road (Oyigbo End)	ND	ND	ND	ND	ND
T2: Agbonchia–Oyigbo Road (Agbonchia End)	47	29	53	10	139
T3: Agbonchia New Road–East-West Road	129	22	117	0	268
T4: Indorama North East Gate Road	93	3	12	0	109
T5: Indorama Complex Road	155	174	176	70	575
T6: East-West Road, Akpajo Junction	1,875	2,590	1,645	1,549	7,659
T7: East-West Road, South of Okulu Bridge	1,969	2,456	1,965	2,166	8,556
1: Eleme Junction	727	1,105	785	308	2,926
2: East-West Road Refinery Junction	1,007	1,335	724	566	3,618
3: Trailer Park to Onne Port Road	478	525	1,184	817	3,004
4: Agbonchia New Road	1	67	257	7	333
5: Agbonchia New Road Junction	787	976	789	790	3,342

ND = no data recorded

7.8.3 ROAD SAFETY

Nigeria reported 5,053 traffic fatalities in 2016, although the World Health Organization (WHO) estimated a significantly larger number. The WHO estimated that Nigeria experienced 17.2 fatalities per 100,000 population in 2021, equivalent to nearly 40,000 traffic fatalities per year (a reduction from 21.4 per 100,000 in 2016) (WHO 2024). This rate was lower than the Africa-wide estimate of approximately 19 fatalities per 100,000 population (WHO 2024). Nigeria has established numerous regulations to increase road safety, including road design standards, seat belts and motorcycle helmets requirements, a ban on hand-held mobile phone use, blood alcohol limits and speed limits. WHO ranks Nigeria's traffic regulation enforcement at 3 to 9 on a scale of 1 to 10 (with 10 representing the most rigorous enforcement).

7.8.4 SUMMARY OF KEY TRAFFIC SENSITIVITIES

Notable traffic sensitivities in the AoI are summarized below.

- The East West Road, which connects south-eastern Nigeria to Port Harcourt, is heavily congested, particularly during peak hours.
- There are congestion and safety concerns at the intersection of the Indorama Complex access road and the East West Road, primarily due to the volume of vehicle turning movements at this intersection.
- The route between Onne Port and to the East-West Road experiences congestion due to truck traffic volumes.

To address these concerns, Indorama has undertaken the measures listed below. These measures are considered to be embedded controls for purposes of this TIA.

- Construction and urea export traffic associated with the IFF Line 1 project including urea export traffic associated with existing IFZ Line 1 and Line 2, uses the new Northeast Gate to enter and exit the Indorama facility and then travels along the Agbonchia New Road to access the regional road network and Onne Port. This has reduced some of the traffic movement at the intersection of the Indorama Complex access road and East West Road.
- Indorama uses signage and traffic marshals/flaggers to guide traffic at the intersection of the Indorama Complex access road and Wast West Road.

The State traffic police have also enhanced traffic controls at the intersection of the Indorama Complex access road and East West Road.

8. ASSOCIATED AND POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS

8.1 INTRODUCTION

The predicted impacts on the physical, biological, and socio-economic environment arising from the IFF Line 2 Fertilizer Project are presented in this chapter. This chapter also identifies the residual impacts that are expected to remain following the implementation of appropriate mitigation and management measures.

Chapter 9 sets out the mitigation and management measures designed to avoid, minimise, reduce, remedy, or compensate for adverse impacts, and to enhance potential Project benefits. The implementation of these measures, together with the management of residual impacts, is further detailed in the ESMMP provided in Chapter 10.

The approach and methodology used to identify, predict, and evaluate impacts are described in Chapter 5. The impact assessment presented in this chapter follows a consistent and structured approach, as outlined below:

- Each section begins by defining the type of impact being assessed.
- This is followed by background information, including a description of the relevant baseline conditions, the Project activities giving rise to the impact, and the receptors likely to be affected.
- The significance of impacts prior to mitigation is then evaluated using defined significance rating criteria.
- Residual impacts, taking into account the implementation of mitigation and management measures described in Chapter 9, are subsequently assessed and rated using an appropriate post-mitigation framework.

8.2 IMPACTS TO THE PHYSICAL ENVIRONMENT

The predicted impacts on the physical environment are presented as follows:

- Risk of Climate Change on the Project (refer to Section 8.2.1);
- GHG Assessment (refer to Section 8.2.2)
- Impacts on Air Quality (refer to Section 8.2.3)
- Noise Impacts (refer to Section 8.2.4);
- Impacts on Soil and Geology (refer to Section 8.2.5);
- Impacts on Groundwater Resources (refer to Section 8.2.6); and
- Impacts on Surface Water Resources (refer Section 8.2.7).

8.2.1 RISK OF CLIMATE CHANGE ON THE PROJECT

8.2.1.1 IDENTIFIED CLIMATIC HAZARDS

As part of the climate change risk assessment, the physical climate hazards relevant to the Project were identified through a structured hazard screening process informed by baseline

climate conditions, published literature, and future climate projection data. Existing baseline information was used to indicate the presence and current expression of climate hazards at the Project location, while future scenario data were used to determine how these hazards may change over time and whether they are likely to become material to the design, construction and operation of the proposed IFF Line 2 Fertilizer Project.

In line with the methodology adopted for the Physical Climate Change Risk Assessment, both acute and chronic physical climate hazards were initially considered. These included extreme precipitation, extreme heat, cyclones and hurricanes, landslides, drought and wildfires as acute hazards, together with higher average temperatures, sea level rise and coastal flooding, changing precipitation patterns, ocean acidification and colder average temperatures as chronic hazards.

Following screening, the principal physical climate hazards identified as applicable to the Project are extreme heat, extreme rainfall flooding, wildfires, and water stress and drought. These hazards were taken forward for further assessment because they are considered relevant to the Project's physical setting, operational context and anticipated lifetime.

Three hazards were screened out of the detailed climate risk profile on the basis that they are not considered credible or material for the Project location. These are colder temperatures, rainfall-induced landslides, and cyclones. Colder temperatures were excluded because Port Harcourt remains warm throughout the year and available projections indicate that cold extremes are expected to become less frequent and less severe over time. Rainfall-induced landslides were excluded because the Project area does not exhibit the terrain or rainfall conditions typically associated with landslide occurrence, and the relevant indicator remains zero across baseline and future scenarios. Cyclones were excluded because tropical cyclone activity is not characteristic of the Project area and the available Project-specific data indicate no relevant cyclone wind hazard across the assessed assets.

The principal physical climate hazards applicable to the Project are summarised in Table 7-12, while the hazards screened out of the detailed assessment and the rationale for their exclusion are presented in Table 7-13.

Overall, extreme heat is identified as the most material long-term climate hazard for the Project. This reflects both the broader warming trend evident in the Port Harcourt area and the Project-specific climate projections, which indicate rising maximum daily temperatures together with a substantial increase in the persistence of prolonged hot conditions over time.

Extreme rainfall flooding is also identified as an important hazard for the Project. This is due both to the broader flood-prone setting of the Port Harcourt area and to the modelled inundation projected for part of the Project site under baseline and future climate conditions.

Wildfires and water stress and drought remain relevant to the Project, although they are of lower materiality than extreme heat and flooding. In particular, the assessment indicates that wildfire remains an existing and manageable hazard within the surrounding landscape, while water-related risks are more likely to arise from short-term variability and episodic dry conditions than from structural long-term water scarcity.

There are also important linkages between the identified hazards. Rising temperatures contribute to greater ambient thermal stress and may exacerbate seasonal water balance

pressures during drier periods, while projected increases in rainfall intensity increase the potential for rainfall-driven flooding. Taken together, the identified hazard profile indicates that the Project's climate resilience requirements are likely to be driven primarily by extreme heat and flood-related risks, with wildfire and episodic water stress requiring proportionate management and preparedness measures.

8.2.1.2 SENSITIVE RECEPTORS

Table 8-1 and Table 8-2 provide an overview of the Project elements during the construction and operational phases that can be deemed as being susceptible to climate change risks.

8.2.1.3 POTENTIAL IMPACTS TO SENSITIVE RECEPTORS

The subsections below present an overview of the principal potential impacts to Project elements and other sensitive receptors that may arise from the material climate hazards identified for the Project during the construction and operational phases, respectively. These tables draw together the risk pathways associated with extreme heat, extreme rainfall flooding, wildfires, and water stress and drought, and illustrate how these hazards may affect machinery, storage and materials, structures and operations, infrastructure, transport-related assets, and human receptors. Collectively, they provide the basis for understanding the principal climate-related vulnerabilities of the Project across its lifecycle.

Extreme Heat

A summary of the project aspects considered, and the related climate risks are shown in Table 8-3 and Table 8-4 below for the construction and operation phases for **Extreme Heat**.

Extreme Rainfall Flooding

A summary of the project aspects considered, and the related climate risks are shown in the Table 8-5 and Table 8-6 below for **Extreme Rainfall Flooding** for the construction and operation phases.

Wildfires

A summary of the project aspects considered, and the related climate risks are shown in Table 8-7 and Table 8-8 below for the construction phase and operation phases for **Wildfires**.

Water Stress and Drought

A summary of the project aspects considered, and the related climate risks are shown in the below Table 8-9 and Table 8-10 for the construction phase for **Water Stress and Drought**.

TABLE 8-1: SITE RECEPTORS FOR THE IFF LINE 2 PROJECT FOR THE CONSTRUCTION PHASE

Receptor	Operational Site Elements	
Construction		
Machinery	• Construction equipment • Construction trucks / vehicles	Construction Vehicles
Storage & Materials	• Raw material: Iron bars, cement, bricks, steel, plastic pipe, wood, catalyst, lube oil, equipment, and general construction items	
Structures and Operations	• Switchyard • Substation • Transformer station • Power House • Inverter	• Reservoir • Processing plant (FCU, Ammonia, Urea, UFC85) • Main manufacturing facility • Associated facilities
Infrastructure *(On site and off-site surface)*	• Substation connections • Telephone Lines • Transmission Lines • Temporary Office	• Temporary Construction – Related to the Project Components • Laydown, Pre-fabrication, Construction warehouse area
Transport	• Site access roads and haul roads • Vehicles	• Internal roads, parking areas and walkways • Culverts & Bridges
Human *(staff and community)*	• Staff working on ground • Workers Camps and Contractor Lay-Down Areas	• Local community and farmers

TABLE 8-2: SITE RECEPTORS FOR THE IFF LINE 2 PROJECT FOR THE OPERATIONAL PHASE

Receptor	Operational Site Elements	
Operations*		
Machinery	• Operations/maintenance trucks/vehicles	
Structures and Operations	• Power House • Transformer • Inverter • Electrical sub stations • Fuelling tanks / Diesel tanks • Foundations • Polisher, wastewater treatment, and air dryer units • Urea storage • Fire and Gas System • DCS/ESC Systems	• Conveyors • Boilers • Generators • Fire water storage tanks • Processing plant (FCU, Ammonia, Urea, UFC85) • Warehouses/manufacturing • Natural gas receiving station • Cooling Towers • Water Treatment (Eaw, DM, Polisher units)
Infrastructure *(On-site and off-site surface)*	• Substation Connections • Permanent Housing • Mobile (temporary) offices and administrative buildings • Offices / administrative space • Stores and freight yard	• Laydown areas, service areas and salvage yard • Concrete surfaces associated with infrastructure • Maintenance / Workshop facilities • Storage areas • Electrical power distribution network and associated infrastructure

Receptor	Operational Site Elements	
	• Workshops & warehouses • Electrical Sub Stations • Fuelling tanks • Telephone Lines	• Raw water pipeline • Power lines • Sewage treatment plants
Transport	• Site Access Roads and haul roads • Vehicles • Truck loading facilities	• Internal roads, parking areas, and walkways • Culverts and Bridges
Human *(staff and community)*	• Staff working on the ground • Operators' village permanent accommodation • Local community and farmers	• Nearby developments/neighbours/warehouses

*It is to be noted that for operations, we have taken the worst-case scenario

TABLE 8-3: CONSTRUCTION PHASE - POTENTIAL IMPACTS FROM EXTREME HEAT TO SITE RECEPTORS ON THE IFF LINE 2 PROJECT

Climate Hazard	Risk Item	Potential Impact **Key:** *Those which are in **bold** and highlighted have been identified as those risks which are likely to be of greater materiality.*	Site Receptor Type					
			Machinery	Storage and Materials	Structures & Operations	Infrastructure	Transport	Human
Extreme Heat	Could disrupt and / or delay construction (e.g.: site	**Reduced efficiency of equipment / engines due to higher ambient temperatures.**	**X**					

Climate Hazard	Risk Item	Potential Impact **Key:** *Those which are in **bold** and highlighted have been identified as those risks which are likely to be of greater materiality.*	Site Receptor Type					
			Machinery	Storage and Materials	Structures & Operations	Infrastructure	Transport	Human
	clearance, construction of roads, plant construction, substation construction and site restoration).	Decrease in surface water or supply of water used for construction. Reservoir / water source will decrease in depth and area if dry spells are longer leading to water shortages.		**X**				
		Overheating of electrical structures (e.g.: switchyard, powerhouse, transformer and inverter).			**X**			
		Heat stress to structural steel by thermal expansion.			**X**			
		Extreme heat could damage infrastructure causing inefficiency / breakage / bursting and hence delay construction (e.g.: substation connections, transmission lines, telephone lines etc.). **Additionally, construction materials behave differently under extreme heat, therefore, extra precautions may be necessary.**		**X**		**X**		
		Increased use of air conditioning at staff temporary offices over an extended period to assist with staff health, safety, and wellbeing.						**X**
	May disrupt and / or delay debris and other material being removed from site, raw materials being brought to site and vehicles / trucks and equipment coming onto site.	Days of extreme and prolonged heat periods could cause cracks and potholes in the road surface.	**X**				**X**	
		Overheating of vehicles / trucks.	**X**				**X**	

Climate Hazard	Risk Item	Potential Impact **Key:** *Those which are in **bold** and highlighted have been identified as those risks which are likely to be of greater materiality.*	Site Receptor Type					
			Machinery	Storage and Materials	Structures & Operations	Infrastructure	Transport	Human
	Could result in health issues for workers.	Delays in removing materials from site or delivering to site due to health issues of workers.		**X**				**X**
		Prolonged heat causing fatigue, sunstroke, and other related health issues, which could result in restricted working hours, or work delays due to shortages of staff.						**X**

TABLE 8-4: **OPERATION PHASE** - POTENTIAL IMPACTS FROM EXTREME HEAT TO SITE RECEPTORS ON THE IFF LINE 2 PROJECT

Climate Hazard	Risk Item	Potential Impact **Key:** *Those which are in **bold** and highlighted have been identified as those risks which are likely to be of greater materiality.*	Site Receptor Type				
			Machinery	Structures & Operations	Infrastructure	Transport	Human
Extreme Heat	Could disrupt and / or delay operations.	Reduced efficiency of equipment / engines due to higher ambient temperatures.	**X**				
		Heat stress to steel infrastructure by thermal expansion.		**X**			
		Extreme heat may cause overheating to generators, substations, inverters, transformer etc. Plus, heat-sensitive equipment may require additional cooling capacity.		**X**			

Climate Hazard	Risk Item	Potential Impact **Key:** *Those which are in **bold** and highlighted have been identified as those risks which are likely to be of greater materiality.*	Site Receptor Type				
			Machinery	Structures & Operations	Infrastructure	Transport	Human
		Extreme heat causing overheating of operation vehicles / trucks.				**X**	
		Increased use of air conditioning at staff sites over an increased period.			**X**		
	May disrupt and / or delay transport vehicles onto and off site.	Days of extreme and prolonged heat periods could cause cracks and potholes in the road surface.	**X**			**X**	
	May result in damage to operation / maintenance infrastructure.	**Extreme Heat could damage infrastructure and hence delay operation / maintenance (e.g.: damage to substation connections, raw water pipeline, power lines etc.).**			**X**		
		Extreme heat may cause pressure valve to open and therefore lead to Natural gas leakage.			**X**		
	Could result in health issues for workers.	**Heat impacting workers, resulting in health issues and restricted working hours and work delays due to shortages of staff.**					**X**

TABLE 8-5: CONSTRUCTION PHASE - POTENTIAL IMPACTS FROM EXTREME RAINFALL FLOODING TO SITE RECEPTORS FOR CONSTRUCTION PHASE ON THE IFF LINE 2 PROJECT

Climate Hazard	Risk Item	Potential Impact **Key:** *Those which are in **bold** and highlighted have been identified as those risks which are likely to be of greater materiality.*	Site Receptor Type					
			Machinery	Storage and Materials	Structures & Operations	Infrastructure	Transport	Human
Extreme Rainfall Flooding	Heavy precipitation and extreme flooding can restrict site access.	Heavy precipitation and river flooding may result in surface runoff on access and internal roads.					**X**	
		Potential delays in raw material delivery due to wet and flooded roads.		**X**				
		Flooding of roads during heavy precipitation causing road closure and delays of vehicles / trucks onto site.	**X**				**X**	
	Heavy precipitation and extreme flooding can delay construction operations (e.g.: site clearance, construction of roads, plant construction, substation construction and site restoration).	Disable construction equipment resulting in delays due to flooding.	**X**					
		Damage to equipment and possible washing away of equipment during flooding.	**X**					
		Potential lightning strikes causing damage to equipment and electrical disruptions.	**X**					
		Site clearance and building interruptions and / or complications due to flooding. Additionally, flooding can waterlog the site, so it is unsuitable for building upon.			**X**			
		Damage to or loss of switchyard, powerhouse, transformer and inverter by flood waters.			**X**			
		Flooding of roads causing road closure and delays.					**X**	

Climate Hazard	Risk Item	Potential Impact **Key:** *Those which are in **bold** and highlighted have been identified as those risks which are likely to be of greater materiality.*	Site Receptor Type					
			Machinery	Storage and Materials	Structures & Operations	Infrastructure	Transport	Human
		Inaccessible or unsafe working conditions in temporary site offices for staff.						**X**
	Heavy precipitation and extreme flooding can damage site infrastructure, storage & materials.	Loss of raw materials which are washed away due to flooding.		**X**				
		Extreme flooding could damage key infrastructure (e.g.: temporary site offices, substation connections, etc.).				**X**		
	Heavy precipitation and extreme flooding can lead to increasing damage to local communities and farms.	Severe precipitation and flooding events reducing surface water quality, affecting clean water availability for workers and surrounding community.						**X**
	Heavy precipitation and extreme flooding have the potential to result in injuries / illness to workers or delay in work.	**Risk of injuries due to both surface and flowing water.**						**X**
		Potential spread of waterborne disease as a result of standing water (e.g.: cholera etc.).						**X**

TABLE 8-6: **OPERATION PHASE** - POTENTIAL IMPACTS FROM EXTREME RAINFALL FLOODING TO SITE RECEPTORS FOR OPERATION PHASE ON THE IFF LINE 2 PROJECT

Climate Hazard	Risk Item	Potential Impact **Key:** *Those which are in **bold** and highlighted have been identified as those risks which are likely to be of greater materiality.*	Site Receptor Type				
			Machinery	Structures & Operations	Infrastructure	Transport	Human
Extreme Rainfall Flooding	Heavy precipitation and extreme flooding can restrict site access.	Heavy precipitation with flooding may result in surface runoff on access and internal roads.				**X**	
		Waterlogging of road surface during flooding, creating surface cracking.				**X**	
	Heavy precipitation and extreme flooding can delay operations / maintenance.	Disable maintenance machinery resulting in delays due to flooding.	**X**				
		Potential lightning strikes causing damage to equipment and electrical disruptions.	**X**				
		Damage to machinery and possible washing away of machinery during flooding.	**X**				
		Extreme flooding could damage steel infrastructure. It can also lead to ground instability and subsidence which may reduce the structural integrity of key infrastructure this could lead to collapse.		**X**			
		Flooding causes damage to transformer, inverters, generators and substations.		**X**			
		Extreme flooding could damage infrastructure and delay operations (e.g.: substation connections, raw water pipeline, power lines etc.).			**X**		
		Maintenance of plant difficulties due to flooding.		**X**	**X**		

Climate Hazard	Risk Item	Potential Impact **Key:** *Those which are in **bold** and highlighted have been identified as those risks which are likely to be of greater materiality.*	Site Receptor Type				
			Machinery	Structures & Operations	Infrastructure	Transport	Human
		Flooding of roads during heavy precipitation causing road closure and delays of vehicles onto site.				**X**	
		Inaccessible or unsafe working conditions for staff, which could cause delays in repair, maintenance work.					**X**
	Heavy precipitation with extreme flooding can lead to increasing damage to local communities and farms.	Severe precipitation events reducing surface water quality, affecting clean water availability for workers and community uses.					**X**
	Heavy precipitation and extreme flooding have the potential to result in injuries / illness to workers or delay in work.	**Risk of injuries due to both surface and flowing water.**					**X**
		Potential spread of waterborne disease because of standing water (e.g., cholera etc.).					**X**

TABLE 8-7: CONSTRUCTION PHASE - POTENTIAL IMPACTS FROM WILDFIRES TO SITE RECEPTORS FOR CONSTRUCTION PHASE ON THE IFF LINE 2 PROJECT

Climate Hazard	Risk Item	Potential Impact **Key:** *Those which are in **bold** and highlighted have been identified as those risks which are likely to be of greater materiality.*	Site Receptor Type					
			Machinery	Storage and Materials	Structures & Operations	Infrastructure	Transport	Human
Wildfires	Restrict access to roads.	**Delays in getting construction equipment & vehicles to site due to access problems.**	**X**					
		Delays in getting materials to and off site due to wildfires causing access problems.		**X**				
		Restricting access to roads, potential delays to construction.					**X**	
		Prevent site staff from accessing their workplace.						**X**
	Damage temporary offices & infrastructure.	**Damage to structures, switchyard, powerhouse, transformer and inverter due to fires.**			**X**			
		Potential damage from wildfires to infrastructure (e.g.: substation connections, project components, temporary offices etc.).				**X**		
		Impact of fire damages to construction site.			**X**			

Climate Hazard	Risk Item	Potential Impact **Key:** *Those which are in **bold** and highlighted have been identified as those risks which are likely to be of greater materiality.*	Site Receptor Type					
			Machinery	Storage and Materials	Structures & Operations	Infrastructure	Transport	Human
	Delay or interrupt construction operations (e.g.: site clearance, construction of roads, plant construction, substation construction and site restoration).	Felling, site clearance and foundations delays or interruption due to fires (or smoke restricting visibility).			X			
		Plant and substations construction delays or interruption due to fires.			X			
		Evacuations of staff from site areas may be necessary which may lead to downtime and loss of revenue.						X
	Damage equipment.	**Possible damage to equipment from wildfires**.	X					
	Health issues for workers and surrounding communities.	Impacts on health and safety e.g., respiratory issues, burns, air quality for staff and surrounding communities.						X

TABLE 8-8: **OPERATION PHASE** - POTENTIAL IMPACTS FROM WILDFIRES TO SITE RECEPTORS FOR OPERATION PHASE ON THE IFF LINE 2 PROJECT

Climate Hazard	Risk Item	Potential Impact **Key:** *Those which are in **bold** and highlighted have been identified as those risks which are likely to be of greater materiality.*	Site Receptor Type				
			Machinery	Structures & Operations	Infrastructure	Transport	Human
Wildfires	Wildfires damage operations / maintenance.	**Potential damage from wildfires to steel infrastructure. Physical damage to power lines, through direct heat damage, falling trees and debris.**		**X**	**X**		
		Potential damage from wildfires to transformer, inverters, generators and substations. Additionally, damage to power lines could be exacerbated by extreme heat causing lowering in the drop of power lines making them closer to the ground and more susceptible to fires.		**X**	**X**		
		Potential damage from wildfires to substation connections, raw water pipeline, power lines etc.			**X**		
		Prevent site staff from accessing their workplace (operations / maintenance).					**X**
		Possible damage as a result of wildfires to urea and ammonia storage and may result in explosions.		**X**			
		Evacuations of staff from site areas may be necessary which may lead to downtime and loss of revenue (operations / maintenance).					**X**
	Wildfires restrict access to roads and site.	Delays in getting operation vehicles to site due to access problems.	**X**				
		Restricting access to roads, potential delays to operation.				**X**	
		Possible damage to machinery from wildfires.	**X**				

Climate Hazard	Risk Item	Potential Impact **Key:** *Those which are in **bold** and highlighted have been identified as those risks which are likely to be of greater materiality.*	Site Receptor Type				
			Machinery	Structures & Operations	Infrastructure	Transport	Human
	Wildfires have the potential for health issues for surrounding communities and staff.	**Impacts on health and safety, e.g., respiratory issues, burns, air quality for staff and surrounding communities.**					**X**

TABLE 8-9: CONSTRUCTION PHASE - POTENTIAL IMPACTS FROM WATER STRESS AND DROUGHT TO SITE RECEPTORS FOR THE CONSTRUCTION PHASE ON THE IFF LINE 2 PROJECT

Climate Hazard	Risk Item	Potential Impact **Key:** *Those which are in **bold** and highlighted have been identified as those risks that are likely to be of greater materiality.*	Site Receptor Type					
			Machinery	Storage and Materials	Structures & Operations	Infrastructure	Transport	Human
Water Stress and Drought	Prolonged and more frequent dry periods may constrain access to water for construction.	**Surface and ground water will decrease in depth and area if dry spells are longer leading to water shortages. Competition for water may be higher, and during periods of low water availability, limits on water usage may be set by the local government.**			**X**			
		There may be a health and safety risk for site personnel if there is not adequate drinking water supply and the cost of water may go up.						**X**
	Prolonged and more frequent dry periods	**Higher evaporation and water shortages can lead to an increase in the withdrawal of more water for operations.**			**X**			

Climate Hazard	Risk Item	Potential Impact **Key:** *Those which are in **bold** and highlighted have been identified as those risks that are likely to be of greater materiality.*	Site Receptor Type					
			Machinery	Storage and Materials	Structures & Operations	Infrastructure	Transport	Human
	result in higher evaporation.	Higher evaporation and water shortages due to extreme heat can lead to surface and ground water decreasing in depth and area if dry spells are longer leading to water shortages for surrounding communities, farmers.						**X**
		Instability and erosion of ground (soil) can lead to potential damage or becoming unstable to steel infrastructure.			X			
		Instability and erosion of ground (soil) can lead to potential damage or becoming unstable to infrastructure.				X		
	Prolonged and more frequent dry periods result in dust generation (dust storms) for site and local communities.	Raw materials storage may become the source of dust which may lead to reduced efficiency of equipment / engines.	**X**					
		Dry ground / raw material becomes the source of dust which may impact the functionality of structures.			**X**			
		Impacts on visibility along transportation corridors.					**X**	
		Impacts on health and safety of surrounding communities, e.g.: respiratory issues.						**X**

TABLE 8-10: OPERATION PHASE - POTENTIAL IMPACTS FROM WATER STRESS AND DROUGHT TO SITE RECEPTORS FOR THE OPERATION PHASE ON THE IFF LINE 2 PROJECT

Climate Hazard	Risk Item	Potential Impact **Key:** *Those which are in **bold** and highlighted have been identified as those risks which are likely to be of greater materiality.*	Site Receptor Type				
			Machinery	Structures & Operations	Infrastructure	Transport	Human
Water Stress and Drought	Prolonged and more frequent dry periods result in higher water consumption for operations / maintenance.	**Surface and ground water will decrease in depth and area if dry spells are longer leading to water shortages. Competition for water may be higher, and during periods of low water availability, limits on water usage may be set by the local government.**		**X**			
		There may be a health and safety risk for site personnel if there is not adequate drinking water supply and the cost of water may go up.					**X**
	Prolonged and more frequent dry periods result in higher evaporation.	**Higher evaporation and water shortages can lead to an increase in the withdrawal of more water for operations or maintenance.**		**X**			
		Higher evaporation and water shortages due to extreme heat can lead to surface and ground water decreasing in depth and area if dry spells are longer leading to water shortages for surrounding communities, farmers.					**X**
		Instability and erosion of ground (soil) can lead to potential damage or becoming unstable to steel infrastructure.		**X**			
		Instability and erosion of ground (soil) can lead to potential damage or becoming unstable to infrastructure.			**X**		

8.2.1.4 CUMULATIVE IMPACTS

Although the physical climate change risk assessment was undertaken primarily to assess the direct exposure of the Project to climate hazards, the findings indicate that several climate-related risks may also arise in a cumulative manner when the Project is considered together with the wider IFZ, existing industrial operations, surrounding transport corridors, nearby developments, and local communities. The Project is located directly adjacent to existing fertilizer and petrochemical operations within the wider Indorama Complex, and the CCRA identifies both off-site and community receptors as relevant receptors during the construction and operational phases, including local community and farmers and nearby developments/neighbours/warehouses.

The climate-related assessment should consider broader environmental interactions, including impacts on shared water resources and other wider environmental pathways. In this context, cumulative climate-related effects are most relevant where a climate hazard affects not only Project assets, but also shared infrastructure, surrounding land uses, community receptors, or the broader receiving environment at the same time.

Extreme Heat

Extreme heat is assessed as a high-materiality hazard for the Project because it is likely to materially affect one or more receptor types and may result in major disruption or delays with plausible knock-on effects. Potential impacts include reduced equipment efficiency, overheating of substations, transformers and inverters, damage to infrastructure, damage to roads, increased cooling demand, and heat-related illness affecting workers. The projected increase in warm-spell duration is particularly marked, increasing from a baseline of 22.80 days to 111.00–122.40 days by 2030 and up to 233.90 days by 2050 under the higher-emissions scenario.

In cumulative terms, prolonged and increasingly frequent extreme heat events may coincide with existing operational heat exposure across the wider Indorama Complex, thereby increasing concurrent demand on cooling systems, electrical infrastructure, workforce management arrangements, and shared transport infrastructure. Because human receptors, transport, and infrastructure are all identified as exposed receptor groups, and because a High materiality rating denotes plausible cascading effects and major disruption, extreme heat should be treated as a **High materiality impact hazard** for the Project and adjacent operations.

Extreme Rainfall Flooding

Extreme rainfall flooding is assessed as a moderate to high material hazard. Port Harcourt is highly susceptible to recurrent urban flooding, and flooding in the wider area is widespread and recurrent. At Project level, modelling indicates that flood risk is concentrated at Indorama North, where inundation depths remain above 1 m under baseline and future scenarios, reaching 1.13 m by 2050 under SSP5-8.5, while Indorama South remains unaffected in the model outputs.

Potential impacts include effects on roads, access, equipment, substations, transformers, generators, power lines, raw water pipelines and human receptors. Severe precipitation and

flooding events may also reduce surface water quality, affecting clean water availability for workers and community uses, together with injury risk and the potential spread of waterborne disease.

In cumulative terms, flood-related impacts may be amplified where intense rainfall affects the Project together with surrounding industrial areas, shared drainage systems, access roads, nearby developments and community areas at the same time. Because the hazard rating reflects both the regional flood susceptibility of Port Harcourt and site-specific flooding at Indorama North, and because the identified receptors include community and surrounding receptors, cumulative flood-related impacts should be rated as a **Moderate to High material impact hazard**.

Wildfires

Wildfires are assessed as a moderate hazard. The wider project area has historical wildfire exposure, with a maximum burned area of 7.31 km² within a 30 km radius of both Indorama North and Indorama South, although projected wildfire-conducive days remain low in absolute terms. Potential impacts include damage to structures, substations, power lines and equipment, restricted road access, evacuations, downtime, and health and safety effects such as respiratory impacts and burns affecting staff and surrounding communities.

In cumulative terms, wildfire events could affect the Project and surrounding industrial operations simultaneously, particularly through shared access constraints, exposure of adjacent facilities with flammable materials, and smoke-related effects on surrounding communities and neighbouring developments. Because the available projections do not indicate a strong upward trend in fire-conducive weather but do confirm a real and existing wildfire exposure pathway affecting shared receptors, cumulative wildfire impacts should be rated as **Moderate material impact hazard**.

Water Stress and Drought

Water stress and drought are assessed as a moderate materiality hazard. The wider Port Harcourt area has experienced episodic dry anomalies and moderate drought events, but project-specific water stress remains very low, increasing only from 0.00 at baseline to 0.01 under future scenarios. The principal climate-related water risk is therefore linked to short-term seasonal variability rather than structural long-term scarcity. Potential impacts include increased competition for water, increased operational water demand, reduced surface and groundwater availability during longer dry spells, potential impacts on surrounding communities and farmers, and dust-related respiratory effects and more prominent during the construction phase.

In cumulative terms, dry periods could coincide with water demand across the wider complex and surrounding users, increasing pressure on shared water resources and water-management systems, particularly where multiple operational activities, dust suppression needs, and community water uses occur at the same time. However, because structural climate-driven water scarcity is not expected to be a significant long-term constraint and such risks are expected to remain manageable through routine planning and supply measures, the cumulative materiality of water stress and drought should be rated as a **Moderate materiality impact hazard**.

Overall cumulative climate-risk conclusion

The climate-related cumulative impacts relevant to the Project are therefore assessed as follows:

- Extreme heat — High materiality impact hazard;
- Extreme rainfall flooding — Moderate to High materiality impact hazard;
- Wildfires — Moderate materiality impact hazard; and
- Water stress and drought — Moderate materiality impact hazard.

These ratings are aligned with the materiality framework applied in the physical climate risk assessment, under which hazards are classified according to the scale of disruption, receptor reach, and potential for knock-on effects across the Project. In line with this approach, climate-related cumulative effects are best expressed as materiality ratings rather than conventional ESIA significance classes.

8.2.1.5 CLIMATE RELATED TRANSITIONAL RISK

As earlier stated the GHG emission of the project is estimated at **686,590 tonnes of carbon dioxide equivalent (tCO_2e) per annum** and when compared with Nigeria's estimated national GHG emissions of approximately 345 million tCO_2e per annum (Boyle, 2024), the Project's annual Scope 1and 2 emissions would represent approximately **0.20% of the national emissions inventory.** Although this percentage indicates a relatively small contribution to Nigeria's overall GHG emissions profile, the absolute volume of emissions remains significant from a facility-level perspective. Furthermore, GHG emissions have a cumulative and global impact, meaning that their contribution to climate change is not confined to the geographical location of the emission source.

In addition to its contribution to climate change, the Project may be exposed to **climate-related transition risks** arising from the global and national shift towards lower-carbon industrial development. Such risks may include evolving environmental regulations, more stringent GHG reporting requirements, potential future carbon-pricing mechanisms, increasing energy-efficiency expectations and changing requirements from international financial institutions, investors and customers. These factors could influence the Project's long-term operating costs, financing conditions, market competitiveness and overall commercial resilience, which IFF shall keep under review and manage through the GHG reduction initiatives and the monitoring, reporting and verification framework in Section 9.2.2, periodic review of national climate policy (including Nigeria's Climate Change Act 2021 and updated NDC) and lender requirements, and consideration of potential carbon pricing in investment decisions.

8.2.1.6 MITIGATION AND MANAGEMENT MEASURES

Refer to Section 9.2.1 for the recommended mitigation and management measures associated with Climate Change.

8.2.1.7 RESIDUAL IMPACTS (POST MITIGATION)

Project Impacts

Following incorporation of the recommended adaptation and management measures, residual climate-related risks to the Project are expected to reduce, but not be eliminated, because the underlying hazards remain physically present and are projected to intensify over time. The principal residual climate risks therefore remain associated with extreme heat, extreme rainfall flooding, wildfires, and water stress and drought, but at reduced levels of materiality where site planning, design, operational controls and emergency preparedness measures are effectively implemented. High-level mitigation and management measures include flood defences, flood-resilient planning, emergency evacuation and occupational health and safety procedures, workforce preparedness measures, and broader planning for protection of electrical equipment, access, materials, buildings, infrastructure, water availability, and vehicles.

Residual risk from extreme heat is expected to remain **Moderate to High**. This reflects the fact that heat exposure is a persistent and increasing hazard for the Project area, with potential effects on workers, transport, infrastructure, machinery and operations. Adaptation measures can materially reduce the frequency and severity of operational disruption and worker health impacts, but they cannot remove the underlying exposure of the Project to prolonged and more frequent extreme heat conditions. Residual risk is therefore expected to remain material, particularly during the operational phase when fixed infrastructure and continuous operations are exposed over the life of the Project and may affect long-term operational maintenance and management.

Residual risk from extreme rainfall flooding is expected to reduce to **Moderate** where stormwater management, flood protection measures, flood-resilient infrastructure planning and emergency preparedness are incorporated into design and operation. Flood-related disruption to access, infrastructure and operations remains plausible, particularly in relation to the northern parts of the site where modelled inundation depths remain in excess of 1 m across the assessed scenarios. However, the inclusion of drainage controls and flood risk management measures is expected to materially reduce the severity and consequence of flood-related impacts relative to the unmitigated case.

Residual risk from wildfires is expected to reduce to **Low to Moderate**. Historical wildfire exposure exists within the wider surrounding area, and wildfire-related disruption to access, infrastructure and human receptors remains possible. However, the projected wildfire-conducive conditions remain limited in absolute terms, and site-level emergency planning, fire detection, suppression and vegetation/fuel management are expected to substantially reduce the likelihood of major Project disruption. Residual wildfire risk therefore remains present, but is expected to be lower than under unmitigated conditions.

Residual risk from water stress and drought is expected to reduce to **Low**. Project-specific water stress remains very low under the assessed future scenarios, and the principal risk is associated with short-term seasonal variability rather than structural long-term scarcity. Water planning, storage, efficient water use and contingency supply measures are expected to manage the majority of the credible residual risk. On this basis, drought- and water-stress-

related residual impacts are not expected to be a dominant physical climate constraint on the Project following mitigation.

Overall, after mitigation, the residual physical climate risks to the Project are expected to remain material but manageable, with extreme heat and extreme rainfall flooding remaining the most important residual hazards for detailed engineering, operational planning and emergency preparedness.

Project Cumulative Impacts

Following implementation of the recommended adaptation and management measures, residual cumulative climate-related risks are also expected to reduce, but not be eliminated, because the Project is located within the wider IFZ and adjacent to existing industrial operations, shared infrastructure, access roads and nearby receptors. Climate hazards such as extreme heat and extreme rainfall flooding may therefore affect the Project and surrounding operations at the same time, creating residual cumulative effects through shared infrastructure, workforce exposure, emergency response requirements and surrounding community receptors. Relevant receptors include staff, local communities and farmers, nearby developments, shared transport routes, and site-wide infrastructure.

Residual cumulative risk from extreme heat is expected to remain **Moderate to High**, because concurrent heat exposure across the wider industrial area may continue to affect site access, transport, electrical systems, cooling demand, operational efficiency and workforce wellbeing simultaneously. Even with mitigation, the cumulative effect of increasingly frequent and prolonged heat events across multiple facilities and shared infrastructure means that heat remains the most important residual cumulative material climate impact hazard.

Residual cumulative risk from extreme rainfall flooding is expected to remain **Moderate**. Integrated stormwater management and flood protection measures can materially reduce local Project vulnerability, but residual cumulative effects may still arise where severe rainfall affects multiple adjoining facilities, drainage systems, access corridors and surrounding receptors concurrently. In this context, cumulative flood-related disruption remains plausible even after mitigation, particularly where regional flood conditions combine with site-specific drainage constraints.

Residual cumulative risk from wildfires is expected to be **Low to Moderate**, reflecting the fact that wildfire remains a credible but secondary hazard in the wider area. Where wildfire or smoke affects multiple nearby facilities, transport corridors and surrounding receptors simultaneously, some cumulative disruption may still occur. However, site-wide emergency planning and fire protection measures are expected to limit the severity of such cumulative effects.

Residual cumulative risk from water stress and drought is expected to remain at **Low to Moderate**. While structural long-term scarcity is not expected to be a dominant constraint, short-term seasonal dry periods may still create cumulative pressure where multiple facilities and surrounding users rely on shared water supply and water management systems at the same time. With routine water planning and contingency arrangements in place, these cumulative residual effects are expected to remain manageable.

Overall, the residual cumulative climate-related impacts are expected to remain manageable, with the most important residual cumulative risks associated with extreme heat and extreme rainfall flooding across the wider industrial area and shared infrastructure network.

8.2.2 GHG ASSESSMENT

The GHG assessment for the IFF Line 2 Fertilizer Project has been undertaken in accordance with internationally recognised methodologies, including the Greenhouse Gas Protocol Corporate Accounting and Reporting Standard (Revised Edition) and the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. These frameworks guide the identification, quantification, and reporting of emissions associated with project activities. The assessment focuses on carbon dioxide (CO_2) emissions, which represent the predominant greenhouse gas associated with fuel combustion, process operations, and energy use during both the construction and operational phases of the Project. Minor quantities of methane (CH_4) and nitrous oxide (N_2O) may also be generated from combustion activities and fugitive emissions; however, these are generally negligible in comparison to CO_2 and have not been quantified separately in this assessment. This approach is consistent with IPCC guidance, which recognises CO_2 as the principal GHG from fuel combustion and industrial processes, with non-CO_2 gases typically contributing only a small fraction of total emissions.

8.2.2.1 PROJECT BOUNDARIES

Establishing the boundaries of the assessment is essential to accurately reflect the emissions associated with the Project. Two sets of boundaries are defined: organisational and operational.

Organisational Boundaries

For the IFF Line 2 Fertilizer Project, the organisational boundary has been defined using the operational control approach. Indorama Fertilizer FZE, as the Project Proponent and executing entity, will assume operational control over all activities and assets associated with the Project during both the construction and operational phases. Under this approach, emissions from all facilities and activities directly associated with the IFF Line 2 Project are included within the GHG inventory, including the Feed Conditioning Unit (FCU), ammonia and urea production units, UFC-85 plant, and associated supporting infrastructure.

Where utilities such as steam and power are supplied from shared infrastructure within the existing Indorama Free Zone, emissions have been proportionally allocated to the Project based on estimated consumption and utilisation rates. This includes the allocation of emissions associated with steam generation and in-house power generation systems that are not exclusively dedicated to IFF Line 2 operations.

By applying the operational control approach consistently, the Project ensures a transparent and representative accounting of Scope 1 emissions associated with fuel combustion, process operations, flaring, and utilities. Scope 2 emissions are not applicable for this Project because power is generated on-site (i.e., no grid electricity purchases). This approach aligns with international best practice under the GHG Protocol and reflects the integrated nature of the Project within the broader Indorama industrial complex.

Operational Boundaries

Operational boundaries define which sources of emissions are included in the assessment and how they are categorised. In line with the GHG Protocol, emissions are classified into three scopes:

Scope 1 – Direct GHG Emissions:

These are emissions from sources that are directly owned or controlled by the Project. For the IFF Line 2 project, Scope 1 emissions include:

- **Construction Phase:**
    - Emissions from diesel-powered construction equipment (e.g., excavators, bulldozers, cranes, and earthmoving equipment)
    - Fuel use from vehicles used for material transport and workforce movement within the Project boundary
    - Emissions from generators, compressors, pumps, and other construction support equipment and Power consumption
- **Operational Phase:**
    - CO_2 emissions from natural gas combustion in reformers, boilers, and gas turbine generators
    - Process-related CO_2 emissions from natural gas reforming and ammonia/urea production
    - Emissions from flaring during start-up, shutdown, and emergency conditions
    - Minor emissions from process vents, where applicable

Scope 2 – Indirect GHG Emissions from Energy Use:

Scope 2 emissions are the indirect emissions associated with the purchase of grid electricity.

The Project does not generate Scope 2 emissions because the facility is not connected to the national electricity grid; rather, power is generated on site and emissions are accounted for under Scope 1.

Scope 3 – Other Indirect Emissions:

Scope 3 emissions, including those associated with upstream material production, transportation outside of Project control, and employee commuting, are not included in this assessment. These emissions fall outside the defined system boundary for the ESIA but may be considered in future lifecycle or value chain assessments.

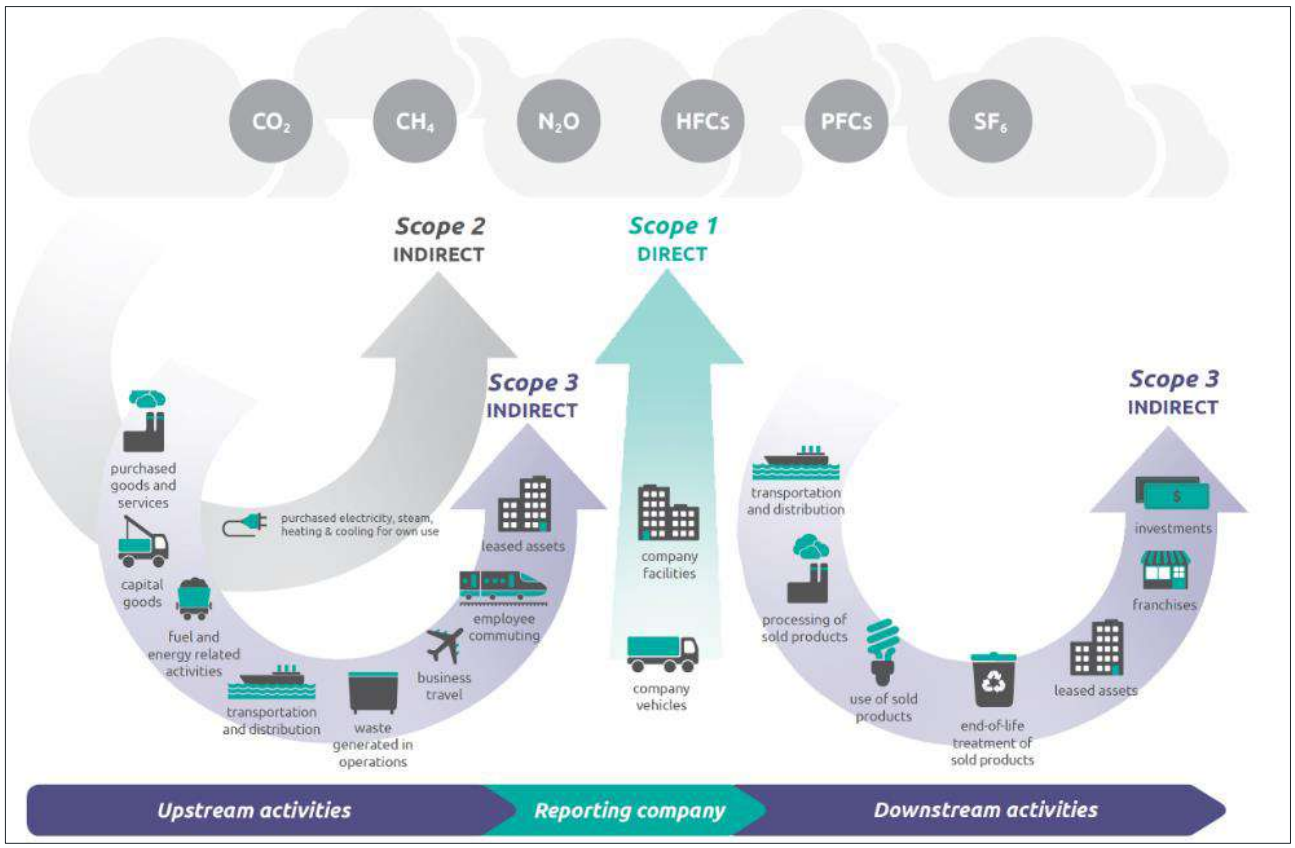


FIGURE 8-1: OVERVIEW OF SCOPE 1, SCOPE 2, AND SCOPE 3 EMISSIONS ACROSS THE VALUE CHAIN

Source: WBCSD and WRI, 2004

8.2.2.2 EMISSION TIER APPROACH

The methodology for estimating GHG emissions for the Project follows the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories. A tiered approach is used to define the precision of the emissions estimates, depending on the availability and quality of data:

Tier 1: Utilises default IPCC emission factors and generalised activity data. This approach provides indicative estimates and carries a higher degree of uncertainty.

Tier 2: Applies country- or technology-specific emission factors and refined activity data to improve accuracy.

Tier 3: Employs detailed, project-specific measurements or modelling, including direct monitoring or process simulation.

For the construction phase, a Tier 1 approach has been applied due to the preliminary nature of available data, using estimated fuel consumption and default emission factors. For the operational phase, a Tier 2 approach has been adopted using project-specific activity data (e.g., natural gas consumption and process inputs), improving the accuracy and representativeness of emissions estimates.

8.2.2.3 GHG EMISSIONS CALCULATIONS

GHG emissions are expressed in carbon dioxide equivalents (CO_2e), enabling the comparison of different GHGs based on their Global Warming Potential (GWP) over a 100-year time horizon.

The general equation applied is:

Emissions (tCO_2e) = Activity Data × Emission Factor × GWP

Where:

- **Activity Data** = fuel consumption or energy use (e.g., litres of diesel, TJ of natural gas)
- **Emission Factor** = emissions per unit of activity (based on IPCC or other recognised sources)
- **GWP** = global warming potential of each gas relative to CO_2

In this assessment, emissions are limited to CO_2, which represents the predominant GHG associated with the Project. As such, a GWP of 1 has been applied, and emissions are effectively reported as CO_2e. Minor quantities of other GHGs (e.g., CH_4 and N_2O) are not explicitly quantified, as their contribution is expected to be negligible relative to CO_2 and does not materially influence the results.

Natural gas emission factors have been applied in accordance with IPCC default values (e.g., approximately 56.1 tCO_2/TJ), unless otherwise specified.

Limitations and Exclusions

The construction-phase GHG emissions assessment is based on indicative construction activities, equipment requirements, and estimated fuel consumption data available at this stage. Actual emissions may vary depending on equipment selection, utilisation rates, operating hours, and construction practices.

The assessment focuses on Scope 1 emissions from diesel combustion associated with construction equipment and on-site vehicles. These emissions relate to activities such as site preparation, civil works, equipment installation, and development of supporting infrastructure.

Key GHG Sources for the Project

Emission sources are defined as processes or activities that release GHGs into the atmosphere. For the IFF Line 2 Fertilizer Project, the primary GHG of concern is CO_2, which is predominantly associated with natural gas combustion and process-related emissions.

During the operational phase, emissions arise from:

- Natural gas combustion for process heating, power generation and utilities
- Process-related emissions from natural gas reforming and ammonia production
- CO_2 generation and utilisation in urea production
- Flaring during start-up, shutdown, and emergency conditions

The CO_2 generated during ammonia production is captured and utilised as a feedstock in urea synthesis. This CO_2 is not emitted at the point of generation but is incorporated into the urea

product. The treatment of this CO_2 is consistent with GHG Protocol and IPCC guidance and is addressed within the emissions accounting methodology to avoid double counting.

Scope 3 emissions, including upstream natural gas production, material manufacturing, and downstream product use, are excluded from this assessment.

During the construction phase, Scope 1 emissions arise primarily from diesel consumption associated with construction equipment and on-site vehicles. In contrast, the operational phase of the IFF Line 2 Project is characterised by continuous industrial processes and therefore represents the dominant source of GHG emissions. These include emissions from natural gas combustion for process heating, power generation and utilities, as well as process-related CO_2 emissions from ammonia and urea production. As such, operational emissions are expected to be material and constitute the majority of the Project's GHG footprint.

A summary of Scope 1 emission sources by project area and phase is provided in the table below.

TABLE 8-11: SUMMARY OF GHG EMISSIONS SOURCES FOR THE PROJECT

Project Area	Phase	Scope 1 Emission Sources
Construction of Process Units (FCU, Ammonia, Urea, UFC – 85)	Construction	Diesel usage in heavy machinery, installation equipment and on-site transport vehicles
Process Units (FCU, Ammonia, Urea, UFC-85)	Operation	Natural gas combustion in reformers and process heaters; process-related CO_2 emissions from ammonia and urea production
Utilities (Boilers, GTG)	Operation	Natural gas combustion in boilers and gas turbine generators (GTG) for steam and power generation
Flaring Systems	Operation	Flaring emissions during start-up, shutdown, and emergency conditions
Temporary Construction Facilities (Offices, laydown Areas)	Construction	Diesel consumption from generators, light vehicles, material handling equipment, and support machinery operating within temporary facilities
Site Infrastructure (Storage, Loading, Roads, Ancillary Systems)	Construction	Diesel usage from earthmoving equipment, construction vehicles, and on-site material transport
Site Infrastructure (Storage, Loading, Roads, Ancillary Systems)	Operation	Emissions from maintenance vehicles and operational support equipment

Temporary construction components do not directly generate emissions but are associated with fuel use from equipment and support activities within these areas

Construction Phase

The construction phase is expected to last approximately 33 months and includes site preparation, civil works, installation of process equipment, and development of supporting infrastructure.

GHG emissions during construction arise primarily from Scope 1 sources, including diesel combustion in heavy machinery, vehicles, and auxiliary equipment. These emissions are associated with earthworks, material handling, equipment installation, and internal transport.

Table 8-12 presents the emission factors used to quantify Scope 1 emissions for both the construction and operation phases. Table 8-13 summarises the activity data used to quantify construction-phase GHG emissions.

TABLE 8-12: GHG EMISSION FACTOR FOR DIESEL CONSUMPTION (SCOPE 1)

Scope	Source	Emission Factor	Emission Factor Unit	Tier Method
Scope 1	Diesel consumption	2.66	$kgCO_2e/l$	1
Scope 1	Natural gas combustion	56.1	tCO_2/TJ	1

TABLE 8-13: ACTIVITY DATA DURING THE CONSTRUCTION PHASE

Scope	Source	Main Activity	Approximate Quantity used during construction (33 months)
Scope 1	Diesel consumption	Construction Activities (mobile and stationary combustion)	4,000 kilolitres (kl)

Using the emission factors (Table 8-12) and the activity data (Table 8-13), the total CO_2e emissions for the proposed Project's construction phase are estimated at 20 340 tCO_2e over 33 months, with Scope 1 emissions accounting for 100% of the total (Table 8-14).

TABLE 8-14: CONSTRUCTION PHASE GHG EMISSIONS FOR THE PROPOSED PROJECT

Scope	Source	Total tCO_2e /lifetime (33 months)
Scope 1	Diesel consumption	10 640
Scope 1	Natural Gas	9 700
Total		**20 340**

Operational Phase

Operational Phase Emissions

The operational phase of the IFF Line 2 Fertilizer Project comprises an integrated process chain including the Feed Conditioning Unit (FCU), ammonia plant, urea plant, UFC-85 unit, and associated utility systems. The facility operates as part of the existing Indorama complex, with energy requirements met through on-site natural gas–fired power generating and steam generation systems.

Natural gas is the primary input to the operational phase and is used both as a feedstock for ammonia production and as a fuel for heat, steam, and power generation. Operational data provided by the Client indicates that natural gas consumption is approximately 105 MMSCFD, while total power consumption is approximately 40 MW, supplied by on-site gas turbine generators (GTGs)

The operational phase of the IFF Line 2 Project involves continuous combustion and chemical processing activities, resulting in significant GHG emissions. The primary GHG emitted is carbon dioxide (CO_2), arising from both fuel combustion and process-related reactions.

Scope 1 – Direct Emissions

Direct (Scope 1) emissions arise from natural gas combustion and process emissions associated with reforming, ammonia synthesis and utility systems specifically:

- Natural gas combustion (primary reformer, boiler and Gas turbine generators).
- Process off-gas utilisation as secondary fuel in primary reformer;
- Flaring;
- Minor auxiliary sources (Emergency diesel generators)

Fuel consumption associated with these activities has been quantified and converted to CO_2 emissions using internationally recognised emission factors. The calculated operational emissions are continuous in nature and are primarily driven by natural gas consumption within the process and utility systems.

Importantly:

- There are continuous combustion processes, including natural gas combustion in reformer, boiler, and gas turbine generators (GTGs)
- There are significant process emissions, primarily associated with natural gas reforming during ammonia production
- Chemical reactions involved in ammonia production result in the generation of CO_2 which will be used in Urea synthesis.
- Electricity generation within the Indorama complex is based on natural gas–fired systems and produces direct GHG emissions, which are accounted for under Scope 1

GHG emissions for Scope 1 arise from process and combustion activities across the IFF Line 2 Project. The activity data used to calculate GHG emissions during the operational phase are presented in Table 8-15.

TABLE 8-15: ACTIVITY DATA DURING THE OPERATIONAL PHASE

Scope	Source	Main Activity	Unit	Quantity/Annum
Scope 1	Natural gas (reformer fuel)	Combustion	TJ/year	3 753
Scope 1	Process off – gas	Combustion	TJ/year	1 663
Scope 1	Steam generation (boiler)	Combustion	TJ/year	579
Scope 1	Power generation (GTG)	Combustion	TJ/year	6 096
Scope 1	Flaring	Combustion	TJ/year	313

Using the emission factors (Table 8-12) and the activity data provided (Table 8-15Table 8-15), the total CO_2e emissions during the operational phase were estimated to be 686 590 tCO_2e/annum (Table 8-16).

TABLE 8-16: OPERATIONAL PHASE GHG EMISSIONS FOR THE PROJECT

Scope	Source	Total Emissions tCO_2e /annum
Scope 1	Reformer fuel (natural gas)	210 524
Scope 1	Process off-gas combustion	93 292
Scope 1	Steam generation (boiler)	32 504
Scope 1	Power generation (GTG)	341 756
Scope 1	Flaring	8 514
Total		**686 590**

The quantified operational emissions are continuous through the life of the project and substantial in magnitude. Emissions are primarily driven by natural gas consumption, with

power generation and reforming processes representing the largest contributors to the Project's overall GHG footprint.

Scope 2 – Indirect Emissions

The Project does not generate Scope 2 (indirect) emissions because the facility is not connected to the national electricity grid; rather, power is generated on site and emissions are accounted for under Scope 1.

Comparison of GHG emissions between Construction and Operational Phases

Construction emissions are temporary and associated with diesel combustion and electricity consumption supplied from the existing gas-fired power plant, totalling approximately 20,340 tCO_2e over the 33-month construction period. This includes approximately 10,640 tCO_2e from diesel consumption and approximately 9,700 tCO_2e from construction-phase power consumption.

In contrast, operational emissions are continuous and substantially higher, estimated at approximately 686,590 tCO_2e per annum, driven by natural gas consumption and process-related emissions.

This difference reflects the nature of the Project as a natural gas-based ammonia and urea production facility involving continuous combustion and chemical processes.

Decommissioning Phase

The decommissioning phase will involve shutdown, dismantling, and removal of infrastructure, including process equipment and utilities. GHG emissions during this phase are expected to arise primarily from:

- Fuel combustion in demolition equipment
- Material handling and transport
- Minor emissions from plant shutdown and depressurisation

Due to limited data availability, emissions have not been quantitatively estimated. However, they are expected to be temporary, intermittent, and significantly lower than operational emissions.

8.2.2.4 GHG IMPACT ASSESSMENT

In an ESIA, the potential impacts of a project are typically evaluated based on direction, intensity (or severity), duration, extent, and probability of occurrence. However, given the relatively minor contribution of the project to global GHG emissions and the long-time lag between GHG emissions and potential climate change impacts, traditional impact assessment methods may be less suitable. Therefore, GHG emissions assessments often employ alternative approaches, such as benchmarks.

In this assessment, the following benchmarks are used to evaluate the significance of potential impacts associated with the proposed project:

- Comparison of the Project's emissions intensity (e.g., tCO_2 per tonne of urea produced) against typical values for natural gas-based urea production, to provide sector-specific context.
- Evaluation of the Project's contribution relative to Nigeria's total GHG emissions to understand its significance at a national scale.
- Application of established thresholds (e.g., European Bank for Reconstruction and Development) to categorise the magnitude of annual GHG emissions and assign a qualitative significance rating.

This comparative approach enables the Project's emissions profile to be evaluated not only in absolute terms but also relative to sector norms and emerging best practice. Benchmarking against comparable natural gas-based ammonia and integrated ammonia–urea facilities provide additional context regarding whether the Project's emissions intensity aligns with, exceeds, or performs better than industry averages.

Together, these benchmarks support a transparent and proportionate evaluation of GHG significance within the broader national and sectoral context.

Industry emissions intensity benchmark

Ammonia and urea production are energy and emissions-intensive industrial processes due to the reliance on natural gas as both feedstock and fuel. In integrated ammonia–urea facilities, however, a portion of the CO_2 generated during ammonia production is captured and utilised in urea synthesis, thereby reducing direct facility-level emissions.

The IFF Line 2 Project represents an integrated ammonia–urea production complex, including associated utility systems and supporting infrastructure. Based on the estimated net operational emissions of approximately 686,590 tCO_2e per annum and annual urea production, the Project's net emissions intensity is estimated at approximately 0.49 tCO_2e per tonne of urea (IEA, 2021).

Benchmarking information presented by the International Fertilizer Society indicates that emissions intensities for integrated urea production facilities typically range between approximately 0.75 and 1.27 tCO_2e per tonne of urea across major producing regions (Hoxha and Christensen, 2018). Relative to these benchmarks, the Project demonstrates a comparatively low net emissions intensity, reflecting the benefits of natural gas-based production, integrated CO_2 utilisation in urea synthesis, and process efficiency measures incorporated into the facility design.

In integrated ammonia–urea facilities, a portion of the CO_2 generated during ammonia production is captured and utilised as a feedstock in urea synthesis. This results in the incorporation of CO_2 into the urea product and reduces the net emissions intensity at the facility level.[35]The Project's net emissions intensity—after accounting for the CO_2 that is captured and used in urea is estimated to be approximately 0.49 tCO_2e per tonne of Urea. This

[35] Gross emissions intensity is expressed per tonne of ammonia produced to facilitate comparison with published ammonia-sector benchmarks. Net emissions intensity is expressed per tonne of urea produced because ammonia acts as an intermediate product within the integrated process, while urea represents the final product incorporating internally utilised CO_2. The two metrics therefore reflect different accounting boundaries and are not directly comparable.

value reflects a net facility-level emissions intensity and is not directly comparable to standard industry benchmarks, which typically represent gross emissions from ammonia production only.

CO_2 utilised in urea production is not permanently sequestered, as it is ultimately released during downstream use (e.g. agricultural application). As such, CO_2 utilisation represents a transfer and temporary storage of emissions rather than a permanent reduction. In this assessment, emissions are therefore reported on a net basis at the facility level, consistent with standard GHG accounting practices, provided that double counting is avoided.

National Emissions Contribution Benchmark

In terms of direct Scope 1 emissions, the Project will emit approximately 686,590 tCO_2e/annum during the operation phase. When compared to the national GHG emissions of Nigeria, estimated at approximately 345 million tCO_2e per annum (Boyle, 2024), the Project's emissions represent a small fraction of national emissions. On this basis, the Project's contribution to national GHG emissions is estimated to be approximately 0.20% in 2025. This indicates that, while the Project is emissions-intensive at a facility level due to its industrial nature, its contribution at the national scale remains relatively small. Accordingly, the Project's contribution to national GHG emissions is considered low in significance in the context of Nigeria's overall emissions profile.

Pre-defined thresholds

The European Bank for Reconstruction and Development (EBRD) developed thresholds which can be used for benchmarking the magnitude of annual emissions of a project, as shown in Table 8-17.

Scope 1 GHG emissions for the construction and operational (cumulative) phase activities were estimated to be 686,590 tCO_2e/annum. As such, the project falls within the 100 001 – 1,000 000 tCO_2e threshold and the impact is therefore rated as Medium - High.

TABLE 8-17: BENCHMARK THRESHOLDS FOR ANNUAL CO_2E EMISSIONS (EBRD, 2010)

GHG Emissions (tCO_2e/annum)	Qualitative Rating
< 10 000	Nominal/Negligible
10 001 – 25 000	Low
25 001 – 100 000	Medium-Low
100 001 – 1,000 000	Medium-High
> 1 000 001	High

Impact Assessment Summary

Table 8-18 presents a summary of the potential impacts of the project in terms of the two benchmarks as detailed in the preceding sections. The overall impact of the project, with

respect to GHG emissions, is rated a Medium-High based on its contribution to national emissions and based on the EBRD thresholds.

TABLE 8-18: SUMMARY OF POTENTIAL GHG EMISSIONS IMPACTS FOR THE PROJECT

Potential Impact	Qualitative Rating
Contribution to the country's national GHG emissions	Low
Pre-defined thresholds	Medium-High
Overall	**Medium-High**

8.2.2.5 CUMULATIVE IMPACT ASSESSMENT

GHG emissions are inherently cumulative, because their effects are not confined to the Project site or immediate area of influence, but instead contribute incrementally to the wider atmospheric greenhouse gas burden. In this context, the cumulative GHG effect of the Project arises from the additional emissions attributable to IFF Line 2, when considered alongside existing emissions from the wider industrial setting and the national emissions profile. Unlike locally bounded impacts such as noise or air quality, the effect of greenhouse gas emissions is global and long-term in nature, and cumulative significance is therefore most appropriately interpreted using the same benchmark and contextual approach applied in the main GHG assessment.

The Project is located within the wider IFZ and will operate as part of an existing industrial complex. The GHG inventory has therefore been defined using the operational control approach and includes emissions associated with all facilities and activities directly related to the Project. Where utilities such as steam and power are supplied from shared infrastructure within the existing complex, the associated emissions have been proportionally allocated to the Project based on estimated consumption and utilisation rates. This ensures that the Project's cumulative contribution within the broader complex is represented within the Scope 1 inventory used for the assessment.

On this basis, the quantified GHG inventory indicates total operational Scope 1 emissions of approximately 686,590 tCO_2e per annum, with the dominant contributions arising from power generation (GTG), reformer fuel, and process off-gas combustion, as shown in Table 8-16. Construction emissions are substantially lower, estimated at 20,340 tCO_2e over 33 months, and are temporary in nature. The annualised benchmark assessment therefore remains driven primarily by the continuous operational emissions associated with the fertilizer production process.

In cumulative terms, the Project's emissions represent an additional contribution to Nigeria's overall GHG emissions and to the broader industrial emissions profile of the Indorama Free Zone. When compared to Nigeria's total annual GHG emissions of approximately 345 million tCO_2e, the Project contributes approximately 0.20% on an annual basis. On this benchmark alone, the contribution is considered Low in significance at the national scale. However, when

assessed against the European Bank for Reconstruction and Development (EBRD) annual emissions thresholds, the Project falls within the 100,001–1,000,000 tCO_2e per annum category, which corresponds to a **Medium–High** qualitative rating.

Taking both benchmarks into account, and recognising that the Project's emissions are continuous, process-driven, and arise within an existing fertilizer and petrochemical complex with shared utilities and infrastructure, the cumulative greenhouse gas impact of the Project is assessed as **Medium–High**. This rating is consistent with the overall GHG significance assigned in the assessment and reflects the fact that the Project is a major industrial point source at facility level, even though its proportional contribution at national scale remains comparatively small.

The significance of cumulative greenhouse gas impacts should also be considered in light of the mitigation and reduction measures identified for the Project. General mitigation measures include optimisation of combustion efficiency in the reformer, boilers and gas turbine generators, heat integration, reduction of flaring, preventive and predictive maintenance, monitoring and tracking of fuel consumption and emissions, and optimisation of natural gas use as both feedstock and fuel, as set out in Chapter 9. In addition, planned reduction initiatives have the potential to reduce emissions by approximately 570,000 tCO_2e per annum, including efficiency improvements, new hardware installation and flare reduction activities, with a longer-term CCS pilot project identified as an additional opportunity. If implemented and verified, these measures would materially reduce the cumulative GHG footprint attributable to the Project over time.

Notwithstanding these reduction opportunities, the cumulative GHG impact remains significant in a broad climate policy context because greenhouse gas emissions are additive and long-lived in the atmosphere. Accordingly, the Project should continue to pursue the identified reduction initiatives and ensure that the measures in Chapter 9 are integrated into the ESMMP and monitored during construction and operation.

Overall cumulative GHG significance

The cumulative greenhouse gas impact of the Project is assessed as **Medium–High**.

8.2.2.6 MITIGATION AND MANAGEMENT MEASURES

Refer to Section 9.2.3 for the recommended mitigation and management measures associated with Climate Change.

8.2.2.7 RESIDUAL IMPACTS (POST MITIGATION)

Project Impacts

GHG emissions are assessed using a dedicated accounting and benchmarking approach rather than the standard ESIA receptor–magnitude significance matrix. Under the adopted benchmark framework, annual emissions are interpreted against qualitative threshold bands, with less than 10,000 tCO_2e/annum rated as Nominal / Negligible, 10,001–25,000 tCO_2e/annum as Low, 25,001–100,000 tCO_2e/annum as Medium-Low, 100,001–1,000,000 tCO_2e/annum as Medium-High, and greater than 1,000,001 tCO_2e/annum as High.

Following implementation of the recommended mitigation measures, residual construction-phase GHG emissions are expected to remain **Nominal / Negligible**. Construction emissions are temporary, arise primarily from diesel combustion and construction-phase energy use, and total approximately 20,340 tCO_2e over the full 33-month construction period. Fuel-efficient equipment, optimisation of construction logistics and good maintenance practice are expected to reduce avoidable fuel use, and the annualised emissions profile remains at the lower end of the adopted benchmark framework. Residual construction-phase GHG impacts are therefore expected to be **low** in significance in the context of the benchmark approach applied for this ESIA.

Residual operational-phase GHG emissions are expected to remain **Medium-High** following mitigation. The Project's operational emissions are substantial in absolute terms, estimated at approximately 686,590 tCO_2e/annum, and are driven primarily by natural gas use for reforming, power generation, process off-gas combustion, boiler use and flaring. However, the Project also demonstrates a comparatively low net emissions intensity of approximately 0.49 tCO_2e per tonne of urea, which is below the typical benchmark range of approximately 0.75 to 1.27 tCO_2e per tonne of urea for comparable integrated urea production facilities, reflecting the benefits of natural-gas-based production, integrated CO_2 use in urea synthesis and process efficiency measures.

A series of planned reduction initiatives has been identified, including efficiency improvements and flare-reduction measures, with a stated potential reduction of approximately 570,000 tCO_2e/annum, subject to implementation, verification and allocation to the Project. These measures could substantially reduce or offset the Project's operational emissions over time. Even if these reductions are implemented, the residual operational emissions attributable to the Project would still remain above the 100,000 tCO_2e/annum threshold and would therefore continue to fall within the **Medium-High** benchmark category. On this basis, the Project's residual operational GHG impact remains Medium-High, albeit materially reduced relative to the unmitigated condition.

Overall, the Project's residual GHG impact after mitigation remains benchmark-significant at operational level but comparatively efficient in sector terms, indicating that mitigation improves performance but does not eliminate the Project's role as a material point source of greenhouse gas emissions.

Project Cumulative Impacts

GHG impacts are inherently cumulative, diffuse and global, and are therefore interpreted through the adopted benchmark and proportional-context approach rather than through local receptor-specific significance scoring. In cumulative terms, the Project must be considered alongside the existing and developing fertilizer operations within the wider IFZ, including IFF Line 1, because both facilities are large natural-gas-based ammonia–urea production units with substantial Scope 1 emissions.

The estimated operational Scope 1 emissions for IFF Line 1 are approximately 688,156 tCO_2e/annum, while those for the Project are approximately 686,590 tCO_2e/annum. On this basis, the combined operational emissions from IFF Line 1 and the Project would exceed 1,000,001 tCO_2e/annum and would therefore fall within the High benchmark category under

the adopted threshold framework. The unmitigated cumulative operational GHG impact is therefore appropriately interpreted as High.

Following implementation of the planned reduction initiatives identified for the Project, the cumulative residual GHG impact is expected to reduce, but not to cease being material. The identified reduction initiatives for the Project have the potential to reduce or offset approximately 570,000 tCO_2e/annum, subject to implementation, verification and allocation to the Project. If those reductions are achieved and attributed to the Project, the combined operational emissions from IFF Line 1 and the Project would reduce materially but would still remain above 100,000 tCO_2e/annum. Accordingly, the residual cumulative GHG impact would reduce from **High to Medium-High** under the adopted benchmark framework.

This residual cumulative rating is also consistent with the broader contextual benchmarks used in the assessment. At the individual Project level, operational emissions represent approximately 0.20% of Nigeria's estimated total GHG emissions and the Project demonstrates relatively low sectoral emissions intensity compared with comparable integrated urea facilities. These contextual factors do not remove the cumulative nature of the impact, but they do indicate that the Project's residual cumulative contribution is more appropriately interpreted as **Medium-High** rather than **High** once the planned reduction measures are applied.

Overall, following mitigation and planned reduction measures, the residual cumulative GHG impact remains material and long-term, but is expected to reduce from **High to Medium-High**, provided the identified reduction initiatives are implemented, verified and demonstrably attributed to the Project.

8.2.3 AIR QUALITY IMPACT ASSESSMENT

8.2.3.1 INTRODUCTION AND ASSESSMENT BASIS

The air quality impact assessment for the IFF Line 2 Project has been undertaken using a topic-specific methodology combining baseline monitoring, construction-phase screening tools and operational atmospheric dispersion modelling. The assessment considered the pollutants most relevant to the Project, namely oxides of nitrogen (NO_x), nitrogen dioxide (NO_2), particulate matter (PM_{10} and $PM_{2.5}$), sulphur dioxide (SO_2) and ammonia (NH_3). The assessment has been undertaken with reference to the National Environmental (Air Quality Control) Regulations, 2021, the IFC / WHO ambient air quality guidelines, and the WBG General EHS Guidelines, with Project-adopted standards based on the most stringent applicable values, as set out in Table 8-19,

Table 8-20 and Table 8-21 of the air quality assessment report.

For construction, the air quality study area extends to 250 m from construction activities for dust and 50 m from construction access routes for traffic-related effects. For operation, the study area extends to 10 km from the proposed IFF Line 2 plant to reflect the potential dispersion of stack emissions. Operational impacts were assessed using the USEPA AERMOD 24142 dispersion model within a 10 km × 10 km domain, incorporating building effects and five years of hour-sequential meteorological data for the period 2018 to 2022. The operational assessment scenarios are presented in Table 8-22, while the operational methodology and model domain are illustrated in Figure 5-4 and Figure 8-1below.

TABLE 8-19: NIGERIAN AMBIENT AIR QUALITY STANDARDS (µg/m^3)

Pollutant	1 hour	8 hours	24 hours	Annual Mean
Nitrogen dioxide (NO_2)	200		120	80
Particulate Matter (PM_{10})			150	60
$PM_{2.5}$			40	20
NH_3			600	200
SO_2	350		120	80
CO	10 000	5000		

TABLE 8-20: WHO/IFC AMBIENT AIR QUALITY STANDARDS (µg/m^3)

Pollutant	10 Minute	1 hour	24 hours	Annual Mean
Nitrogen dioxide (NO_2)		200	-	40
Sulphur dioxide (SO_2)	500		125	
Particulate Matter (PM_{10})			150	70
Particulate Matter ($PM_{2.5}$)			75	35

TABLE 8-21: PROJECT ADOPTED AMBIENT AIR QUALITY STANDARDS (µg/m^3)

Pollutant	1 hour	24 hours	Annual Mean
Nitrogen dioxide (NO_2)	200	120	40
Particulate Matter (PM_{10})		150	60
Particulate Matter ($PM_{2.5}$)		40	20
Sulphur dioxide (SO_2)		125	80
Ammonia (NH_3)		600	200

TABLE 8-22: ASSESSMENT SCENARIOS

Scenario	Train 3 (IFF Line 1)			Train 4 (IFF Line 2)		
	Reformer	Granulator	GT	Reformer	Granulator	GT
1	x	X	x	YES (SCR)	YES (no SCR)	YES (no SCR)
2	YES (no SCR)	YES (no SCR)	YES (no SCR)	YES (SCR)	YES (no SCR)	YES (no SCR)

8.2.3.2 BASELINE CONTEXT AND RECEPTOR SENSITIVITY

Combined wet- and dry-season ambient air quality monitoring indicates that baseline concentrations used in the assessment remain below 50% of the applicable air quality standards and that the airshed can therefore be considered undegraded for the pollutants assessed. The baseline concentrations applied in the AQIA include NO_2 annual mean of 17.9 µg/m³ (44% of the adopted annual standard), PM_{10} annual mean of 26.4 µg/m³ (44%), PM_{10} 24-hour maximum of 52.8 µg/m³ (35.2%), and NH_3 annual mean of 18.1 µg/m³ (9.05%), as shown in Table 7-21. The rainy- and dry-season monitoring results on which these baseline values are based are presented in Table 7-18 and Table 7-19, respectively, and the sampling locations are shown in Figure 7-9 and listed in Table 7-16.

For the purposes of significance determination, the AQIA defines high sensitivity receptors as locations where particularly vulnerable individuals may be present, including hospitals and schools; medium sensitivity receptors as locations where the general population is present for large periods of the year, including residential areas, towns and villages; and low sensitivity receptors as locations where people are transient or present only for short periods. Within the model domain, the sensitivity of human health at sensitive human receptors is taken as medium. This significance framework is set out in Table 5-5 and Table 5-6.

8.2.3.3 DISPERSION MODEL

Setup

The Aermod dispersion model was used to predict the impact of the emissions from IFF Line 1 and Line 2 as per the scenarios identified in Table 8-22.

The results of the model are used to provide a comprehensive understanding of the potential for air quality impacts at sensitive receptors. The key data for the overall model approach, and key input data for each source type is summarized in Table 8-23.

TABLE 8-23: MODEL APPROACH AND PARAMETERS

Parameter	Approach	Notes
Dispersion model	USEPA Aermod 24142	
Number of sources	See Table 8-22	
Model domain	10km x 10km	
Receptor grid resolution	25m within 2,000m 50m within 5,000m 100m within 10,000m	Environment Agency for England guidance[36] (cited by IFC) states that the grid resolution is no greater than 1.5 times the stack height
Buildings	Included	See Figure 5-3 and Table 8-24.
Terrain	Not included	The terrain elevation is not significant, with no sustained gradients of 1:10 or greater in the vicinity of the Project and therefore terrain was not included in the model.

[36] Environment Agency (2012) Dispersion Modelling Frequently Asked Questions

Parameter	Approach	Notes
Albedo	0.14 – 1.00	
Bowen Ratio	9.82 – 9.96	
Surface Roughness	0.80 – 0.80	
Meteorological data	Weather Research and Forecasting (WRF) data for Project site, sourced from Lakes Environmental 2018 to 2022	5 years hour-sequential data.
NO_x to NO_2 conversion ratio	Short-term concentrations: 35% Long-term concentrations: 70%	Environment Agency for England guidance[2] (cited by IFC)

FIGURE 8-1: MODEL SETUP

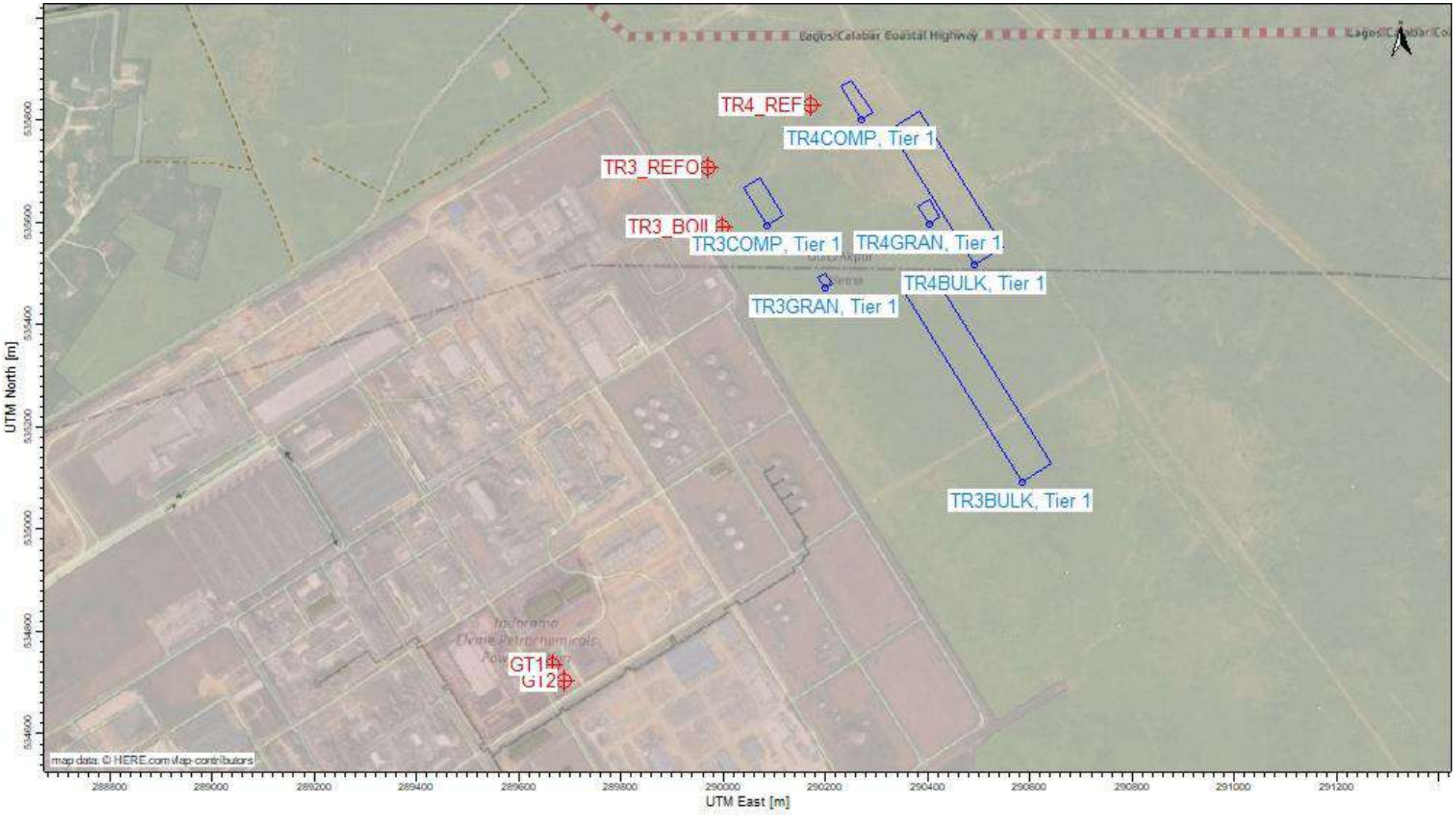


TABLE 8-24: BUILDINGS MODELLED

Name on Figure 8-1	Scenarios Included	x SW corner (m, UTM)	y SW corner (m, UTM)	Height (m)	Length (m)	Width (m)	Rotation Angle (⁰)
TR3GRAN	All	290200	535471	53	15.8	26.2	32.4
TR3COMP	All	290086	535595	30	35.6	85.6	32.4
TR3BULK	All	290585	535092	31	66	439.6	32.4
TR4GRAN	All	290404	535597	53	24.2	41.5	32.4
TR4COMP	All	290271	535801	30	24.6	75.5	32.4
TR4BULK	All	290493	535517	31	66	313	32.4

Emissions Data

The emission parameters for the emission source and each scenario are identified in Table 8-25, the location of the emission source is presented in Figure 8-1.

TABLE 8-25: EMISSION PARAMETERS

Parameter	Unit	Train 3 (IFF Line 1)			Train 4 (IFF Line 2)		
		Urea Granulator	Reformer	GT	Urea Granulator	Reformer	GT
Stack location (UTM)	x, y; m	290196, 535442	289969, 535707	289667,534737	290396, 535538	290172, 535830	289688, 534703
Stack height actual	m	55	34.5	54.1	55	34.5	54.1
Flue diameter	m	5	3.65	3.34	5	3.65	3.34
Emission velocity	m/s	17.0	11.0	37.8	16.8	11.1	37.8
Emission temperature (Actual)	Celsius	58.5	130	161	59.5	130	161
Volume flow rate Normalised, DRY							
Normalised Emissions							
NO_X (no SCR)	Mg/Nm^3	-	74.2	33.1	-	75.4	33.1
NO_x (with SCR)	Mg/Nm^3	-	7.42	3.31	-	7.54	3.31
NH_3	Mg/Nm^3	44.5	50.0	-	45.7	50	-
PM	Mg/Nm^3	10.9	2.0	2	23.1	2	2
Actual Emissions							
NO_x (as NO_2) emissions	g/s	-	4.71	0.351	-	0.483	0.351

Parameter	Unit	Train 3 (IFF Line 1)			Train 4 (IFF Line 2)		
		Urea Granulator	Reformer	GT	Urea Granulator	Reformer	GT
NH_3	g/s	13.7	3.17	-	14.0	3.21	-
PM_{10}	g/s	3.34	0.127	0.0213	7.10	0.128	0.0213

8.2.3.4 DISPERSION MODELLING RESULTS AND DISCUSSION

Table 8-26 presents the results of the modelling which are also illustrated by contour plots in Figure 8-2 to Figure 8-13.

Scenario 1

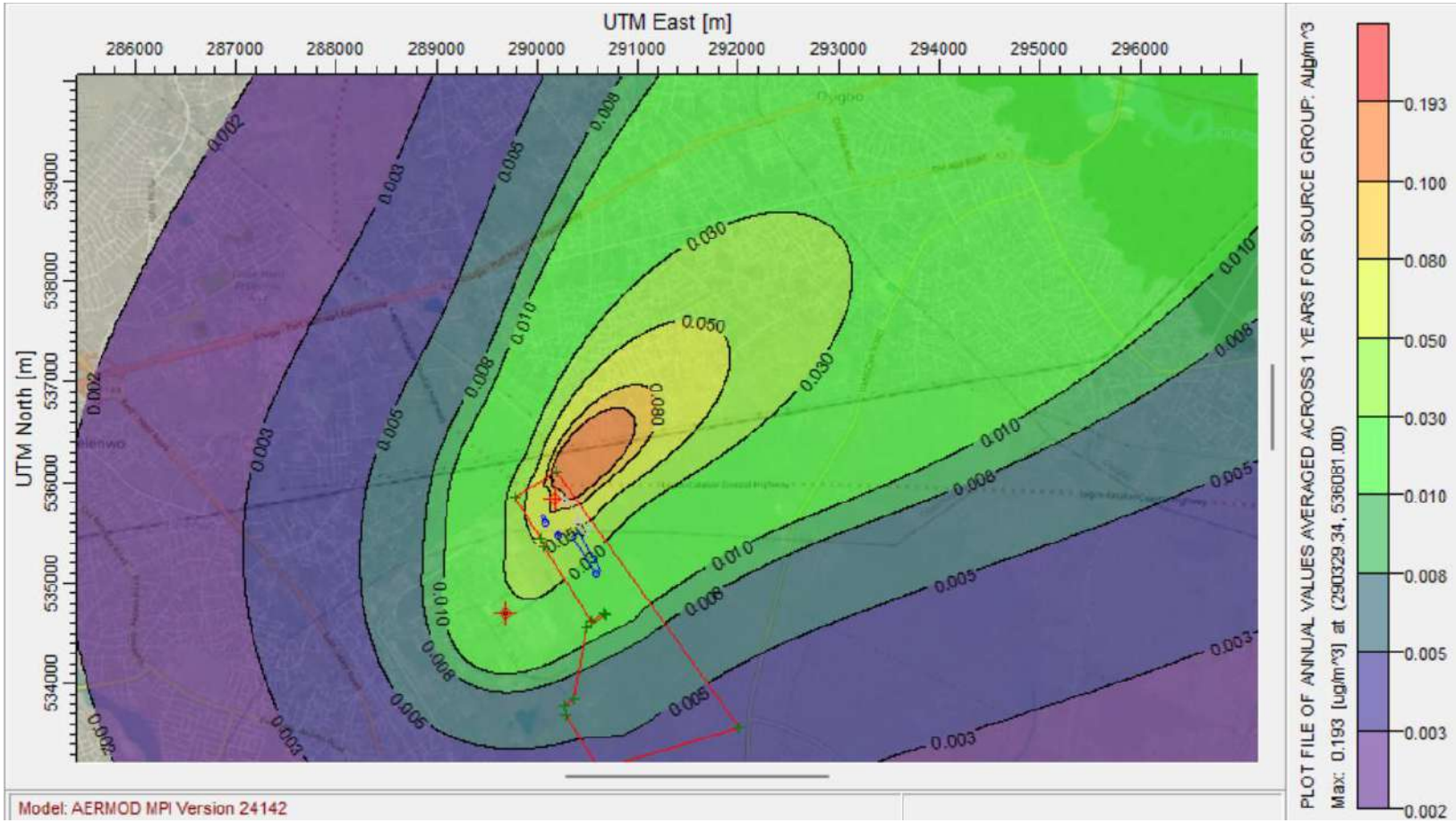


FIGURE 8-2: NO_2 ANNUAL MEAN

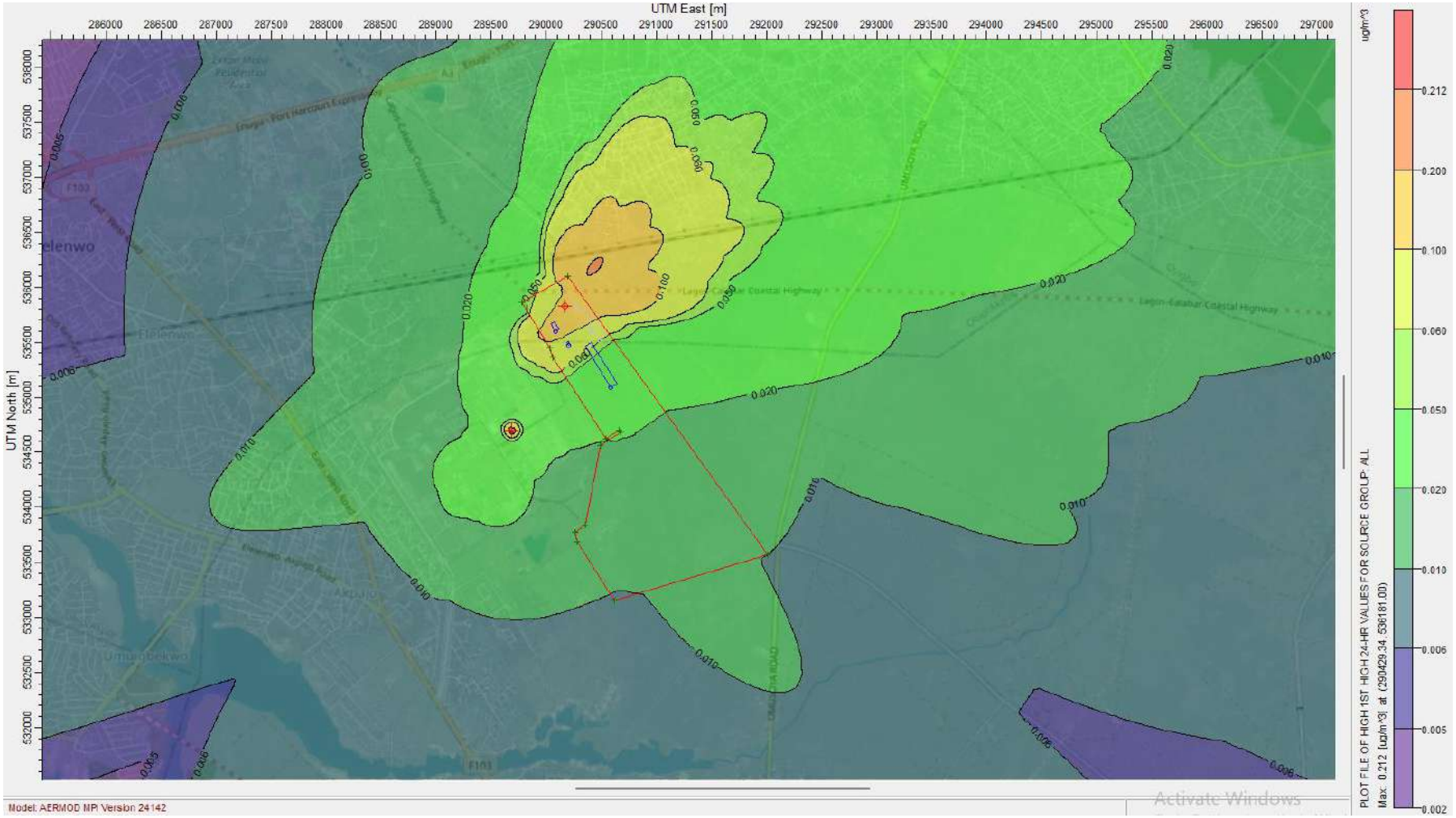


FIGURE 8-3: NO_2 24 HOUR MEAN

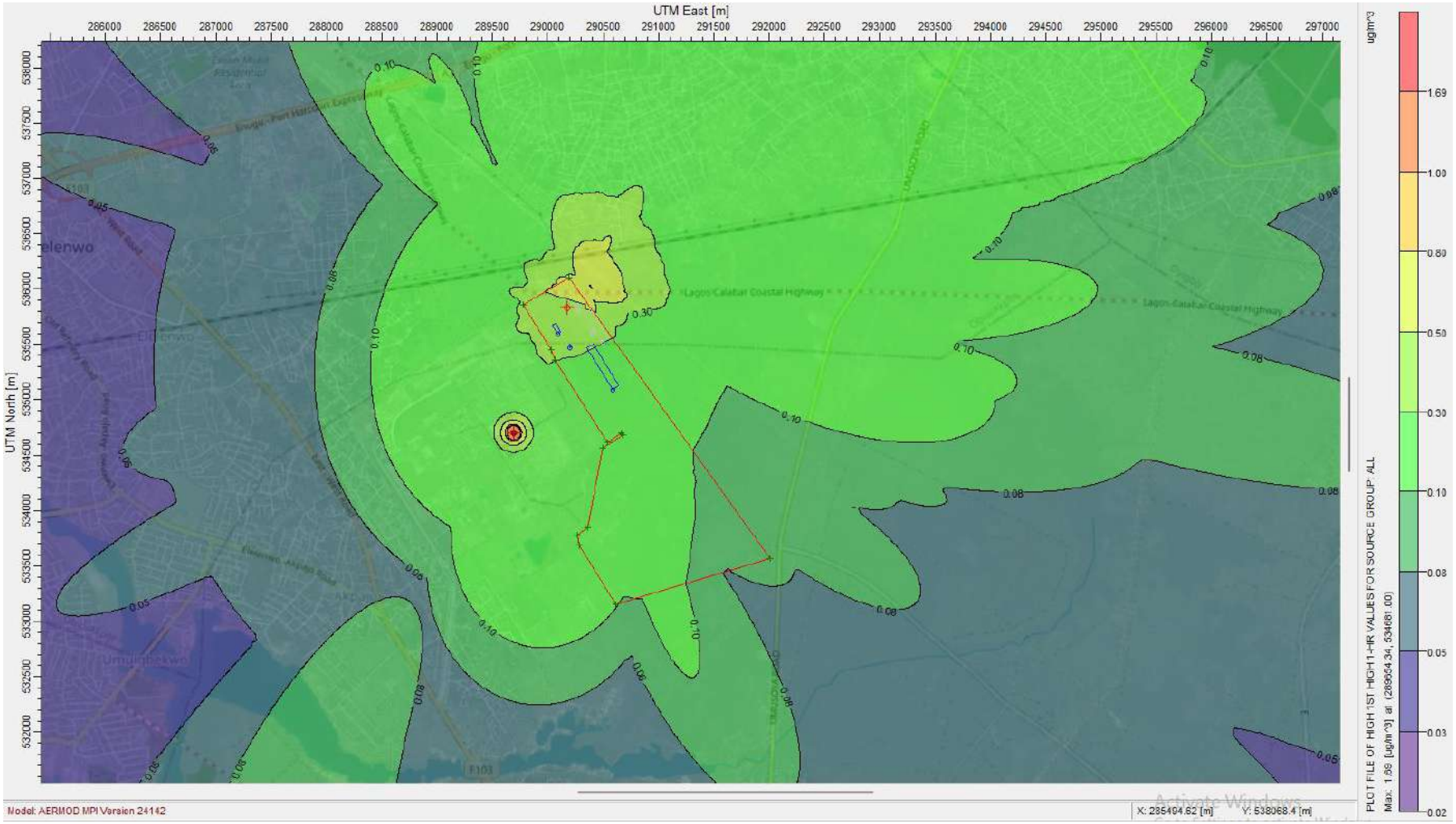


FIGURE 8-4: NO_2 1 HOUR MEAN

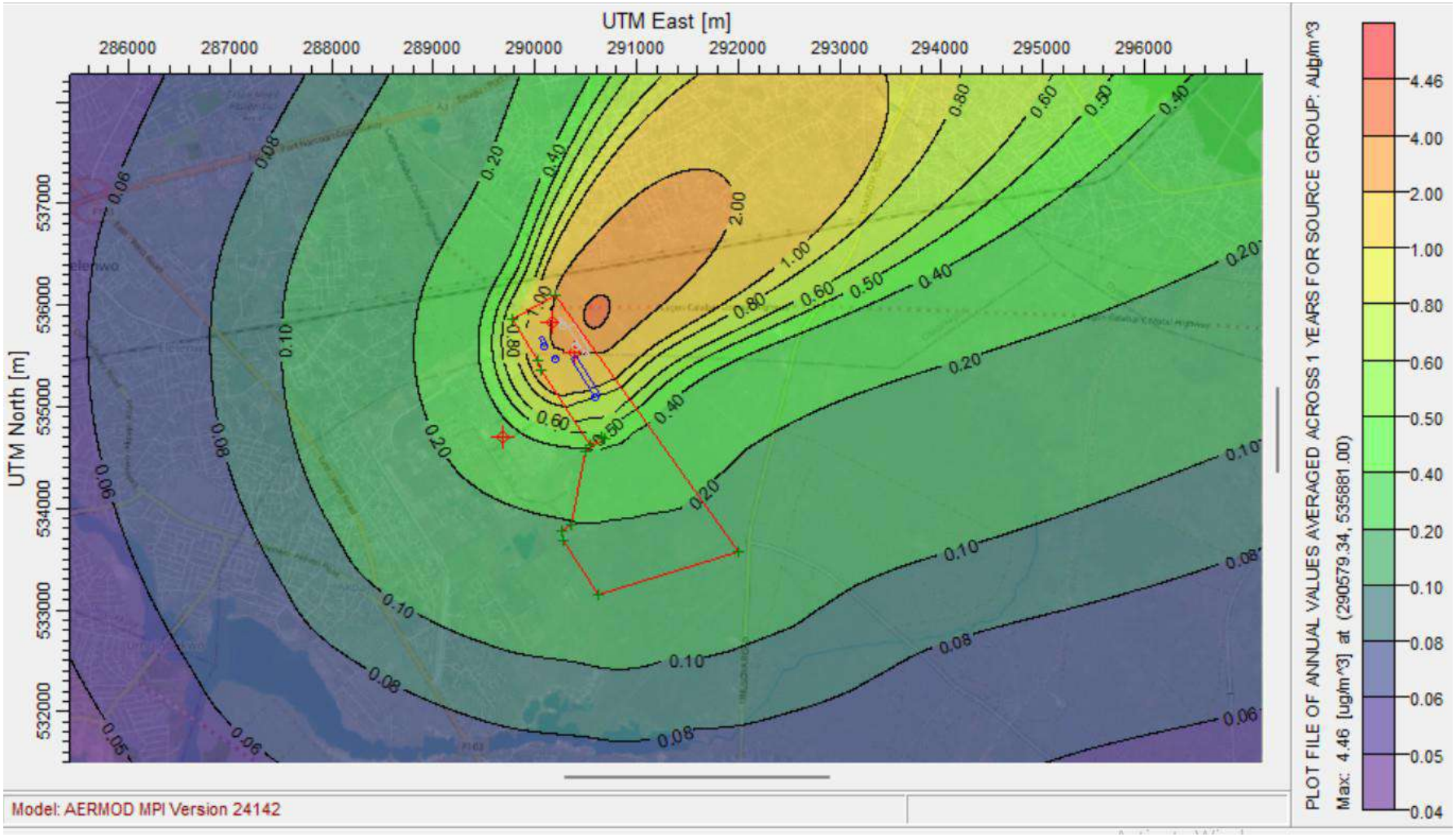


FIGURE 8-5: NH_3 ANNUAL MEAN

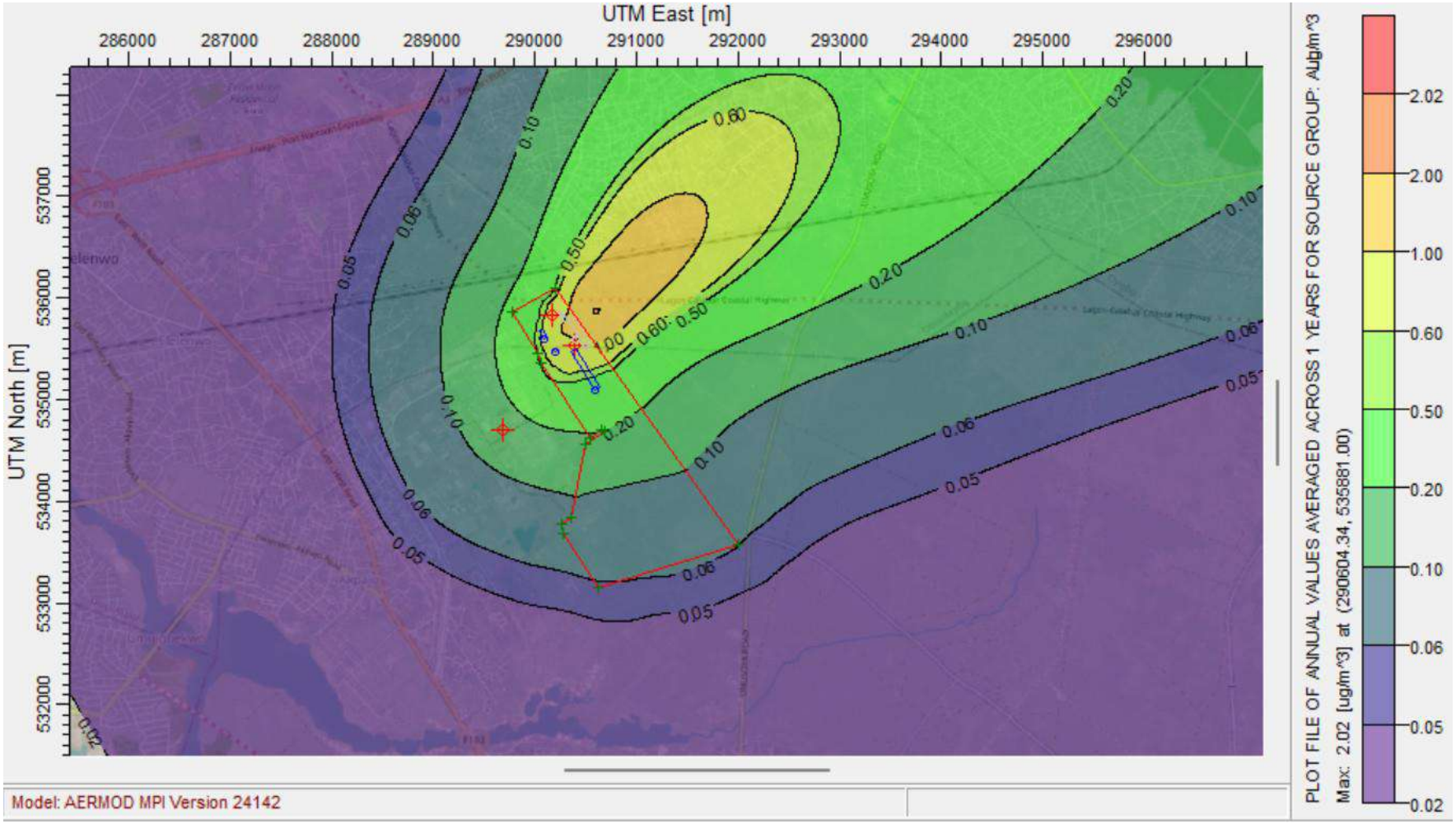


FIGURE 8-6: PM10 ANNUAL MEAN

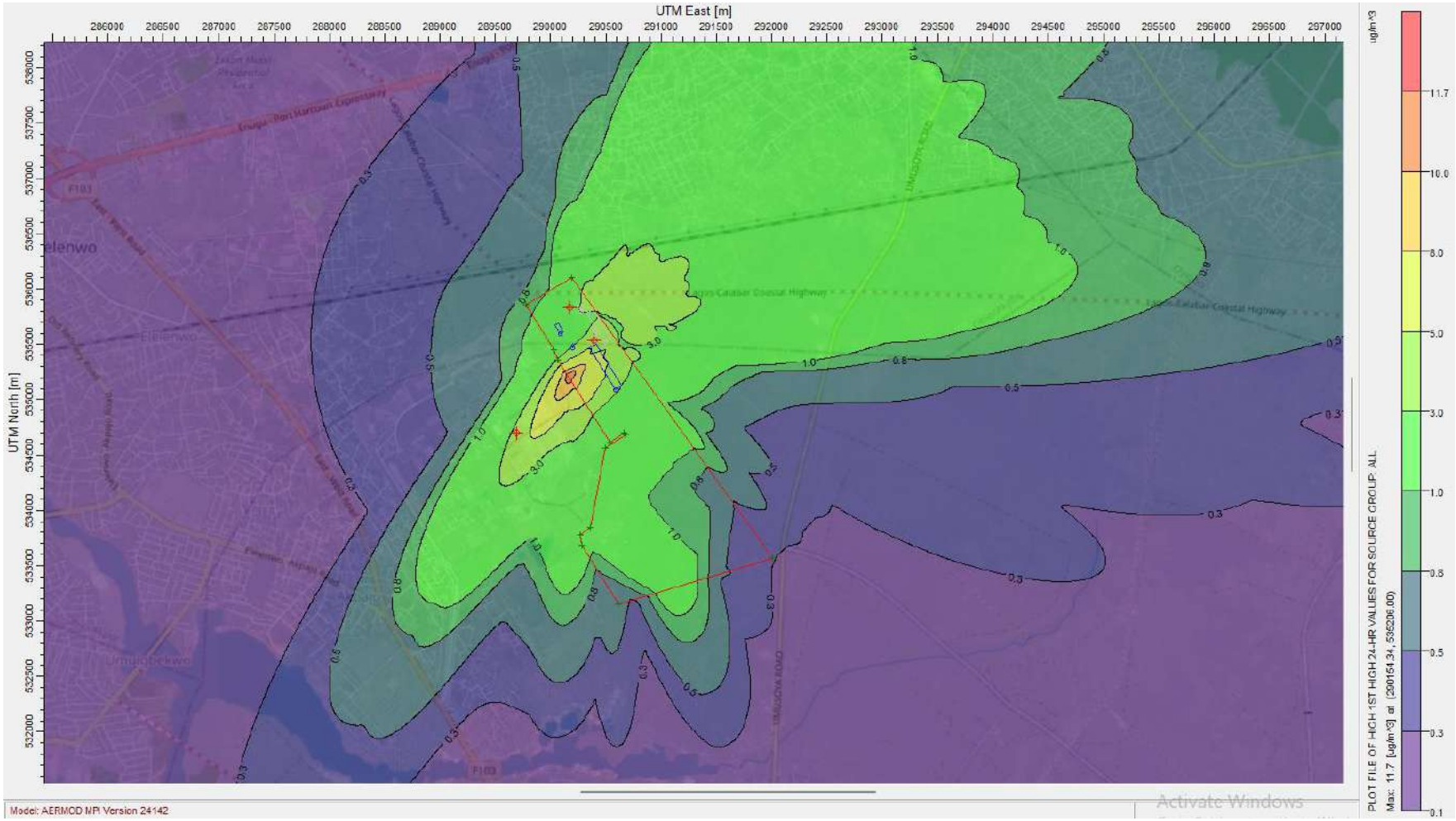


FIGURE 8-7: 24 HOUR PM10

Scenario 2

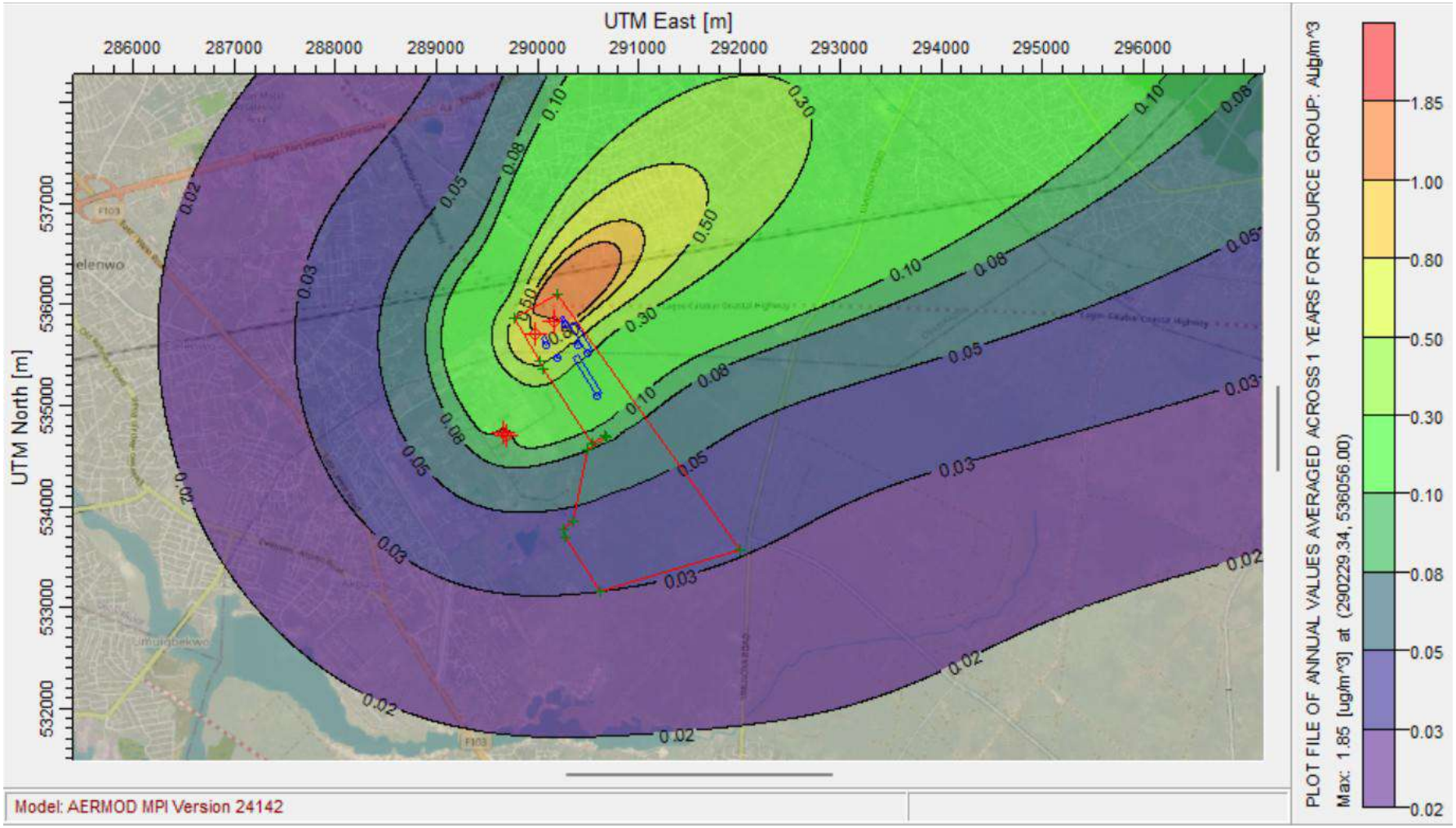


FIGURE 8-8: NO_2 ANNUAL MEAN

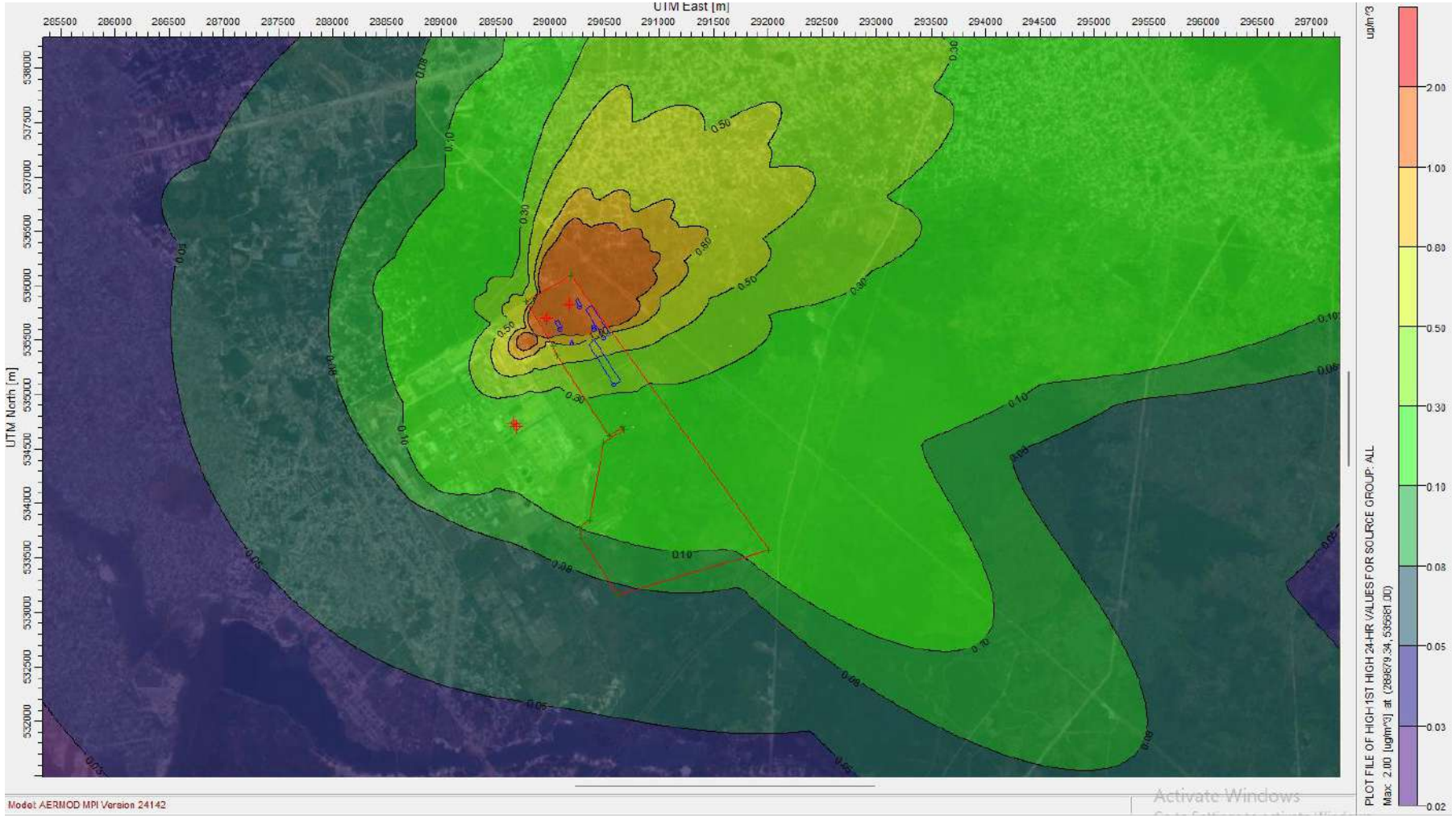


FIGURE 8-9: NO_2 24 HOUR MEAN

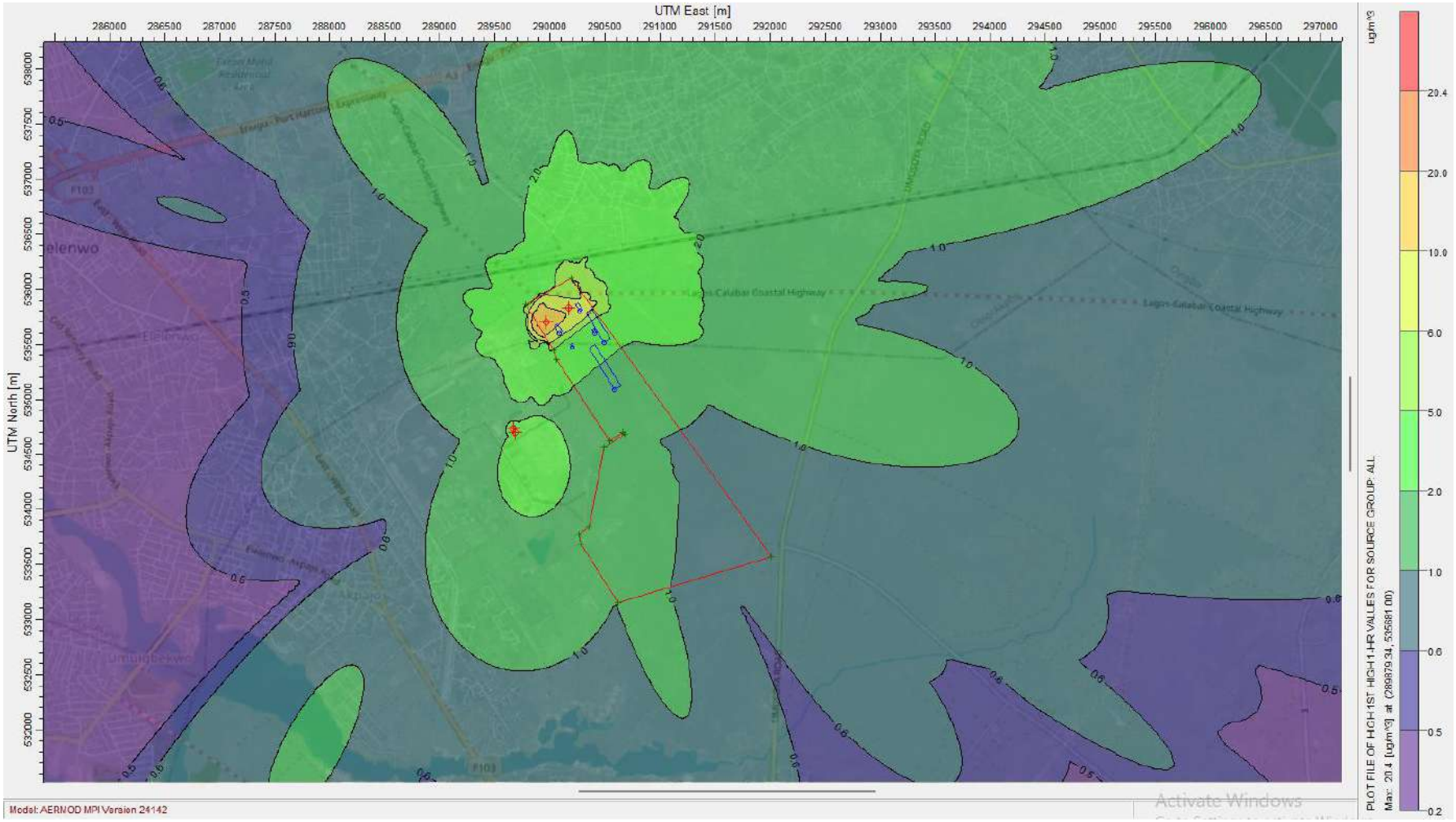


FIGURE 8-10: NO_2 1 HOUR MEAN

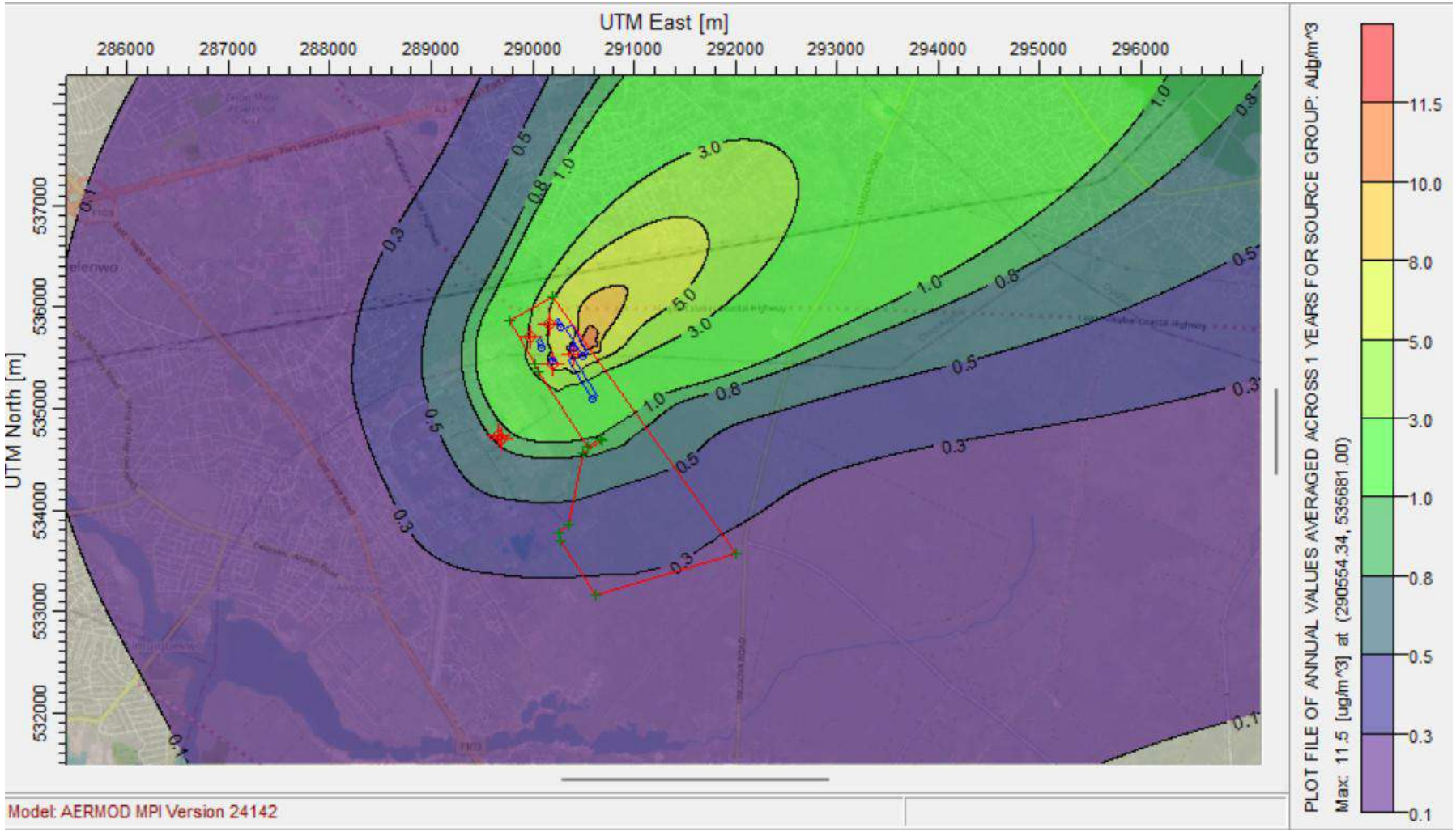


FIGURE 8-11: NH_3 ANNUAL MEAN

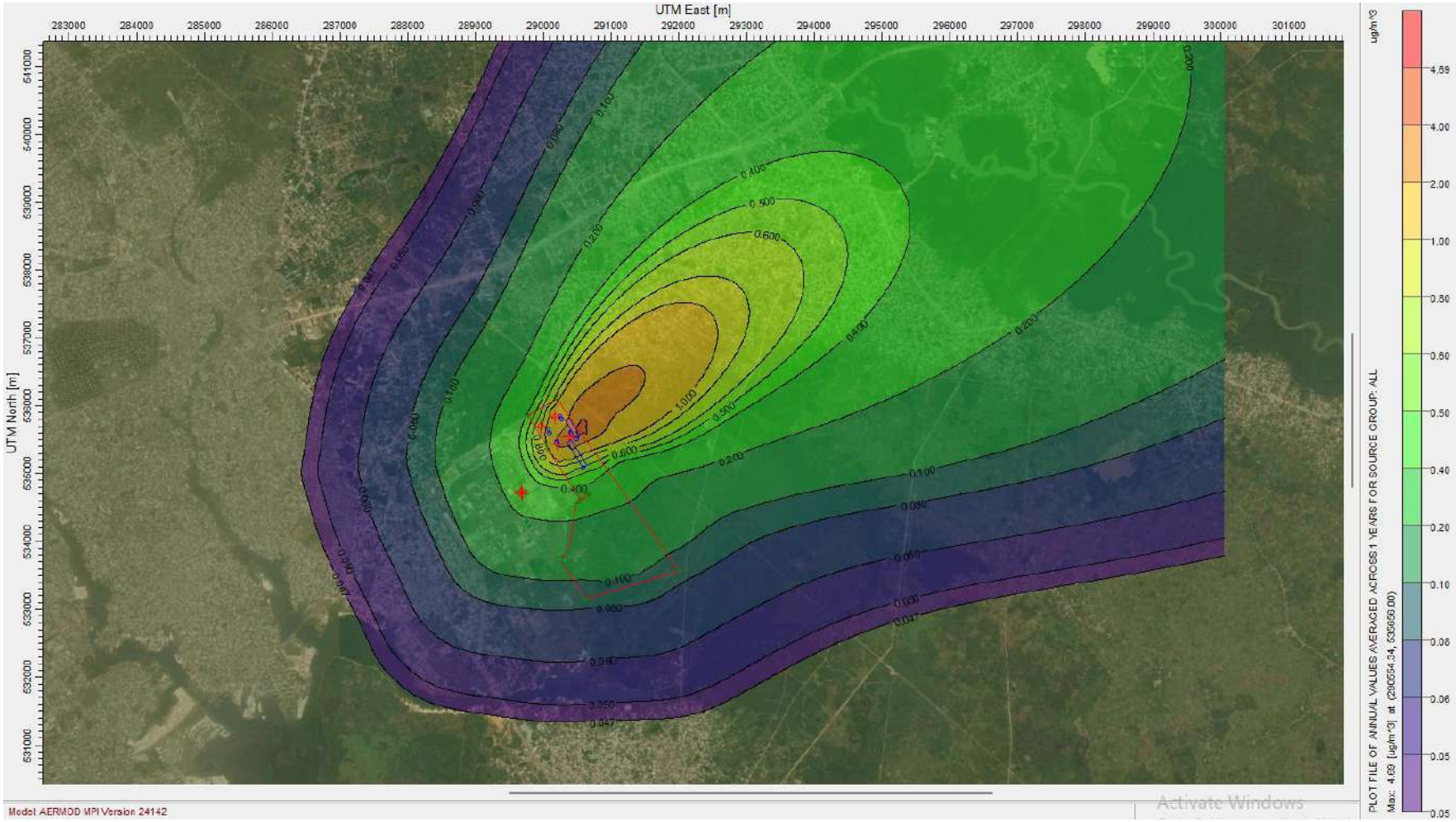


FIGURE 8-12: PM_{10} ANNUAL MEAN

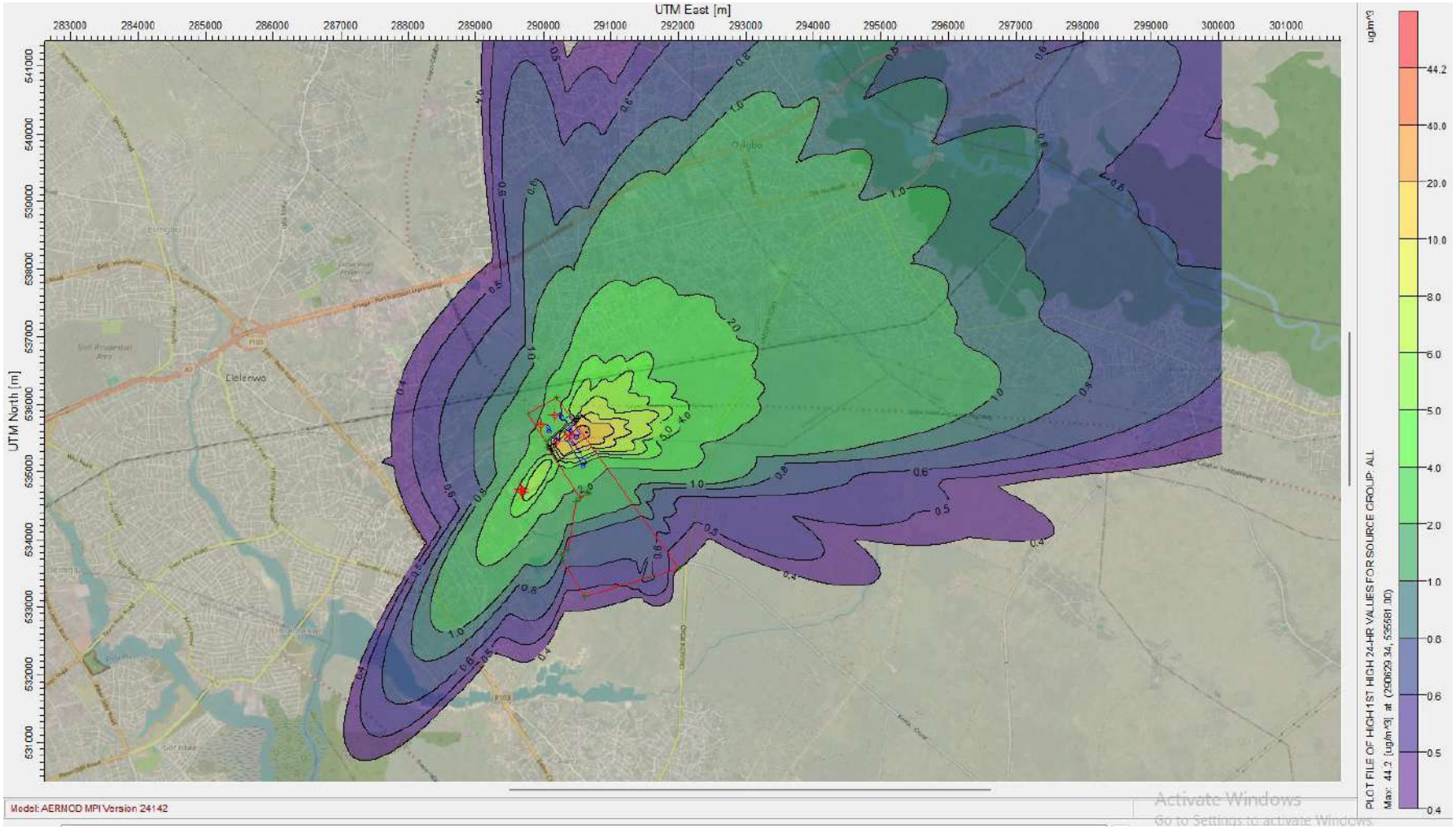


FIGURE 8-13: PM10 24 HOUR

8.2.3.5 IMPACT IDENTIFICATION AND SIGNIFICANCE (PRE-MITIGATION)

Potential air quality impacts arise from construction dust, construction-related traffic exhaust emissions, and operational point-source emissions associated with fertilizer production and related utilities. The principal impact pathways are the generation and atmospheric dispersion of particulates and combustion-related emissions, with nearby communities and other sensitive human receptors as the key receptors of concern.

Construction Phase Impacts

The main sources of atmospheric emissions during the construction phase are associated with:

- site preparation activities;
- general construction activities for Project infrastructure;
- vehicle movement over unpaved surfaces; and
- vehicle exhaust emissions.

Activities during the construction phase can result in emissions of dust and particulate matter (PM_{10} and $PM_{2.5}$). In addition, the use of construction vehicles and equipment will result in emissions of NO_x, SO_2 and combustion-related particulate matter. The movement of vehicles around the Project area will furthermore be associated with exhaust emissions and dust emissions from road surfaces and exposed surfaces.

Dust-raising activities may have an effect on human receptors sensitive to dust and PM_{10}. The Project workforce also has the potential to be exposed to occupational air quality risks; however, for the purposes of this community-level assessment, workers are considered less sensitive than residential and community receptors.

As such, dust and particulate generation during the construction phase is determined to be of high magnitude and of major significance prior to mitigation.

Construction traffic-related exhaust emissions were assessed using a screening approach derived from the UK Design Manual for Roads and Bridges and adapted for the traffic fleet likely to occur in Nigeria. The AQIA identifies expected additional traffic during construction of approximately 25 trucks / containers per day for logistics and approximately 100 buses per day during peak manpower. On the basis that construction traffic is unlikely to exceed the screening thresholds used in the AQIA, traffic-related air quality impacts are considered to be of low magnitude and of minor significance prior to mitigation.

Operational Phase Impacts

Dispersion modelling was performed to assess the potential effects of the Project's operational emissions on ambient air quality and on receptors around the Project area. The operational assessment considered two scenarios:

- Scenario 1: operation of IFF Line 2 alone, with SCR installed on the IFF Line 2 primary reformer stack; and
- Scenario 2: the in-combination operation of IFF Line 1 and IFF Line 2.

During the operational phase, the Project alone is not predicted to result in any adopted air quality standard being exceeded. Based on the dispersion modelling results summarised in

Table 8-26, air quality standards are not exceeded for any pollutant under Scenario 1, and the resulting project-only impacts are negligible.

Under Scenario 2, the results similarly indicate negligible impacts for most pollutants and averaging periods. However, the highest modelled effect is associated with PM_{10} over the 24-hour averaging period, for which the maximum process contribution is 44.2 µg/m³, equivalent to 29.5% of the applicable standard, with a resulting PEC of 97 µg/m³ (65% of the standard). This corresponds to a medium magnitude and moderate significance outcome within the AQIA significance framework.

Cumulative Impacts

Cumulative air quality impacts were assessed by considering the baseline environment together with the predicted incremental contribution from the combined operation of IFF Line 1 and IFF Line 2. The cumulative assessment notes that baseline monitoring already captures the influence of surrounding industrial activities, traffic emissions and regional air pollution sources within the study area. Baseline concentrations for PM_{10}, $PM_{2.5}$ and NO_2 are already influenced by these existing sources, while baseline NH_3 remains below 10% of the applicable annual standard.

Dispersion modelling indicates that the combined operation of IFF Line 1 and IFF Line 2 will lead to a measurable but generally limited incremental increase in pollutant concentrations at identified receptors. The cumulative assessment confirms that no adopted air quality standards are exceeded, and that the highest combined effect is associated with PM_{10} over the 24-hour averaging period, as shown in Table 8-26. In spite of this moderate significance outcome at the worst-case receptor level, the cumulative AQIA concludes that the Project does not result in significant adverse cumulative air quality impacts overall because the PEC remains below the relevant standard and the Project contributes only a limited increment to an already industrialised baseline environment.

TABLE 8-26: SUMMARY OF OPERATIONAL AND IN-COMBINATION AIR QUALITY MODELLING RESULTS

	AQS	baseline	PC	PC/AQS	PEC	PEC/AQS	Magnitude	Significance
Scenario 1 NO_2								
Annual Mean	40 (IFC)	17.9	0.193	0.5%	18.1	45%	Negligible	Negligible
Annual Mean	80 (Nigeria)	17.9	0.193	0.2%	18.1	23%	Negligible	Negligible
24h maximum	120 (Nigeria)	61.2	0.212	0.2%	36	30%	Negligible	Negligible
1h maximum	200 (Nigeria/IFC)	61.2	1.69	0.84%	37	19%	Negligible	Negligible
Scenario 1 NH_3								
Annual Mean	200 (Nigeria)	18.2	4.46	2.2%	22.7	11%	Negligible	Negligible
Scenario 1 PM_{10}								
Annual Mean	60 (Nigeria)	26.4	2.02	3%	28.4	47%	Negligible	Negligible
Annual Mean	70 (IFC)	26.4	2.02	2.9%	28.4	41%	Negligible	Negligible
24h maximum	150 (Nigeria/IFC)	52.8	11.8	7.8%	64.5	43%	Negligible	Negligible
Scenario 2 NO_2								
Annual Mean	40 (IFC)	17.9	1.85	5%	19.7	49%	Negligible	Negligible
Annual Mean	80 (Nigeria)	17.9	1.85	2.3%	19.7	25%	Negligible	Negligible
24h maximum	120 (Nigeria)	61.2	2.00	1.7%	37.8	31%	Negligible	Negligible
1h maximum	200 (Nigeria/IFC)	61.2	20.4	10%	56	28%	Small	Negligible
Scenario 2 NH_3								

	AQS	baseline	PC	PC/AQS	PEC	PEC/AQS	Magnitude	Significance
Annual Mean	200 (Nigeria)	18.2	11.5	5.7%	29.7	15%	Negligible	Negligible
Scenario 2 PM_{10}								
Annual Mean	60 (Nigeria)	26.4	4.69	8%	31.1	52%	Negligible	Negligible
Annual Mean	70 (IFC)	26.4	4.69	6.7%	31.1	44%	Negligible	Negligible
24h maximum	150 (Nigeria/IFC)	52.8	44.2	29.5%	97	65%	Medium	Moderate

Significance:
Negligible - a resource/receptor will essentially not be affected in any way by the PC, or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations.
Minor - a resource/receptor will experience a noticeable effect, but the impact magnitude is sufficiently small and well within applicable standards.
Moderate - the impact magnitude is within applicable standards but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit.
Major - an accepted limit or standard may be exceeded.

8.2.3.6 MITIGATION AND MANAGEMENT MEASURES

Refer to Section 9.2.4 (Chapter 9) for the recommended mitigation and management measures associated with air quality.

8.2.3.7 RESIDUAL IMPACT (POST-MITIGATION)

Construction Phase

The construction of the Project is not predicted to result in significant impacts due to road traffic, based on the expected level of traffic. In terms of construction dust, with the correct implementation of the recommended mitigation and management measures, residual impacts are considered to be negligible, or at worst minor.

Operational Phase

The operation of the proposed IFF Line 2 Project is not predicted to result in adopted air quality standards being exceeded in its own right. Under Scenario 1, all project-only impacts are negligible. Under Scenario 2 (combined operation of IFF Line 1 and IFF Line 2), the highest predicted cumulative air quality effect is associated with 24-hour PM_{10} concentrations. The maximum predicted environmental concentration is 97 µg/m³ (65% of the adopted standard), with all modelled pollutants remaining below applicable air quality criteria and no exceedances predicted at sensitive receptors. Consequently, cumulative operational air quality impacts are considered acceptable and manageable through the proposed mitigation and monitoring measures.

Cumulative Impacts

The cumulative AQIA concludes that, when considered alongside existing and surrounding emission sources, the Project is not expected to result in significant adverse cumulative air quality impacts. The highest cumulative air quality impact identified is the 24-hour PM_{10} concentration. However, predicted concentrations remain below the adopted air quality standard, indicating that cumulative effects are acceptable and can be effectively managed through the Project's embedded design features, operational controls, and routine environmental management measures. As compliance with applicable standards is maintained, no additional mitigation measures or design modifications are considered necessary specifically for cumulative air quality impacts.

8.2.4 NOISE IMPACT ASSESSMENT

This section assesses the likely noise impacts at the nearby NSRs in the Study Area due to the construction and operation of the Project. It be read together with the baseline noise section presented in Chapter 7. The assessment confirms that, because of the distance between the Project and surrounding receptors, vibration due to construction and operation is anticipated to be insignificant and was therefore scoped out; accordingly, this ESIA subsection addresses airborne noise only.

8.2.4.1 DESCRIPTION OF THE BASELINE ENVIRONMENT

The baseline acoustic environment, as presented in Chapter 7, is based on noise surveys undertaken during both the wet season (16 to 25 October 2025) and the dry season (20 February to 5 March 2026) in order to characterise seasonal acoustic conditions in the vicinity of the Project. The noise study established 11 baseline noise monitoring locations around the Project area, and these are shown in Table 7-28 and Figure 7-11.

For the purpose of impact assessment, only receptors N2, N3 and N4 were taken forward as assessment locations, because these receptors are located near the Project area and are therefore the nearest and most relevant NSRs for Project-induced change. The remaining baseline monitoring locations were considered too far from the Project to represent meaningful assessment receptors for the construction and operational noise modelling.

Baseline monitoring results indicate that daytime noise levels (LAeq) remain below the 55 dB criterion at all monitored locations. At the nearest assessed receptors, the daytime baseline LAeq values are 46 dB at N2, 46 dB at N3, and 46 dB at N4. During the night-time period, the corresponding LAeq values at these assessed receptors are 44 dB at N2, 42 dB at N3, and 44 dB at N4, which remain below the 45 dB IFC night-time criterion. During the assessment it was noted that night-time exceedance of the 45 dB criterion was recorded only at N9, which is not one of the receptors taken forward into the Project impact assessment. These baseline results are presented in Table 7-33.

Accordingly, the baseline acoustic environment in the immediate vicinity of the Project is characterised by moderate daytime noise levels and generally compliant night-time conditions at the receptors assessed for Project noise impacts.

8.2.4.2 PROPOSED PROJECT ACTIVITIES

Construction Phase

Predicted noise levels at nearby receptors due to the Construction activity are presented in Table 8-27. The predicted noise contours due to construction of the project are presented in Figure 7-12.

TABLE 8-27: PREDICTED NOISE LEVELS DURING CONSTRUCTION ACTIVITY

Receptor	Predicted Noise Levels, L_{Aeq} dB	Criteria	Impact Magnitude
		Day	Day
N2	48	75	Negligible
N3	59	75	Negligible
N4	48	75	Negligible

Source: ERM, 2026.

Noise levels are predicted to comply with the relevant criteria at all assessment locations during daytime. The predicted impact magnitude is anticipated to be **Negligible.**

In line with lender requirements, the predicted construction noise levels have also been compared with the more stringent IFC EHS Guideline value of 55 dB(A) (daytime, 07:00–22:00) adopted for residential receptors (Section 5.6.3.2.2.1, Table 5-7A), as shown in Table 827A.

TABLE 8-27A: PREDICTED CONSTRUCTION NOISE LEVELS COMPARED WITH THE IFC EHS GUIDELINE CRITERION

Receptor	Baseline daytime LAeq, dB(A)	Predicted construction LAeq, dB(A) (worst case)	IFC criterion – day, dB(A)	Difference from criterion, dB	Magnitude (pre-mitigation)	Residual (post-mitigation)
N2	46	48	55	–7	Negligible	Negligible
N3	46	59	55	+4	Small (Moderate significance)	Minor (with targeted controls)
N4	46	48	55	–7	Negligible	Negligible

At N3 (Iriebe), the worst-case prediction, which assumes the simultaneous operation of the noisiest construction plant nearest to the receptor, exceeds the IFC daytime value by 4 dB and the background by more than 3 dB. Against this criterion, the pre-mitigation impact at N3 is therefore of Moderate significance during the noisiest construction activities, while N2 and N4 remain Negligible; no night-time construction is planned. Targeted controls shall be applied for works within line of sight of N3: temporary acoustic barriers or hoardings along the northern site boundary, siting of stationary plant away from the receptor, low-noise piling methods where practicable, restriction of high-noise activities to 08:00–18:00 on weekdays, advance community notification and the noise monitoring programme in Section 5.6.3.2.5. With these controls, which typically provide 5–10 dB of attenuation, construction noise at N3 is expected to meet the 55 dB(A) criterion and the residual impact is assessed as Minor. Operational noise from IFF Line 2 alone and in combination with IFF Line 1 (Tables 828 and 829) is below the IFC criteria at all receptors.

Operation

Predicted operational noise levels at nearby receptors are presented in Table 8-28 for IFF Line 2 operating independently and in Table 8-29 for the cumulative operation of IFF Line 1 and Line 2. The predicted noise contours due to operation of the project are presented in Figure 7-13 and Figure 7-14.

TABLE 8-28: PREDICTED NOISE LEVELS DURING OPERATION ACTIVITY – TRAIN 4

Receptor	Predicted Noise Levels, L_{Aeq} dB	Criteria, L_{Aeq} dB		Impact Magnitude	
		Day	Night	Day	Night
N2	26	55	45	Negligible	Negligible
N3	43	55	45	Negligible	Negligible
N4	32	55	45	Negligible	Negligible

Source: ERM, 2026.

TABLE 8-29: PREDICTED NOISE LEVELS DURING OPERATION ACTIVITY – IFF LINE 1 AND LINE 2

Receptor	Predicted Noise Levels, L_{Aeq} dB	Criteria, L_{Aeq} dB		Impact Magnitude	
		Day	Night	Day	Night
N2	28	55	45	Negligible	Negligible
N3	44	55	45	Negligible	Negligible
N4	36	55	45	Negligible	Negligible

Source: ERM, 2026.

Predicted noise levels are expected to comply with the relevant criteria for day and night-time periods at all locations assessed. The predicted impact magnitude is anticipated to be **Negligible.**

8.2.4.3 SIGNIFICANCE OF IMPACTS (PRE AND POST-MITIGATION)

The expected impacts are assessed in Table 8-30 and Table 8-31. Based on the analysis provided:

- the impact of noise associated with construction activity is considered a "**Direct, Negative impact, negligible impact**" pre-mitigation; and
- the impact of noise associated with the operation activity is considered as "**Direct, Negative impact, negligible impact**" pre-mitigation.

Even though no impacts are anticipated, frequent noise monitoring should be undertaken at the nearest receptors to the plant.

Construction

TABLE 8-30: RATING OF IMPACTS RELATED TO NOISE DURING CONSTRUCTION ACTIVITIES

Description of Impact		
Noise associated with construction activity may cause annoyance to near sensitive receptors		
Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	At receptors in the near proximity of the project.
Duration	Medium-term	Construction is expected to last 33 months.
Scale	n/a	In the near proximity of the project
Frequency	Irregular and rare	Impact is likely to occur irregularly and rarely
Likelihood	Unlikely	Impact is unlikely
Magnitude		
Negligible magnitude related to the construction noise		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
The receptors in the proximity of the Project are classified as "buildings other than hospitals, schools, institutions of higher learning and homes for the disabled" receptors group according to the Nigerian construction standards.		
Significant Rating Post Mitigation		
Negligible Impact		

Source: ERM, 2026.

Operation

TABLE 8-31: RATING OF IMPACTS RELATED TO NOISE DURING OPERATION ACTIVITIES

Description of Impact
Noise associated with engines, ventilation, air charge intakes and other installations related to the operation may cause annoyance to near sensitive receptors
Type of Impact

Direct		
Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	At receptors in the near proximity of the project.
Duration	Long term	During operational phase
Scale	n/a	In the near proximity of the project
Frequency	Irregular and rare	Impact is likely to occur irregularly and rarely
Likelihood	Unlikely	Impact is unlikely
Magnitude		
Negligible magnitude related to the operational noise		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
The receptors in the proximity of the Project are classified as "mixed residential" receptors group as per Nigerian noise criteria.		
Significant Rating Post Mitigation		
Negligible Impact		

Source: ERM, 2026.

8.2.4.4 MITIGATION AND MANAGEMENT MEASURES

Refer to Section 9.2.5 (Chapter 9) for the recommended mitigation and management measures associated with Noise.

8.2.5 IMPACTS ON SOILS AND GEOLOGY

8.2.5.1 DESCRIPTION OF BASELINE ENVIRONMENT

The geology and soils within the Project Footprint are predominantly classified as Coastal Plain Sands of the Niger Delta Basin, characterised by loamy sand to sandy loam textures, with sand content typically exceeding 75%. These soils are generally well-drained, highly permeable, and structurally weak, with low clay content and limited cohesion. Bulk density values (approximately 1.2–1.5 g/cm³) and porosity (40–55%) are indicative of loosely packed soils with high infiltration capacity, while permeability rates (0.12–0.48 cm/s) confirm rapid fluid movement through the soil profile.

Chemically, soils exhibit slightly acidic to neutral pH conditions (approximately 5.0–7.9), consistent with typical tropical sandy soils influenced by leaching and organic matter decomposition. Nutrient concentrations, including nitrate, phosphate, and sulphate, are generally low, reflecting limited nutrient retention capacity and active leaching processes. Organic matter content is moderate, supporting basic soil functionality but not indicating high fertility. Hydrocarbon compounds (THC, TPH, and PAHs) and toxic metals (As, Pb, Hg, Cr) were

below laboratory detection limits, confirming the absence of anthropogenic contamination. Elevated iron and manganese concentrations observed across all locations are consistent with natural geogenic background conditions typical of tropical weathering environments.

From a functional perspective, the soils are considered moderately to highly sensitive under the ERM impact assessment framework due to several key factors:

- Their granular texture and weak structure increase susceptibility to erosion and physical disturbance, especially under high rainfall conditions.
- Their high permeability and low adsorption capacity increase vulnerability to contaminant migration, thereby presenting a potential pathway for pollutant transport to underlying groundwater systems.
- They play a critical role in groundwater recharge, particularly where they overlie shallow aquifer systems characteristic of the Niger Delta.
- They are used in the surrounding areas, include agricultural lands and community-utilised soils, indicating socio-economic reliance on soil productivity for subsistence farming and local livelihoods.

Overall, the baseline environment constitutes soils that are physically fragile, chemically unimpacted, but hydrologically sensitive, providing an important control on contaminant mobility and groundwater protection within the Project Area. There are currently no evidence of significant geological faulting, structural deformation, or geologically induced hazards identified within the Project Area, indicating a relatively stable geological environment with no anticipation of contaminant mobility.

8.2.5.2 PROPOSED PROJECT ACTIVITIES

Construction Phase

During the construction phase, the primary impacts on soils are expected to arise from land disturbance, machinery operation, and material handling activities. The most significant impacts include:

- Soil erosion, loss of topsoil and sediment mobilisation resulting from vegetation clearance, topsoil stripping, and exposure of bare soil surfaces to rainfall, leading to increased surface runoff and removal of nutrient rich topsoil. Given the sandy and weakly structured nature of soils, this represents a key impact within the Project Area.
- Soil compaction caused by heavy machinery and vehicle movement, particularly along access routes and work areas, resulting in reduced soil porosity and permeability. This may alter natural infiltration patterns and increase runoff.
- Soil contamination from establishment of site offices, spoil storage areas, and workshops has the potential to result in soil contamination and degradation if not appropriately managed. Activities at these facilities may generate greywater, sewage, and sediment-laden runoff which, if discharged onto unprotected ground surfaces, can lead to localized soil contamination, increased nutrient loading, and deterioration of soil quality.
- Soil contamination associated with accidental spills or leaks of hydrocarbons (e.g. fuels, lubricants), chemicals, and wastewater (including greywater and blackwater) produced during construction. Due to the high permeability of soils, contaminants may infiltrate vertically, posing a risk to subsurface soils and groundwater.

- Alteration of the soil-water balance arising from compaction and surface modification, which may reduce infiltration, increase runoff, and disrupt natural drainage patterns, potentially leading to localised flooding and reduced groundwater recharge.
- Subsurface disturbance, cuttings handling and drilling-fluid management associated with the installation of three new water-supply boreholes. Although the spatial footprint of each borehole is minor (limited to the wellhead pad, mud pit and short access track at each site), drilling activities can mobilise fine sediments at the surface, generate cuttings that may smother adjacent soils if uncontained, and - where boreholes are inadequately grouted - create vertical preferential pathways between surface soils and the shallow aquifer. Given the high permeability and weak structure of the Coastal Plain Sands, these effects are most relevant where drilling fluids or cuttings come into contact with bare soil surrounding the wellhead.

Operational Phase

During the operational phase, impacts on soils are expected to be more localised but may persist over the long term. The key impacts include:

- Soil contamination resulting from accidental leaks or spills of hydrocarbons, process chemicals during plant operations, and wastewater (including greywater and blackwater) produced during operation. The high permeability and low adsorption capacity of soils increase the risk of contaminant migration to underlying groundwater.
- Changes in soil-water balance due to the long-term effects of soil compaction and the presence of impermeable surfaces, leading to reduced infiltration, increased surface runoff, and possible localised ponding.
- Residual soil degradation associated with prior construction activities, including persistent compaction and altered drainage patterns, which may continue to affect soil structure and hydrological functioning over time.

8.2.5.3 SENSITIVE RECEPTORS

Soil within the Project Footprint is treated as the sensitive receptor for this assessment, reflecting both its intrinsic quality and stability and its role in supporting other receptors. Soil underpins groundwater and surface water quality, agricultural productivity, community land use, and ecological habitats; an impact on the soil resource can therefore propagate to each of these.

The reliance of surrounding communities, agricultural areas, surface water, groundwater and ecological receptors on the soil resource is incorporated into the sensitivity assigned to the soil receptor, and any adverse impact on the soil receptor would in turn adversely affect these users. Impacts are therefore assessed against soil as a single representative receptor.

8.2.5.4 SIGNIFICANCE OF IMPACT (PRE-MITIGATION)

The anticipated impacts prior to the implementation of mitigation measures have been assessed and summarised as follows:

- Soil Erosion, Loss of Topsoil and Sediment Mobilisation – Classified as a Moderate Negative Impact (refer to Table 8-32).
- Soil Compaction – Classified as a Minor Negative Impact (refer to Table 8-33).

- Soil Contamination from Hydrocarbon / Chemical / Wastewater Spills and Leaks – Classified as a Moderate Negative Impact (refer to Table 8-34).
- Changes to Soil-Water Balance – Classified as a Minor *Negative Impact* (refer to Table 8-35).
- Subsurface Disturbance, Cuttings and Drilling-Fluid Handling from Water-Supply Borehole Installation – Minor Negative Impact (Table 8-36)

These ratings reflect the significance of potential impacts under pre-mitigation conditions and provide the basis for determining appropriate management and mitigation measures in subsequent sections.

TABLE 8-32: RATING OF IMPACTS RELATED TO SOIL AND GEOLOGY (PRE-MITIGATION): SOIL EROSION, LOSS OF TOPSOIL AND SEDIMENT MOBILISATION

Project Phase: Construction		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local to Regional	Impact can extend down-gradient beyond the Project Area into low-lying drainage.
Duration	Medium-term	Persists until vegetation/cover is re-established.
Scale	250 ha – across Project Area	Cleared/exposed surfaces during bulk earthworks; sediment can mobilise across the whole disturbed footprint.
Frequency	Frequent	Occurs throughout all major construction phases.
Likelihood	Likely	Expected without erosion controls.
Magnitude		
Medium Magnitude -soils across the full disturbed area are mobilisable; sediment can be exported off-site		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
Soils are erodible (granular, weakly structured); fertile topsoil is a valued resource for adjacent communities; sediment loading affects downstream surface water.		
Impact Rating Before Mitigation		
Moderate Impact		

TABLE 8-33: RATING OF IMPACTS RELATED TO SOIL AND GEOLOGY (PRE-MITIGATION): SOIL COMPACTION

Project Phase: Construction and Operation		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Confined to permanent infrastructure footprints, laydown areas, and vehicle/access corridors — does not extend across the wider Project Area.
Duration	Long-term	Persists where infrastructure is permanent; reversible in laydown/access areas if remediated.
Scale	< 250 ha Project Area	Compaction is spatially discrete - only soils directly beneath traffic and infrastructure are impacted.
Frequency	Frequent	Occurs throughout construction activities and may persist in operational phase where there is permanent infrastructure footprints. .
Likelihood	Likely	Expected in all active work zones.
Magnitude		
Small Magnitude - impact is patchy and confined to the directly disturbed/built footprint; surrounding soils retain natural structure and porosity		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
The soils are susceptible to compaction due to weak structure and low clay content, which could increase surface runoff during rainfall events and influence the soil-water balance.		
Impact Rating Before Mitigation		
Minor Impact		

TABLE 8-34: RATING OF IMPACTS RELATED TO SOIL AND GEOLOGY (PRE-MITIGATION): SOIL CONTAMINATION FROM HYDROCARBON / CHEMICAL / WASTEWATER SPILLS AND LEAKS

Project Phase: Construction and Operation		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Can migrate hundreds of metres from a point source via the permeable soil profile; pathway to groundwater established.
Duration	Long-term	Contaminants may persist in soil without remediation.
Scale	Medium	Depends on contaminant type and spill volume; high soil permeability accelerates vertical migration to shallow aquifer.
Frequency	Occasional	Linked to leaks, spills and poor handling.
Likelihood	Possible	Spills are realistically possible during construction and operations.
Magnitude		
Medium Magnitude - contaminant plumes can reach the shallow aquifer given high permeability and low adsorption capacity; not confined to the spill footprint.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
The surrounding communities are dependent on groundwater, which could be an indirect receptor of contamination through the soil profile. Subsequent contamination of the groundwater resource may impact water supply of communities down-gradient of the Project Area. However, the communities are located more than 1 km from the Project Area boundaries, which lowers the likelihood of contaminant plumes reaching domestic water supply wells (however, where groundwater flow gradients may directed towards domestic supply wells, there may be heightened sensitivity to contaminated groundwater flowing from the project site).		
Impact Rating Before Mitigation		
Moderate Impact		

TABLE 8-35: RATING OF IMPACTS RELATED TO SOIL AND GEOLOGY (PRE-MITIGATION): CHANGES TO THE SOIL WATER BALANCE

Project Phase: Construction and Operation		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Patchy/intermittent across the Project Area - confined to footprint of impervious surfaces and compacted zones; surrounding undisturbed soil retains baseline infiltration behaviour. .
Duration	Long-term	Impact is expected to continue to persist where permanent infrastructure footprints are established.
Scale	<250 ha	Hydrological alteration occurs in discrete patches beneath buildings, hardstanding, and compacted zones - not across the entire 250 ha. Sheet flow and infiltration continue across the remaining undeveloped portions.
Frequency	Frequent	Within the affected patches; intermittent at the receptor scale.
Likelihood	Likely	Expected where soils are sealed or compacted.
Magnitude		
Small Magnitude - water balance shift is patchy, spatially intermittent, and limited to sealed/compacted zones; doesn't fundamentally alter site-wide hydrology		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
The soils' sensitivity to soil-water balance change (high infiltration capacity, role in shallow aquifer recharge) is unchanged. The reduced significance comes from the limited spatial footprint of the impact.		
Impact Rating Before Mitigation		
Minor Impact		

TABLE 8-36: RATING OF IMPACTS RELATED TO SUBSURFACE DISTURBANCE, CUTTINGS AND DRILLING-FLUID HANDLING FROM WATER-SUPPLY BOREHOLE INSTALLATION (PRE-MITIGATION)

Project Phase: Construction		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Patchy/intermittent across the Project Area - confined to Confined to wellhead pad, mud pit, cuttings disposal area and access track at each of the 3 borehole sites.
Duration	Short-term	Active drilling lasts days to weeks per borehole; surface disturbance reversible through site restoration.
Scale	<1 ha (≈0.3% of Project Area)	Sum of wellhead pad + mud pit + temporary laydown across all 3 boreholes; negligible relative to the 250 ha footprint.
Frequency	One-off	Discrete drilling campaign; does not repeat over the life of the Project.
Likelihood	Likely	Drilling is a planned, scheduled activity.
Magnitude		
Small Magnitude - drilling impacts (cuttings, drilling fluid release, localised compaction around pad, transient mobilisation of fine sediments) are spatially confined and time-limited. Permeability and weak structure of Coastal Plain Sands means cuttings can locally smother surface soil if uncontained, and improperly grouted boreholes could create preferential vertical pathways — but at small spatial scale		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
Soils retain inherent vulnerability due to high permeability and role in shallow aquifer recharge; communities rely on adjacent agricultural soils and groundwater.		
Impact Rating Before Mitigation		
Minor Impact		

8.2.5.5 MITIGATION AND MANAGEMENT MEASURES

Refer to Section 9.2.6 (Chapter 9) for the recommended mitigation and management measures associated with Soils and Geology.

8.2.5.6 SIGNIFICANCE OF IMPACT (POST-MITIGATION)

Following implementation of the mitigation measures outlined in Section 9, the residual significance of impacts on soils and geology is assessed as follows:

- Soil Erosion, Loss of Topsoil and Sediment Mobilisation – Minor Negative Impact (
- Table 8-37)

- Soil Compaction – Minor Negative Impact (Table 8-38)
- Soil Contamination from Hydrocarbon / Chemical / Wastewater Spills and Leaks – Minor Negative Impact (Table 8-39)
- Changes to the Soil Water Balance – Minor Negative Impact (Table 8-40)
- Subsurface Disturbance, Cuttings and Drilling-Fluid Handling from Water-Supply Borehole Installation – Minor Negative Impact (Table 8-41)

TABLE 8-37: RATING OF IMPACTS RELATED TO SOIL AND GEOLOGY (POST-MITIGATION): SOIL EROSION, LOSS OF TOPSOIL AND SEDIMENT MOBILISATION

Project Phase: Construction		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	ESCP measures (silt fences, sediment traps, vegetated buffers) confine sediment to within the construction footprint; off-site sediment transport substantially reduced.
Duration	Short-term	Rapid re-vegetation and progressive rehabilitation re-establishes cover within months of works.
Scale	<25 ha exposed at any one time	Staged clearance and phased earthworks limit area of bare soil exposure at any time.
Frequency	Occasional	Triggered by rainfall events on actively disturbed ground only - not site-wide.
Likelihood	Unlikely	ESCP and weather-dependent scheduling make significant sediment release unlikely
Magnitude		
Small Magnitude - active controls reduce both intensity and area of erosion; topsoil reused on site rather than exported		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
Soils are erodible (granular, weakly structured); fertile topsoil is a valued resource for adjacent communities; sediment loading affects downstream surface water.		
Impact Rating After Mitigation		
Minor Impact		

TABLE 8-38: RATING OF IMPACTS RELATED TO SOIL AND GEOLOGY (POST-MITIGATION): SOIL COMPACTION

Project Phase: Construction and Operation		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Restricted to designated traffic routes and permanent infrastructure footprints.
Duration	Medium-term *(temporary zones)* / Long-term *(permanent footprint)*	Post-construction ripping/aeration restores temporary zones; permanent footprints remain compacted.
Scale	<250 ha	Reduced from pre-mitigation through restricted vehicle movement and post-construction aeration, where required.
Frequency	Occasional	Restricted to active work corridors only.
Likelihood	Unlikely	Designated routes, supervision and aeration reduce occurrence beyond planned zones.
Magnitude		
Small Magnitude - Compaction confined to a small, well-defined footprint (but negligible rating not valid here)		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
The soils are susceptible to compaction due to weak structure and low clay content, which could increase surface runoff during rainfall events and influence the soil-water balance.		
Impact Rating After Mitigation		
Minor Impact		

TABLE 8-39: RATING OF IMPACTS RELATED TO SOIL AND GEOLOGY (POST-MITIGATION): SOIL CONTAMINATION FROM HYDROCARBON / CHEMICAL / WASTEWATER SPILLS AND LEAKS

Project Phase: Construction and Operation		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Bunding, secondary containment and spill kits keep releases within the immediate spill area.
Duration	Short-term	Rapid spill response prevents plume development; affected soils excavated and treated/disposed.
Scale	Small	Containment prevents migration.
Frequency	Rare	Procedural controls (leak detection, tank integrity testing) make releases infrequent.
Likelihood	Unlikely	Multiple containment layers and trained personnel substantially reduce occurrence.
Magnitude		
Small Magnitude - volume and migration extent meaningfully reduced; pathway to shallow aquifer potentially interrupted in most credible scenarios.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
The surrounding communities are dependent on groundwater, which could be an indirect receptor of contamination through the soil profile. Subsequent contamination of the groundwater resource may impact water supply of communities down-gradient of the Project Area. However, the communities are located more than 1 km from the Project Area boundaries, which lowers the likelihood of contaminant plumes reaching domestic water supply wells (however, where groundwater flow gradients may directed towards domestic supply wells, there may be heightened sensitivity to contaminated groundwater flowing from the project site).		
Impact Rating After Mitigation		
Minor Impact		

TABLE 8-40: RATING OF IMPACTS RELATED TO SOIL AND GEOLOGY (POST-MITIGATION): CHANGES TO THE SOIL WATER BALANCE

Project Phase: Construction and Operation		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Confined to footprint of impervious surfaces and compacted zones; surrounding undisturbed soil retains baseline infiltration.
Duration	Long-term	Persists for the life of permanent infrastructure (cannot be reversed during operations).
Scale	<250 ha *(≈8% of Project Area)*	Stormwater management restores some infiltration.
Frequency	Frequent *(within footprint)* / Intermittent *(at the receptor scale)*	—
Likelihood	Likely *(within footprint)*	Some change is unavoidable where infrastructure is impervious.
Magnitude		
Small Magnitude - mitigation reduces severity but cannot eliminate the residual change beneath permanent impervious cover.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
The soils' sensitivity to soil-water balance change (high infiltration capacity, role in shallow aquifer recharge) is unchanged. The reduced significance comes from the limited spatial footprint of the impact.		
Impact Rating After Mitigation		
Minor Impact		

TABLE 8-41: RATING OF IMPACTS RELATED TO SUBSURFACE DISTURBANCE, CUTTINGS AND DRILLING-FLUID HANDLING FROM WATER-SUPPLY BOREHOLE INSTALLATION (POST-MITIGATION)

Project Phase: Construction		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Sediment control measures confine disturbance to the immediate well pad.
Duration	Short-term	Site stabilises and is rehabilitated within weeks of drilling completion; surface footprint reduced to wellhead only.
Scale	<0.5 ha *(post-rehabilitation)*	Wellhead only after restoration; mud pits backfilled, cuttings disposed offsite, pads regraded and revegetated.
Frequency	One-off	—
Likelihood	Unlikely	Proper drilling technique (controlled fluid handling, full annular grouting, abstraction monitoring) makes adverse outcomes unlikely.
Magnitude		
Small Magnitude - residual footprint trivial; grouting prevents vertical preferential flow; cuttings/fluids managed offsite (however, magnitude is not reduced to negligible due to the requirement to ensure correct grouting is undertaken to prevent vertical preferential flow)		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
Soils retain inherent vulnerability due to high permeability and role in shallow aquifer recharge; communities rely on adjacent agricultural soils and groundwater.		
Impact Rating After Mitigation		
Minor Impact		

8.2.5.7 CUMULATIVE IMPACTS

The Project is located within an already developed industrial area where similar soil-related pressures are already present from existing fertilizer and petrochemical operations and associated infrastructure. In this setting, cumulative effects on soils are expected to arise from the combined influence of vegetation clearance, earthworks, repeated heavy vehicle movement, hard surfacing, accidental spills or leaks, and long-term alteration of runoff and infiltration patterns across the wider industrial sub-catchment. Existing development has already increased built cover and altered local drainage conditions, and the Project will incrementally add to these existing pressures.

The assessment indicates that cumulative impacts are primarily relevant to soil condition and soil function, rather than to geology itself. Due to the shallow nature of excavation and the

absence of significant faulting, instability, or other geologically induced hazards within the Project Area, no material cumulative impacts on geology are expected. The cumulative issue is therefore one of soil erosion and topsoil loss, soil compaction, soil contamination, and cumulative changes to the soil-water balance within the broader developed footprint.

Identified Cumulative Impacts

The cumulative impacts on soils and geology that are relevant to the Project are identified as follows:

- Cumulative soil erosion, loss of topsoil and sediment mobilisation resulting from site clearance, de-vegetation, exposed soils and earthworks occurring in combination with existing disturbed areas across the wider complex. This may increase the combined area of mobilisable soil and increase the risk of sediment export within the local sub-catchment.
- Cumulative soil compaction resulting from the addition of Project-related heavy vehicle movement, machinery use, laydown areas and work zones to an already industrialised landscape. This may progressively reduce soil porosity and infiltration capacity over a wider footprint.
- Cumulative soil contamination from hydrocarbon, chemical and wastewater spills/leaks, where the addition of another major industrial unit increases the number of potential contamination pathways in permeable sandy soils that already support industrial activities.
- Cumulative changes to the soil-water balance arising from the long-term combination of compaction, hard surfacing and altered drainage patterns across the wider industrial area, reducing infiltration and increasing surface runoff and localized ponding or flow concentration.
- No material cumulative impacts on geology are expected, because excavations are shallow and the area is not characterised by geological instability or deep geotechnical sensitivity.

Significance of Impacts (Pre-Mitigation)

Using the same impact logic applied in the soils and geology assessment, the cumulative pre-mitigation significance of the identified impacts is assessed as follows:

- Cumulative soil erosion, loss of topsoil and sediment mobilisation – **Moderate Negative Impact**.

  This reflects the combined effect of additional disturbed ground within a wider sub-catchment that is already affected by industrial development, together with the sandy and weakly structured nature of local soils, which increases susceptibility to erosion and sediment movement.
- Cumulative soil compaction – **Moderate Negative Impact**.

  While compaction caused by the Project alone is generally localised, the addition of further heavy traffic and construction activity to an already disturbed industrial area increases the cumulative spatial footprint of compacted soils and associated loss of infiltration function.

- Cumulative soil contamination from hydrocarbon, chemical and wastewater spills/leaks – **Moderate Negative Impact**.

  The cumulative significance reflects the increasing number of contamination pathways within a wider industrial area and the relatively high permeability of site soils, which could allow localised downward migration of contaminants if not properly managed.
- Cumulative changes to the soil-water balance – **Moderate Negative Impact.**

  Existing industrial development has already altered natural infiltration and runoff conditions, and the Project will add incrementally to this trend through additional compaction and hardstanding.
- Cumulative geology impacts – **Negligible / Not Material**.

  No cumulative geology impact of significance is expected because the Project does not involve deep excavation or activities likely to affect geological integrity at a wider scale.

Mitigation and Management Measures

Refer to Section 9.2.6.2 for the recommended mitigation and management measures associated with cumulative impacts on Geology and Soils.

Significance of Impacts (Post-Mitigation)

Following implementation of the above mitigation and management measures, the cumulative residual significance of impacts on soils is expected to reduce as follows:

- Cumulative soil erosion, loss of topsoil and sediment mobilisation – **Minor Negative Impact**.

  With staged disturbance, erosion controls, and progressive rehabilitation in place, sediment mobilisation would largely remain confined to the active construction footprint and would be substantially reduced in extent and duration.
- Cumulative soil compaction – **Minor Negative Impact**.

  Effective footprint control, route management and rehabilitation of temporary work areas would reduce the overall area affected and limit long-term degradation of soil structure outside permanent operational surfaces.
- Cumulative soil contamination from hydrocarbon, chemical and wastewater spills/leaks – **Minor Negative Impact**.

  Containment, controlled storage and handling, rapid spill response and remediation would reduce contamination risk to localized and manageable events only.
- Cumulative changes to the soil-water balance – **Minor Negative Impact**.

  Although some permanent increase in hardstanding and modified runoff patterns will remain within the wider industrial footprint, the overall cumulative effect would be localized and manageable through integrated drainage and strict disturbance control.
- Cumulative geology impacts – **Negligible / Not Material**.

  No meaningful residual cumulative impact on geology is anticipated.

Overall, the Project is expected to contribute incrementally to cumulative soil-related pressures within the wider industrial sub-catchment, but these effects are expected to remain manageable and predominantly minor after mitigation.

8.2.6 IMPACTS ON GROUNDWATER RESOURCES

8.2.6.1 DESCRIPTION OF THE BASELINE ENVIRONMENT

The primary groundwater receptor beneath the Project Area comprises a multi-layered aquifer system within the Benin Formation, including shallow (unconfined), intermediate (semi-confined), and deep (confined) aquifers. The shallow aquifer occurs at relatively shallow depths (approximately 0-30 m bgl), while the intermediate aquifer extends to approximately 60–70 m bgl, and the deep aquifer is encountered at depths exceeding 150 m bgl.

Due to the high permeability of unconsolidated sandy lithologies, the shallow aquifer is highly vulnerable to contamination from surface sources. Recharge occurs predominantly via direct infiltration of rainfall, facilitated by permeable soils, resulting in strong hydraulic connectivity between soils, groundwater, and surface water systems. Groundwater flow is generally directed toward the south to southwest, discharging into surface water bodies such as the Okulu River, indicating a strong groundwater–surface water interaction.

Groundwater within the Study Area is extensively utilised for both domestic and industrial purposes. Local communities rely on shallow and intermediate boreholes for potable water supply, while the Indorama Manufacturing Complex have 16 deep abstraction boreholes, each with abstraction rates of up to 300 m^3/hr, supplying water for industrial processes.

The mechanism of potential interaction between the shallow (0–30 m bgl), intermediate (60–70 m bgl) and deep (>150 m bgl) aquifers in the Project Area has been evaluated by the regional numerical groundwater model developed for the Indorama Manufacturing Complex (Mogaba, 2025), which attributes the inter-aquifer connection to natural hydraulic leakage where the confining clay horizons of the Benin Formation are laterally discontinuous or heterogeneous (zones of sand-mixed clay). A secondary pathway - short-circuiting along the annular space of existing boreholes - is considered less likely given the possibility of natural leakage, and can be verified through well construction records and periodic borehole-integrity checks. Reflecting the potential hydraulic connection, this impact assessment treats the multi-aquifer system as a single sensitive receptor for the purpose of significance rating, and applies the embedded integrity measures for new IFF Line 2 boreholes to all three aquifer horizons.

Baseline groundwater quality indicates that the aquifer system is generally fresh and unimpacted by hydrocarbons or heavy metals, with most parameters compliant with NSDWQ, WHO, and IFC guideline values. However, the presence of total and faecal coliforms across multiple boreholes indicates microbiological contamination and aquifer vulnerability, particularly within the shallow aquifer system.

Overall, groundwater within the Project Area is considered a highly sensitive receptor, due to:

- High permeability and rapid contaminant transport potential
- Shallow depth to groundwater
- Strong hydraulic connectivity to surface water systems
- Dependence by surrounding communities and industries

- Existing microbiological vulnerability

For a detailed discussion of the baseline groundwater environment, refer to Section 7.4.8.

8.2.6.2 PROPOSED PROJECT ACTIVITIES

Construction Phase

Potential impacts during construction include:

- Hydrocarbon, Chemical and Wastewater Spills and Leaks from machinery operations, fuel/lubricant transfers, materials handling, and workforce sanitation facilities. Contaminants released to unprotected soil can migrate vertically through the permeable Coastal Plain Sands to the shallow aquifer and disperse down-gradient toward the Okulu River.
- Excavation, dewatering and earthworks associated with foundation construction for the ammonia, urea and UFC-85 plants and underground utility trenches. Given the shallow static water level (5–7 m bgl in the Project Area), foundation excavations may intersect the shallow aquifer, requiring controlled dewatering and discharge management.
- Installation of three new water-supply boreholes as back-up to the existing borehole network. Improperly grouted boreholes have the potential to create vertical preferential pathways between the shallow, intermediate and deep aquifers, particularly relevant given the possible influence of abstraction in the deep aquifer on the shallow aquifer.

Operational Phase

During the operational phase, impacts on groundwater are associated with plant operations, waste management, and water use activities. The most significant impacts include:

- Spills and leaks of hydrocarbons, process chemicals and wastewater during routine operation - including process condensates, cooling tower blowdown, and stored process chemical inventories. Accidental releases may infiltrate the shallow aquifer through the permeable soil profile.
- Overflow of the ETP retention pond and release of solid waste under flood conditions or operational failure, with potential infiltration of contaminants into the shallow aquifer.
- Groundwater abstraction from the existing and new back-up boreholes for plant water supply. Under normal operation, 13 of the 16 existing boreholes will be operated post IFF Line2 at a maximum combined rate of 3,560 m³/hr, with the three new IFF Line 2 boreholes held as back-up; abstraction may alter local water levels and baseflow contributions to the Okulu River where boreholes are not managed within sustainable yield (Mogaba, 2026).
- Saline-water intrusion induced by sustained groundwater abstraction. Where abstraction lowers hydraulic heads sufficiently to reduce or reverse the gradient toward the brackish river and connected creek (~1.7 km south of the proposed boreholes), brackish water could migrate inland. Variable-density (SEAWAT) re-modelling of the confirmed operational regime - 3,560 m³/hr from 13 producing boreholes (Mogaba, 2026) - predicts no inland encroachment into any aquifer over one year, and very minor, creek-confined interface extension over five years. A short-duration emergency scenario (4,290 m³/hr from 19 boreholes, demand under 72 hours) likewise predicts no inland encroachment. An earlier all-wells scenario (~6,010 m³/hr, including proposed future expansion; Mogaba, 2025) had

indicated limited migration confined to the creek/river corridor (~1,200 m shallow, ~450 m intermediate, ~360 m deep). Residual risk relates principally to cumulative future wellfield expansion rather than to IFF Line 2 operation.

8.2.6.3 SENSITIVE RECEPTORS

Groundwater within the Project Footprint is treated as a highly sensitive receptor, reflecting both its hydrogeological characteristics and its role in supporting other receptors.

Groundwater Resources (Shallow, Intermediate and Deep Aquifers): identified as a critical receptor due to community potable supply (boreholes GW6–GW17 in the surrounding Study Area), industrial abstraction (16 deep boreholes operated by the Indorama Complex; three new back-up boreholes for IFF Line 2), and the existing baseline impact signal at GW1 in the shallow aquifer. As set out in the baseline description, the regional groundwater modelling (Mogaba, 2025) indicates a degree of natural hydraulic connection between the three aquifer units due to the laterally discontinuous nature of the clay horizons. The system is therefore treated as a single sensitive receptor for the purpose of this assessment, with the shallow aquifer representing a potential pathway to the deeper, strategically important aquifers used for water supply.

On this basis, the reliance of surrounding communities, industrial users, surface water and ecological receptors on the resource is incorporated into the sensitivity assigned to the groundwater receptor, and any adverse impact on the groundwater receptor would in turn adversely affect these users.

8.2.6.4 SIGNIFICANCE OF IMPACT (PRE-MITIGATION)

The anticipated impacts prior to mitigation are assessed as follows:

- Hydrocarbon, Chemical and Wastewater Spills and Leaks – Moderate Negative Impact (Table 8-42)
- Overflow of the Effluent Treatment Plant Retention Pond and Release of Solid Waste – Moderate Negative Impact (Table 8-43)
- Groundwater Abstraction from New Back-up Water-Supply Boreholes – Major Negative Impact (Table 8-44)
- Saline-Water Intrusion induced by Groundwater Abstraction – Moderate Negative Impact (Table 8-45)
- Excavation, Dewatering and Earthworks – Moderate Negative Impact (Table 8-46)
- Vertical Preferential Flow between Aquifers from Borehole Installation – Moderate Negative Impact (Table 8-47)

TABLE 8-42: RATING OF IMPACTS RELATED TO GROUNDWATER RESOURCES (PRE-MITIGATION): HYDROCARBON, CHEMICALS AND WASTEWATER SPILLS AND LEAKS DURING CONSTRUCTION AND OPERATION

Project Phase: Construction and Operation		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Spill or leak plumes may migrate a few hundred metres down-gradient from a point source given the high permeability of Coastal Plain Sands and the shallow depth to groundwater; down-gradient discharge ultimately reaches the Okulu River via baseflow.
Duration	Long-term	Contaminants may persist in the shallow aquifer for years without active remediation.
Scale	Medium	Depends on contaminant type and release volume; varies between construction-phase fuel and lubricant releases and operational-phase chemical and condensate releases.
Frequency	Occasional	Linked to handling, transfer and integrity events; not a continuous source.
Likelihood	Possible	Accidental releases remain credible despite embedded design features.
Magnitude		
Small Magnitude - embedded project design features substantially reduce credible release volumes reaching unprotected soil, including the use of existing IZF / IFF / IEPL refuelling and ammonia storage infrastructure (no new fuel depot or new bulk ammonia tank), collection and reuse of spilled process chemicals, oil/water separation at fuel and chemical handling areas, closed-loop operational water management with no normal-operation wastewater discharge, and routing of workforce sewage to the existing Line 1 sewage treatment plant. The residual pathway relates principally to operational chemical inventories not covered by specific design provisions.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The shallow aquifer is highly sensitive due to its unconfined nature, shallow depth (~0–30 m bgl), high permeability with limited natural attenuation, strong hydraulic connectivity to the Okulu River, and the dependence of surrounding communities (Iriebe, Agbonchia, Aleto, Akpajo, Elelenwo, Njuru, Okerewa) and the Indorama Manufacturing Complex on groundwater for potable supply and industrial use. .		
Impact Rating Before Mitigation		
Moderate Impact		

TABLE 8-43: RATING OF IMPACTS RELATED TO GROUNDWATER RESOURCES (PRE-MITIGATION): OVERFLOW OF THE ETP RETENTION POND AND RELEASE OF SOLID WASTE DURING OPERATION

Project Phase: Operation		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Impact has the potential to migrate a few hundred metres down-gradient from the retention pond and solid waste handling area into the shallow aquifer.
Duration	Long-term	Infiltration from a compromised pond or improperly handled solid waste has the potential to continue over the long term.
Scale	<50 ha	Limited to the vicinity of the retention pond and solid waste handling area.
Frequency	Occasional	Events limited to wastewater recovery plant shutdown periods or flood-driven overflow.
Likelihood	Possible	Flood events and operational failures remain credible despite embedded design features.
Magnitude		
Small Magnitude - embedded design provides for zero normal-operation discharge: process and operational wastewater is fully recovered through the existing wastewater recovery plant (neutralised wastewater and de-oiled stormwater are routed to the existing retention pond; no wastewater discharge during normal operation, with any discharge to the receiving water body (Okulu River) controlled to meet the Project-Adopted treated-effluent quality standards and monitored under the ESMMP). The residual risk relates to retention pond overflow under flood conditions and to handling of operational solid waste, neither of which is fully resolved by embedded project design alone.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The shallow aquifer is highly sensitive due to permeable lithology, shallow depth, hydraulic connectivity to the Okulu River, and the dependence of surrounding communities and industry on groundwater quality.		
Impact Rating Before Mitigation		
Moderate Impact		

TABLE 8-44: RATING OF IMPACTS RELATED TO GROUNDWATER RESOURCES (PRE-MITIGATION): GROUNDWATER ABSTRACTION FROM NEW BACK-UP WATER-SUPPLY BOREHOLES DURING OPERATION

Existing abstraction from the production wellfield already produces a localised cone of depression in the deeper aquifer and represents a potential driver of saline-water intrusion from the brackish river to the south (Mogaba, 2026). The three new IFF Line 2 boreholes are provided as back-up supply only. Under a worst case in which all boreholes are pumped continuously, drawdown would deepen and extend across the Complex; under normal operation, however, the back-up boreholes function solely as short-duration emergency supply (demand under 72 hours; Mogaba, 2026), for which the impact is considerably lower than the continuous worst case.

Project Phase: Operation		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local to Sub-regional	Drawing on the regional numerical groundwater model (Mogaba, 2026); the re-modelled cone remains of the order of a few hundred metres under intermittent operation, extending toward kilometre scale only under sustained continuous pumping. Footprint-scale pump testing and quantitative analysis are proposed to confirm the cone geometry for the new boreholes.
Duration	Long-term	Drawdown persists for the life of operations when boreholes are in use and reverses on cessation.
Scale	~250 ha	The cumulative drawdown of the wellfield - the three new back-up boreholes together with the existing 16 production boreholes - has been modelled at the Complex scale (Mogaba, 2026), with drawdown attenuating away from the wellfield (communities lie >1 km from the Project Area). Site-specific pump testing and ongoing monitoring should be used to validate this once the boreholes are installed.
Frequency	Intermittent	Embedded design positions the three new boreholes as back-up to existing supply, implying intermittent rather than continuous abstraction.
Likelihood	Possible	Drawdown is definite when boreholes are in use; impact on community wells is rated as possible given community distance
Magnitude		
Medium Magnitude - existing abstraction already produces a localised cone of depression. Even as back-up supply, the boreholes may be drawn upon during emergencies; under a conservative worst case of continuous pumping of all boreholes the cone could expand from a few hundred metres toward kilometre scale, superimposing on the existing wellfield, while variable-density modelling of this maximum-abstraction case shows the freshwater–brackish interface remaining creek-confined. Under normal operation the back-up boreholes are limited to short-duration emergency use (under 72 hours), for which drawdown is		

Project Phase: Operation
considerably lower. On a precautionary basis, and pending site-specific long-term monitoring, a Medium magnitude is retained rather than a lower rating.
Sensitivity/Vulnerability/Importance of the Resource/Receptor
High Sensitivity
The shallow aquifer is highly sensitive due to permeable lithology, shallow depth, hydraulic connectivity to the Okulu River, and the dependence of surrounding communities and industry on groundwater quality. Possible hydraulic connection between the shallow and intermediate aquifers, and potential vertical leakage via natural pathways across the discontinuous clay horizons or borehole integrity issues, increase the sensitivity of the multi-aquifer system.
Impact Rating Before Mitigation
Major Impact

TABLE 8-45: RATING OF IMPACTS RELATED TO GROUNDWATER RESOURCES (PRE-MITIGATION): SALINE-WATER INTRUSION INDUCED BY GROUNDWATER ABSTRACTION

Project Phase: Operation		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Modelled intrusion is confined to the creek and river corridor on Indorama-owned land (up to ~1,200 m in the shallow aquifer, ~450 m intermediate, ~360 m deep under an extreme continuous-abstraction scenario) and is not predicted to reach community supply boreholes (Mogaba, 2025).
Duration	Long-term	Persists while abstraction is sustained; the saline front recedes on cessation or reduction of pumping.
Scale	Wellfield / Complex	Driven by cumulative abstraction (notably the high-density Train-2 cluster and future expansion). The three IFF Line 2 boreholes contribute comparatively little owing to their lower collective abstraction and are not predicted to draw the front toward them.
Frequency	Intermittent	Boreholes are back-up supply; intrusion develops only under prolonged, near-continuous pumping.
Likelihood	Unlikely to Possible	Unlikely for the Line 2 boreholes alone; Possible under cumulative future expansion of the wellfield.
Magnitude		
Small to Medium Magnitude - migration is potentially moderate and spatially restricted; marginal interface salinity change (7.8 → 7.9 ppt) under the extreme scenario; deep production aquifer largely protected.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
Brackish tidal source proximity, permeable shallow aquifer, and community/industrial dependence on groundwater; deep supply aquifer comparatively well protected.		
Impact Rating Before Mitigation		
Moderate Impact		

TABLE 8-46: RATING OF IMPACTS RELATED TO GROUNDWATER RESOURCES (PRE-MITIGATION): EXCAVATION, DEWATERING AND EARTHWORKS DURING CONSTRUCTION

Project Phase: Construction		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Excavation footprints are confined to the Project Area; dewatering drawdown extends laterally by tens to a few hundred metres depending on aquifer transmissivity.
Duration	Short-term	Drawdown and direct aquifer disturbance persist only during active excavation and dewatering works; water levels recover on cessation.
Scale	<250 ha	Combined excavation and dewatering influence area across the construction programme.
Frequency	Continuous (during works)	Continuous during major foundation and underground utility installation.
Likelihood	Likely	Excavation depths for plant foundations and process trenches are expected to intersect the shallow water table (static water level 5–7 m bgl).
Magnitude		
Small Magnitude - excavation and dewatering impacts are inherently short-term and confined to the construction programme, with potentially no permanent aquifer modification. Specific dewatering management measures are not addressed in the embedded project design and are dealt with under mitigation.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The shallow aquifer is highly sensitive to direct intrusion: high permeability and low natural attenuation, hydraulic connectivity to the Okulu River, community and industrial dependence, and existing microbiological vulnerability evidenced by baseline coliform detections.		
Impact Rating Before Mitigation		
Moderate Impact		

TABLE 8-47: RATING OF IMPACTS RELATED TO GROUNDWATER RESOURCES (PRE-MITIGATION): VERTICAL PREFERENTIAL FLOW BETWEEN AQUIFERS FROM WATER-SUPPLY BOREHOLE INSTALLATION DURING CONSTRUCTION

Project Phase: Construction		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Vertical pathway risk is confined to the borehole annulus at each of the three new water-supply borehole sites.
Duration	Long-term	An inadequately sealed annulus creates a permanent vertical conduit between aquifers unless properly decommissioned.
Scale	<0.05 ha	Cross-aquifer hydraulic connection occurs at the wellbore; potential consequence extends through the full borehole depth.
Frequency	One-off (installation)	Risk is established at the time of borehole construction; consequence is ongoing if installation is deficient.
Likelihood	Possible	Risk is controllable through standard well construction practice; residual risk relates to construction quality
Magnitude		
Small Magnitude - construction practice (full annular grout seals and aquifer isolation across the shallow, intermediate and deep units). The rating reflects the localised wellbore extent and the controllability of the risk at installation; however, an inadequately sealed or corroded annulus would form a long-term cross-aquifer conduit, allowing head equalisation or cross-contamination, which is why the consequence is not negligible. Specific borehole sealing, integrity-testing and decommissioning requirements are not provided in the embedded project design and are dealt with under mitigation.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The shallow aquifer is highly sensitive to direct intrusion: high permeability and low natural attenuation, hydraulic connectivity to the Okulu River, community and industrial dependence, and existing microbiological vulnerability evidenced by baseline coliform detections.		
Impact Rating Before Mitigation		
Moderate Impact		

8.2.6.5 MITIGATION AND MANAGEMENT MEASURES

Refer to Section 9.2.7 (Chapter 9) for the recommended mitigation and management measures associated with Groundwater.

8.2.6.6 SIGNIFICANCE OF IMPACT (POST-MITIGATION)

Following implementation of the mitigation measures outlined in Section 9, the residual significance of impacts on groundwater is assessed as follows:

- Hydrocarbon, Chemical and Wastewater Spills and Leaks – Moderate Negative Impact (Table 8-48)
- Overflow of the Effluent Treatment Plant Retention Pond and Release of Solid Waste – Minor Negative Impact (Table 8-49)
- Groundwater Abstraction from New Back-up Water-Supply Boreholes – Moderate Negative Impact (Table 8-50)
- Saline-Water Intrusion induced by Groundwater Abstraction – Minor Negative Impact (Table 8-51).
- Excavation, Dewatering and Earthworks – Minor Negative Impact (Table 8-52)
- Vertical Preferential Flow between Aquifers from Borehole Installation – Minor Negative Impact (Table 8-53)

TABLE 8-48: RATING OF IMPACTS RELATED TO GROUNDWATER RESOURCES (POST-MITIGATION): HYDROCARBON, CHEMICALS AND WASTEWATER SPILLS AND LEAKS DURING CONSTRUCTION AND OPERATION

Project Phase: Construction and Operation		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Containment and sealed handling areas confine most releases to the immediate source; a limited down-gradient plume remains possible in the high-permeability sands.
Duration	Long-term	If a release does reach the shallow aquifer, contaminants may persist for an extended period despite monitoring-led intervention.
Scale	Small	Containment and separation reduce credible release volumes reaching unprotected ground.
Frequency	Occasional	Linked to handling, transfer and integrity events; not eliminated by embedded design or mitigation.
Likelihood	Possible	Accidental releases reaching groundwater remain credible despite layered controls.
Magnitude		
Small Magnitude - containment, sealed hardstanding, oil/water separation, maintenance and a monitoring network with trigger levels substantially reduce release probability and volume; however, a residual pathway remains for operational chemical inventories, and given the high permeability and low natural attenuation of the shallow aquifer the risk is reduced but not eliminated - magnitude therefore remains Small rather than Negligible.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The shallow aquifer is highly sensitive due to its unconfined nature, shallow depth (~0–30 m bgl), high permeability with limited natural attenuation, strong hydraulic connectivity to the Okulu River, and the dependence of surrounding communities (Iriebe, Agbonchia, Aleto, Akpajo, Elelenwo, Njuru, Okerewa) and the Indorama Manufacturing Complex on groundwater for potable supply and industrial use. .		
Impact Rating After Mitigation		
Moderate Impact		

TABLE 8-49: RATING OF IMPACTS RELATED TO GROUNDWATER RESOURCES (POST-MITIGATION): OVERFLOW OF THE ETP RETENTION POND AND RELEASE OF SOLID WASTE DURING OPERATION

Project Phase: Operation		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Any seepage is contained at the pond/waste area; no significant down-gradient migration expected.
Duration	Short-term	Alarms, inspection and quality confirmation enable prompt intervention before sustained infiltration occurs.
Scale	Small	Limited to the immediate vicinity of the pond and waste handling area.
Frequency	Rare	Storm-capacity design, alarms and waste controls make overflow or leachate release infrequent.
Likelihood	Unlikely	Engineered capacity plus monitoring substantially reduce credible failure pathways.
Magnitude		
Negligible Magnitude - storm capacity, level alarms, integrity inspection, pre-discharge quality confirmation and lined waste storage potentially reduce the residual infiltration risk to negligible.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The shallow aquifer is highly sensitive due to permeable lithology, shallow depth, hydraulic connectivity to the Okulu River, and the dependence of surrounding communities and industry on groundwater quality.		
Impact Rating Before Mitigation		
Minor Impact		

TABLE 8-50: RATING OF IMPACTS RELATED TO GROUNDWATER RESOURCES (POST-MITIGATION): GROUNDWATER ABSTRACTION FROM NEW BACK-UP WATER-SUPPLY BOREHOLES DURING OPERATION

Project Phase: Operation		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Capped sustainable yield, intermittent operation and trigger-level monitoring potentially confine the managed cone toward the few-hundred-metre range; the kilometre-scale seasonal case is controlled by limiting sustained continuous pumping.
Duration	Long-term	Drawdown still occurs over the operational life when boreholes are used, but is actively managed.
Scale	Small–Medium	Pumping is aligned to sustainable yield derived from pump testing and quantitative analyses, to avoid material interference with the production and community wellfields.
Frequency	Intermittent	Back-up role retained; sustained seasonal pumping avoided where monitoring indicates approach to trigger levels.
Likelihood	Unlikely	Metering, trigger levels and capped yield make significant community-well interference unlikely.
Magnitude		
Small Magnitude - the 2026 abtraction re-modelling predicts that normal back-up operation (short-duration emergency use under 72 hours) potentially produces only limited, localised drawdown that recovers between events, supported by metering, capped sustainable yield and trigger-level monitoring. This could potentially reduce magnitude from Medium to Small; residual uncertainty in the cumulative cone prevents reduction to Negligible.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The shallow aquifer is highly sensitive due to permeable lithology, shallow depth, hydraulic connectivity to the Okulu River, and the dependence of surrounding communities and industry on groundwater quality. Possible hydraulic connection between the shallow and intermediate aquifers, and potential vertical leakage via natural pathways or borehole integrity issues, increase the sensitivity of the multi-aquifer system.		
Impact Rating Before Mitigation		
Moderate Impact		

TABLE 8-51: RATING OF IMPACTS RELATED TO GROUNDWATER RESOURCES (POST-MITIGATION): SALINE-WATER INTRUSION INDUCED BY GROUNDWATER ABSTRACTION

Project Phase: Operation		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Spatial limit unchanged, but actively monitored; abstraction near the southern boundary is adjusted if an inland salinity trend is detected.
Duration	Long-term (managed/reversible)	Managed abstraction scheduling and trigger-based response prevent progressive advance; the front recedes when pumping stress is reduced.
Scale	Wellfield / Complex (controlled)	Cumulative drawdown managed through metering, trend monitoring and periodic model recalibration; no new boreholes added without prior hydrogeological assessment.
Frequency	Intermittent	Controlled back-up operation within confirmed sustainable yield.
Likelihood	Unlikely	Early-warning (EC/TDS) monitoring and managed abstraction make inland migration to sensitive receptors unlikely.
Magnitude		
Small Magnitude - Early detection enables intervention well before any property-boundary or community effect; deep aquifer protected.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
Brackish tidal source proximity, permeable shallow aquifer, and community/industrial dependence on groundwater; deep supply aquifer comparatively well protected.		
Impact Rating After Mitigation		
Minor Impact		

TABLE 8-52: RATING OF IMPACTS RELATED TO GROUNDWATER RESOURCES (POST-MITIGATION): EXCAVATION, DEWATERING AND EARTHWORKS DURING CONSTRUCTION

Project Phase: Construction		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Drawdown confined to the active excavation vicinity and minimised by footprint control.
Duration	Short-term	Restricted to active works; water levels recover on cessation.
Scale	Small	Phasing and footprint minimisation keep the dewatering influence area limited.
Frequency	During works only	Occurs only during active excavation and dewatering.
Likelihood	Likely	Excavation will still intersect the shallow water table, but the effect is controlled.
Magnitude		
Negligible Magnitude - Footprint/duration minimisation, effluent treatment and reinstatement leave no permanent aquifer modification and only temporary, localised disturbance.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The shallow aquifer is highly sensitive to direct intrusion: high permeability and low natural attenuation, hydraulic connectivity to the Okulu River, community and industrial dependence, and existing microbiological vulnerability evidenced by baseline coliform detections.		
Impact Rating Before Mitigation		
Minor Impact		

TABLE 8-53: RATING OF IMPACTS RELATED TO GROUNDWATER RESOURCES (POST-MITIGATION): VERTICAL PREFERENTIAL FLOW BETWEEN AQUIFERS FROM WATER-SUPPLY BOREHOLE INSTALLATION DURING CONSTRUCTION

Project Phase: Construction		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Risk remains confined to each wellbore and is controlled by construction quality.
Duration	Long-term	A correctly sealed annulus is durable; residual risk relates only to long-term seal/casing integrity, addressed by inspection.
Scale	<0.05 ha	Cross-aquifer connection point eliminated at source by proper sealing.
Frequency	One-off (installation)	Established at construction; controlled by QA at that point.
Likelihood	Unlikely	Standard construction, integrity testing and decommissioning make a persistent conduit unlikely.
Magnitude		
Negligible Magnitude - Full annular sealing, aquifer isolation, integrity testing and proper decommissioning remove the credible cross-aquifer pathway, potentially leaving negligible residual risk.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The shallow aquifer is highly sensitive to direct intrusion: high permeability and low natural attenuation, hydraulic connectivity to the Okulu River, community and industrial dependence, and existing microbiological vulnerability evidenced by baseline coliform detections.		
Impact Rating Before Mitigation		
Minor Impact		

8.2.6.7 CUMULATIVE IMPACTS

The Project is located within the wider IFZ, where groundwater is already being used by existing industrial operations and where the hydrogeological setting includes shallow, intermediate and deep aquifer systems. Existing abstraction within the wider Indorama Manufacturing Complex has already created a localised drawdown footprint around the operational wellfield, and there is evidence at one locality of vertical leakage between the deep and shallower systems where intervening clay horizons are not fully isolating the units. At the same time, the drawdown footprint is described as localised to the existing wellfield, and outside that area the regional flow pattern remains broadly consistent with topographic

control, indicating that no broader disturbance to groundwater–surface water connectivity or discharge to the Okulu River is currently evident.

In this context, cumulative groundwater impacts are most relevant where the Project's new back-up boreholes, accidental spills and leaks, or wastewater-related incidents are added to the existing industrial and local groundwater-use setting. The key cumulative issues are therefore expected to relate to groundwater availability and drawdown, groundwater quality, and the potential for localised inter-aquifer hydraulic interaction where new boreholes and ongoing abstraction are superimposed on the existing wellfield conditions.

Identified Cumulative Impacts

The cumulative groundwater impacts identified for the Project are as follows:

- Cumulative reduction in groundwater availability and sustainable yield due to the addition of new Project-related back-up abstraction to the existing industrial wellfield and to other surrounding groundwater users. Additional abstraction may reduce the water balance of the local sub-catchment and, where private wells fall within an abstraction drawdown cone, may reduce the sustainable yield of those wells.
- Cumulative groundwater level drawdown and wellfield interaction within the shallow, intermediate and deep aquifer systems. The existing hydrogeological setting already shows a localised drawdown cone and evidence of hydraulic interaction between deeper and shallower units at one location, which means that additional abstraction needs to be considered cumulatively with the existing production wellfield.
- Cumulative deterioration in groundwater quality resulting from the combined effect of hydrocarbon, chemical and wastewater spills or leaks, together with potential overflow or release from wastewater management infrastructure and other development-related contamination sources within the wider study area. In this setting, contaminants may migrate downgradient toward the Okulu River, and contaminated groundwater may also enter surface water as baseflow.
- Potential cumulative effects on groundwater–surface water interaction, where groundwater abstraction or groundwater contamination influences surface water in the wider sub-catchment. Available evidence indicates that any current drawdown effect is potentially localised and that broader groundwater–surface water connectivity may as yet not be materially disturbed; however, additional abstraction and contamination pathways may incrementally add to that broader pressure if not well controlled.
- Potential cumulative vertical preferential flow between aquifers where multiple boreholes and localised stratigraphic discontinuities increase the possibility of hydraulic communication between aquifer units. This is particularly relevant because the local hydrogeological setting already indicates that clay horizons may not fully isolate the shallower and deeper systems in all areas.

Significance of Impacts (Pre-Mitigation)

Using the same impact logic applied in the groundwater assessment, the cumulative pre-mitigation significance of the identified impacts is assessed as follows:

- Cumulative reduction in groundwater availability and sustainable yield – **Major Negative Impact**.

  Groundwater abstraction from the new back-up water-supply boreholes is already assessed as a Major Negative Impact before mitigation at Project level, and in cumulative terms this effect becomes more material because abstraction is added to the existing production wellfield and to other surrounding groundwater users within the same hydrogeological setting.

- Cumulative groundwater level drawdown and wellfield interaction – **Major Negative Impact**.

  The existing drawdown footprint is localised, but additional Project abstraction may increase interference across the shallow, intermediate and deep aquifers and may reduce sustainable yields for surrounding users if not properly assessed and controlled.

- Cumulative deterioration in groundwater quality – **Moderate Negative Impact**.

  Hydrocarbon, chemical and wastewater spills and leaks are assessed as Moderate Negative Impacts before mitigation at Project level, and in cumulative terms the addition of further industrial contamination pathways to an already developed setting increases the potential for combined downgradient groundwater quality deterioration.

- Cumulative groundwater–surface water interaction effects – **Moderate Negative Impact**.

  Groundwater abstraction may reduce baseflow contribution to surface streams and groundwater contamination may enter surface water through baseflow pathways. Although the magnitude of this indirect effect is described as relatively small, it remains a relevant cumulative pathway within the wider sub-catchment.

- Cumulative vertical preferential flow between aquifers – **Moderate Negative Impact**.

  Vertical preferential flow from borehole installation is assessed as a Moderate Negative Impact before mitigation at Project level. In cumulative terms, this remains relevant because the local setting already indicates incomplete isolation between aquifer units at one locality.

Mitigation and Management Measures

Refer to Section 9.2.7.1 for the recommended mitigation and management measures associated with cumulative impacts on Groundwater.

Significance of Impacts (Post-Mitigation)

Following implementation of the above mitigation and management measures, the cumulative residual significance of impacts on groundwater is expected to reduce as follows:

- Cumulative reduction in groundwater availability and sustainable yield – **Moderate Negative Impact**.

  At Project level, groundwater abstraction from the new back-up water-supply boreholes reduces from Major Negative to Moderate Negative after mitigation. In cumulative terms, the effect remains material because abstraction continues within

an existing wellfield setting, but the use of pump testing, cumulative drawdown assessment, intermittent operation, abstraction limits and long-term monitoring is expected to reduce the significance to Moderate Negative.

- Cumulative groundwater level drawdown and wellfield interaction – **Moderate Negative Impact**.

  Drawdown effects are expected to remain localised and manageable if abstraction is operated within confirmed sustainable yield limits and monitored over time. The need for a cumulative analytical / numerical drawdown assessment is specifically intended to control this residual cumulative effect.

- Cumulative deterioration in groundwater quality – **Moderate Negative Impact**.

  Hydrocarbon, chemical and wastewater spills and leaks remain Moderate Negative after mitigation at Project level because, even with containment and sealed handling areas, accidental releases to groundwater remain credible in a high-permeability sandy setting. In cumulative terms, groundwater quality impacts are therefore also expected to remain Moderate Negative, although the frequency and scale of credible impacts should reduce substantially under mitigated conditions.

- Cumulative groundwater–surface water interaction effects – **Minor to Moderate Negative Impact**.

  The available findings indicate that the existing drawdown footprint is localised and that broader groundwater–surface water connectivity has not yet been materially disturbed. With abstraction controls, monitoring and early-warning measures in place, any indirect cumulative effect on baseflow or connected surface water is expected to remain limited.

- Cumulative vertical preferential flow between aquifers – **Minor Negative Impact**.

  At Project level, vertical preferential flow between aquifers from borehole installation reduces from Moderate Negative to Minor Negative after mitigation. In cumulative terms, this remains a credible but controlled risk where borehole integrity testing, sealing of redundant boreholes and multi-level groundwater monitoring are applied.

Overall, the Project is expected to contribute incrementally to cumulative groundwater pressures within the wider industrial and sub-catchment setting, particularly in relation to groundwater abstraction and groundwater quality. However, with the recommended controls in place, these cumulative effects are expected to remain manageable, with the most important residual cumulative impacts relating to groundwater availability/drawdown and groundwater quality.

8.2.7 IMPACTS ON SURFACE WATER RESOURCES

8.2.7.1 DESCRIPTION OF BASELINE ENVIRONMENT

The primary surface water receptor within the Project Area is the Okulu River system, a tidally influenced river forming part of the Bonny Estuary within the Niger Delta hydrological basin. The river exhibits a mixed hydrodynamic regime controlled by both fluvial discharge and tidal forcing, resulting in bidirectional flow, variable velocities (0.0166–0.384 m/s), and fluctuating water depths ranging from approximately 1.8 m to over 7.9 m. These tidal dynamics influence contaminant transport, enabling both downstream and upstream dispersion.

Surface water quality across the Study Area reflects a transition from freshwater conditions upstream to increasingly saline conditions downstream, driven by marine intrusion. Electrical conductivity ranges from 138 to 34,687 µS/cm, total dissolved solids from 83 to 23,934 mg/L, and salinity reaches up to 21.58 ppt in tidal zones. Nutrient concentrations indicate moderate enrichment, with nitrate ranging from 1.98 to 6.18 mg/L, phosphate from 0.09 to0.65 mg/L, and ammonium from 0.40 to1.70 mg/L. Dissolved oxygen concentrations are above guideline value (5.0 to 5.4 mg/L), while elevated biochemical oxygen demand (8.8 to 20.8 mg/L) indicates moderate organic loading within the system.

Microbiological contamination is also evident, with total and faecal coliform counts exceeding guideline values, indicating external anthropogenic influences. Overall, the Okulu River system is characterised as a moderately impacted but environmentally sensitive receptor, due to:

- Tidal dynamics enabling wide contaminant dispersion
- Existing nutrient enrichment and organic loading
- Connectivity with downstream estuarine and marine systems
- Dependence of aquatic ecosystems and downstream users

For detailed baseline conditions, refer to Section 7.4.9.

8.2.7.2 PROPOSED PROJECT ACTIVITIES

Construction Phase

Potential impacts during construction include:

- Erosion and sedimentation from site clearance, grading, piling and foundation works, with sediment laden runoff entering local drainage channels and the Okulu River.
- Stormwater contamination from exposed soil stockpiles, concrete works (alkaline wash water) and vehicle movements (oil and grease, hydrocarbons) across the plant footprint.
- Accidental spills of diesel, gasoline and lubricants during refuelling, storage and equipment maintenance.
- Construction water demand abstracted and potentially affecting overall water balance.
- Sanitary effluent generated by a peak workforce of more than 4000 and routed to the existing sewage treatment plant.
- Construction camp wastes (organic waste, greywater, mixed urban waste) with associated discharge and leachate risks.
- Increased raising the risk of road-derived pollutant runoff.
- Alteration of natural drainage during land grading and temporary works, with potential to alter local flow paths and increase peak runoff.

Operational Phase

The following types of direct impacts are considered during the operation phase:

- Continuous raw water abstraction with potential cumulative pressure on local groundwater resources supporting baseflow to surface watercourses.
- Cooling tower blowdown from the new cooling towers, with elevated dissolved salts, biocides and corrosion inhibitors.

- Controlled discharge to the Okulu River during wastewater recovery plant shutdowns via the existing IFZ1/IFZ2 holding and retention ponds, with potential to alter receiving water quality (temperature, salinity, nutrients).
- Nutrient loading and eutrophication risk in the receiving environment from residual ammoniacal nitrogen, nitrate and urea in treated effluent.
- Accidental spill risk during operations from hazardous substances stored on site.
- Stormwater contamination from process areas, refuelling points and chemical storage, with the first flush carrying the highest pollutant load.
- Atmospheric deposition of nitrogen (NOx, NH_3) from stacks contributing diffuse nitrogen loading to local surface water bodies.
- Flood-related risk to retention pond integrity and the controlled discharge point, the magnitude of which can only be quantified once the floodline assessment is available.
- The potential for thermal discharge to enter the surface water environment is not considered in this impact assessment as the cooling design is closed loop without any thermal discharge to surface water.

8.2.7.3 SENSITIVE RECEPTORS

The following sensitive receptors have been identified within the Study Area:

- Surface Water (Okulu River System): The primary receptor receiving treated effluent and stormwater runoff, with high vulnerability due to tidal flow enabling widespread contaminant dispersion.
- Downstream Estuarine and Marine Systems (Bonny Estuary): Hydraulically connected systems that may be affected by downstream transport of contaminants, impacting estuarine and coastal water quality.
- Riverine and Aquatic Ecosystems: Sensitive to reduced dissolved oxygen, nutrient enrichment (eutrophication), and sediment deposition, which may degrade habitat quality and ecological functioning.
- Riverine Sediments: Act as contaminant sinks, accumulating metals and organics, with potential long-term ecological risks through remobilisation and bioaccumulation.
- Local Communities: Indirect receptors through subsistence fishing activities and limited domestic use of surface water, with potential impacts on livelihoods and health from declining water quality.

Whilst each of the above are considered receptors, riverine and aquatic ecosystems, sediments and local communities would be impacted secondarily to an initial impact to the Okulu River System. As the Bonny Estuary is downstream of the Okulu River System, it would also only be impacted if the upstream Okulu River is impacted. For this reason, only the Okulu River System is considered in the subsequent impact rating tables.

8.2.7.4 SIGNIFICANCE OF IMPACT (PRE-MITIGATION)

The anticipated impacts prior to mitigation are assessed as follows:

- Hydrocarbon Spills – Minor Negative Impact (refer to Table 8-54)
- Spill of Untreated Effluent from Treatment Plant due to Malfunction – Critical Negative Impact (refer to Table 8-55)

- Spill of Untreated Effluent from Treatment Plant due to overfill – moderate Negative Impact (refer to Table 8-56)
- Impact from hard surfacing and effluent discharge increasing flow in Okulu river during operation – Moderate Negative Impact (refer to Table 8-57)
- Impact from sediment-laden runoff and turbidity from construction earthworks – Major Negative Impact (refer to Table 8-58)
- Impact due to construction phase wastewater discharges – Major Negative Impact (refer to Table 8-59)
- Impact from contaminated stormwater runoff from operational process and storage areas – Moderate Negative Impact (refer to Table 8-60).

TABLE 8-54: RATING OF IMPACTS RELATED TO SURFACE WATER RESOURCES (PRE-MITIGATION): HYDROCARBON SPILLS DURING CONSTRUCTION AND OPERATION

Project Phase: Construction		
Direct (spills to surface water) and indirect (spills migrating to surface water through soils or groundwater), Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	Hydrocarbons reaching the Okulu River have the potential to migrate several kilometres downstream and into the Okrika mangrove system.
Duration	Long-term	Petroleum hydrocarbons persist in sediments and bind to mangrove substrates, with effects extending well beyond the spill event.
Scale	Medium	Even modest fuel or lubricant volumes are acutely toxic to fish, invertebrates and mangrove seedlings; published toxicity thresholds for common fuels are in the low mg/L range.
Frequency	Irregular and rare	Spills are unplanned events, occurring sporadically during refuelling, equipment failure or material handling.
Likelihood	Likely	Without dedicated containment, spills during construction works and routine plant operation are realistic given the inventory of hydrocarbons handled.
Magnitude		
Medium Magnitude: small to moderate spill volumes can still cause measurable degradation in an already-stressed receiving water, with hydrocarbon persistence in sediment and the downstream mangrove substrate.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The Okulu River flows downstream of the Project Area through a freshwater to brackish transition zone before discharging into the Okrika mangrove swamp in the southern Niger		

Project Phase: Construction
Delta. Although already heavily modified by sand mining and industrial discharge evidenced by depressed pH at some stations, elevated conductivity and raised heavy metal concentrations the river remains hydrologically connected to a downstream mangrove ecosystem of high conservation value, and existing impacts reduce its assimilative capacity.
Significant Rating Before Mitigation
Minor Impact

TABLE 8-55: RATING OF IMPACTS RELATED TO SURFACE WATER RESOURCES (PRE-MITIGATION): EFFLUENT TREATMENT PLANT MALFUNCTION DURING OPERATION

Project Phase: Operation		
Direct (untreated effluent to surface water) and indirect (leaks from ponds migrating to surface water through soils or groundwater), Negative Impact.		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	Untreated or partially treated effluent reaching the Okulu River will be transported downstream into the Okrika mangrove system.
Duration	Long-term	Malfunction conditions can persist for the life of the plant if maintenance and monitoring regimes are inadequate.
Scale	Medium	Process effluent from a urea / ammonia plant typically contains ammonia, nitrate, urea and trace metals. Ammonia in particular is acutely toxic to fish at concentrations as low as 0.1–2 mg/L (un-ionised NH3).
Frequency	Constant	A malfunction has the potential to release substandard effluent continuously until it is detected and corrected.
Likelihood	Possible	Without redundancy, online monitoring and structured maintenance, plant malfunction is a credible scenario over operational life.
Magnitude		
Large Magnitude; during malfunction large continuous volumes of nitrogen-rich effluent can be released without treatment which would exceed both Nigerian National Environmental Standards and Regulations Enforcement Agency (NESREA) limits and IFC EHS Guideline values for fertilizer manufacturing, with acute toxicity to aquatic life.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		

Project Phase: Operation
The Okulu River flows downstream of the Project Area through a freshwater to brackish transition zone before discharging into the Okrika mangrove swamp in the southern Niger Delta. Although already heavily modified by sand mining and industrial discharge evidenced by depressed pH at some stations, elevated conductivity and raised heavy metal concentrations the river remains hydrologically connected to a downstream mangrove ecosystem of high conservation value, and existing impacts reduce its assimilative capacity.
Impact Rating Before Mitigation
Critical Impact

TABLE 8-56: RATING OF IMPACTS RELATED TO SURFACE WATER RESOURCES (PRE-MITIGATION): EFFLUENT TREATMENT PLANT OVERFLOW DURING OPERATION

Project Phase: Operation		
Direct (overflow of retention or polishing ponds discharging to surface water during high-rainfall events), Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	Overflow events that reach the Okulu River will propagate downstream into the Okrika mangrove.
Duration	Long-term	Individual overflow events are episodic, typically lasting hours to days during and immediately after extreme rainfall.
Scale	Small	Overflow volumes can be substantial during the Niger Delta wet season but are diluted by storm flow in the receiving water; the load delivered to the river is significant but not catastrophic.
Frequency	Constant	Overflows would be associated with extreme rainfall or flood events, which occur intermittently in the Niger Delta.
Likelihood	Likely	Niger Delta flood vulnerability is well documented, and an overflow event is plausible if pond sizing relies on under-conservative design rainfall.
Magnitude		
Small: episodic discharges of partially treated effluent during storm events.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The Okulu River flows downstream of the Project Area through a freshwater to brackish transition zone before discharging into the Okrika mangrove swamp in the southern Niger Delta. Although already heavily modified by sand mining and industrial discharge evidenced by depressed pH at some stations, elevated conductivity and raised heavy metal		

Project Phase: Operation
concentrations the river remains hydrologically connected to a downstream mangrove ecosystem of high conservation value, and existing impacts reduce its assimilative capacity.
Impact Rating Before Mitigation
Moderate Impact

TABLE 8-57: RATING OF IMPACTS RELATED TO SURFACE WATER RESOURCES (PRE-MITIGATION): HARD SURFACING AND EFFLUENT DISCHARGE INCREASING FLOW IN OKULU RIVER DURING OPERATION

Project Phase: Operation		
Direct (hydrological change due to increased impervious area and continuous effluent discharge), Negative Impact.		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	Flow change is concentrated in the river reach immediately downstream of the discharge point and decays with distance as the river increases in cross-section.
Duration	Long-term	The impact will be present for the entire operational life of the plant.
Scale	Small	Effluent discharge of about 385 m^3/h (~106.94 L/s) represents about 6% of the average natural flow regime of the Okulu River, particularly during the wet season.
Frequency	Constant	The discharge is continuous during operation.
Likelihood	Likely	The hydrological change is a planned and inevitable consequence of operation.
Magnitude		
Small Magnitude: the additional discharge represents a small proportion of natural flow and the impervious-area contribution is modest at catchment scale.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The Okulu River flows downstream of the Project Area through a freshwater to brackish transition zone before discharging into the Okrika mangrove swamp in the southern Niger Delta. Although already heavily modified by sand mining and industrial discharge evidenced by depressed pH at some stations, elevated conductivity and raised heavy metal		

Project Phase: Operation
concentrations the river remains hydrologically connected to a downstream mangrove ecosystem of high conservation value, and existing impacts reduce its assimilative capacity.

Impact Rating Before Mitigation
Moderate Impact

TABLE 8-58: RATING OF IMPACTS RELATED TO SURFACE WATER RESOURCES (PRE-MITIGATION): SEDIMENT-LADEN RUNOFF AND TURBIDITY FROM CONSTRUCTION EARTHWORKS

Project Phase: Construction		
Direct (sediment-laden surface runoff from cleared, stockpiled or excavated areas reaching surface water bodies during rainfall), Negative Impact.		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Regional	Sediment deposition is concentrated in the Okulu reach immediately downstream of the construction footprint and its associated stormwater discharge points.
Duration	Long-term	Niger Delta annual rainfall exceeds 2,000 mm, with intense convective storms mobilising sediment from cleared lateritic soils. Elevated suspended solids and turbidity smother benthic habitat, reduce light penetration, and clog the gills of fish and invertebrates.
Scale	Small	Planned containment approaches would ensure the control of runoff during construction.
Frequency	Constant	Mobilisation of sediment is expected with every significant rainfall event during the construction period.
Likelihood	Likely	Without dedicated erosion and sediment controls, sediment migration from a Niger Delta construction site to the nearest watercourse is a near-certain outcome.
Magnitude		
Medium Magnitude: frequent storm driven sediment loads from cleared and excavated areas could materially elevate total suspended solids and turbidity in the Okulu River during the construction phase		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		

Project Phase: Construction
The Okulu River flows downstream of the Project Area through a freshwater to brackish transition zone before discharging into the Okrika mangrove swamp in the southern Niger Delta. Although already heavily modified by sand mining and industrial discharge evidenced by depressed pH at some stations, elevated conductivity and raised heavy metal concentrations the river remains hydrologically connected to a downstream mangrove ecosystem of high conservation value, and existing impacts reduce its assimilative capacity.
Impact Rating Before Mitigation
Major Impact

TABLE 8-59: RATING OF IMPACTS RELATED TO SURFACE WATER RESOURCES (PRE-MITIGATION): CONSTRUCTION PHASE WASTEWATER DISCHARGES

Project Phase: Construction		
Direct (uncontrolled discharge of construction-phase wastewater: sanitary effluent, concrete washings, hydrotest water and dewatering to surface water), Negative Impact.		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	Construction wastewater released within the site footprint reaches the Okulu reach via surface drainage; downstream propagation is limited by intermittent volumes.
Duration	Long-term	Confined the construction phase, generally 24–36 months.
Scale	Small	Concrete washings are highly alkaline (pH > 12), dewatering discharges can carry elevated suspended solids and trace contaminants from excavations, and untreated sanitary effluent from the workforce contributes biological oxygen demand, pathogens and nutrients.
Frequency	Constant	Generation is essentially daily during active construction, although volumes vary with the work front.
Likelihood	Likely	Without dedicated facilities; washout pits, package sewage treatment, dewatering treatment, runoff to the Okulu River is a credible default outcome.
Magnitude		
Medium Magnitude: daily, low-to-moderate volumes of variably contaminated wastewater released to surface water during the construction period would cause measurable degradation of receiving water quality.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		

Project Phase: Construction
The Okulu River flows downstream of the Project Area through a freshwater to brackish transition zone before discharging into the Okrika mangrove swamp in the southern Niger Delta. Although already heavily modified by sand mining and industrial discharge evidenced by depressed pH at some stations, elevated conductivity and raised heavy metal concentrations the river remains hydrologically connected to a downstream mangrove ecosystem of high conservation value, and existing impacts reduce its assimilative capacity.
Impact Rating Before Mitigation
Major Impact

TABLE 8-60: RATING OF IMPACTS RELATED TO SURFACE WATER RESOURCES (PRE-MITIGATION): CONTAMINATED STORMWATER RUNOFF FROM OPERATIONAL PROCESS AND STORAGE AREAS

Project Phase: Operation		
Direct (contaminated stormwater runoff from operational process, chemical storage, raw material handling and product loading areas reaching surface water), Negative Impact.		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	Loads are concentrated in the immediate downstream reach of the Okulu River, with attenuation through dilution along the river.
Duration	Long-term	The hazard persists for the full operational life of the plant whenever rainfall occurs over operational surfaces.
Scale	Small	First-flush stormwater from process platforms, urea handling areas, fuel bays, transformer compounds and product loading bays picks up hydrocarbons, urea and ammonium nitrate dust, lubricants and trace metals at levels capable of elevating ammonia, nitrate, oil-and-grease and total dissolved solids in the receiving water.
Frequency	Constant	Loads are mobilised with each significant rainfall event over the operational footprint.
Likelihood	Likely	Without segregated drainage and treatment, contaminated stormwater would reach the Okulu River through the site's storm system as a normal operational outcome.
Magnitude		
Medium Magnitude: recurrent, rainfall-driven loads of nutrients, hydrocarbons and dissolved solids from operational surfaces would contribute measurably to the cumulative load on the receiving water.		

Project Phase: Operation
Sensitivity/Vulnerability/Importance of the Resource/Receptor
High Sensitivity
The Okulu River flows downstream of the Project Area through a freshwater to brackish transition zone before discharging into the Okrika mangrove swamp in the southern Niger Delta. Although already heavily modified by sand mining and industrial discharge evidenced by depressed pH at some stations, elevated conductivity and raised heavy metal concentrations the river remains hydrologically connected to a downstream mangrove ecosystem of high conservation value, and existing impacts reduce its assimilative capacity.
Impact Rating Before Mitigation
Moderate Impact

8.2.7.5 MITIGATION AND MANAGEMENT MEASURES

Refer to Section 9.2.8 (Chapter 9) for the recommended mitigation and management measures associated with Surface Water Resource.

8.2.7.6 SIGNIFICANCE OF IMPACTS (POST-MITIGATION)

Following the implementation of the proposed mitigation measures outlined in Section 9 the residual significance of impacts on surface water resources is expected to be as follows:

- Hydrocarbon Spills – Residual impact is classified as Negligible Negative Impact (refer to Table 8-61).
- Effluent Discharge from Treatment Plant due to Malfunction – Residual impact is classified as Major Negative Impact (refer to Table 8-62).
- Effluent Discharge from Treatment Plant due to Flooding – Residual impact is classified as Minor Negative Impact (Table 8-63).
- Hard Surfacing and Increased Flow in Okulu River – No specific mitigation measures are proposed; therefore, the residual impact remains classified as Minor Negative Impact (refer to Table 8-64).
- Sediment laden runoff and turbidity from construction - the impact is classified as moderate impact (refer to Table 8-65)
- Construction phase wastewater discharge to Okulu River – the impact is classified as moderate negative impact (refer to Table 8-66)

These ratings indicate that, while mitigation measures significantly reduce certain risks, some impacts, particularly those related to flow regime changes, cannot be fully eliminated and will require ongoing monitoring and management.

TABLE 8-61: RATING OF IMPACTS RELATED TO SURFACE WATER RESOURCES (POST-MITIGATION): HYDROCARBONS SPILLS DURING CONSTRUCTION AND OPERATION

Project Phase: Construction and Operation		
Direct (hydrological change due to increased impervious area and continuous effluent discharge), Negative Impact.		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	If a spill reaches surface water it could still migrate downstream; however, mitigation reduces the likelihood and volume of any release.
Duration	Long-term	Any residual contamination would persist, but mitigation reduces volumes to levels where natural attenuation is effective.
Scale	Small	Hydrocarbon storage and refuelling will be undertaken on bunded, impermeable surfaces with secondary containment sized to 110 % of the largest container, spill kits at all operations, and trained response personnel.
Frequency	Constant	Residual spill risk is sporadic and tied to incidents only.
Likelihood	Likely	With structured containment, inspection and response procedures, a spill reaching the Okulu River is unlikely.
Magnitude		
Small Magnitude: residual release volumes that could plausibly reach surface water are small and amenable to containment and clean-up.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The Okulu River flows downstream of the Project Area through a freshwater to brackish transition zone before discharging into the Okrika mangrove swamp in the southern Niger Delta. Although already heavily modified by sand mining and industrial discharge evidenced by depressed pH at some stations, elevated conductivity and raised heavy metal concentrations the river remains hydrologically connected to a downstream mangrove ecosystem of high conservation value, and existing impacts reduce its assimilative capacity.		
Impact Rating After Mitigation		
Negligeable Impact		

TABLE 8-62: RATING OF IMPACTS RELATED TO SURFACE WATER RESOURCES (POST-MITIGATION): EFFLUENT TREATMENT PLANT MALFUNCTION DURING OPERATION

Project Phase: Operation		
Direct (untreated effluent to surface water) and indirect (leaks from ponds migrating to surface water through soils or groundwater), Negative Impact.		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	Any residual non-compliant discharge would still propagate downstream, but mitigation reduces the load and duration.
Duration	Long-term	Online monitoring, alarms and redundancy mean that any malfunction is detected and corrected within hours rather than persisting for the life of the plant.
Scale	Small	With redundant treatment trains, online ammonia and nitrate analysers, and scheduled preventive maintenance, residual non-compliance events are short and bounded.
Frequency	Constant	Reduced from a continuous risk to discrete, short events linked to specific equipment trips.
Likelihood	Likely	Likelihood is reduced by redundancy, monitoring, operator training and discharge consent verification.
Magnitude		
Medium Magnitude: short-duration, low-load excursions that are detected and corrected before significant in-river concentrations are reached would be considered small magnitude; however, given the evidence of environmental impact from releases at the existing plant, this is rated as medium.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The Okulu River flows downstream of the Project Area through a freshwater to brackish transition zone before discharging into the Okrika mangrove swamp in the southern Niger Delta. Although already heavily modified by sand mining and industrial discharge evidenced by depressed pH at some stations, elevated conductivity and raised heavy metal concentrations the river remains hydrologically connected to a downstream mangrove ecosystem of high conservation value, and existing impacts reduce its assimilative capacity.		
Impact Rating After Mitigation		
Major Impact		

TABLE 8-63: RATING OF IMPACTS RELATED TO SURFACE WATER RESOURCES (POST-MITIGATION): EFFLUENT TREATMENT PLANT OVERFLOW DURING OPERATION

Project Phase: Operation		
Direct (overflow of retention or polishing ponds discharging to surface water during high-rainfall events), Negative Impact.		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	Overflow water that does escape would be diluted within the Okulu reach immediately downstream rather than propagating regionally.
Duration	Long-term	Storm-event timescales only.
Scale	Small	Retention and polishing ponds will be sized to contain at minimum a 1-in-100 year storm event consistent with IFC EHS Guidelines, with high-level alarms and an emergency holding capacity.
Frequency	Constant	Overflow only conceivable in extreme exceedance conditions.
Likelihood	Likely	Conservative flood design and proactive pond drawdown ahead of forecast storms make an overflow event unlikely.
Magnitude		
Small Magnitude — overflow volumes and pollutant loads under residual conditions are small relative to wet-season flows in the receiving water.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The Okulu River flows downstream of the Project Area through a freshwater to brackish transition zone before discharging into the Okrika mangrove swamp in the southern Niger Delta. Although already heavily modified by sand mining and industrial discharge evidenced by depressed pH at some stations, elevated conductivity and raised heavy metal concentrations the river remains hydrologically connected to a downstream mangrove ecosystem of high conservation value, and existing impacts reduce its assimilative capacity.		
Impact Rating After Mitigation		
Minor Impact		

TABLE 8-64: RATING OF IMPACTS RELATED TO SURFACE WATER RESOURCES (POST-MITIGATION): HARD SURFACING AND EFFLUENT DISCHARGE INCREASING FLOW IN OKULU RIVER DURING OPERATION

Project Phase: Operation		
Direct (hydrological change due to increased impervious area and continuous effluent discharge), Negative Impact.		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	Hydrological change is local to the reach downstream of the discharge.
Duration	Long-term	Discharge continues for the operational life of the plant.
Scale	Small	Stormwater attenuation, retention and metered discharge smooth peak flows and limit the change in the natural flow regime of the receiving water.
Frequency	Constant	The mitigated discharge regime is continuous but controlled.
Likelihood	Likely	Discharge will occur but in a controlled, attenuated form.
Magnitude		
Negligible Magnitude: controlled, attenuated discharge is within the natural variability of the Okulu River.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The Okulu River flows downstream of the Project Area through a freshwater to brackish transition zone before discharging into the Okrika mangrove swamp in the southern Niger Delta. Although already heavily modified by sand mining and industrial discharge evidenced by depressed pH at some stations, elevated conductivity and raised heavy metal concentrations the river remains hydrologically connected to a downstream mangrove ecosystem of high conservation value, and existing impacts reduce its assimilative capacity.		
Impact Rating After Mitigation		
Negligible Impact		

TABLE 8-65: RATING OF IMPACTS RELATED TO SURFACE WATER RESOURCES (POST-MITIGATION): **S**EDIMENT LADEN RUNOFF AND TURBIDITY FROM CONSTRUCTION EARTHWORKS

Project Phase: Construction
Direct (sediment-laden surface runoff from cleared, stockpiled or excavated areas reaching surface water bodies during rainfall), Negative Impact.

Project Phase: Construction		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	Residual sediment release is contained close to source by perimeter controls.
Duration	Long-term	Limited to the construction phase, with progressive rehabilitation reducing exposed surfaces over time.
Scale	Small	Silt fences, sediment traps and basins, contour drainage, stockpile cover, vegetated buffer strips along the riparian corridor and progressive rehabilitation reduce sediment delivery to surface water.
Frequency	Constant	Residual sediment loads are limited to exceedance events that overwhelm the designed controls.
Likelihood	Likely	With an Erosion and Sediment Control Plan implemented and audited, releases that reach the receiving water are unlikely.
Magnitude		
Small Magnitude: residual sediment loads are small relative to natural wet-season suspended sediment concentrations in the receiving water.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The Okulu River flows downstream of the Project Area through a freshwater to brackish transition zone before discharging into the Okrika mangrove swamp in the southern Niger Delta. Although already heavily modified by sand mining and industrial discharge evidenced by depressed pH at some stations, elevated conductivity and raised heavy metal concentrations the river remains hydrologically connected to a downstream mangrove ecosystem of high conservation value, and existing impacts reduce its assimilative capacity.		
Impact Rating After Mitigation		
Moderate Impact		

TABLE 8-66: RATING OF IMPACTS RELATED TO SURFACE WATER RESOURCES (POST-MITIGATION): CONSTRUCTION PHASE WASTEWATER DISCHARGES

Project Phase: Construction		
Direct (uncontrolled discharge of construction-phase wastewater: sanitary effluent, concrete washings, hydrotest water and dewatering to surface water), Negative Impact.		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**

Project Phase: Construction		
Extent	Regional	Residual releases are contained within the site footprint and any escape is localised to the nearest drainage line.
Duration	Long-term	Limited to specific construction activities and the overall construction phase.
Scale	Small	Dedicated concrete washout pits, a package sewage treatment plant or chemical toilets serving the workforce camp, dewatering treatment (settlement / coagulation / pH neutralisation) and segregated drainage with first-flush capture limit residual release volumes and loads.
Frequency	Constant	Residual wastewater reaching surface water is event-driven only (system upset, hose failure).
Likelihood	Likely	Wastewater management procedures, supervision and discharge consent monitoring keep accidental release to the river unlikely.
Magnitude		
Small Magnitude — residual loads from construction wastewater are minor in the context of the receiving water and the duration of construction.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The Okulu River flows downstream of the Project Area through a freshwater to brackish transition zone before discharging into the Okrika mangrove swamp in the southern Niger Delta. Although already heavily modified by sand mining and industrial discharge evidenced by depressed pH at some stations, elevated conductivity and raised heavy metal concentrations the river remains hydrologically connected to a downstream mangrove ecosystem of high conservation value, and existing impacts reduce its assimilative capacity.		
Impact Rating After Mitigation		
Moderate Impact		

8.2.7.7 CUMULATIVE IMPACTS

The Project is located within an established industrial complex and will utilise existing water management systems, including process water supply networks, wastewater treatment facilities, and stormwater drainage systems. The principal receiving water body is the Okulu River, which is hydrologically connected to the Bonny Estuary and downstream mangrove environments. The receiving system is described as highly sensitive because it is tidally influenced, connected to downstream ecological receptors, subject to contaminant accumulation in sediments, and already characterised by an impaired baseline associated with existing discharges and sand mining, which reduces assimilative capacity.

In this context, cumulative impacts on surface water are most relevant where Project-related discharges or runoff are added to existing industrial pressures, existing stormwater and wastewater pathways, and ongoing in-channel sediment disturbance in the wider catchment. The key cumulative issues for the ESIA are therefore expected to relate to surface water quality, surface water flow and runoff behaviour, and sediment disturbance / turbidity within the wider Okulu River system.

Identified Cumulative Impacts

The cumulative surface water impacts identified for the Project are as follows:

- Cumulative deterioration in surface water quality resulting from the combined effect of hydrocarbon and chemical spills, contaminated stormwater runoff, process/wastewater releases, and wastewater treatment failures or overflow, superimposed on an already industrialised receiving environment. The Okulu River already shows evidence of industrial pressure, including depressed pH at some stations, elevated conductivity, raised heavy metal concentrations, nutrient enrichment, and poor microbiological quality.
- Cumulative changes to flow and runoff behaviour arising from the addition of new hardstanding, engineered drainage, and intermittent discharge pathways to an existing complex-wide stormwater and wastewater management system. Existing impervious cover and engineered drainage are already established within the wider complex, and the new development will add incrementally to that system.
- Cumulative sediment disturbance, turbidity and channel instability resulting from the combined influence of construction earthworks, local runoff and the already significant anthropogenic disturbance caused by sand mining and dredging within the Okulu River. The baseline confirms that in-channel sand mining is a significant existing driver of sediment disturbance and channel instability.
- Potential cumulative thermal and nutrient loading associated with operational discharges and runoff entering a sensitive, tidally influenced receiving water body with downstream ecological connectivity. The Project will generate nutrient-containing wastewater streams and thermal discharge is separately assessed during operation.

Significance of Impacts (Pre-Mitigation)

Using the same impact logic applied in the surface water assessment, the cumulative pre-mitigation significance of the identified impacts is assessed as follows:

- Cumulative surface water quality deterioration – **Major Negative Impact**.

  This reflects the combination of several Project-level surface water risks that are already assessed at Major pre-mitigation in a highly sensitive receiving system, together with an already degraded baseline in the Okulu River and the wider industrial setting. The receiving environment already has reduced assimilative capacity, and the combined effect of existing industrial pressures and additional Project-related pollutant pathways would therefore be material if not properly controlled.
- Cumulative changes to flow and runoff behaviour – **Moderate Negative Impact**.

The Project adds incrementally to an already engineered and partly impervious industrial catchment. While the report indicates that the existing and proposed drainage systems are designed to accommodate site runoff, the cumulative increase in hardstanding and managed runoff pathways remains relevant at the wider sub-catchment scale.

- Cumulative sediment disturbance and turbidity – **Major Negative Impact**.

  This reflects the combination of Project-related earthworks and runoff with the already significant influence of dredging and sand mining in the Okulu River, which are identified as major existing drivers of sediment disturbance, channel instability and sediment redistribution.

- Cumulative thermal and nutrient loading – **Moderate to Major Negative Impact**.

  The receiving system is highly sensitive and already shows nutrient enrichment, while thermal discharge and nutrient-bearing wastewater streams are recognised Project impact pathways. In cumulative terms, these effects are material because they are superimposed on a sensitive estuarine/fluvial receiving system with downstream ecological connectivity.

Mitigation and Management Measures

Refer to Section 9.2.8 for the recommended mitigation and management measures associated with cumulative impacts on Surface Water.

Significance of Impacts (Post-Mitigation)

Following implementation of the above mitigation and management measures, the cumulative residual significance of impacts on surface water is expected to reduce as follows:

- Cumulative surface water quality deterioration – **Moderate Negative Impact**.

  This reflects the fact that several key Project-level surface water impacts remain at Moderate significance after mitigation, including hydrocarbon spills, contaminated stormwater runoff, construction wastewater discharges and thermal discharge. In cumulative terms, these residual effects remain relevant because the receiving system is already under pressure, but the implemented controls are expected to keep residual contaminant loads within managed and monitored limits.

- Cumulative changes to flow and runoff behaviour – **Minor Negative Impact**.

  Hard surfacing and hydrological change remain a residual effect at Project level, but the drainage network, culverts and retention pond are designed to attenuate runoff and reduce flood risk both on site and to surrounding land. In cumulative terms, the Project would add incrementally to an already engineered drainage setting, but the residual effect is expected to remain managed and relatively limited.

- Cumulative sediment disturbance and turbidity – **Moderate Negative Impact**.

  Sediment and turbidity impacts remain relevant after mitigation because the receiving river is already influenced by sand mining and dredging and because residual construction-phase sediment runoff remains a recognised pathway. However, with runoff and erosion controls in place, the Project's incremental contribution is expected to reduce relative to the unmitigated case.

- Cumulative thermal and nutrient loading – **Moderate Negative Impact**.

Thermal discharge remains a controlled and monitored residual effect, and nutrient-bearing wastewater streams are expected to be managed through site treatment and recovery systems. In cumulative terms, the residual effect remains relevant in a sensitive receiving environment, but it is expected to remain within the managed range once mitigation is implemented.

Overall, the Project is expected to contribute incrementally to cumulative surface water pressures within the broader Okulu River system, particularly in relation to water quality, sediment disturbance and managed runoff. However, with the recommended controls in place, these cumulative effects are expected to remain manageable, with the most important residual cumulative impacts relating to surface water quality deterioration and sediment / turbidity pressure in a receiving environment that is already sensitive and partly degraded.

8.3 IMPACTS ON BIODIVERSITY AND ECOSYSTEM SERVICES

8.3.1 DESCRIPTION OF THE BASELINE ENVIRONMENT

The baseline study identified that while the terrestrial and aquatic biodiversity of the Project Area have been altered through anthropogenic impacts; the area does contain some biodiversity of value and provides ecosystem services to the greater community in the Study Area.

8.3.2 PROPOSED PROJECT ACTIVITIES

8.3.2.1 CONSTRUCTION PHASE

The following types of potential impacts are considered during the construction phase:

- **Loss of biodiversity** – during the construction process there will be loss of biodiversity in the Project Area, as well as potential impacts to the surrounding fauna and flora through accidental spills of fuels and oils, erosion onto adjoining land parcels, and direct disturbance of fauna and flora by construction personnel and activities.

8.3.2.2 OPERATIONAL PHASE

The following types of direct impacts are considered during the operation phase:

- **Loss of Biodiversity** – during the operational phase, there are potential impacts to the surrounding fauna and flora through accidental spills of fuels and oils and direct disturbance of fauna and flora by personnel and operations.
- **Surface water contamination from effluent discharges, leaks or spills from the Effluent Treatment Plant** – the potential to introduce pollutants to surface water courses via:

- Release of effluent that does not meet required standards due to i) malfunction or failures of effluent treatment plant or poor operation and maintenance, ii) due to flood or overflow from retention pond;
- Accidental release or intentional dumping of solid waste from effluent treatment plant to surface waters; and
- Spills or leaks from the effluent treatment plant ponds or transport lines occurring direct to surface water where in contact or occurring to soil/ groundwater and then reaching surface water receptors.

8.3.3 SENSITIVE RECEPTORS

- The **Terrestrial Biodiversity** of the Project Area has been impacted upon by anthropogenic forces, but still retains both plants and animals that form an integral part of the community's ecosystem services. The loss of the area to be cleared for the Project could directly affect the surrounding ecosystem through siltation and pollution, alien invasive species introduction, and changes to the functionality of the systems.
- While little to no direct impact is predicted to occur to the **Aquatic Biodiversity** of the Project Area, the possibility exists that effluent discharge could lead to contamination of these systems, which is already under threat from a number of anthropogenic impacts. Most of the threatened species identified (including migratory waterbirds, fish and reptiles) as well as those that may potentially trigger critical habitat considerations observed, are closely linked with aquatic habitats.

8.3.4 SIGNIFICANCE OF IMPACT (PRE-MITIGATION)

The impacts listed above are assessed in the following tables. Based on the analysis provided:

- The impact from loss of biodiversity during construction is considered a "**Major Negative Impact**" pre-mitigation (refer to Table 8-67).
- The impact from loss of biodiversity during operation is considered a "**Major Negative Impact**" pre-mitigation (refer to Table 8-68).
- The impact from loss of aquatic biodiversity through effluent treatment plant malfunction during operation is considered a "**Major Negative Impact**" pre-mitigation (refer to Table 8-69).

TABLE 8-67: RATING OF IMPACTS RELATED TO BIODIVERSITY RESOURCES (PRE-MITIGATION): BIODIVERSITY LOSS DURING CONSTRUCTION

Type of Impact		
Direct (Loss of Biodiversity) Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	Impact has the potential to cause changes up to a few kms of the Project Area.
Duration	Short-term	Impact has the potential to continue for the short-term.
Scale	Medium	The affected habitat is modified and relatively widespread within the greater landscape. No loss of unique habitats or species are expected to occur.
Frequency	Constant	Impact has the potential to be continual.
Likelihood	Likely	Impact is possible unless mitigation is implemented.
Magnitude		
Large Magnitude related to the potential loss of biodiversity and ecosystem services		

Sensitivity/Vulnerability/Importance of the Resource/Receptor
Medium Sensitivity
The biodiversity of the Project Area is partially degraded, but still supplies valuable ecosystem services to the immediate community.
Significant Rating Before Mitigation
Major Impact

TABLE 8-68: RATING OF IMPACTS RELATED TO BIODIVERSITY RESOURCES (PRE-MITIGATION): BIODIVERSITY LOSS DURING OPERATION

Type of Impact		
Direct (Loss of Biodiversity) Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	Impact has the potential to cause changes up to a few kms of the Project Area.
Duration	Long-term	Impact has the potential to continue for the long-term lifetime of Project.
Scale	Medium	The affected habitat is modified and relatively widespread within the greater landscape. No loss of unique habitats or species are expected to occur.
Frequency	Constant	Impact has the potential to be continual.
Likelihood	Likely	Impact is possible unless mitigation is implemented.
Magnitude		
Large Magnitude related to the potential loss of biodiversity and ecosystem services		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
The biodiversity of the Project Area is partially degraded, but still supplies valuable ecosystem services to the immediate community.		
Significant Rating Before Mitigation		
Major Impact		

TABLE 8-69: RATING OF IMPACTS RELATED TO BIODIVERSITY RESOURCES (PRE-MITIGATION); AQUATIC BIODIVERSITY LOSS THROUGH EFFLUENT TREATMENT PLANT MALFUNCTION DURING OPERATION

Description of Impact		
Loss of aquatic biodiversity through direct spills to surface water and indirect (leaks from ponds migrating to surface water through soils or groundwater).		
Type of Impact		
Direct, Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	Impact has the potential to migrate beyond the Project Area several kms transported by surface water.
Duration	Long-term	Impact has the potential to continue for the long-term lifetime of Project.
Scale	Medium	The scale of the impact is dependent on the type of contaminants that enter the surface water resource and their concentrations.
Frequency	Frequent	Impact will be frequent during operation.
Likelihood	Possible	Impact is possible
Magnitude		
Large Magnitude related to the potential for large volumes of untreated effluent to be released in cases of malfunction of plant, poor operations and maintenance		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The aquatic biodiversity of the area is partially degraded, but still supplies valuable ecosystem services to the immediate community.		
Significant Rating Before Mitigation		
Major Impact		

8.3.5 MITIGATION AND MANAGEMENT MEASURES

Refer to Section 9.3 (Chapter 9) for the recommended mitigation and management measures associated with Biodiversity.

8.3.6 RESIDUAL IMPACT (POST MITIGATION)

Based on the implementation of the proposed mitigation measures provided in Section 9, the residual significance of the impacts to biodiversity is as follows:

- The residual impact from loss of biodiversity during construction is considered a "Minor Negative Impact" post-mitigation (refer to Table 8-70).
- The residual impact from loss of biodiversity during operation is considered a "Minor Negative Impact" post-mitigation (refer to Table 8-71).
- The residual impact from loss of aquatic biodiversity through effluent treatment plant malfunction during operation is considered a "Minor Negative Impact" post-mitigation (refer to Table 8-72).

TABLE 8-70: RATING OF IMPACTS RELATED TO BIODIVERSITY RESOURCES (POST-MITIGATION): BIODIVERSITY LOSS DURING CONSTRUCTION

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	Impact has the potential to cause changes up to a few kms of the Project Area.
Duration	Short-term	Impact has the potential to continue for the short term
Scale	Medium	The affected habitat is modified and relatively widespread within the greater landscape. No loss of unique habitats or species are expected to occur.
Frequency	Constant	Impact has the potential to be continual
Likelihood	Unlikely	Impact is unlikely
Magnitude		
Small Magnitude related to the control of the Project Sites' impact on the surrounding environment		
Significant Rating Post Mitigation		
Minor Impact		

TABLE 8-71: RATING OF IMPACTS RELATED TO BIODIVERSITY RESOURCES (POST-MITIGATION): BIODIVERSITY LOSS DURING OPERATION

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	Impact has the potential to cause changes up to a few kms of the Project Area.

Duration	Long-term	Impact has the potential to continue for the long-term lifetime of Project.
Scale	Medium	The affected habitat is modified and relatively widespread within the greater landscape. No loss of unique habitats or species are expected to occur.
Frequency	Constant	Impact has the potential to be continual.
Likelihood	Unlikely	Impact is unlikely.
Magnitude		
Small Magnitude related to the control of the Project Sites' impact on the surrounding environment		
Significant Rating Post Mitigation		
Minor Impact		

TABLE 8-72: RATING OF IMPACTS RELATED TO BIODIVERSITY RESOURCES (POST-MITIGATION): AQUATIC BIODIVERSITY LOSS THROUGH EFFLUENT TREATMENT PLANT MALFUNCTION DURING OPERATION

Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Regional	Impact has the potential to migrate beyond the Project Area several kms transported by surface water.
Duration	Long-term	Impact has the potential to continue for the long-term lifetime of Project.
Scale	Medium	The scale of the impact is dependent on the type of contaminants that enter the surface water resource and their concentrations.
Frequency	Rarely	Impact will be rare during operation.
Likelihood	Unlikely	Impact is unlikely based on assumed adequate design of Site storm water drainage and treatment plant retention pond
Magnitude		
Small Magnitude related to related to the likelihood of only small volumes being released if proper flood assessment is incorporated in design.		
Significant Rating Post Mitigation		
Minor Impact		

8.3.7 SUMMARY OF IMPACT ASSESSMENT

A summary of pre- and post- (residual) impacts is provided in table in Table 8-73.

TABLE 8-73: SUMMARY OF BIOPHYSICAL ENVIRONMENTAL IMPACTS

Impact	Significance (pre-mitigation)	Residual Impact Significance
Impacts related to Biodiversity Loss during construction	Major Negative Impact	Minor Negative Impact
Impacts related to Biodiversity Loss during operation	Major Negative Impact	Minor Negative Impact
Aquatic Biodiversity Loss through treatment plant malfunction	Major Negative Impact	Minor Negative Impact

8.3.8 CUMULATIVE BIODIVERSITY IMPACTS

While the proposed IFF Line 2 Project is situated in a landscape shaped by human activity, the area still supports notable biodiversity and delivers valuable ecosystem services to the wider community within the Study Area. The ongoing rise in human population is driving expansion of settlements and agricultural land, which in turn reduces the availability of natural habitats. Furthermore, the conversion of greenfield sites for industrial use across the broader Study Area has already contributed, and will continue to contribute, to the loss of undeveloped land. This development also accelerates the decline of biodiversity by increasing the risk of alien invasive species entering the area and facilitating illegal access for resource extraction. As development intensifies throughout the broader Study Area, the prevalence of hardened surfaces is expected to grow, leading to elevated stormwater runoff. This increase in stormwater flows is likely to trigger erosion hazards, resulting in further declines in aquatic biodiversity due to deteriorating water quality and heightened pollution risks associated with these developments.

The Project is located within predominantly modified habitat that is widespread in the surrounding landscape and does not support critical or unique biodiversity features. Following application of the mitigation hierarchy, residual impacts are Minor Negative and not expected to result in measurable loss at a landscape scale. In line with IFC PS6, No Net Loss applies to natural habitat; however, given the modified habitat context and low significance of residual impacts, the Project is not expected to result in a net loss of biodiversity and no offsets are required at this stage, with this to be confirmed through ongoing ESMS monitoring.

8.4 IMPACTS TO THE SOCIO-ECONOMIC ENVIRONMENT

This section presents the assessment of potential social and socioeconomic impacts associated with the proposed Indorama IFF Line 2 Fertilizer Project. The assessment has been undertaken as part of the overall ESIA and is informed by the socioeconomic baseline conditions described in Section 7.6. The assessment considers both beneficial and adverse impacts on local

communities, workers, livelihoods, infrastructure, public services, and community wellbeing within the AoI. Potential impacts have been assessed based on the nature of Project activities, the sensitivity of affected receptors, and the likelihood, magnitude, extent, duration, and significance of the identified impacts. Where necessary, mitigation and enhancement measures have been identified to avoid, minimize, manage, or enhance Project-related impacts throughout the Project lifecycle. The predicted impacts to the social environment as a result of the proposed Project are described in this Box 8-1 below.

BOX 8-1: POTENTIAL SOCIO-ECONOMIC IMPACTS

- Increase employment within the area of - influence (construction and operation)
- Increased income and spending within the area of influence (construction and operation)
- Socioeconomic development benefits (construction and operation)
- Influx of migrant workers and job seekers (construction)
- Community Frustration over Unmet Expectations (construction and operation)
- Public and Worker Health and Safety Impacts (construction and operation), including:
  - Increased Incidence of Communicable Diseases (construction)
  - Increased Risk of Traffic Accidents during (construction and operation)

8.4.1 INCREASE EMPLOYMENT WITHIN THE AREA OF INFLUENCE

8.4.1.1 PROPOSED PROJECT ACTIVITIES

The AoI is characterised by high levels of unemployment (approximately 26.3%) and limited access to formal employment opportunities. Livelihoods are largely informal, with a strong reliance on farming, trading, and small-scale business activities. Formal sector employment remains limited, resulting in high dependence on a relatively small proportion of employed individuals within households. The population is predominantly young and economically active (approximately 71% working age), with evidence of in-migration driven by employment-seeking behaviour.

Construction phase

Employment generation during the construction phase will be driven by large-scale civil, mechanical, and installation works associated with the development of the IFF Line 2 fertilizer facility. The construction phase is expected to extend over approximately 33–35 months and will require a peak workforce of approximately 5,250 personnel, comprising around 4,500 national workers and 750 expatriates.

The workforce will include a mix of skilled (approximately 1,350), semi-skilled (approximately 2,790), and unskilled labour (approximately 360), with a significant proportion of workers expected to be sourced from the Niger Delta region.

These activities will result in substantial short-term employment opportunities within the Project Area of Influence (AoI), particularly during peak construction periods.

Operational phase

During operation, employment will be associated with the ongoing functioning of the fertilizer production facility, including technical, maintenance, administrative, and management roles. The Project is expected to create approximately 160 permanent positions, comprising around 110 national employees and 50 expatriates.

These opportunities will be long-term and formal in nature, aligned with the anticipated 30-year operational lifespan of the facility.

8.4.1.2 SENSITIVE RECEPTORS

Sensitive receptors include:

- Unemployed and underemployed individuals within the AoI, where unemployment is estimated at approximately 26.3%
- Youth and economically active populations, given the high proportion of working-age individuals (approximately 71%)
- Women, who demonstrate lower participation in formal employment and higher representation in informal and household roles
- Local households, which currently experience lowincome levels and limited livelihood opportunities

8.4.1.3 SIGNIFICANCE OF IMPACT

TABLE 8-74: RATING OF IMPACTS RELATED TO POSITIVE SOCIAL IMPACTS DURING CONSTRUCTION PHASE (PRE-MITIGATION)

Type of Impact		
Direct Positive Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local to regional	Employment opportunities will primarily benefit communities within the Project AoI and wider Rivers State, with approximately 89% of workers expected to be sourced from the Niger Delta region.
Duration	Short-term and long-term	Construction employment will occur over approximately 33–35 months (short-term), while operational employment will extend over the 30-year project lifespan (long-term).
Scale	Locally significant	The scale of employment during construction is substantial (approximately 5,250 workers at peak), relative to high unemployment levels (approximately 26.3%) and limited formal job opportunities within the AoI.
Frequency	Continual	Employment opportunities will be sustained throughout the construction phase and continue during operations, although at reduced levels.

Type of Impact		
Likelihood	Certain	Employment generation is inherent to project development and operation, with defined workforce requirements already established.
Magnitude		
High Positive during Construction		Medium Positive Magnitude during Operation
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
High unemployment (±26.3%) and limited formal employment opportunities High proportion of economically active population (≈71%) dependent on livelihoods Low household income levels and reliance on informal economy Structural vulnerability of youth and women in accessing formal employment		
Significant Rating Before Mitigation		
Major Positive		Moderate Positive

8.4.1.4 MITIGATION MEASURES

Refer to Section 9.4.2.1 (Chapter 9) for the recommended enhancement measures associated with increased employment within the Study Area.

8.4.1.5 RESIDUAL IMPACT (POST-MITIGATION)

Following implementation of the proposed enhancement and management measures, the positive employment impact is expected to be strengthened, more inclusive, and more sustainably distributed across the AoI. The mitigation measures primarily enhance access, equity, and long-term benefits rather than reducing the impact.

Type of Impact: Direct Positive Impact (Enhanced)

TABLE 8-75: RATING OF RESIDUAL POSITIVE SOCIAL IMPACTS RELATED TO INCREASED INCOME AND SPENDING (POST-MITIGATION)

Characteristic	Designation	Summary of Reasoning
Extent	Local to regional (enhanced)	• Increased prioritisation of local recruitment and collaboration with community leadership structures will expand equitable access to opportunities within host communities and the wider Rivers State region.
Duration	Short-term (construction) and long-term (operation)	• Duration remains unchanged; however, skills development initiatives enhance longer-term livelihood benefits beyond the construction phase.
Scale	Locally significant (enhanced)	• The scale of benefit improves through targeted inclusion of local labour, women, and vulnerable

Characteristic	Designation	Summary of Reasoning
		groups, increasing the proportion of AoI beneficiaries.
Frequency	Continual	• Employment remains continuous through construction and operation, with improved uptake due to transparent processes.
Likelihood	Certain	• Employment generation remains inherent to the Project, with mitigation measures ensuring improved accessibility and uptake.
Magnitude	**Very High Positive during Construction High Positive during Operation**	• Magnitude is increased due to improved local participation, enhanced skills, and greater inclusivity, leading to stronger and more sustained socio-economic benefits.
Sensitivity / Vulnerability / Importance	High Sensitivity	• Receptor sensitivity remains high given unemployment levels (≈26.3%), reliance on informal livelihoods, and structural vulnerabilities of youth and women

Significance Rating After Mitigation

- Construction Phase: Major Positive (Enhanced)
- Operational Phase: Major Positive (Improved from Moderate Positive)

Summary of Residual Impact

The residual impact remains strongly positive and is significantly enhanced through the implementation of mitigation measures. While the duration and nature of employment opportunities remain largely unchanged, the introduction of local hiring prioritisation, skills development, and inclusive recruitment practices will improve both the distribution and sustainability of benefits, particularly for vulnerable groups. This results in a more equitable and higher-value socio-economic outcome for the AoI.

8.4.2 INCREASED INCOME AND SPENDING WITHIN THE AREA OF INFLUENCE (CONSTRUCTION AND OPERATION)

8.4.2.1 DESCRIPTION OF BASELINE ENVIRONMENT

Household income levels within the AoI are low, with a mean monthly income of approximately ₦51,374 and the majority of households earning below ₦71,000. Livelihoods are largely informal and subsistence-based, with reliance on farming, trading, and small-scale business activities, and limited access to formal employment opportunities. Household expenditure is primarily focused on basic needs, with limited capacity for savings, reflecting low financial resilience and high vulnerability to economic change.

Construction phase

During the construction phase, increased income and spending will arise from employment of approximately 5,250 workers, including skilled, semi-skilled, and unskilled labour engaged in construction, logistics, and support activities.

This will result in increased household income for employed individuals and indirect benefits through local procurement and service demand (e.g. food, accommodation, transport, small businesses). These effects are expected to be temporary and concentrated within the construction period.

Operational phase

During operation, increased income and spending will be associated with approximately 160 permanent jobs linked to plant operations, including technical, administrative, and maintenance roles.

While the scale of employment is lower than during construction, these positions are long-term and will provide sustained income generation within the AoI.

8.4.2.2 SENSITIVE RECEPTORS

Sensitive receptors include:

- Low-income households within the AoI, where the mean monthly income is approximately ₦51,374
- Individuals engaged in informal and subsistence livelihoods
- Unemployed and underemployed populations
- Small-scale traders and local businesses dependent on household spending

8.4.2.3 SIGNIFICANCE OF IMPACT

TABLE 8-76: RATING OF IMPACTS RELATED TO POSITIVE SOCIAL IMPACTS DURING CONSTRUCTION PHASE (PRE-MITIGATION)

Type of Impact		
Direct Positive Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Income benefits will be concentrated within the Project AoI where workers reside and spend earnings.
Duration	Short-term and long-term	Short-term during construction (33–35 months) and long-term during operations (30-year lifespan).
Scale	Locally significant	The scale of employment during construction is substantial (approximately 5,250 workers at peak), relative to high unemployment levels (approximately 26.3%) and limited formal job opportunities within the AoI.

Type of Impact		
Frequency	Continual	Employment opportunities will be sustained throughout the construction phase and continue during operations, although at reduced levels.
Likelihood	Certain	Employment generation is inherent to project development and operation, with defined workforce requirements already established.
Magnitude		
High Positive during Construction		Medium Positive Magnitude during Operation
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
Receptors are highly sensitive to changes in income due to the prevailing socio-economic conditions within the AoI. The baseline indicates that the mean monthly household income is approximately ₦51,374, with the majority of households earning below ₦71,000, reflecting widespread low-income conditions and economic vulnerability.		
Significant Rating Before Mitigation		
Major positive (Construction Phase)		Moderate Positive (Operational Phase)

8.4.2.4 MITIGATION MEASURES

Refer to Section 9.4.1.1 (Chapter 9) for the recommended enhancement measures associated with increased employment within the Study Area.

8.4.2.5 RESIDUAL IMPACT (POST-MITIGATION)

Following implementation of the proposed measures, the impact on income generation and local expenditure is enhanced in terms of distribution, retention, and sustainability within the AoI. The focus of mitigation is not to reduce the impact, but to ensure that economic benefits are locally captured, equitably shared, and extended beyond direct employment.

Type of Impact: Direct Positive Impact (Enhanced)

TABLE 8-77: RATING OF RESIDUAL POSITIVE SOCIAL IMPACTS RELATED TO INCREASED INCOME AND SPENDING (POST-MITIGATION)

Characteristic	Designation	Summary of Reasoning
Extent	Local (enhanced)	Strengthened local procurement and hiring increase the proportion of income retained and circulated within host communities.
Duration	Short-term and long-term	While construction benefits remain temporary, Subject Matter Expert (SME) support and operational employment improve continuity of income and longer-term economic resilience.

Characteristic	Designation	Summary of Reasoning
Scale	Locally significant (enhanced)	Expanded participation of SMEs and local suppliers increases the number of beneficiaries beyond direct employees.
Frequency	Continual	Income inflows and spending occur consistently throughout construction and continue during operation, supported by structured procurement and employment practices.
Likelihood	Certain	The impact remains inherent to the Project, with mitigation measures improving effectiveness and local capture.
Magnitude	**Very High Positive during Construction High Positive during Operation**	Increased local income retention, broader inclusion, and strengthened local enterprise base enhance overall magnitude.
Sensitivity / Vulnerability / Importance	High Sensitivity	Receptors remain highly vulnerable due to low baseline income and limited financial resilience.

Significance Rating After Mitigation

- Construction Phase: Major Positive (Enhanced)
- Operational Phase: Major Positive (Improved from Moderate Positive)

Summary of Residual Impact

The residual impact is strongly positive and enhanced, driven by improved local procurement, inclusive hiring, and support to SMEs. These measures ensure that project-related income is more widely distributed and retained within the AoI, strengthening local economic activity and household resilience. While construction-phase benefits are inherently short-term, the interventions improve the sustainability and inclusivity of income generation, resulting in a more durable positive socio-economic outcome during operations.

8.4.3 INFLUX OF MIGRANT WORKERS AND JOB SEEKERS (CONSTRUCTION)

8.4.3.1 DESCRIPTION OF BASELINE ENVIRONMENT

The AoI already experiences moderate in-migration driven primarily by employment and business opportunities, linked to existing industrial and commercial activity. This has contributed to population growth, increased demand for housing and services, and evolving settlement patterns. Infrastructure and services, including water supply, sanitation, waste management, and healthcare, are available but constrained in capacity and reliability. The area is also characterised by high unemployment (≈26.3%), low incomes, and strong reliance on informal livelihoods, contributing to sensitivity around access to economic opportunities.

Construction phase

The construction phase will result in an influx of workers and job seekers into the Project AoI, driven by employment opportunities associated with a peak workforce of approximately 5,250 personnel. This influx will increase demand for housing, services, and economic opportunities within host communities and surrounding areas.

Operational phase

No significant influx is expected during the operational phase, as the workforce will be significantly smaller (approximately 160 personnel) and largely stabilised.

8.4.3.2 SENSITIVE RECEPTORS

Sensitive receptors include:

- Host community residents within the AoI
- Households dependent on local infrastructure and services
- Low-income households vulnerable to increases in cost of living
- Community structures and local governance systems
- Informal housing and rental markets

8.4.3.3 SIGNIFICANCE OF IMPACT

TABLE 8-78: RATING OF IMPACTS RELATED TO INFLUX OF MIGRANT WORKERS AND JOB SEEKERS INTO ADJACENT COMMUNITIES (PRE-MITIGATION)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local to Regional	Influx will affect host communities and surrounding areas within Rivers State.
Duration	Long-term	Migrants are likely to settle fairly permanently and throughout the construction and operation phases of the Project.
Scale	Locally significant	Large workforce influx relative to infrastructure capacity and existing population dynamics.
Frequency	Continual	Influx-related pressures will persist throughout construction.
Likelihood	Certain	Existing migration patterns indicate strong potential for increased in-migration..
Magnitude		
High Negative (Construction)		Medium Negative (Operation)
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
Receptors are highly sensitive to influx-related pressures due to existing constraints in infrastructure, services, and socio-economic conditions within the AoI. The baseline indicates that		

Type of Impact	
water supply, electricity, waste management, and sanitation systems are already limited in reliability and capacity. The area is also characterised by high unemployment and strong community expectations for employment opportunities, which increases the risk of tension where perceived competition occurs between local residents and incoming job seekers.	
Significant Rating Before Mitigation	
Major Negative (Construction Phase)	Moderate Negative (Operational Phase)

8.4.3.4 MITIGATION MEASURES

Refer to Section 9.4.1.2 (Chapter 9) for the recommended enhancement measures associated with increased employment within the Study Area.

8.4.3.5 RESIDUAL IMPACT (POST-MITIGATION)

Following implementation of the proposed management measures, the negative impacts associated with labour influx are expected to be substantially reduced in scale, duration, and intensity. The mitigation approach focuses on controlling in-migration, reducing pressure on local services, and minimising social tensions through proactive planning and local workforce prioritisation.

Type of Impact: Direct Negative Impact (Managed/Reduced)

TABLE 8-79: RATING OF RESIDUAL SOCIAL IMPACTS RELATED TO INFLUX OF MIGRANT WORKERS AND JOB SEEKERS (POST-MITIGATION)

Characteristic	Designation	Summary of Reasoning
Extent	Local (reduced)	• Impacts are largely contained within the immediate Project AoI due to controlled workforce accommodation and influx management measures.
Duration	Short-term to medium-term	• Influx effects are largely limited to the construction period, with reduced likelihood of long-term settlement due to active management and communication measures.
Scale	Moderate (reduced from locally significant)	• Prioritisation of local employment and provision of worker accommodation reduces the number of incoming job seekers and pressure on local systems.
Frequency	Intermittent to continual	• Influx pressures may occur periodically during peak construction but are reduced through monitoring and management.
Likelihood	Likely	• While influx cannot be fully eliminated, measures significantly reduce uncontrolled in-migration.

Characteristic	Designation	Summary of Reasoning
Magnitude	**Medium Negative (Construction)** **Low Negative (Operation)**	• Magnitude is reduced due to controlled labour sourcing, accommodation strategies, and reduced community-level pressures.
Sensitivity / Vulnerability / Importance	High Sensitivity	• Receptors remain sensitive due to existing infrastructure constraints, unemployment, and socio-economic vulnerability.

Significance Rating After Mitigation

- Construction Phase: Moderate Negative (Reduced from Major Negative)
- Operational Phase: Minor Negative (Improved from Moderate Negative)

Summary of Residual Impact

The residual impact is moderate to minor negative and significantly reduced following mitigation. The implementation of a labour influx management plan, local hiring prioritisation, and provision of worker accommodation will help limit in-migration, reduce pressure on infrastructure and services, and minimise potential social tensions. While some level of influx remains inevitable during peak construction, the impact is expected to be manageable, localised, and largely confined to the construction phase, with minimal long-term effects during operation.

8.4.4 SOCIO-ECONOMIC DEVELOPMENT BENEFITS (CONSTRUCTION AND OPERATION)

8.4.4.1 DESCRIPTION OF BASELINE ENVIRONMENT

The AoI is characterised by a predominantly informal, subsistence-based economy, with livelihoods centred on farming, trading, and small-scale enterprise activities. Formal employment opportunities are limited, and unemployment remains high (approximately 26.3%). Household incomes are generally low (mean ~₦51,374/month), with most households falling within lower income brackets, reflecting limited financial resilience. Economic activity is largely localised and dependent on internal demand, with small-scale businesses operating with limited access to capital and markets.

Construction phase

During the construction phase, socioeconomic development benefits will arise from the combined effects of employment generation, increased income flows, and demand for local goods and services. The presence of a large construction workforce will stimulate local economic activity through increased demand for accommodation, food supply, transportation, and other services.

This is expected to create indirect economic opportunities for local businesses, including small-scale traders, service providers, and informal sector participants, thereby supporting broader local economic development within the AoI.

Operational phase

During operation, socioeconomic development benefits will be associated with sustained formal employment (approximately 160 jobs), continued procurement of goods and services, and the Project's contribution to industrial and economic activity within the region. The Project is also expected to reinforce the role of the area as an industrial hub, supporting longer-term economic stability and ongoing opportunities for local businesses and service providers.

8.4.4.2 SENSITIVE RECEPTORS

Sensitive receptors include:

- Local businesses and informal sector operators within the AoI
- Small and medium enterprises
- Low-income households reliant on local economic activity
- Youth and economically active population seeking livelihood opportunities
- Community development structures and local economic systems

8.4.4.3 SIGNIFICANCE OF IMPACT

TABLE 8-80: RATING OF IMPACTS RELATED TO POSITIVE SOCIAL IMPACTS DURING CONSTRUCTION PHASE (PRE-MITIGATION)

Type of Impact		
Direct Positive Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local to Regional	Benefits will be experienced within the AoI and extend to surrounding areas through supply chains and economic linkages.
Duration	Short-term and Long-term	Benefits will occur during construction (short-term) and continue during operations over the Project lifecycle.
Scale	Locally significant	The scale of economic stimulation is notable given the existing reliance on informal livelihoods and limited formal economic opportunities within the AoI.
Frequency	Continual	Economic activity and associated benefits will occur continuously throughout construction and operation.
Likelihood	Certain	Economic benefits are a direct outcome of project implementation, employment, and procurement activities.
Magnitude		
Medium–High Positive (Construction Phase)	Medium Positive (Operational Phase)	
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		

Type of Impact	
Receptors are highly sensitive due to low household incomes, high reliance on informal livelihoods, and limited access to formal economic opportunities within the AoI. These conditions mean that increases in economic activity directly influence income, livelihoods, and overall household welfare.	
Significant Rating Before Mitigation	
Major Positive (Construction Phase)	Moderate Positive (Operational Phase)

8.4.4.4 MITIGATION MEASURES

Refer to Section 9.4.1.4 (Chapter 9) for the recommended enhancement measures associated with increased employment within the Study Area.

8.4.4.5 RESIDUAL IMPACT (POST-MITIGATION)

Following implementation of the proposed measures, the socio-economic development benefits associated with the Project are expected to be enhanced, more inclusive, and more sustainable across the Area of Influence (AoI). The measures focus on strengthening local economic linkages, improving SME participation, and building long-term capacity, thereby increasing the depth and durability of benefits.

Type of Impact: Direct Positive Impact (Enhanced)

TABLE 8-81: RATING OF RESIDUAL POSITIVE SOCIAL IMPACTS RELATED TO SOCIO-ECONOMIC DEVELOPMENT BENEFITS (POST-MITIGATION)

Characteristic	Designation	Summary of Reasoning
Extent	Local to regional (enhanced)	• Strengthened local procurement and supply chain participation expand benefits within the AoI and into wider regional economic networks.
Duration	Short-term and long-term	• Construction-related benefits remain temporary, while SME strengthening, skills development, and sustained operations enhance long-term economic stability.
Scale	Locally significant to regional (enhanced)	• Increased participation of SMEs and informal businesses broadens the reach of economic benefits across multiple sectors and stakeholders.
Frequency	Continual	• Economic activity and associated benefits continue throughout construction and operation, with improved consistency due to structured engagement and procurement.
Likelihood	Certain	• Benefits remain inherent to Project implementation, with mitigation measures ensuring improved access and distribution.

Characteristic	Designation	Summary of Reasoning
Magnitude	**High Positive during Construction Medium–High Positive during Operation**	• Magnitude is enhanced through stronger local economic linkages, improved SME capacity, and sustained industrial activity during operations.
Sensitivity / Vulnerability / Importance	High Sensitivity	• Receptors remain highly sensitive due to low incomes, reliance on informal livelihoods, and limited access to formal economic opportunities.

8.4.4.6 MITIGATION MEASURES

Refer to Section 9.2.8.1 (Chapter 9) for the recommended enhancement measures associated with increased employment within the Study Area.

Significance Rating After Mitigation

- Construction Phase: Major Positive (Enhanced)
- Operational Phase: Major Positive (Improved from Moderate Positive)

Summary of Residual Impact

The residual impact is strongly positive and enhanced, reflecting improved local economic participation, capacity building, and inclusivity. Measures such as local procurement, SME support, and skills development ensure that benefits are more widely distributed and sustained beyond the immediate Project workforce. This contributes to strengthened local economies, improved livelihoods, and increased resilience, positioning the AoI for longer-term socio-economic development.

8.4.5 COMMUNITY FRUSTRATION OVER UNMET EXPECTATIONS (CONSTRUCTION AND OPERATION)

8.4.5.1 DESCRIPTION OF BASELINE ENVIRONMENT

The Project AoI is characterised by high levels of unemployment (approximately 26.3%) and limited access to formal employment opportunities, with livelihoods largely dependent on informal and subsistence-based activities such as farming, trading, and small-scale businesses. Household income levels are low, with a mean monthly income of approximately ₦51,374, and the majority of households earning below ₦71,000. These conditions reflect widespread economic vulnerability and limited financial resilience among community members. The population is relatively young and economically active (approximately 71% working-age), with evidence of in-migration driven primarily by employment and business opportunities, reinforcing the role of the AoI as an emerging economic centre. There is notable reliance on industrial development, including existing Indorama operations, for employment and economic activity. Access to these opportunities is influenced by skills requirements, which may limit participation of unskilled and semi-skilled individuals. Expectations for employment,

procurement, and broader socioeconomic benefits are therefore relatively high, reflecting prevailing economic conditions, population growth, and ongoing industrial expansion.

Construction phase

During the construction phase, community frustration may arise where expectations around employment, procurement opportunities, and project benefits are not met. Given the scale of the construction workforce (approximately 5,250 personnel), the Project is likely to generate strong expectations among host communities for direct employment and participation in project-related activities.

However, the availability of positions for skilled and semi-skilled roles may not align with local labour capacity, resulting in a proportion of opportunities being filled by non-local workers. This may contribute to perceptions of exclusion, particularly among youth and unemployed individuals. In addition, the temporary nature of construction employment may lead to short-lived economic benefits, which, if not clearly communicated, may exacerbate dissatisfaction once employment opportunities decline.

Operational phase

During operation, the potential for frustration may persist due to the significantly reduced workforce compared to the construction phase. This reduction in employment opportunities may result in unmet expectations regarding long-term job creation and sustained economic benefits. In addition, community expectations for broader development benefits may extend beyond the Project's direct scope, increasing the risk of perceived inequitable benefit distribution.

8.4.5.2 SENSITIVE RECEPTORS

Sensitive receptors include:

- Unemployed and underemployed individuals within host communities
- Youth and economically active population seeking employment
- Local businesses expecting procurement opportunities
- Traditional leadership structures and community governance systems
- Households with high dependency on Project-related opportunities

8.4.5.3 SIGNIFICANCE OF IMPACT

TABLE 8-82: RATING OF IMPACTS RELATED TO COMMUNITY ANGER OVER UNMET EXPECTATIONS (PRE-MITIGATION)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Frustration is likely to be concentrated within host communities and the immediate AoI
Duration	Short-term and Long-term	May arise during construction and persist into operations due to reduced employment opportunities.
Scale	Locally significant	The scale of economic stimulation is notable given the existing reliance on informal livelihoods and limited formal economic opportunities within the AoI.
Frequency	Continual	Likely to occur periodically, particularly during recruitment cycles and transition between construction and operation.
Likelihood	Certain	Baseline conditions indicate high unemployment and strong dependence on Project-related opportunities, increasing the likelihood of unmet expectations.
Magnitude		
High Negative (Construction)	Medium Negative (Operational Phase)	
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
Receptors are highly sensitive due to high unemployment, limited formal job opportunities, and strong dependence on Project-related employment and economic benefits within the AoI.		
Significant Rating Before Mitigation		
Major Negative (Construction Phase)	Moderate Negative (Operational Phase)	

8.4.5.4 MITIGATION MEASURES

Refer to Section 9.4.1.4 (Chapter 9) for the recommended enhancement measures associated with increased employment within the Study Area.

8.4.5.5 RESIDUAL IMPACT (POST-MITIGATION)

Following implementation of the proposed measures, the impact related to community frustration over unmet expectations is expected to be reduced in intensity, better managed, and more contained. The mitigation approach focuses on transparent communication, realistic expectation setting, inclusive engagement, and grievance redress, which collectively reduce the likelihood of dissatisfaction escalating into broader social tensions.

TABLE 8-83: RATING OF RESIDUAL SOCIAL IMPACTS RELATED TO COMMUNITY FRUSTRATION OVER UNMET EXPECTATIONS (POST-MITIGATION)

Characteristic	Designation	Summary of Reasoning
Extent	Local (contained)	• Frustration remains largely confined to host communities, with improved communication and engagement limiting escalation beyond the immediate AoI.
Duration	Short-term to medium-term	• Frustration is primarily associated with recruitment phases and transition from construction to operations, with reduced persistence due to proactive expectation management.
Scale	Moderate (reduced from locally significant)	• Transparent recruitment processes, local hiring measures, and skills development reduce perceptions of exclusion and scale of dissatisfaction.
Frequency	Intermittent	• Occurs periodically (e.g. recruitment cycles), but reduced through continuous engagement and communication mechanisms.
Likelihood	Likely	• While expectations cannot be fully eliminated, mitigation measures significantly reduce misunderstandings and grievances.
Magnitude	**Medium Negative (Construction) Low Negative (Operation)**	• Magnitude is reduced due to improved awareness of employment limitations, better access to opportunities, and functional grievance mechanisms.
Sensitivity / Vulnerability / Importance	High Sensitivity	• Receptors remain highly sensitive due to unemployment, low incomes, and reliance on Project-related opportunities.

Significance Rating After Mitigation

- Construction Phase: Moderate Negative (Reduced from Major Negative)
- Operational Phase: Minor Negative (Improved from Moderate Negative)

Summary of Residual Impact

The residual impact is moderate to minor negative and effectively managed. Through clear communication of employment limitations, transparent recruitment, and active stakeholder engagement, the Project reduces the risk of unrealistic expectations and perceived inequities. The establishment of a grievance mechanism and continued engagement with community

leadership further supports early identification and resolution of concerns. While some level of dissatisfaction may persist due to underlying socio-economic conditions, the impact is expected to be localised, intermittent, and unlikely to escalate into significant community conflict.

8.4.6 PUBLIC AND WORKER HEALTH, SAFETY, AND HUMAN RIGHTS IMPACTS

8.4.6.1 DESCRIPTION OF BASELINE ENVIRONMENT

The AoI has moderate access to infrastructure and services, but with capacity and reliability constraints. Healthcare facilities are present but limited and unevenly distributed. Water supply relies largely on boreholes and vendors, while sanitation and waste management systems are mixed, with continued use of informal practices. The area is well connected by major roads, with high dependence on road transport (≈65%). Socio-economic conditions are characterised by low incomes (mean ~₦51,374/month), high unemployment (~26.3%), and reliance on informal livelihoods, which limit access to services and increase vulnerability.

Construction phase

During the construction phase, public and worker health and safety risks will arise primarily from increased project activity, workforce presence, and interaction with surrounding communities.

The large construction workforce personnel will increase the concentration of people within and around the Project AoI, placing additional pressure on already constrained health services and infrastructure. The baseline indicates that healthcare facilities are limited in capacity and unevenly distributed, with communities relying on a combination of small clinics, maternity centres, and informal health providers.

Influx of workers and increased mobility may elevate the risk of communicable disease transmission, particularly where living conditions are crowded or where access to adequate water, sanitation, and waste management remains inconsistent. Existing reliance on boreholes, informal waste disposal practices, and variable sanitation systems further contributes to this vulnerability. Construction activities will also increase traffic volumes, including heavy-duty vehicles transporting equipment and materials along key transport corridors such as the East–West Road and Port Harcourt–Aba Expressway. This introduces an elevated risk of road safety incidents affecting both workers and local communities who depend on these routes for daily movement and livelihoods.

Occupational health and safety risks will be inherent to construction activities, including exposure to machinery, working at height, and general construction hazards. While these risks are typical of large infrastructure projects, their significance is influenced by the scale and duration of construction activities. From a human rights perspective, key considerations relate to fair access to employment, non-discrimination in recruitment, and the conduct of security arrangements. In a context where access to economic opportunities is limited, perceptions of exclusion or unfair recruitment practices may raise concerns regarding equity and inclusion, particularly among vulnerable groups.

Operational phase

Sensitive receptors include workers directly employed on-site, as well as host community residents, particularly those living in proximity to transport routes and industrial infrastructure.

Communities with limited access to healthcare, water, sanitation, and other essential services are particularly sensitive to changes in public health conditions. In addition, vulnerable groups including low-income households, women, and youth may be disproportionately affected due to limited access to services and economic opportunities. Local road users, informal traders operating along transport corridors, and households situated near high-traffic routes are also key receptors in relation to safety risks.

8.4.6.2 SENSITIVE RECEPTORS

- Sensitive receptors include workers directly employed by the Project, as well as host community residents within the AoI, particularly those located near major transport routes (e.g. East–West Road and Port Harcourt–Aba Expressway) and existing industrial infrastructure, where exposure to traffic and industrial risk is highest.
- Communities are considered highly sensitive due to limited and uneven access to healthcare facilities, which are predominantly small clinics and maternity centres with constrained capacity. In addition, reliance on boreholes for water supply, inconsistent sanitation systems, and mixed waste management practices increase vulnerability to public health impacts.
- Vulnerable groups including low-income households, women, and youth—are particularly susceptible due to high dependence on informal livelihoods, limited access to services, and existing economic constraints within the AoI.
- Local road users, including pedestrians, informal traders, and transport operators along key corridors, are also sensitive receptors given the high reliance on road-based transport (approximately 65% of mobility), which increases exposure to traffic-related safety risks.

8.4.6.3 SIGNIFICANCE OF IMPACT

TABLE 8-84: RATING OF IMPACTS RELATED TO PUBLIC AND WORKER HEALTH, SAFETY, AND HUMAN RIGHTS IMPACTS (PRE-MITIGATION)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local to Regional	Health and safety risks affect both the Project site and surrounding communities, particularly along transport routes and within host communities.
Duration	Short-term and Long-term	Construction-related risks are short-term, while operational risks extend over the Project lifecycle.
Scale	Locally significant	Risks are notable due to the scale of construction, existing infrastructure constraints, and the presence of industrial hazards during operation.
Frequency	Continual	Health and safety risks are present throughout construction and operation, with peak intensity during construction.
Likelihood	Certain	Risks are inherent to construction and industrial activities, compounded by baseline vulnerabilities within the AoI..

Type of Impact	
Magnitude	
High Negative (Construction)	Medium Negative (Operational Phase)
Sensitivity/Vulnerability/Importance of the Resource/Receptor	
High Sensitivity	
Receptors are highly sensitive due to limited healthcare capacity, inconsistent access to water and sanitation, and existing socio-economic vulnerabilities within the AoI, which increase exposure to public health and safety risks.	
Significant Rating Before Mitigation	
Major Negative (Construction Phase)	Moderate Negative (Operational Phase)

8.4.6.4 MITIGATION MEASURES

Refer to Section 9.4.1.5 (Chapter 9) for the recommended enhancement measures associated with increased employment within the Study Area.

8.4.6.5 RESIDUAL IMPACT (POST-MITIGATION)

Following implementation of the proposed measures, the impacts on public and worker health, safety, and human rights are expected to be substantially reduced, controlled, and systematically managed. The mitigation measures introduce structured systems for occupational health and safety, transport management, public health protection, and human rights compliance, thereby reducing both the likelihood and severity of adverse outcomes.

Type of Impact: Direct Negative Impact (Managed/Reduced)

TABLE 8-85: RATING OF RESIDUAL IMPACTS RELATED TO PUBLIC AND WORKER HEALTH, SAFETY, AND HUMAN RIGHTS (POST-MITIGATION)

Characteristic	Designation	Summary of Reasoning
Extent	Local (contained)	• Risks are largely confined to the Project site and immediate AoI due to effective health, safety, and transport management controls.
Duration	Short-term and long-term	• Construction risks remain temporary, while operational risks persist but are reduced through continuous management systems and monitoring.
Scale	Moderate (reduced from locally significant)	• Implementation of OHS systems, workforce management, and health measures reduces the scale and spread of potential impacts.
Frequency	Continual (controlled)	• Risks remain present but are systematically managed through ongoing procedures, supervision, and training.

Characteristic	Designation	Summary of Reasoning
Likelihood	Unlikely to Likely (reduced)	• Strong management frameworks and controls reduce the probability of incidents and health impacts compared to baseline conditions.
Magnitude	**Medium Negative (Construction) Low Negative (Operation)**	• Magnitude decreases due to effective mitigation, including reduced exposure to hazards, improved health controls, and safer transport practices.
Sensitivity / Vulnerability / Importance	High Sensitivity	• Receptors remain highly sensitive due to baseline constraints in healthcare, water, sanitation, and socio-economic conditions.

Significance Rating After Mitigation

Following implementation of mitigation measures, the residual significance of impacts related to public and worker health, safety and human rights is assessed as **Minor Negative** during the construction phase and **Minor Negative** during the operational phase. While risks are inherently higher during construction due to workforce size, traffic and community interaction, the application of robust management measures reduces these risks to a localised and manageable level. During operation, lower workforce intensity and established management systems further reduce impact magnitude, resulting in a low, stable and manageable residual effect consistent with international good practice.

Summary of Residual Impact

The residual impact is moderate to minor negative and effectively managed. The implementation of robust occupational health and safety systems, transport management measures, and public health interventions significantly reduces risks to both workers and surrounding communities. Human rights risks are also mitigated through transparent recruitment, non-discrimination policies, and accessible grievance mechanisms.

While risks cannot be entirely eliminated due to the nature of construction and industrial operations, they are expected to be controlled, localised, and maintained within acceptable limits, consistent with international standards and good industry practice.

8.4.7 CUMULATIVE IMPACT ASSESSMENT

8.4.7.1 INTRODUCTION

IFC PS 1 (Paragraph 5) defines the broader Project Area as including "…areas potentially impacted by cumulative impacts from further planned development of the Project, any existing project or condition, and other project-related developments that are realistically defined at the time the Environmental and Social Impact Assessment is undertaken." In the context of the IFF Line 2 Project, the broader Project Area includes the surrounding AoI located within Eleme and Obio/Akpor LGAs, where existing industrial operations, including the Indorama Industrial Complex, and ongoing urban and industrial expansion contribute to cumulative

environmental and social impacts. Cumulative impacts arise from the interaction of the Project with existing conditions and other developments, where combined effects may increase the magnitude or significance of impacts on shared receptors, including communities, infrastructure, and services. The assessment presented in this Chapter considers the cumulative social impacts associated with the Project in combination with existing and reasonably foreseeable developments within the AoI.

8.4.7.2 THE DEVELOPMENT CONTEXT

The Project AoI is located within a highly industrialized and rapidly urbanizing area of Rivers State, influenced by the presence of major industrial infrastructure, including the existing Indorama Fertilizer and Petrochemical Complex. The Project is situated within the Indorama Free Zone (IFZ), which forms part of a broader industrial corridor associated with petrochemical, fertilizer, oil and gas, logistics, and port-related activities.

Existing development trends within the broader area that contribute to cumulative impacts include:

- Continued industrial expansion within the Indorama Free Zone, reinforcing the area as a regional industrial hub;
- Implementation of the Greater Port Harcourt City (GPHC) Development Plan, which promotes urban expansion, infrastructure development, and increased population density;
- Ongoing in-migration driven by employment and business opportunities, contributing to population growth and increased demand for housing, infrastructure, and services; and
- Expansion of residential, commercial, and service-related developments associated with industrial growth and urbanization.

These factors have contributed to increasing pressure on infrastructure, housing, land availability, and service delivery systems within the AoI. The presence of existing industrial facilities, transport infrastructure, and associated economic activities has also influenced settlement patterns, economic opportunities, and population dynamics within surrounding communities. The proposed Project will therefore contribute to an already evolving socioeconomic environment where cumulative impacts may arise through the interaction of multiple existing and future developments.

8.4.7.3 IDENTIFIED CUMULATIVE IMPACTS

The cumulative impacts associated with the Project arise from the interaction between Project activities and existing development trends within the AoI, including ongoing industrial expansion, urbanisation, and population growth. These cumulative impacts affect shared receptors, including host communities, infrastructure, public services, and local economies, and are influenced by existing baseline conditions such as high unemployment, relatively low household incomes, and constraints in service delivery and infrastructure provision.

Key cumulative impacts identified include:

- Population influx and urban expansion driven by employment and business opportunities associated with multiple industrial developments;

- Increased pressure on infrastructure and public services, including water supply, sanitation, healthcare, housing, transportation, and waste management systems;
- Elevated community expectations regarding employment, procurement opportunities, community investment, and broader socioeconomic benefits associated with industrial development;
- Increased competition for employment opportunities and access to resources, particularly among economically vulnerable groups;
- Increased traffic volumes, congestion, and associated road safety risks resulting from combined industrial, commercial, and logistics activities within the area; and
- Increased demand for housing and land, potentially contributing to rising living costs and pressure on available accommodation.

These impacts are interrelated and may be amplified where multiple developments occur concurrently. Without appropriate planning and management, they have the potential to contribute to cumulative pressure on community infrastructure, public services, and socioeconomic wellbeing within the AoI. Conversely, effective coordination between developers, government authorities, and service providers may enhance the cumulative socioeconomic benefits associated with ongoing industrial development in the area.

8.4.7.4 MITIGATION MEASURES FOR CUMULATIVE IMPACTS

Refer to Section 9.4.1.5 for management measures.

8.4.8 MAJOR ACCIDENT HAZARDS, PROCESS SAFETY AND EMERGENCY PREPAREDNESS

AfDB OS4 (paras 25–31) and IFC PS4 require the Borrower to assess the risk of community exposure to hazardous materials and to prepare an Emergency Preparedness and Response Plan based on a risk and hazard assessment. IFF Line 2 will hold significant inventories of flammable natural gas and synthesis gas, toxic and flammable anhydrous ammonia and, at the UFC-85 plant, methanol and formaldehyde. A loss of containment could result in toxic gas dispersion, jet or pool fires, flash fires or vapour cloud explosions with potential consequences for workers, neighbouring facilities and nearby communities.

The process safety design of IFF Line 2 replicates that of IFF Line 1 (Section 4.3.1.1) and includes an integrated DCS/ESD system, a Fire and Gas System (gas, ammonia and fire detection, alarms, deluge and FM-200 suppression, hydrant network), relief and pressure-control devices sized for worst-case conditions and routed to dedicated flares, remotely operated isolation valves and the 24-hour manned complex fire station. Process hazards will be further reviewed through HAZOP and SIL studies during detailed engineering under the EPC contract.

The Indorama complex is covered by an integrated QRA developed by DNV using the Safeti software. The most recent study, the IEFCL Line-3 QRA (DNV Report No. 10405953-002, Rev. 1, 11 December 2023), assessed the IEPL petrochemical complex and fertilizer Lines 1–3 against UK HSE tolerability criteria (individual risk upper limit for the public of 10^{-4} per year; LSIR of 10^{-5} per year for off-site residential populations; societal risk F-N criterion through 2×10^{-4} per year for N = 50). The QRA concluded that site risk is dominated by toxic ammonia releases; that LSIR at the nearest residential property is approximately 1×10^{-5} per year, within the "tolerable if ALARP" region; that the 10^{-4} per year contour extends approximately 250 m

beyond the north-west site boundary into an area confirmed by a third-party survey to be uninhabited; and that societal risk lies within the "tolerable if ALARP" region. Its recommendations (verification of ammonia leak detection and isolation performance, updating of the Emergency Management Plan and of emergency communication protocols with government agencies, monitoring of residential development to the north and north-west of the complex, provision of emergency announcement, CCTV and breathing apparatus in new plant areas, adherence to preventive maintenance and testing schedules, and regular emergency training and drills) apply equally to IFF Line 2.

Because IFF Line 2 will be located north of IFF Line 1, its ammonia inventory is expected to extend the off-site risk contours further to the north and north-west. IFF has therefore engaged DNV to update the integrated QRA model (DNV proposal OPP-00483666, 9 October 2026) to include IFF Line 2 (Line 4), FCU-3 and the UF-85 plant (including methanol storage and road-tanker operations), together with the ammonia storage and export road-tanker facilities. Line 4 and FCU-3 are functionally identical to Line 3 and FCU-1 respectively, so the established failure-case definitions, parts counts and leak frequencies will be applied, while UF-85 will be modelled from its PFDs and heat and material balances. The study will report LSIR contours, individual risk per annum and F-N curves for each development and cumulatively for the complex, together with hazard-frequency contours for fire and blast loads and any risk-reduction measures required to demonstrate ALARP. Completion is planned for December 2026, ahead of commissioning.

IFF commits to the following: (i) the draft and final QRA reports shall be shared with AfDB and the other lenders; (ii) QRA recommendations shall be incorporated into detailed design, the ESMMP and the EPRP before commissioning; (iii) IFF shall continue to monitor land use within the off-site risk contours; and (iv) a consolidated EPRP for IFF Line 2, combining the on-site and off-site emergency plans of the complex and reviewed at least every three years or after any significant change or incident. With these measures, the residual community risk from major accidents is expected to remain within the tolerable (ALARP) region.

8.5 CULTURAL HERITAGE IMPACTS

8.5.1 IDENTIFICATION OF POTENTIAL IMPACTS

The predicted impacts to the cultural heritage resources as a result of the Project are described in this section. The impact assessment considers both tangible and intangible cultural heritage resources as described below[37]:

- Tangible cultural heritage – such as (but not limited to) archaeological sites, built heritage (historic or culturally significant buildings or structures), places of worship, historic enclosures, and potential settlements; and
- Intangible cultural heritage – such as (but not limited to) places that hold cultural, artistic, or religious values, knowledge, innovations, and practices of communities embodying traditional lifestyles, and living heritage resources (shrines, cemeteries, religious/ritual sites) etc.

[37] https://www.ifc.org/content/dam/ifc/doc/2010/2012-ifc-performance-standard-8-en.pdf. Accessed: 09/06/2026

8.5.1.1 DIRECT, INDIRECT, AND CUMULATIVE IMPACTS

Three types of impacts to cultural heritage resources are considered in this assessment resulting from construction and operation phases of the Project:

- **Direct**: ground disturbance due to earthworks are the most likely source of direct, physical impacts to known and unknown cultural heritage resources, with the potential to partially or wholly remove these resources. Direct impacts have the potential to be once off, non-reversible and permanent. Unless the principle of avoidance is adopted in the first instance, mitigation measures may not significantly reduce the predicted residual effect of this impact on the cultural heritage.
- **Indirect**: cultural heritage resources are susceptible to indirect impacts through the introduction of intrusive visual, auditory or dust elements to their physical environment or 'setting'. Indirect impacts also include restricted access to existing cultural heritage resources as a result of construction and/or operation phases; and
- **Cumulative**: impacts to cultural heritage resulting from incremental change caused by surrounding projects in the past, present or reasonably foreseeable future, combined with this Project.

8.5.2 IMPACT MAGNITUDE

Standard terminology and designations of impact magnitude as per Table 8-86 is provided to ensure consistency when characteristics are described in an impact assessment report. An assessment of the overall magnitude of impact is provided by considering all the dimensions of the impact described in order to determine whether an impact is of negligible, small, medium or large magnitude (ERM Impact Assessment Methodology, 2021).

TABLE 8-86: IMPACT MAGNITUDE DEFINITIONS FOR CULTURAL HERITAGE

Magnitude	Cultural Heritage resources
Negligible	No discernible change in the physical condition, setting or accessibility of the site
Small	Small part of the site is lost or damaged, resulting in a loss of scientific or cultural value; Setting undergoes temporary or permanent change that has limited effect on the site's perceived value to stakeholders; Stakeholder/public or scientific access to site is temporarily impeded; and/or Historic building suffers minor, reparable, structural damage.
Medium	A significant portion of the site is lost or damaged, resulting in a loss of scientific or cultural value; Setting undergoes permanent change that permanently diminishes the site's perceived value to stakeholders; Site becomes inaccessible for the life of the Project to stakeholders including traditional users or researchers; and/or Historic building suffers major structural damage that is not reparable.
Large	The entire site is damaged or lost, resulting in a nearly complete or complete loss of scientific or cultural value; Setting is sufficiently impacted to cause site to lose nearly all or all cultural value or functionality; Site becomes permanently inaccessible to stakeholders including traditional users or researchers; and/or Historic building suffers major structural failure.

8.5.3 SUMMARY OF IMPACTS TO CULTURAL HERITAGE RESOURCES

A summary of the potential direct and indirect impacts to Cultural Heritage at construction and operation phase is presented in Table 8-87.

TABLE 8-87: SUMMARY OF POTENTIAL IMPACTS TO CULTURAL HERITAGE RESOURCES

Construction Phase (quantity of Cultural Heritage resources impacted as shown)			
Sensitivity	**Direct Impacts**	**Indirect impacts**	**No Impact**
High	0	0	9
Medium	0	0	8
Low	0	0	4
Total	**0**	**0**	**21**
Operation Phase (quantity of Cultural Heritage resources impacted as shown)			
Sensitivity	**Direct Impacts**	**Indirect impacts**	**No Impact[38]**
High	0	0	9
Medium	0	0	8
Low	0	0	4
Total	**0**	**0**	**21**

8.5.3.1 NO IMPACTS:

None of the identified cultural heritage resources were identified within the Project Site. This is because all cultural heritage resources fall outside of the construction corridor and the identified cultural heritage resources may experience no impact during the construction and operation phase.

8.5.4 MANAGEMENT MEASURES.

Refer to Section 9.5 for the identified management measures.

8.6 TRAFFIC AND TRANSPORT IMPACTS

This section describes the impacts of Project traffic on public roads within the AoI. Section 7.8 describes the baseline environment for traffic and transportation.

[38] If a Cultural Heritage resource falls wholly within the construction area, it has been assumed it will be fully removed at construction phase, and therefore no impact will occur at operation phase.

8.6.1 PROPOSED PROJECT ACTIVITIES

The Project would include the construction and operation of the Project as described in Section 7.8. Trucks carrying urea and over dimensional cargo (ODC) or super ODC loads to or from Onne Port would travel southeast via the Agbonchia New Road, briefly west on the East-West Road, and would then access the port via Onne Road and Federal Ocean Terminal. Roadway, a 27.3 km trip (return trips would use the inverse route). Other traffic would access the Project site via the East-West Road and Indorama Complex Road. The trip from the Indorama Complex to the port using this route is 21.5 km. Figure 8-14 shows these routes.

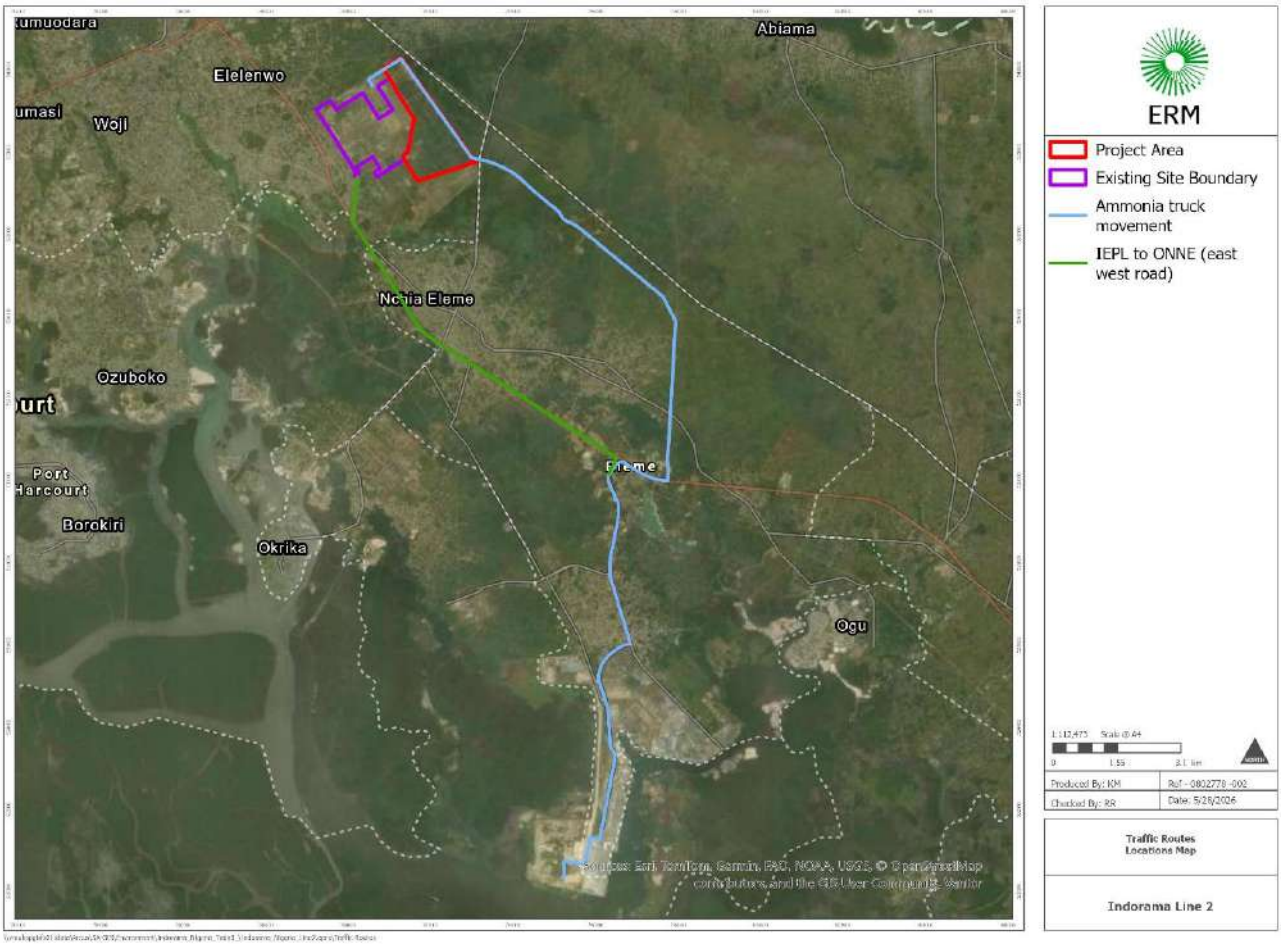


FIGURE 8-14: PROJECT TRANSPORTATION ROUTES

Construction is estimated to take approximately 33 months. Table 8-88 summarizes the Project activities generating traffic, based on estimates provided by Indorama. As a conservative measure, the traffic volumes cited below assume that all trips (other than workers) would be spread over 500 construction days during the construction period.

Truck congestion in the port area will make these movements challenging, and oversized trucks may not be able to clear corners and traffic circles without encroaching on adjacent land. Personnel from the Federal Road Safety Corporation and Government Security will clear roads before an ODC convoy departs the port area and provide traffic control at narrow areas, cross-junctions and bridge crossings. Indorama will coordinate with Port Harcourt Electricity Distribution Company to cut electrical power and disconnect cables that would obstruct high loads when needed. The advantage of night-time travel is recognised. Estimated construction traffic volumes are summarized in Table 8-88.

TABLE 8-88: PROJECT-RELATED CONSTRUCTION TRAFFIC

Trip Purpose	Description	Average Daily Trips
Construction contractor buses	Up to 100 buses daily at beginning and end of shifts. Each bus arriving in the morning will remain parked at the Project site until the shift end.	200
Deliveries (standard-size)	Average of 19.5 daily round trips	39
ODC/Super ODC loads	460 deliveries of Project modules and other specialized loads	2
Total trips		**241**

As summarised in Table 8-89, Project operations would result in an average of 410 one-way trips per day, including 200 movements associated with urea deliveries to Onne Port and 210 other trips, primarily by employees, employee buses, and contractors.

TABLE 8-89: PROJECT-RELATED OPERATIONS TRAFFIC

Trip Purpose	Description	Average Daily Trips
Urea delivery trucks	Average of 100 daily round trips between the Project and Onne Port	200
Other trucks	Miscellaneous deliveries and other activities	20
Staff buses	Typically 25 buses daily at beginning and end of shifts. Each bus arriving in the morning will remain parked at the Project site until the shift end.	50
Employee and contractor vehicles (cars and light vans)	Round trips by an average of 20 employee vehicles and 50 contractor vehicles per day	140
Total trips		**410**

8.6.2 SENSITIVE RECEPTORS

Receptors for the Project's transportation-related impacts include users of and residents or business owners with property adjacent to the East West Road, Agbonchia New Road, Federal Ocean Terminal Road, and local roads. As shown in Table 8-90, receptor sensitivity is characterised as either Low, Medium, or High, based on the ability of these receptors to adapt to Project-related changes in road traffic volumes, transportation safety risk, and degradation of road infrastructure.

TABLE 8-90: RECEPTOR SENSITIVITY TO TRANSPORTATION IMPACTS

Sensitivity	Description
Low	Receptors can easily adapt to Project traffic, because they are accustomed to anticipated traffic volumes and heavy vehicle traffic, are comfortable sharing the road with Project-related vehicles or are able to reach their destination using alternative routes not affected by Project traffic.
Medium	Somewhat frequent or regular users of the affected roads, and residents/business owners for properties impacted by Project traffic, but whose property is not adjacent to Project roads. These receptors can adapt to Project traffic with some difficulty, either because of lack of comfort with frequent heavy vehicle traffic or lack of alternative routes. These receptors may choose to delay or reschedule trips due to Project traffic.
High	Frequent, regular users of the affected roads and residents/business owners of properties adjacent to Project roads. These receptors would have great difficulty adapting to Project traffic, either because of lack of comfort with frequent heavy vehicle traffic, lack of alternative routes, or concerns about direct access to their property. These receptors may avoid travel altogether or may find even limited travel on Project roads to be highly stressful.

8.6.3 SIGNIFICANCE OF IMPACT (PRE-MITIGATION)

This ESIA evaluates three types of transportation impacts related to Project construction, operation, and closure, as described below:

- Increased traffic congestion and delay, due to Project-related vehicle trips. These impacts would primarily occur along the East West Road, which connects the Project to the regional and national road network. These impacts could also occur on the Onne Road and Federal Ocean Terminal Road, which carry heavy truck traffic to the port at Onne. Impacts are possible but less likely along the Agbonchia New Road, due to relatively low existing traffic volumes.
- Increased deterioration of public roads due to Project-related vehicle trips, especially heavy vehicle trips. This deterioration is most likely to occur on the Agbonchia New Road, the East West Road, Onne Road and Federal Ocean Terminal Road, the roads that will carry the largest share of heavy Project vehicles.
- Increased risk of deaths, injuries, and property damage due to crashes involving Project vehicles on public roads. Due to their size, weight, and limited manoeuvrability, trucks, buses, and other heavy vehicles are typically associated with more severe outcomes resulting from crashes.

8.6.3.1 TRAFFIC OPERATIONS

During construction, an additional 200 daily bus trips and 39 other trips by standard sized vehicles would use the East-West Road and other local roads to access the Project site (either via the Agbonchia New Road or via the existing Indorama Complex Road). This would be less than a 1 percent increase over existing traffic volumes observed in late 2025. The 100 one-way employee bus trips would be as much as a 3 percent increase in existing peak hour traffic. As a result, increased traffic from the Project would marginally increase peak hour and overall road congestion. Delivery of ODC and super ODC modules could cause additional traffic delays, especially if they occur during existing peak hours.

Anticipated truck traffic would be higher during operations than during construction, with an estimated additional 205 truck and bus round trips (410 one-way trips) daily, of which 100

round trips (200 one-way trips, including return trips of empty trucks) would be urea shipments via the Agbonchia New Road. Assuming these trips are distributed through a 24-hour day, Project operations would add an average of approximately 8 to 9 truck trips per hour to the Agbonchia New Road, East-West Road, Onne Road, and Federal Ocean Terminal Road. These roads all carry large volumes of truck traffic, although information on the level of congestion and delay on these roads is not known. Employee and contractor trips would add 140 one-way trips per day to the East-West Road and other public roads. This study assumes that 70 one-way trips would be added during each of the morning and afternoon peak hours, approximately a 3 percent increase in existing peak hour traffic on the East West Road.

Based on the analysis provided above, it is anticipated that Project construction and operations would have a "**Moderate Negative Impact**" pre-mitigation (refer to Table 8-91), primarily due to marginal increases in traffic volumes and the concentration of truck traffic on the segment of the East-West Road between the Agbonchia New Road and Onne Road.

TABLE 8-91: RATING OF IMPACTS RELATED TO TRAFFIC OPERATIONS (PRE-MITIGATION)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Most Project traffic would remain in the area between the Project site and Onne Port (the East West Road, Agbonchia New Road, Onne Road, and Federal Ocean Terminal Road).
Duration	Short-term and long-term	Construction would result in short-term impacts on traffic volume and road congestion. Operations would result in long-term impacts.
Scale	Locally significant	Impacts on traffic operation would be most significant the East West Road between the Indorama Complex Road and the Agbonchia New Road. Periodic, short-term delays and congestion would result from construction-related ODC and super ODC loads. The segment could also experience delays due to employee vehicles queuing to turn onto the Indorama Complex Road during the morning commute, or during the evening commute as employee vehicles turn onto the East West Road. Project truck traffic would add to already heavy truck volumes on Onne Road and Federal Ocean Terminal Road, with potential for a minor increase in levels of congestion. The locally significant scale of impacts would be due to the need for significant portions of Project traffic to make left turns across the East West Road.
Frequency	Continual	Traffic would occur daily during Project construction and operation.
Likelihood	Likely	Crashes, breakdowns, or other unplanned events involving Project vehicles on the roads could lead to road closures or partial blockages that result in temporary traffic congestion and delays
Magnitude		
Medium Magnitude on East West Road; small magnitude on the Agbonchia New Road, Onne Road, and Federal Ocean Terminal Road.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
Residents and users of the East West Road, Onne Road and Federal Ocean Terminal would have medium sensitivity. These road users are accustomed to high traffic volumes and heavy vehicles, but these routes are essential for regional truck and freight transport. Alternative routes for passenger vehicles, but not for trucks, are available within towns and settlements.		
Significant Rating Before Mitigation		
Moderate Impact		

8.6.3.2 TRANSPORTATION INFRASTRUCTURE

Project-related heavy truck traffic would result in incrementally faster wear and deterioration of road surfaces. Table 8-92 summarises these impacts. The wear would be most likely on the segment of the East-West Road between the Indorama Complex Road and the Agbonchia New Road, and along the Agbonchia New Road itself. While these roads are designed and intended for heavy vehicles and high volumes, the East-West Road surface currently shows indications of delayed maintenance and resultant deterioration. Deteriorated road surfaces can lead to delays, vehicle damage, increased risk of traffic incidents and stressful travel conditions. Construction of the new access road would provide a significant improvement in the road infrastructure. Based on the analysis provided above, it is anticipated that Project construction and operations would have a "**Minor Negative Impact**" to road infrastructure pre-mitigation.

TABLE 8-92: RATING OF IMPACTS RELATED TO ROAD INFRASTRUCTURE (PRE-MITIGATION)

Type of Impact		
Direct Negative Impact and Direct Positive Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The greatest impacts would be on the segment of the East West Road between the Indorama Complex Road and Agbonchia New Road and-the Agbonchia New Road itself.
Duration	Long-term	Road condition impacts would be observed over the long term, during Project operations.
Scale	Locally significant	Project traffic will contribute incrementally to the already heavy truck traffic volumes on the affected roads.
Frequency	Continual	Heavy vehicle traffic would occur throughout Project construction and operation, resulting in continual wear and deterioration of road surfaces
Likelihood	Unlikely	Unplanned events are unlikely to change the Project's impact on road condition.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
Road users are accustomed to the current, variable condition of the East West Road and Federal Ocean Terminal roads. Alternative routes for truck traffic are not available.		
Significant Rating Before Mitigation		
Minor Impact		

8.6.3.3 TRANSPORTATION SAFETY

Table 8-93 summarises the Project's impacts on the transportation safety risks. The East West Road, Agbonchia New Road, Onne Road, and Federal Ocean Terminal Road have sufficient width to safely carry heavy vehicles; however, the risks of transportation-related deaths, injuries, and property damage generally rise along with the increase in traffic volumes, and especially the increase in truck traffic volumes. The East West Road and Federal Ocean Terminal roads are not intended for use by pedestrians. Based on the analysis provided above, the Project would have a "**Minor Negative Impact** "on transportation safety pre-mitigation.

TABLE 8-93: RATING OF IMPACTS RELATED TO TRANSPORTATION SAFETY (PRE-MITIGATION)

Type of Impact		
Direct Negative Impact and Direct Positive Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The greatest impacts would be on the East West Road and port access roads.
Duration	Long-term	Road safety impacts would be continual during construction and operations. The most substantial safety impacts would occur during construction, when local road users would be unfamiliar with Project traffic schedules and volumes.
Scale	Locally significant	A modest increase in road safety risk attributable to Project-related traffic volume increases could occur on segments of the East West Road and the port access roads. The increased safety risk would be greatest at the planned intersections of the East-West Road with Onne Road and the Agbonchia New Road, due to the need for Project traffic to make left turns at these locations.
Frequency	Continual	The increased vehicle traffic would occur throughout Project construction and operation.
Likelihood	Possible	Unplanned events such as crashes would substantially increase the Project's impacts on transportation safety.
Magnitude		
Small Magnitude on East West Road, Onne Road, Federal Ocean Terminal Road; medium magnitude at the intersections of the East-West Road with Onne Road and the Agbonchia New Road		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
Residents and road users of the East-West Road, Agbonchia New Road, Onne Road, and Federal Ocean Terminal Road can adjust their driving and expectations to accommodate the new intersections with the new access road. Road users on the major roads are accustomed to high traffic volumes and heavy vehicles.		
Significant Rating Before Mitigation		
Minor Impact		

8.6.4 MITIGATION AND MANAGEMENT MEASURES

Refer to Section 9.6 for the recommended mitigation and management measures associated with impacts associated with traffic and transportation.

8.6.5 RESIDUAL IMPACT (POST-MITIGATION)

Implementation of the proposed mitigation measures provided in Section 9 would incrementally reduce the Project's transportation impacts but would not change the significance of the Project's impacts on traffic operations, due to the frequent movement of heavy trucks between the Project site and Onne Port involving multiple left-turn movements across the East West Road. The impact on this resource would remain a "Moderate Negative Impact" post mitigation. Based on the implementation of the proposed mitigation measures, the significance of the impact on transportation infrastructure and transportation safety would be a "Minor negative Impact" post mitigation.

8.6.6 CUMULATIVE IMPACT ASSESSMENT

Please refer to Table 8-94 for the anticipated project cumulative impacts. As with Project-specific impacts, the implementation of the mitigation and management measures provided in Section 9 would not change the significance of cumulative impacts.

TABLE 8-94: TRAFFIC CUMULATIVE IMPACTS

Valued Environmental and Social Component (VEC)	Potential Impacts from the Project	Potential Impacts from Other Projects	Potential Impacts from External Drivers	Cumulative Impact	Priority
Traffic and Transport	▪ Increased traffic congestion and delay on public roads due to movement of Project modules, equipment, materials, workers, and supplies during construction and decommissioning, as well as outputs (i.e., urea), supplies and workers during operations. ▪ Increased wear and tear on public road infrastructure due to Project-related vehicle trips. ▪ Increased safety risks due to increased Project-related traffic volumes and especially due to increased Project-related heavy vehicle trips (i.e., trucks and buses).	▪ Similar impacts as described for the Project. The baseline conditions described in Section 8.6.3 include the traffic and transportation impacts of all existing and ongoing cumulative activities.	▪ Weather conditions (e.g., heavy rain, flooding) can cause traffic congestion and delay, damage to public road infrastructure, and transportation safety risks.	Cumulative traffic and transportation impacts would occur during Project the construction, operations, and decommissioning phase as a result of increased traffic volume. These impacts would include increased congestion and delay, accelerated deterioration of public road infrastructure, and increased transportation safety risks (particularly associated with increased heavy vehicle trips). The Project would mitigate its contribution to these cumulative impacts through effective traffic management and consistent safety practices.	Medium

8.7 SUMMARY OF IMPACT ASSESSMENT

Overall, the impact assessment identifies a mix of significant adverse and beneficial impacts across the physical, biophysical and socio-economic environments during construction and operation. The most material pre-mitigation adverse impacts relate to construction dust, groundwater abstraction and saline intrusion, effluent treatment plant malfunction and overflow to surface water, biodiversity disturbance, labour influx, community frustration over unmet expectations, and public and worker health, safety and human rights risks. Beneficial impacts are concentrated in employment creation, increased income and spending, and broader socio-economic development benefits.

Following implementation of the proposed mitigation and enhancement measures, most impacts are reduced to minor, moderate or negligible levels, while positive socio-economic impacts are enhanced and remain major positive during both construction and operation. The main residual adverse impacts that remain comparatively more material are groundwater abstraction (remaining Moderate Negative), certain surface water quality pathways (with residual Moderate ratings retained for some operational pathways), and traffic operations (remaining Moderate Negative). Physical climate risks and greenhouse gas emissions are assessed using topic-specific materiality / benchmark methods rather than the generic ESIA significance matrix; these remain material after mitigation but manageable within the proposed controls.

The impacts are summarised in Table 8-95 below.

TABLE 8-95: SUMMARY OF PROJECT IMPACTS

Impact	Significance / materiality before mitigation	Residual significance / materiality after mitigation
Physical environment		
Climate change risk – extreme heat	High materiality hazard	Moderate to High residual materiality
Climate change risk – extreme rainfall flooding	Moderate to High materiality hazard	Moderate residual materiality
Climate change risk – wildfires	Moderate materiality hazard	Low to Moderate residual materiality
Climate change risk – water stress and drought	Moderate materiality hazard	Low residual materiality
GHG emissions – construction phase	Nominal / Negligible to Low under benchmark approach (20,340 tCO_2e over 33 months)	Nominal / Negligible to Low
GHG emissions – operational phase	Medium-High under benchmark approach (686,590 tCO_2e/annum)	Medium-High
Air quality – construction dust	Major Negative	Negligible to Minor
Air quality – construction traffic exhaust emissions	Minor Negative	Not significant / negligible to minor residual effect implied by AQIA narrative

Impact	Significance / materiality before mitigation	Residual significance / materiality after mitigation
Air quality – operation	Scenario-based AQIA; no adopted air quality standard exceedance predicted in its own right	Minor project-specific residual impact; cumulative AQIA significance Low
Noise – construction activities	Negligible Negative	Negligible Negative (with monitoring)
Noise – operation activities	Negligible Negative	Negligible Negative (with monitoring)
Soils and geology – soil erosion / loss of topsoil / sediment mobilisation	Moderate Negative	Minor Negative
Soils and geology – soil compaction	Minor Negative	Minor Negative
Soils and geology – soil contamination from hydrocarbon / chemical / wastewater spills and leaks	Moderate Negative	Minor Negative
Soils and geology – changes to the soil-water balance	Minor Negative	Minor Negative
Soils and geology – subsurface disturbance, cuttings and drilling-fluid handling from borehole installation	Minor Negative	Minor Negative
Groundwater – hydrocarbon, chemical and wastewater spills and leaks	Moderate Negative	Moderate Negative
Groundwater – overflow of the ETP retention pond and release of solid waste	Moderate Negative	Minor Negative
Groundwater – abstraction from new back-up water-supply boreholes	Major Negative	Moderate Negative
Groundwater – saline-water intrusion induced by abstraction	Moderate Negative	Minor Negative
Groundwater – excavation, dewatering and earthworks	Moderate Negative	Minor Negative
Groundwater – vertical preferential flow between aquifers from borehole installation	Moderate Negative	Minor Negative
Surface water – effluent treatment plant malfunction during operation	Critical Negative	Residual significance reduced but remains material; moderated post-mitigation impacts for operational surface-water pathways, including Moderate ratings for some operational pathways

Impact	Significance / materiality before mitigation	Residual significance / materiality after mitigation
Surface water – effluent treatment plant overflow during operation	Major Negative	Residual significance reduced; residual Moderate significance for at least some operational surface-water pathways
Surface water – contaminated stormwater runoff from operational process and storage areas	Major Negative	Moderate Negative
Biophysical environment		
Biodiversity loss during construction	Major Negative	Minor Negative
Biodiversity loss during operation	Major Negative	Minor Negative
Aquatic biodiversity loss through effluent treatment plant malfunction during operation	Major Negative	Minor Negative
Cultural heritage		
Cultural heritage resources	No Impact identified for all 21 mapped resources during construction and operation	No Impact
Socio-economic environment		
Increased employment within the area of influence	Construction: Major Positive; Operation: Moderate Positive	Construction: Major Positive (Enhanced); Operation: Major Positive (Improved from Moderate Positive)
Increased income and spending within the area of influence	Construction: Major Positive; Operation: Moderate Positive	Construction: Major Positive (Enhanced); Operation: Major Positive (Improved from Moderate Positive)
Socio-economic development benefits	Construction: Major Positive; Operation: Moderate Positive	Construction: Major Positive (Enhanced); Operation: Major Positive (Improved from Moderate Positive)
Influx of migrant workers and job seekers	Construction: Major Negative; Operation: Moderate Negative	Construction: Moderate Negative; Operation: Minor Negative
Community frustration over unmet expectations	Construction: Major Negative; Operation: Moderate Negative	Construction: Moderate Negative; Operation: Minor Negative
Public and worker health, safety and human rights impacts	Construction: Major Negative; Operation: Moderate Negative	Construction: Minor Negative; Operation: Minor Negative
Traffic operations	Moderate Negative	Moderate Negative
Transportation infrastructure	Minor Negative	Minor Negative
Transportation safety	Minor Negative	Minor Negative

8.8 RAPID CUMULATIVE IMPACTS ASSESSMENT

8.8.1 INTRODUCTION

This section presents a rapid cumulative impact assessment (RCIA) for the Project. The assessment has been prepared as a focused, desk-based cumulative review that builds directly on the thematic findings presented in Chapter 8 and applies the six-step logic set out in the IFC Good Practice Handbook: Cumulative Impact Assessment and Management. In line with that guidance, the assessment is Valued Environmental and Social Components (VEC)-centred, rather than project-centred only, and focuses on those cumulative issues that are already recognised as important on the basis of scientific concern, baseline evidence and/or community-related sensitivities within the broader area of influence.

The technical proposal committed ERM to prepare a rapid CIA for the Project as a standalone section within the ESIA, using the IFC six-step approach and building on the thematic assessments. The purpose of this section is therefore to draw together the cumulative findings from the physical, biophysical and socio-economic assessments and present them in a transparent and lender-facing format.

Consistent with the IFC handbook, this rapid CIA is based primarily on available information and thematic specialist studies and the current ESIA evidence base. It therefore serves as a screening and structured synthesis tool for cumulative risk management, rather than a full regional CIA with bespoke thresholds, new regional baseline programmes, or multi-party governance arrangements. Where broader site-wide or regional cumulative management is required, the Project should apply its own mitigation hierarchy and best efforts to collaborate with other relevant parties and authorities.

8.8.2 DEVELOPMENT CONTEXT

8.8.2.1 SPATIAL AND TEMPORAL CONTEXT

The Project is a new urea production line within the Indorama Free Zone in Eleme, Port Harcourt, positioned adjacent to the existing Indorama fertilizer and petrochemical complex, including the existing IFZ Line 1, IFZ Line 2, and the adjacent IFF Line 1 facility. The Project occupies an approximately 80 ha plot within the wider 250 ha industrial precinct and relies on, or interfaces with, existing and shared infrastructure including internal roads, utilities, water systems, wastewater facilities and logistics connections. Finished product will be transported to MM FZE Port in the Onne Port Complex, approximately 20 km from the manufacturing site.

For the purposes of this RCIA, the spatial context extends beyond the immediate Project footprint to include the wider industrial complex, connected environmental systems and the surrounding communities and transport corridors that may experience cumulative pressure. In practical terms, the cumulative assessment therefore considers the Project together with other activities affecting the same VECs within the broader industrial area, associated public roads, connected groundwater and surface water systems, and the surrounding socio-economic area of influence. This approach is consistent with the IFC view that cumulative assessment boundaries should reflect the area in which the selected VECs occur and the area in which other developments and external stressors may also affect them.

The temporal context covers the construction, operation and, where relevant, longer-term residual effects of the Project. This is important because a number of cumulative effects are

driven not only by concurrent activities, but also by the interaction of existing stresses with long-term operational pressures and natural external drivers such as extreme rainfall, flooding and heat.

8.8.2.2 OTHER EXISTING, PLANNED AND REASONABLY FORESEEABLE ACTIVITIES / DRIVERS

The other activities and drivers considered relevant to this rapid CIA are as follows:

- Existing fertilizer and petrochemical operations within the wider Indorama Free Zone and Indorama Manufacturing Complex, including existing operational units, the broader utilities network, water and wastewater systems, the captive power plant and associated logistics movement.
- The adjacent IFF Line 1 development, for which the ESIA explicitly states that existing air quality and noise models were expanded to evaluate combined operational conditions, and whose proximity is central to the cumulative assessment context.
- Existing and ongoing industrial and urban sources that already influence baseline conditions, including industrial emissions, traffic, fugitive dust, wastewater inputs and urban/community pressures.
- Existing public-road and logistics activity on the road network serving the Project and Onne Port, combined with additional heavy vehicle movements associated with the Project and other industrial developments.
- Existing environmental stressors affecting connected receiving environments, including industrial discharge and sand mining in the Okulu River system, as well as existing groundwater abstraction in the wider wellfield.
- Natural environmental and social external drivers relevant to selected VECs, including extreme heat, flooding, seasonal hydrological variability, and broader socio-economic dynamics such as population influx, urbanisation, unemployment and service-delivery constraints.

8.8.3 IDENTIFIED CUMULATIVE IMPACTS

8.8.3.1 VEC SCREENING

In line with the IFC handbook, the rapid CIA focuses on VECs that are important because they are sensitive receptors, support ecosystem or community functions, or are already subject to cumulative pressure. The VEC screening undertaken for this Project is summarised in Table 8-96.

TABLE 8-96: VEC SCREENING FOR THE RAPID CIA

VEC	Screening outcome	Basis for inclusion / exclusion
Climate resilience of Project assets, shared infrastructure and exposed receptors	**Included**	Chapter 8 already identifies cumulative climate-related pressures associated with extreme heat, extreme rainfall flooding, wildfire and drought, with heat and flooding the most important cumulative climate hazards.

VEC	Screening outcome	Basis for inclusion / exclusion
Ambient air quality and human health	**Included**	A dedicated cumulative air quality assessment has been prepared. It concludes that the Project contributes incrementally to pollutant concentrations, but does not cause exceedance of relevant air quality limits and is therefore associated with low cumulative impact significance.
Groundwater quantity and quality	**Included**	Existing abstraction already creates a localised drawdown footprint, and the groundwater assessment explicitly requires cumulative drawdown assessment for new back-up boreholes operating with the existing production wellfield.
Surface water quality, hydrology, sediments and connected aquatic receiving environment	**Included**	The Okulu River is a sensitive receiving system already affected by industrial discharge and sand mining, with the Project adding potential runoff, discharge and hydrological interaction pathways.
Aquatic biodiversity and related ecosystem services	**Included**	Aquatic systems are already under anthropogenic pressure, and biodiversity documentation notes that aquatic habitats and associated species are important receptors linked to surface-water condition and effluent-related risk.
Community infrastructure, services, livelihoods and social stability	**Included**	The SIA cumulative chapter identifies population influx, service pressure, rising expectations, employment competition, traffic and housing pressure as key cumulative social issues.
Traffic operations, road condition and road safety	**Included**	The traffic assessment already includes a cumulative impact table that identifies additional congestion, road wear and safety risk arising from combined industrial/logistics activity and weather-related external drivers.
Noise at nearby sensitive receptors	**Screened out from detailed CIA**	The noise assessment indicates that predicted construction and operation noise levels comply with relevant criteria at all assessed locations and the overall predicted magnitude is negligible. Combined modelling for IFF Line1 & Line2 (Line 3 & 4) has already been undertaken in the specialist analysis.
Cultural heritage resources	**Screened out from detailed CIA**	The cultural heritage study reports no direct or indirect impacts across the identified cultural heritage resources in the study area.
Project GHG emissions	**Addressed separately, not treated as a local VEC in this rapid CIA**	The IFC handbook recognises that greenhouse gas emissions are often addressed through dedicated ESIA / ESMS approaches rather than a separate local CIA process. The Project already includes a dedicated GHG assessment and reduction initiatives.

8.8.3.2 ASSESSMENT OF CUMULATIVE IMPACTS ON SELECTED VECS

Climate resilience of assets, shared infrastructure and exposed receptors

The Project is located within an already industrialised setting with shared electrical systems, roads, drainage, utilities and workforce exposure pathways. The climate risk work identifies extreme heat and extreme rainfall flooding as the most material hazards, with cumulative implications for infrastructure, operations, transport, local communities and workers when

climate stress coincides across multiple facilities and shared systems. Flood-related cumulative effects are particularly relevant at the northern part of the site and along shared drainage and access systems, while cumulative heat effects may manifest through concurrent cooling demand, electrical load, workforce heat stress and broader operational disruption.

RCIA priority is considered **High**. The combination of high hazard materiality, shared infrastructure dependency and existing industrial concentration means this VEC should be treated as a leading cumulative-risk priority for management and monitoring.

Groundwater quantity and quality

Groundwater is a cumulative VEC because the Project proposes new back-up abstraction within an area where industrial abstraction already occurs and where surrounding users and community wells may depend on the same multi-aquifer system. The available hydrogeological evidence indicates that the current drawdown footprint is localised to the existing wellfield, but it also identifies possible vertical leakage between deeper and shallower units at one location and requires a quantitative cumulative drawdown assessment of the new boreholes operating together with the existing production wellfield. Groundwater quality is also a cumulative concern because contaminant pathways from spills, leaks and wastewater-related incidents can combine within a permeable sandy setting and move downgradient toward connected surface-water receptors.

RCIA priority is **High** for groundwater availability / drawdown and **Moderate to High** for groundwater quality. This reflects the sensitivity of the aquifer system, dependency of surrounding users, and the need for cumulative drawdown management before and during operation.

Surface water quality, hydrology, sediments and connected aquatic receiving environment

The surface-water cumulative pathway is centred on the Okulu River system and its downstream connection to the Bonny Estuary and the Okrika mangrove system. The baseline already shows that the receiving environment is sensitive and moderately to heavily modified by existing industrial discharge and sand mining, with reduced assimilative capacity. The Project introduces additional pathways through stormwater runoff, contaminated stormwater from process and storage areas, wastewater treatment risks, hydrological change associated with hardstanding and drainage, and potential thermal discharge during operation. The Project will also use existing complex-wide drainage infrastructure, meaning cumulative water-quality and hydrological interactions are not purely site-contained.

The cumulative issue is not only water chemistry, but also the condition of river sediments and the resilience of the receiving aquatic environment under multiple pollutant and flow-related pressures. Because the river is tidally influenced, connected to downstream ecological receptors and already affected by external stressors, even controlled additional loads remain cumulatively relevant.

RCIA priority is **High**. This VEC is already stressed, supports downstream ecological and community functions, and receives combined pressures from the Project, existing industrial activities and existing channel disturbance.

Aquatic biodiversity and connected ecosystem services

Aquatic biodiversity is closely linked to the cumulative condition of the Okulu River, associated wetlands and estuarine systems. Biodiversity information in the current evidence base indicates that aquatic systems are already under anthropogenic pressure and that many of the more sensitive biodiversity considerations are associated with aquatic habitats. The proposal also explicitly recognises the need to describe existing stressors on the aquatic ecosystem, current pollution loads and aquatic ecosystem services when assessing biodiversity and wetland-related receptors.

RCIA priority is **Moderate to High**. This VEC is screened in because it depends on the integrity of an already stressed aquatic system, but its management is inseparable from cumulative surface-water quality, sediment and hydrological controls.

Ambient air quality and human health

A dedicated cumulative air-quality assessment concludes that the Project will contribute incrementally to pollutant concentrations when assessed together with IFF Line 1 and the broader baseline environment, but will not cause exceedances of relevant air-quality limits and is therefore associated with low cumulative impact significance. The main cumulative issues are background pollutant loading and localised construction-related interaction with traffic and fugitive dust, especially where baseline pollutant concentrations are already influenced by surrounding industrial and urban sources. The Project-specific controls identified in the AQIA, including dust management and SCR on the reformer stack, are considered sufficient to manage both project-specific and cumulative air-quality impacts.

RCIA priority: **Low to Moderate**. Air quality remains an important VEC for lender visibility, but the available cumulative assessment does not indicate significant adverse cumulative effects where the proposed controls are implemented.

Traffic operations, road condition and road safety

The traffic assessment identifies clear cumulative effects from the interaction between Project-generated traffic and the broader industrial/logistics network. The cumulative traffic impacts include increased congestion and delay, accelerated wear on public road infrastructure, and increased road-safety risk, particularly where heavy vehicle flows from multiple industrial activities combine on shared roads and at intersections. The traffic cumulative table also identifies weather conditions such as heavy rain and flooding as external drivers that can worsen these effects.

RCIA priority: **Moderate**. The impacts are already recognised, largely predictable, and manageable through logistics and traffic-management controls, but they remain cumulatively important because they affect shared public infrastructure and community road safety.

Community infrastructure, services, livelihoods and social stability

The cumulative social assessment identifies that Project-related activities interact with wider industrial expansion, urbanisation and population growth in the surrounding area, creating combined pressures on host communities, infrastructure, public services and local economies. The key cumulative issues already identified include population influx, pressure on water supply, sanitation, healthcare, housing, transportation and waste management systems, rising expectations regarding employment and local benefits, growing competition for jobs and

resources, higher traffic pressure, and increased housing and land demand. The SIA also notes that, without appropriate planning and management, these interacting pressures can contribute to cumulative stress on community wellbeing, infrastructure and service delivery.

RCIA priority is **High** for infrastructure/services and social expectations; Moderate to High for livelihoods-related competition and housing pressure. This reflects the interaction between the Project and broader development trends, as well as the already constrained service-delivery context identified in the socio-economic baseline.

8.8.3.3 RCIA SUMMARY

The RCIA indicates that the most important cumulative VECs for this Project are:

- Climate resilience of shared infrastructure and exposed receptors;
- Groundwater availability and groundwater quality;
- Surface water quality, hydrology, sediments and the connected aquatic receiving environment;
- Community infrastructure, services, livelihoods and social stability; and
- Traffic operations, road condition and road safety.

Air quality is retained as a monitored cumulative VEC, but the available cumulative assessment indicates low cumulative significance under planned controls. Noise and cultural heritage are screened out from detailed CIA follow-through in this ESIA because the current evidence base indicates negligible cumulative noise magnitude and no identified cultural heritage impact pathway requiring cumulative management.

8.8.4 HOLISTIC MANAGEMENT OF CUMULATIVE IMPACTS

Consistent with the IFC handbook, effective management of cumulative impacts requires the Project to do two things: first, apply the mitigation hierarchy to its own incremental contribution to cumulative effects; and second, use best efforts to engage with other relevant stakeholders where management of the cumulative issue goes beyond the control of a single project.

For this Project, the priority cumulative management actions are as follows:

8.8.4.1 SITE-WIDE AND CROSS-PROJECT COORDINATION

A site-wide cumulative management forum or coordination mechanism should be established for the Indorama Free Zone so that shared issues such as groundwater abstraction, surface water discharge, emergency preparedness, traffic/logistics and climate resilience can be reviewed across all relevant units, rather than on a siloed facility-by-facility basis. This is particularly important where the Project relies on or interfaces with shared infrastructure, utilities, drainage systems and logistics routes.

8.8.4.2 SHARED MONITORING AND TRIGGER-BASED MANAGEMENT

The most important cumulative VECs require shared or interoperable monitoring arrangements, including:

- groundwater abstraction, groundwater levels and community-well response;
- surface water and effluent quality upstream and downstream of discharge points;

- stormwater and drainage system performance;
- traffic volumes, road safety incidents and road-condition trends;
- community complaints, expectations and service-pressure indicators; and
- climate-related operational disruption indicators such as heat stress, flood events and shared-infrastructure downtime.

8.8.4.3 INTEGRATED MANAGEMENT RESPONSES BY VEC

- Climate: integrate climate adaptation into site drainage, equipment siting, heat management, emergency response and business continuity planning.
- Groundwater: complete cumulative drawdown assessment before commissioning, cap abstraction within sustainable yield, maintain multi-aquifer monitoring and community grievance management.
- Surface water / aquatic environment: operate drainage, retention and treatment systems as designed, maintain controlled discharge conditions, and monitor the condition of the Okulu River system and connected receiving environments over time.
- Air quality: maintain dust controls, SCR performance and operational monitoring in line with the AQIA commitments.
- Traffic: apply construction and operational logistics planning, routing, driver and speed controls, and interface management for shared roads and port-related movements.
- Socio-economic: manage labour influx, local recruitment communications, grievance handling, service-pressure monitoring and benefit-sharing communications in a coordinated way with authorities and communities.

8.8.4.4 COLLABORATION BEYOND THE PROJECT

Where cumulative issues extend beyond the Project's direct control—particularly regional road safety, broader urban-service pressures, river-system management and wider catchment pollution sources—the Project should use best efforts to engage with regulators, local authorities, other operators and affected communities so that cumulative issues are acknowledged and progressively managed at the appropriate scale.

8.8.5 IMPLICATIONS OF UNCERTAINTY

This RCIA is based on the current ESIA evidence base and thematic studies. In line with the IFC handbook, it is therefore a desk-based rapid assessment, not a full regional CIA supported by agreed regional thresholds, dedicated multi-party governance, or new cross-sector monitoring programmes. The findings should therefore be interpreted as a robust lender-facing screening and synthesis of cumulative issues, rather than as the final word on regional carrying capacity or long-term cumulative thresholds for all VECs.

The main uncertainties relate to:

- the absence of agreed regional thresholds or acceptable future-condition limits for several VECs;
- the future pace and form of industrial and urban growth in the wider area;

- variability in external natural drivers such as flooding, rainfall and heat;
- the current dependence of several cumulative conclusions on specialist studies rather than a formal site-wide CIA governance process; and
- the fact that some cumulative issues, particularly social-service pressure and catchment-level receiving-environment stress, depend on actions beyond the sole control of the Project.

Notwithstanding these uncertainties, the available information is sufficient to identify the Project's key cumulative VECs, distinguish between higher- and lower-priority cumulative issues, and define a practical cumulative management agenda for the Project and the wider complex. The rapid CIA should be treated as an auditable foundation for lender review and should be updated over time using operational monitoring results, future ESIA commitments and any broader Indorama-wide CIA or shared monitoring initiatives that become available.

9. MITIGATION AND MANAGEMENT MEASURES

9.1 INTRODUCTION

This Chapter details potential mitigation measures to avoid, minimise, reduce, remedy, or compensate for potentially negative impacts, and enhance potential benefits of the Project. The development of mitigation/management measures and the management of residual impacts are further described in the ESMMP (refer to Chapter 10 and Appendix C).

Annex E of the ESMMP provides a consolidated set of operational compliance tools to support implementation of IFC Performance Standard 3 and AfDB Operational Safeguard 3 requirements across air emissions, effluent management, resource efficiency, and hazardous materials management.

9.2 PHYSICAL ENVIRONMENT – MITIGATION AND MANAGEMENT MEASURES

9.2.1 CLIMATE CHANGE

9.2.1.1 IMPACT MITIGATION MEASURES

This section provides high-level mitigation/management measures for the site to incorporate into their planning for both construction and operation. In the tables (*Potential Impacts Per Material Hazard* Section) the risks are bold and highlighted for both phases are identified as risk items that are likely to be of greater materiality and therefore shall be considered in the planning for both construction and operation for the IFF Line 2 Project. Nevertheless, these risks shall be considered in more detail and taken through a thorough Risk Review and Risk Ratings in a future Physical CCRA specialist study that aligns to EP4 (2023).

Overall, the potential impacts relate to the site receptors below:

- Electrical equipment.
- Human / people.
- Access to site.
- Raw materials.
- Buildings, infrastructure, structures.
- Water availability.
- Equipment and vehicles.

TABLE 9-1: SUMMARY OF HIGH-LEVEL, HIGH-RISK MITIGATION/MANAGEMENT MEASURES

Risk	Phase	Mitigation/Management Measures
Flooding and wildfires may lead to delays in construction and operations, and damage to equipment, infrastructure, structures, buildings, onsite fuel storage facilities, pipeline system, electrical aspects, etc.	**Construction**	**Flooding** – Implementing mitigation measures, such as flood defences, can significantly reduce the risk of water entering site areas, machinery and infrastructure. Ensure an Emergency Evacuation Policy and an Occupational Health and Safety Policy are in place, and site personnel are trained and practise drills, especially for flooding events, e.g.: undertaking a health and safety plan which provides specific guidance for site personnel to follow prior to, during or after a flood event. **Wildfires** – Ensure a Fire Policy and an Emergency Evacuation Policy are in place, and staff are trained and practice drills. Training staff on fire risk is important and can significantly improve safety and awareness reducing the overall risk.
	Operation	Ensure an occupational health and safety policy is in place (including First Aid & evacuation training), and staff are trained and practise requirements, especially for fires that may result in impacts on health and safety. Training staff on fire risk is important and can significantly improve safety and awareness reducing the overall risk. The health and safety of staff is important and relatively small adjustments to patterns could significantly reduce the risk of negative outcomes.
Prolonged and more frequent dry periods result in higher water consumption for construction and operations.	**Construction**	Ensure that a Water Management Plan is in place that addresses (for example) considering large scale backup battery water storage systems to help manage dry periods, or backup water sources such as rainwater harvesting, or agreements with local authorities. Additionally, for the Plan to consider that it is possible that water issues may become an issue, and IFF shall prepare a plan for dealing with these issues during the construction and operation phases.
	Operation	
Impacts on health and safety for workers, resulting in health issues and restricted working hours.	**Construction**	As part of site Emergency Response Plan, ensure appropriate monitoring of conditions and that an Emergency Evacuation Plan is in place, site personnel are trained and practice drills undertaken such that site personnel know what to do prior to, during or after a flood event, for extreme temperature conditions and for fires. Only 15cm of water is required to knock a person off their feet, which increases the chance of injury. By reducing the chance of flowing water getting this high, it lowers the chance of having staff shortages and delays.
	Operation	IFF shall implement an Occupational Health and Safety procedure for extreme heat conditions, which shall provide drinking water to outdoor workers, more

Risk	Phase	Mitigation/Management Measures
		frequent rest breaks, shaded rest areas across the site and adjustment of work schedules during periods of extreme heat. The health and safety of staff is important and relatively small adjustments to patterns could significantly reduce the risk of negative outcomes.
Extreme heat may cause overheating to electrical power disruption network, substations etc.	**Construction**	Temperature sensitive electrical infrastructure / equipment shall be identified initially to determine what impacts this might have to construction and operations. This shall be completed through a review of all major operating electrical infrastructure / equipment at the site, using its key specification. Once this is completed, a review shall be completed which considers the different ways to cool the electrical infrastructure / equipment to deliver the same outcome (for example through air or water cooling). If the specific electrical infrastructure cannot be cooled in this way, then an alternatives analysis shall be completed to determine other options for achieving the same outcome. It is not possible to prevent overheating to electrical power disruption network and substations from occurring, but by regularly having workers checking on the condition of the electrical infrastructure / equipment, this increases the chance of any early stage damage or stress being identified and therefore repaired. This in turn minimises the risk and costs.
	Operation	

9.2.1.2 CUMULATIVE IMPACTS MITIGATION MEASURES

Given that the Project is co-located within the wider Indorama Free Zone and adjacent to existing fertilizer and petrochemical operations, climate-related hazards may affect not only the Project footprint, but also shared infrastructure, access routes, utilities, nearby developments, workers, and community receptors at the same time. Climate risk management should therefore be implemented at both Project level and wider complex level, particularly where the Project relies on shared infrastructure and operational interfaces within the Indorama Manufacturing Complex. The climate risk work for the Project also identifies electrical equipment, people, access to site, buildings, infrastructure, water availability, equipment and vehicles as the key categories of receptors requiring climate adaptation planning.

Extreme Heat

Cumulative heat risk shall be managed through:

- heat-resilient design specifications for electrical and equipment, including substations, generators, transformers, inverters and other temperature-sensitive systems and for infrastructure (e.g.: substation connections, raw water pipeline, power lines, pressure valves, steel infrastructure etc.);
- thermal resilience of roads, paved areas and exposed infrastructure that may be affected by sustained high temperatures;

- workforce heat-stress management procedures, including work-rest cycles, shaded rest areas, hydration and medical response arrangements;
- work scheduling during extreme heat periods to reduce exposure of both construction and operational personnel;
- coordinated management of cooling demand and electrical load across the wider complex during prolonged heat events; and
- weather-triggered operational preparedness measures so that extreme heat warnings result in timely restrictions, adjustments or protective actions across adjacent facilities where necessary.

These measures are intended to reduce the cumulative effect of prolonged and more frequent heat events on human receptors, transport, and shared infrastructure across the wider industrial area.

Extreme Rainfall Flooding

Cumulative flood risk shall be managed through:

- integrated drainage design across the wider Indorama Free Zone, so that Project drainage ties effectively into the existing lined channels, culverts and retention pond system;
- conservative flood allowances in detailed engineering and the siting or elevation of vulnerable equipment away from areas susceptible to flooding;
- routine inspection, maintenance and desilting of drainage channels, culverts and outfalls to preserve design capacity;
- flood-resilient protection of vulnerable assets such as substations, generators, pipelines, power lines, transformers and access infrastructure;
- emergency access planning and coordinated wet-season logistics management to maintain safe movement of personnel and vehicles during severe rainfall events;
- site-wide and complex-wide flood preparedness, emergency response and evacuation arrangements, including drills and clear responsibilities; and
- post-event checks on runoff quality, standing water, sanitation and receiving water conditions where flooding may also affect workers, nearby receptors or shared water systems.

The wider drainage and retention system serving the development already provides attenuation before release to the existing canal, thereby reducing flood risk both on site and to surrounding land. These measures should be maintained and strengthened at complex scale so that cumulative flood impacts remain manageable.

Wildfires

Cumulative wildfire risk shall be managed through:

- vegetation and fuel-load control around operational areas, undeveloped boundaries and shared access routes;
- maintenance of fire detection, alarm and suppression systems across the Project and adjacent operational areas, plus, maintenance of power lines as extreme heat

could cause lowering in the drop of power lines making them closer to the ground and more susceptible to fires;

- good housekeeping around storage areas, process areas and utility corridors to reduce ignition and fire spread potential (e.g.: urea and ammonia storage);
- site-wide emergency response coordination so that wildfire or smoke-related incidents are managed consistently across adjacent facilities;
- access management during wildfire events to avoid cumulative disruption to emergency movement, evacuation and logistics;
- communication and response planning for nearby operations, neighbouring developments and local receptors that may be affected by smoke or restricted access; and
- periodic review of wildfire preparedness in line with changing site conditions, vegetation state and seasonal weather conditions.

The Project already operates within a broader industrial setting that maintains formal emergency management and response systems, which should be applied on a coordinated basis when wildfire-related cumulative impacts are credible.

Water Stress and Drought

Cumulative water-stress risk shall be managed through:

- coordinated water planning, storage and supply management across the wider complex, particularly during dry periods when multiple users rely on shared systems;
- efficient water use and water recovery measures to reduce avoidable demand during both construction and operation;
- contingency water-supply arrangements for dry periods or short-term supply constraints;
- monitoring of water demand, abstraction and availability within shared systems so that emerging pressure can be identified early;
- trigger-based management of groundwater abstraction and shared supply systems where monitoring indicates increasing stress;
- coordination with broader site water management where shared resources are used across multiple facilities; and
- dry-period dust management planning, recognising that water demand for dust suppression may coincide with operational and community water needs.

These measures are intended to address the cumulative pressure that may arise when dry periods coincide with demand from the Project, adjacent operations and surrounding users at the same time.

Implementation and Coordination

Because the identified cumulative climate risks affect shared receptors and systems, implementation of the above measures shall not be limited to the Project footprint alone. Climate-related mitigation should be integrated with:

- the wider site stormwater and flood management system;

- occupational health, safety and emergency response procedures;
- shared utility and water-management arrangements;
- transport and access management plans; and
- stakeholder communication and grievance mechanisms where nearby receptors may also be affected.

Taken together, these measures are intended to ensure that cumulative climate impacts associated with extreme heat, extreme rainfall flooding, wildfires, and water stress and drought remain managed in a coordinated manner across the Project and the wider Indorama Manufacturing Complex.

9.2.2 PROPOSED GREENHOUSE GAS EMISSION REDUCTION MEASURES AND CLIMATE CHANGE RISK MITIGATION

As part of its commitment to mitigating climate change impacts and managing the Project's carbon footprint, Indorama has undertaken an evaluation of potential greenhouse gas (GHG) emission reduction opportunities and developed a phased implementation strategy aimed at improving operational efficiency, reducing carbon intensity and supporting long-term decarbonisation. These initiatives form an integral component of Indorama's broader climate change mitigation approach and are intended to minimise the Project's contribution to global GHG emissions while reducing its exposure to climate-related transition risks, including evolving regulatory requirements, potential carbon constraints and increasing stakeholder expectations regarding environmental performance.

Indorama has identified four GHG emission reduction schemes, comprising process optimisation, operational efficiency improvements and the installation of new equipment and technologies. These measures are planned for implementation over a three-year period and are estimated to achieve a combined reduction of approximately 227,000 tCO_2e per annum, subject to successful implementation and verification of their performance. These interventions are expected to contribute to reducing the carbon intensity of industrial operations and improving overall resource and energy efficiency.

In addition to these direct emission reduction measures, Indorama is exploring opportunities to mitigate GHG emissions through the reduction of routine flaring at a natural gas supplier's facility. This initiative has the potential to deliver an estimated net emission reduction of approximately 343,000 tCO_2e per annum. Collectively, the proposed process improvement schemes and supplier-level flaring reduction initiative could achieve an overall GHG emission reduction of approximately 570,000 tCO_2e per annum. This represents a substantial potential mitigation contribution when compared with the Project's estimated annual operational emissions of approximately 686,590 tCO_2e.

Furthermore, as part of its longer-term decarbonisation strategy, Indorama has initiated a feasibility study for the development of a Carbon Capture and Storage (CCS) pilot project in Nigeria, in collaboration with the Nigerian Upstream Petroleum Regulatory Commission (NUPRC). The proposed CCS initiative has an indicative carbon sequestration

potential of approximately 1 million tonnes of CO_2 per annum, subject to the outcome of technical, environmental, regulatory and economic feasibility assessments. If demonstrated to be technically and commercially viable, this initiative could provide an additional pathway for managing residual industrial CO_2 emissions and supporting the transition towards lower-carbon industrial operations. At this stage, the potential CCS benefits are considered prospective and have not been included in the quantified emission reduction estimates for the Project.

From a climate change risk management perspective, these initiatives demonstrate Indorama's proactive approach to identifying and implementing measures to avoid, reduce and manage GHG emissions throughout the Project's operational lifecycle. The proposed interventions are consistent with the principles of **IFC PS 3 and AfDB OS3** which emphasises resource efficiency and the consideration of technically and financially feasible options for reducing project-related GHG emissions. They also support Nigeria's broader climate change mitigation objectives and its commitments under the Paris Agreement

The proposed mitigation initiatives demonstrate Indorama's commitment to managing the Project's climate-related impacts through a combination of operational improvements, supply-chain emission reduction opportunities and the exploration of emerging carbon management technologies. Subject to successful implementation, monitoring and independent verification, these measures have the potential to substantially reduce the GHG emissions associated with Indorama's operations and strengthen the Project's long-term climate performance and resilience to transition risks. The effectiveness of these measures shall be reviewed periodically through a structured GHG monitoring, reporting and verification framework to ensure that the anticipated emission reductions are achieved and sustained throughout the operational phase.

9.2.2.1 PROPOSED MONITORING FRAMEWORK FOR CLIMATE CHANGE RISK AND CUMULATIVE CLIMATE IMPACTS

The climate risk assessment identified a number of material physical climate hazards relevant to the Project, including extreme heat, extreme rainfall flooding, wildfires, and water stress / drought. In addition, Section 8.2.1.4 identified cumulative climate risks affecting shared infrastructure, nearby developments, local communities and wider site operations. The monitoring framework below is therefore structured to address both: (i) Project-specific climate risk management actions; and (ii) cumulative climate risk monitoring across the wider Indorama Free Zone and surrounding receptor environment. The proposed frequencies and responsibilities presented below are recommended for integration into the ESMMP and wider ESMS. Refer to Table 9-2 and Table 9-3 below.

TABLE 9-2: MONITORING RECOMMENDATIONS FOR CLIMATE RISK ASSESSMENT FINDINGS

Impact	Mitigation	KPI	Monitoring Method	Frequency	Responsibility	Reporting
Extreme rainfall / flooding affecting site access, equipment, infrastructure and workers	Maintain flood defences, drainage controls, emergency evacuation procedures, and worker flood-response preparedness. Specifically by having an Emergency Evacuation Policy, Occupational Health and Safety Policy, and staff training / drills for flooding events.	Number of flood incidents affecting site operations; number of drainage blockages identified; number of flood drills completed; time taken to restore access after heavy rainfall	Inspection of drainage channels, culverts and flood-control features; review of incident logs; verification of emergency drills and training records	**Recommended:** monthly during wet season; after major storm events; annual drill review	**Recommended:** Site HSE Manager / Utilities & Infrastructure Manager / Emergency Response Lead	**Recommended:** monthly internal HSE report; wet-season summary to ESMS / ESMMP reporting
Extreme heat affecting workers, electrical equipment, infrastructure and operational continuity	Implement heat-stress management, thermal resilience measures for infrastructure and equipment, work scheduling controls, and heat preparedness procedures. Especially focusing on the human receptors, electrical equipment, infrastructure and access as key receptor groups requiring adaptation planning.	Number of heat-related incidents / near misses; exceedances of defined workplace heat thresholds; number of heat-response actions triggered; equipment overheating events	Review of weather / temperature data; occupational incident records; maintenance logs for temperature-sensitive equipment; verification of heat-response implementation during hot periods	**Recommended:** daily during extreme heat periods; monthly summary during hot season	**Recommended:** Site HSE Manager / Operations Manager / Electrical & Maintenance Lead	**Recommended:** monthly HSE report; quarterly climate resilience review
Wildfire affecting access, structures, equipment and staff safety	Maintain vegetation / fuel management, site emergency preparedness, fire detection and response systems, and wildfire-related access controls. Wildfire-related delays, restricted access,	Number of wildfire / smoke incidents affecting operations; percentage of firebreak / vegetation management actions completed;	Inspection of perimeter vegetation and housekeeping, power lines check; fire system inspection records; incident logs; review of drill records	**Recommended:** monthly in dry season; after any fire event; annual drill review	**Recommended:** Fire & Emergency Response Lead / Site HSE Manager / Facilities Manager	**Recommended:** monthly dry-season HSE report; incident-based reporting where required

Impact	Mitigation	KPI	Monitoring Method	Frequency	Responsibility	Reporting
	infrastructure damage and evacuations.	number of wildfire response drills completed				
Water stress / drought affecting water availability and operations	Implement water planning, efficient water use, storage / contingency arrangements, and monitoring of water availability, especially during the construction phase (e.g.:water adaptation planning).	Raw water demand versus available supply; storage availability; activation of contingency supply arrangements; number of drought-response actions triggered	Review of water demand and supply records; inspection of storage status; operational review of contingency arrangements	**Recommended:** monthly; more frequently during prolonged dry periods	**Recommended:** Utilities / Water Systems Manager / Site HSE Manager	**Recommended:** monthly utilities report; dry-season resilience review
Climate risk governance and adaptive management	Carry out more detailed future risk review and risk rating updates, consistent with the recommendation that the identified risks should be taken through a more detailed future physical climate risk review aligned to EP4 (2023).	Completion of climate risk review updates; closure of climate-related actions; evidence of adaptation actions integrated into design / operation	Management review of climate risk register; verification of closure of climate adaptation actions; periodic review of assumptions and lessons learned from actual events	**Recommended:** annual review; also, after major climate-related incidents or major design / operational change	**Recommended:** ESMS Manager / Project Manager / HSE Manager	**Recommended:** annual climate risk review report to Project leadership

TABLE 9-3: PROPOSED MONITORING FRAMEWORK FOR CLIMATE CHANGE RISK AND CUMULATIVE CLIMATE IMPACTS

Impact	Mitigation	KPI	Monitoring Method	Frequency	Responsibility	Reporting
Cumulative extreme heat affecting shared cooling demand, electrical	Coordinate heat-stress procedures, cooling demand planning, electrical resilience measures and work scheduling across the wider industrial area. Cumulative heat impacts were identified as a **High materiality** hazard in Section 8.2.1.4.	Number of simultaneous heat-related disruptions across facilities; heat-related worker incidents; cooling-demand exceedances; shared electrical overload / overheating events	Consolidated review of weather conditions, incident logs, electrical maintenance records, workforce health and safety records, and operational interruptions across co-located facilities	**Recommended:** daily review during extreme heat events; monthly seasonal summary	**Recommended:** Complex HSE Manager / Utilities Manager / Operations Coordination Lead	**Recommended:** monthly complex climate-risk dashboard; event-based escalation reporting
Cumulative extreme rainfall flooding affecting	Integrate drainage inspection, flood preparedness, access management and emergency response across the wider complex. Cumulative flooding was identified as **Moderate to High** in Section 8.2.1.4, and the wider site already relies on lined channels and culverts for runoff management.	Number of concurrent flooding points across the wider site; number of access disruptions; drainage system exceedances; number of off-site / community complaints linked to flooding	Coordinated wet-season inspections; review of drainage performance, access incidents, community complaints, and flood-event response logs	**Recommended:** weekly during wet season; after major storm events	**Recommended:** Complex Infrastructure Manager / HSE Manager / Community Relations / Emergency Response Lead	**Recommended:** wet-season monitoring report; incident reporting after major rainfall events
Cumulative wildfire impacts affecting adjacent facilities, shared access	Coordinate site-wide vegetation management, emergency response and access control for wildfire / smoke events across adjacent operations. Cumulative wildfire impacts were identified	Number of wildfire or smoke events affecting more than one facility; number of access restrictions; number of wildfire-	Consolidated incident review across facilities; inspection of vegetation control and fire readiness; review of access restrictions and	**Recommended:** monthly in dry season; after any wildfire / smoke event	**Recommended:** Fire & Emergency Response Lead / HSE Manager / Community Relations Lead	**Recommended:** seasonal dry-season risk report; incident-specific reporting

Impact	Mitigation	KPI	Monitoring Method	Frequency	Responsibility	Reporting
	as **Moderate** in Section 8.2.1.4.	related complaints or safety events	community notifications			
Cumulative water stress and drought affecting shared water resources, dust suppression needs and surrounding users	Coordinate water planning, abstraction / supply monitoring, storage, and drought contingency arrangements across shared systems. Cumulative water stress and drought were identified as **Moderate** in Section 8.2.1.4.	Combined site water demand versus supply; groundwater or raw-water trigger exceedances; activation of drought contingency measures; number of complaints regarding water availability	Integrated review of site water demand, storage, abstraction and contingency supply records; trend review of shared water system performance	**Recommended:** monthly; more often during prolonged dry periods (especially during construction)	**Recommended:** Utilities / Water Management Lead / ESMS Manager / Community Relations where community issues arise	**Recommended:** monthly water resilience report; seasonal drought summary
Climate-related cumulative effects on shared water quality and receiving environment during severe rainfall	Maintain coordinated monitoring of runoff quality and the receiving water environment, particularly where flooding or heavy rainfall may degrade surface water quality. Severe precipitation and flood-related reduction in surface water quality are explicitly identified in the CCRA, and the surface water study already recommends operational monitoring at agreed upstream, downstream and reference stations on the Okulu River.	Number of monitored exceedances at agreed stations; trend in wet-season water quality indicators; number of flood-related water-quality incidents	Surface water quality monitoring at agreed upstream / downstream / reference stations; event-based visual inspection after major rainfall; review of runoff	**Recommended:** seasonal routine monitoring plus event-based monitoring after major rainfall	**Recommended:** Environmental Manager / Water Quality Specialist / Utilities Manager	**Recommended:** seasonal water quality monitoring report; event-based exception reporting
Climate-related cumulative	Use stakeholder engagement and	Number and type of climate-related	Review of grievance logs,	**Recommended:** monthly grievance	**Recommended:** Community	**Recommended:** monthly grievance

Impact	Mitigation	KPI	Monitoring Method	Frequency	Responsibility	Reporting
impacts on nearby communities, farmers, neighbouring developments and shared transport corridors	grievance systems to monitor recurring climate-related concerns, especially flooding, access disruption, safety concerns and water-related complaints. The cumulative climate section specifically identifies nearby developments, local communities and farmers as relevant receptors. Indorama also has an established grievance and community reporting system with periodic updates and monitoring of trends.	grievances; response time; recurring issue trends; number of community updates issued	community meeting records, PAC / engagement records, and trend analysis of recurring concerns	review; quarterly community reporting	Relations Team / Grievance Manager / ESMS Manager	trend report; quarterly stakeholder update

9.2.3 GHG

9.2.3.1 IMPACT MITIGATION MEASURES

The IFF Line 2 Fertilizer Project is an energy-intensive industrial development, with GHG emissions arising primarily from natural gas used both as a feedstock in ammonia production and as a fuel in combustion processes. These include reformer firing, steam generation in boilers, gas turbine-based power generation, flaring activities, and process-related emissions generated during ammonia production.

During the construction phase, GHG emissions are primarily associated with diesel combustion from construction machinery, vehicles, and equipment. Mitigation measures during this phase focus on optimising fuel use through efficient construction planning, minimising unnecessary idling, maintaining equipment in good operating condition, and reducing avoidable fuel consumption.

During the operational phase, mitigation measures focus on improving energy efficiency and reducing fuel consumption across major emission sources, including reformers, boilers, gas turbine generators, utility systems, and process units. This includes optimisation of combustion efficiency, heat integration, process control systems, preventive maintenance programmes, flare minimisation, and monitoring of operational fuel consumption and GHG emissions. The integrated design of the facility enables the utilisation of CO_2 generated during ammonia production in urea synthesis, contributing to reduced net facility-level emissions intensity relative to conventional ammonia production systems. The table below presents general mitigation measures applicable to both the construction and operational phases of the Project.

PLANNED GHG REDUCTION INITIATIVES

Indorama has evaluated various options for reducing the carbon footprint associated with the Project and plans to implement these initiatives over a 3-year period. The identified four schemes have the potential to reduce approximately 227,000 tCO_2e per annum through process improvement and new hardware installation. Indorama also has plans to offset GHG emissions through flaring reduction at a natural gas supplier facility, with a net potential reduction of approximately 343,000 tCO_2e per annum. These initiatives are projected to deliver an overall reduction of approximately 570,000 tCO_2e per annum. These initiatives could substantially offset the estimated annual operations operational emissions from IFF Line 2, subject to implementation, verification, and allocation of reductions to the Project.

In addition, Indorama has initiated a feasibility study to develop a Carbon Capture and Storage (CCS) pilot project in Nigeria in collaboration with the Nigerian Upstream Petroleum Regulatory Commission (NUPRC), with the potential to sequester approximately 1 million tonnes of CO_2 per annum.

The planned reduction initiatives, including site efficiency projects, flare reduction and the CCS feasibility study, demonstrate a pathway to materially reduce or offset the Project's operational emissions over time. GHG management forms part of the Project ESMS and is implemented through the ESMMP.

TABLE 9-4: GENERAL MITIGATION MEASURES

Activity	Potential Impact	Aspects Affected	Phase	Detailed Mitigation Measures	Time Period for Implementation	Responsible Person
GHG Emission from the Project	GHG emissions	Climate Change	Conststruction	• Use of fuel-efficient and well maintained constcution equipment and vehicles • Optimisation of construction logistics to reduce transport distances and fuel use • Scheduling of construction activities to minimise equipment idling and unnecessary fuel consumption • Efficient use and sizing of temporary diesel generators to reduce fuel consumption	Construction Phase	Project Head and Project Engineer
			Operational	• Optimisation of combustion efficiency in reformer, boiler, and gas turbines through regular maintenance, tuning, and performance monitoring • Maximisation of CO_2 recovery and utilisation in urea production to reduce net direct emissions at the facility level • Optimisation of steam demand and energy use across utilities and process units (including the FCU, ammonia and urea plants) through heat integration and process control • Implementation of heat recovery systems (e.g., waste heat recovery from reformer and gas turbines) where feasible to improve overall energy efficiency and reduce fuel consumption • Minimisation of flaring through operational controls, improved process	Operational Phase	Project Head and Project Engineer

Activity	Potential Impact	Aspects Affected	Phase	Detailed Mitigation Measures	Time Period for Implementation	Responsible Person
				stability, and maintenance of flare systems • Implementation of preventive and predictive maintenance programmes to ensure efficient plant performance and avoid excess fuel use and unplanned emissions • Monitoring and tracking of fuel consumption and GHG emissions to support continuous improvement and performance optimisation • Evaluation of opportunities for carbon capture, utilisation, and storage (CCUS) as part of future decarbonisation strategies • Optimisation of natural gas use as both feedstock and fuel to minimise excess consumption and associated emissions • Reduction of fugitive emissions through leak detection and repair (LDAR) programmes for natural gas systems • Integration of energy management systems and performance benchmarking to track efficiency improvements over time		

TABLE 9-5: PLANNED GHG REDUCTION INITIATIVES

Initiative	Type	Estimated Reduction (tCO2e/annum)	Status	Target Completion
GT6 Performance Improvement (PIP)	Operational Improvement	14 000	Planned	2027
HRSG 5 Installation	New Hardware	79 000	Planned	2027
HP Gas Utilisation in Reformer	Operational Improvement	55 000	Planned	2027
HRSG 6 Installation	New Hardware	79 000	Planned	2028
Flare Reduction Programme	New Hardware	343 000	Under Assessment	Ongoing
CCS Pilot Project	Carbon Capture and Storage	1 000 000	Feasibility Stage	Ongoing

9.2.3.2 GREENHOUSE GAS CUMULATIVE IMPACTS MITIGATION MEASURES

As GHG emissions are inherently cumulative and contribute incrementally to the wider atmospheric greenhouse gas burden, mitigation of cumulative GHG impacts should focus on reducing the Project's direct emissions at source, improving energy efficiency, minimising avoidable fuel consumption, and implementing the identified reduction initiatives over time. The GHG assessment confirms that operational emissions from the Project are material and require management and mitigation, and that the identified measures are to be integrated into the ESMP / ESMMP to support regulatory compliance, international good practice and broader decarbonisation objectives.

Construction phase

To reduce the cumulative contribution of the Project during construction, the following measures should be implemented:

- use of fuel-efficient and well-maintained construction equipment and vehicles; and
- optimisation of construction logistics to reduce transport distances and associated fuel use.

Although construction-phase emissions are temporary and substantially lower than operational emissions, these measures are still relevant to cumulative GHG management because they reduce avoidable diesel combustion associated with site preparation, civil works, installation and supporting infrastructure development.

Operational phase

To reduce the cumulative GHG footprint during operation, the following measures should be implemented:

- optimisation of natural gas use as both feedstock and fuel to minimise excess consumption and associated emissions;
- reduction of fugitive emissions through leak detection and repair (LDAR) programmes for natural gas systems;
- integration of energy management systems and performance benchmarking to track efficiency improvements over time; and
- continued operation of the Project's established industrial process controls and emissions management systems, including efficient combustion systems, process optimisation, and emissions management infrastructure that contribute to minimising environmental impacts.

These measures are directly relevant to cumulative GHG impacts because the Project's cumulative significance is driven primarily by continuous operational Scope 1 emissions associated with natural gas consumption for process heating and reforming, ammonia and urea production processes, utility systems (including boilers and gas turbine generators), and flaring activities.

Planned reduction initiatives

In addition to the general mitigation measures above, the Project should proceed with the planned reduction initiatives identified in the GHG assessment. Indorama has evaluated several options for reducing the Project carbon footprint over a three-year period. The four

identified schemes have the potential to reduce approximately 227,000 tCO_2e per annum through process improvement and new hardware installation. A further flare reduction programme at a natural gas supplier facility has a stated net potential reduction of approximately 343,000 tCO_2e per annum, giving a combined potential reduction of approximately 570,000 tCO_2e per annum. The GHG assessment also identifies a longer-term Carbon Capture and Storage (CCS) pilot project with a stated potential to sequester approximately 1 million tonnes of CO_2 per annum, currently at feasibility stage.

Accordingly, mitigation of cumulative GHG impacts should include:

- implementation of the identified process-improvement and new-hardware schemes;
- implementation of the flare reduction programme, subject to confirmation, verification and allocation of reductions to the Project;
- progression of the CCS pilot project feasibility work as a potential longer-term decarbonisation measure; and
- formal tracking of achieved reductions against the estimated annual reduction values set out in the GHG assessment.

Verification and ESMMP integration

The GHG report expressly states that the reduction initiatives could substantially offset the Project's estimated annual operational emissions, subject to implementation, verification, and allocation of reductions to the Project. For that reason, mitigation of cumulative GHG impacts should not rely only on planned initiatives in principle, but should also require:

- integration of all GHG mitigation and reduction measures into the ESMP / ESMMP;
- monitoring and tracking of fuel consumption and emissions performance over time through the energy management and benchmarking systems already identified in the GHG assessment;
- verification of reduction and offset outcomes before they are counted against the Project's cumulative GHG footprint; and
- periodic review of the effectiveness of the implemented measures so that further reductions can be identified where practical.

Overall mitigation approach

Overall, the cumulative GHG impact of the Project should be mitigated through a combination of:

- minimising fuel use and combustion-related emissions during construction;
- improving operational efficiency and reducing fugitive emissions during operation;
- implementing the identified reduction initiatives and flare-related reductions; and
- verifying and tracking emissions reductions over time through the ESMP / ESMMP.

This approach is consistent with the benchmark and contextual significance framework applied in the GHG assessment, which recognises that greenhouse gas impacts are diffuse, cumulative and global in nature, and are therefore best managed through sustained emissions reduction, performance tracking and demonstrable implementation of identified reduction measures.

9.2.3.3 RECOMMENDED MONITORING FRAMEWORK FOR GHG IMPACTS AND CUMULATIVE GHG IMPACTS

The GHG assessment includes mitigation measures, energy performance tracking commitments, and planned reduction initiatives; however, a consolidated monitoring framework is recommended to ensure traceability between mitigation, implementation, verification and reporting. The monitoring framework below is therefore proposed for integration into the ESMMP to cover both Project-specific GHG impacts and cumulative GHG considerations associated with the wider Indorama Manufacturing Complex.

TABLE 9-6: PROJECT-SPECIFIC AND CUMULATIVE GHG MONITORING TABLE

Impact	Mitigation	KPI	Monitoring Method	Frequency*	Responsibility*	Reporting*
Construction-phase GHG emissions	Use fuel-efficient and well-maintained construction equipment and vehicles; optimise construction logistics to reduce transport distances and fuel use.	Total diesel/fuel consumed during construction; estimated construction-phase tCO_2e; fuel use per major construction activity	Fuel purchase and consumption logs; contractor fuel records; periodic emissions calculation using the Project GHG inventory method based on activity data × emission factor × GWP.	**Recommended:** monthly during active construction	**Recommended:** EPC Contractor / Construction Manager / Project HSE Manager	**Recommended:** monthly construction environmental report; quarterly ESMS / ESMMP report
Operational Scope 1 GHG emissions from process heating, reforming, utilities and flaring	Maintain operational mitigation measures including efficient combustion systems, process optimisation, and emissions management infrastructure. Operational emissions are expected to arise mainly from natural gas consumption for process heating and reforming, ammonia and urea production, utility systems (including boilers and GTGs), and flaring.	Total annual operational tCO_2e; natural gas consumed; flare-related activity; emissions intensity per tonne of product	Metered gas and fuel use; plant operating data; flare logs; annual GHG inventory compilation using the Project accounting methodology.	**Recommended:** monthly internal tracking; annual consolidated inventory	**Recommended:** Operations Manager / Project Engineer / Sustainability or Energy Lead	**Recommended:** monthly operational dashboard; annual GHG inventory report
Natural gas use efficiency	Optimise natural gas use as both feedstock and fuel to minimise excess consumption and associated emissions.	Natural gas consumption per tonne of ammonia / urea; trend in specific energy use	Review of metered gas use against production output and process benchmarks.	**Recommended:** monthly	**Recommended:** Operations Manager / Process Engineer	**Recommended:** monthly performance report

Impact	Mitigation	KPI	Monitoring Method	Frequency*	Responsibility*	Reporting*
Fugitive GHG emissions from gas systems	Reduce fugitive emissions through leak detection and repair (LDAR) programmes for natural gas systems.	Number of leaks identified; repair close-out rate; repeat leak points; time to repair	LDAR inspection programme; maintenance close-out records; verification of leak repairs.	**Recommended:** quarterly, and during shutdowns / maintenance periods	**Recommended:** Maintenance Manager / Integrity Engineer / HSE Manager	**Recommended:** quarterly LDAR summary
Energy efficiency and operational performance improvement	Integrate energy management systems and performance benchmarking to track efficiency improvements over time.	Energy intensity trend; completion of benchmark reviews; number of energy-efficiency actions implemented	Energy management system records; plant performance review; benchmarking of consumption and efficiency indicators over time.	**Recommended:** monthly review; annual benchmark summary	**Recommended:** Energy Manager / Project Engineer / Operations Manager	**Recommended:** monthly internal report; annual efficiency review
Implementation of planned GHG reduction initiatives	Implement the planned reduction initiatives identified in the GHG report, including site efficiency improvements, hardware installations, flare reduction, and longer-term CCS opportunity review. The report states that the identified schemes have the potential to reduce approximately **227,000 tCO_2e/annum**, with a further **343,000 tCO_2e/annum** through flare reduction, for an overall potential reduction of approximately **570,000 tCO_2e/annum**; a CCS pilot is also identified at feasibility stage.	Status of each initiative; actual tCO_2e reduction achieved versus estimated annual reduction; target completion status	Initiative tracking register; engineering / commissioning records; post-implementation emissions comparison; reduction performance review.	**Recommended:** quarterly implementation review; annual reduction verification	**Recommended:** Project Head / Project Engineer / Sustainability Lead	**Recommended:** quarterly management update; annual climate / sustainability report

Impact	Mitigation	KPI	Monitoring Method	Frequency*	Responsibility*	Reporting*
Verification and allocation of reductions to the Project	Ensure that any claimed reduction or offset is implemented, verified, and allocated to the Project before it is counted against the Project emissions profile. The GHG report explicitly states that the planned reduction initiatives could offset operational emissions **subject to implementation, verification, and allocation of reductions to the Project**.	Number / percentage of reductions independently verified; documentary evidence of allocation to Project; verified net tCO_2e reduction claim	Review of supporting calculations, internal or third-party verification records, and evidence of Project attribution for reductions / offsets.	**Recommended:** annual	**Recommended:** Sustainability Lead / ESMS Manager / Carbon Accounting Lead	**Recommended:** annual verified GHG statement
Cumulative GHG impact of IFF Line 2 within the wider IFZ / Industrial Complex	Monitor the Project's emissions in the context of the wider complex and shared infrastructure, recognising that GHG emissions are inherently cumulative and that emissions associated with shared utilities are proportionally allocated to the Project inventory. This is also consistent with the benchmark-based approach used in the ESIA because GHG impacts are diffuse, cumulative and global.	Combined annual tCO_2e for Project operations and attributed shared-utility emissions; trend in cumulative Project-attributed emissions over time	Consolidated annual review of the Project GHG inventory, including shared utility allocations and any verified reduction measures attributed to the Project.	**Recommended:** annual	**Recommended:** ESMS Manager / Sustainability Lead / Complex Operations Management	**Recommended:** annual cumulative GHG review
Cumulative GHG reduction performance across shared	Track performance of reduction measures that influence the Project's cumulative carbon	Verified annual reduction achieved from shared / linked	Review of shared-system performance data, flare-reduction	**Recommended:** quarterly review; annual verification	**Recommended:** Sustainability Lead / Utilities Manager / Project Engineer	**Recommended:** quarterly reduction tracker; annual

Impact	Mitigation	KPI	Monitoring Method	Frequency*	Responsibility*	Reporting*
systems / shared initiatives	footprint, especially where initiatives such as flare reduction, hardware upgrades or efficiency gains interact with shared systems or external supplier-linked reduction measures.	initiatives; percentage of estimated 570,000 tCO_2e/annum reduction realised; variance from reduction plan	records, initiative implementation records, and reduction verification documents.			GHG reduction statement
Benchmark and contextual review of GHG significance	Continue to review operational emissions against the benchmark-based significance approach used in the ESIA, including annual tCO_2e bands and broader context. The ESIA explicitly states that GHG significance is assessed by benchmarking and proportional context rather than the standard receptor–magnitude matrix because GHG impacts are cumulative and global.	Annual total tCO_2e compared against benchmark thresholds; emissions intensity trend; qualitative category trend over time	Annual review of Project GHG totals and comparison with adopted benchmark thresholds and Project historical trend.	**Recommended:** annual	**Recommended:** Sustainability Lead / ESMS Manager	**Recommended:** annual management review and lender disclosure package where required

9.2.4 AIR QUALITY

In terms of traffic related impacts, on the basis that construction traffic is unlikely to be in excess of the thresholds provided in this ESIA, no further mitigation is required.

In terms of dust, the following mitigation and management measures are recommended.

9.2.4.1 PROJECT SPECIFIC MITIGATION MEASURES

Management Measures

- IFF shall develop and implement an Environmental Management Procedure, under the ESMS and ESMMP, including for dust deposition, dust flux, PM_{10} monitoring and visual inspections. The procedure shall also include 'action levels' for triggering further dust mitigation when exceeded (feed-back loop).
- Develop and implement a stakeholder communications procedure that includes community engagement before the commencement of the construction phase.
- Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken.

Site Planning

- Plan Project layout so that machinery and dust causing activities are located as far away from receptors as possible.
- Consider fences and enclosures around specific operations where there is a high potential for dust production and the site is actives for an extensive period.
- Limit site runoff (of water or mud) to prevent egress of material to other areas, which can create dust emissions when dried.
- Keep site fencing, barriers and scaffolding clean using wet methods.
- Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover as described below.
- Reduce vehicle speed limits to as low as reasonably possibly, especially on unsurfaced haul roads and work areas (if long haul routes are required these speeds may be increased with suitable additional control measures provided). Implement awareness training for drivers. IFF currently implements a speed limit of no more than 20 kph for construction sites, which is deemed sufficient.

Mitigation Specific to Earthworks

- Re-vegetate or hard stand earthworks and exposed areas and open soils to stabilise surfaces as soon as practicable.
- Beside the wetting procedure for exposed surfaces which is currently in place, consider using Hessian, mulches or tackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.
- Only remove the cover in small areas during work and not all at once.

Construction Material Management

- Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place.
- Ensure bulk cement and other fine powder materials are delivered in enclosed containers or in covered trailers and appropriately stored.in a warehouse to prevent dust emissions.
- For smaller supplies of fine powder materials, ensure bags are sealed after use and stored appropriately to prevent dust.

Mitigation Specific to Track out on Hardstanding Public Roads

- Use water-assisted dust sweeper(s) on hardstanding access and local roads, to remove, as necessary, any material tracked out of the Project site.
- Avoid dry sweeping of large areas.
- Ensure vehicles entering and leaving the Project site are covered to prevent escape of materials during transport.
- Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.
- Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the Site where reasonably practicable).

General Construction Measures

- Where construction compounds cannot be hardstanding, watering as required to supress dust generation.
- Where possible, use cutting, grinding, or sawing equipment fitted or in conjunction with suitable dust suppression techniques, such as water sprays or local extraction, e.g., suitable local exhaust ventilation systems.
- Ensure an adequate water supply on the Project site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate.
- Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate.
- Ensure equipment is readily available on the Project site to clean any dry spillages and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.
- Avoid fires on the Project site and burning of waste materials.

Monitoring Measures

- Undertake on-site and off-site inspections, where receptors (including roads) are nearby, to monitor dust and record inspection results.
- Carry out regular Project site inspections to monitor compliance with the Environmental Management Procedure and the ESMMP, record inspection results and identify any events that require further investigation or actions.

- Increase the frequency of Project site inspections when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.

Operational Phase

As mentioned in Section 8.2.3.5, the operation of the proposed IFF Line 2 Project is not predicted to result in air quality standards being exceeded in its own right, and only medium impacts are predicted associated with PM_{10}.

However, at this stage the in-combination impacts with IFF Line 1 and Line 2 are not anticipated to lead to air quality standards being exceeded. As such, no further mitigation or design changes are proposed.

9.2.4.2 CUMULATIVE IMPACTS MITIGATION MEASURES

The mitigation measures identified in the AQIA for the construction phase, which include dust management practices, are considered sufficient to manage both project-specific and cumulative air quality impacts. These mitigation measures are detailed in Section 9.2.4.1.

Furthermore, the installation of SCR unit at the IFF Line 2 reformer stack will result in a significant reduction of NO_x emissions. No additional mitigation measures are required specifically for cumulative impacts, as the recommended controls, including the SCR system, ensure that impacts from IFF Line 1 and Line 2 remain within acceptable limits and do not materially exacerbate existing air quality conditions.

Ongoing monitoring and adherence to good operational practices will further support the effective management of cumulative air quality impacts.

9.2.5 NOISE

The objective of the Noise Management and Monitoring Plan (NMMP) is to:

- Ensure that noise emissions from ammonia and urea production processes are appropriately managed during construction and operation.
- Verify compliance with applicable regulatory requirements and applicable international guidelines (e.g. IFC/WBG EHS Guidelines, where relevant).
- Minimise disturbance to sensitive receptors through proactive mitigation and adaptive management.

9.2.5.1 MANAGEMENT MEASURES

Construction Phase

Noise management during construction shall include, as a minimum:

- Use of well-maintained equipment fitted with appropriate silencers and mufflers.
- Selection of plant and equipment with lower sound power levels where practicable.
- Implementation of site-specific traffic management measures to minimise vehicle movements near receptors.
- Temporary noise control measures (e.g. localised barriers or enclosures) where required.

- Contractor training on noise awareness and good construction practices.
- Specific controls for works within line of sight of receptor N3 (Iriebe), where worst-case construction noise is predicted to exceed the IFC daytime value of 55 dB(A): temporary acoustic barriers or hoardings along the northern site boundary, siting of stationary plant away from the receptor, low-noise piling methods where practicable, restriction of high-noise activities to 08:00–18:00 on weekdays, and advance notification of the community.
- Stop-work and corrective action by the contractor where monitoring shows the construction noise criteria in Table 5-7A to be exceeded at any receptor.

Operational Phase

Given the continuous (24/7) nature of operations and the identified key sources (compressors, pumps, turbines, blowers), the following measures shall be implemented:

- Use of low-noise design specifications for key plant items (e.g. compressors, blowers, pumps).
- Routine inspection and maintenance of noise-generating plant and equipment.
- Prompt investigation and resolution of abnormal noise events.
- Maintenance of any permanent noise control features (e.g. enclosures, silencers, acoustic barriers).
- Adoption of operational procedures that minimise unnecessary noise emissions.

9.2.5.2 MONITORING PROGRAMME

Noise monitoring will be undertaken to confirm compliance with applicable criteria, and ensure that noise emissions from construction and operational activities remain controlled over the Project lifecycle. The monitoring programme adopts a risk-based approach, focusing on activities and plant components with the highest potential to generate noise, as well as locations representative of nearby NSRs.

Monitoring requirements shall be adaptive and may be refined over time based on observed performance, operational conditions, and stakeholder feedback.

Construction Phase

During the construction phase, the monitoring approach will include:

- Periodic attended noise measurements at representative NSRs, particularly those closest to the construction activities;
- Targeted monitoring during peak construction activities (e.g. earthworks, heavy equipment operation, cranage and batching);
- Measurement of standard environmental noise parameters (e.g. LAeq, LAmax), consistent with applicable guidelines;
- Additional monitoring in response to complaints or where elevated noise emissions are observed;

- Review of monitoring results to identify any emerging trends or deviations from expected performance.
- Monitoring frequency: monthly at N2, N3 and N4 throughout construction, increased to weekly (if needed) during piling and other high-noise activities near the northern site boundary.

Operational Phase

During the operational phase, The monitoring programme will include:

- Verification monitoring following commissioning to confirm that plant operation is consistent with design assumptions and modelling predictions;
- Periodic monitoring at representative NSRs and/or plant boundary locations to verify continued compliance;
- Targeted monitoring of dominant plant sources where required;

Additional monitoring in response to reported complaints or abnormal operational noise conditions.

Monitoring frequency: once after commissioning at full load, then annually at N2, N3 and N4, and following any significant plant modification or noise complaint.

9.2.6 SOILS AND GEOLOGY

9.2.6.1 PROJECT SPECIFIC MITIGATION MEASURES

As outlined in 8.2.5.4, the predicted impacts associated with soil erosion, loss of topsoil and soil compaction, soil contamination from chemical and hydrocarbon spills, and changes in soil-water balance are anticipated to range from moderate to minor.

Accordingly, aside from the general soil mitigation and management measures included in the ESMMP (refer to Chapter 10), no additional design changes are proposed for the Project.

However, the following measures should be implemented to minimize potential impacts on soils within the Project Area:

- Restrict vegetation and soil removal to areas essential for construction activities only.
- Schedule land clearance immediately prior to construction to reduce exposure time.
- Limit construction footprints and associated infrastructure areas (e.g., equipment laydown zones) to the minimum feasible extent and implement controls to prevent footprint creep.
- Excavate and rehabilitate areas affected by soil contamination to the depth of contamination. Minor spills should be cleaned immediately, and contaminated material disposed of appropriately.
- Prohibit ad hoc maintenance of vehicles and equipment within the Project Area. All maintenance should occur in designated workshops equipped with oil and grease traps.
- Train contractors and relevant staff on safe handling, transfer, and transportation of hazardous substances that could impact soil resources.

- Provide hazardous waste storage areas with secondary containment and ensure waste is stored in sealed, covered containers to prevent rainwater intrusion.
- Equip hazardous material storage and handling areas with secondary containment capable of holding 110% of the total capacity of all tanks or vessels.

Confine loading and unloading of hazardous materials to designated areas with secondary containment, following approved handling procedures.

9.2.6.2 SOILS AND GEOLOGY CUMULATIVE IMPACTS MITIGATION MEASURES

Cumulative impacts on soils within the Project Area arise from the interaction of the Project with existing industrial activities within the Indorama complex and wider sub-catchment, including fertilizer and petrochemical operations. These impacts are primarily related to soil condition and soil function and include cumulative soil erosion and topsoil loss, soil compaction, soil contamination, and changes to the soil-water balance. No material cumulative impacts on geology have been identified due to the shallow nature of excavations and absence of geotechnical instability.

Mitigation of cumulative impacts will be achieved through the application of coordinated, site-wide management measures implemented consistently across the Project and existing facilities, in accordance with the Project Environmental and Social Management System (ESMS) and ESMMP. These measures align with Good International Industry Practice and are designed to minimise the incremental contribution of the Project to existing pressures within the industrial sub-catchment.

Cumulative Soil Erosion, Topsoil Loss and Sediment Mobilisation

To manage cumulative soil erosion and sediment mobilisation associated with increased disturbed areas across the industrial complex, the following measures will be implemented:

- Minimise disturbance footprint by restricting vegetation clearance, site preparation, and earthworks to approved work areas and phasing activities to limit the extent and duration of exposed soils
- Implement a site-wide Erosion and Sediment Control Plan applicable across Project and interfacing areas
- Install and maintain temporary erosion and sediment control measures, including diversion drains, berms, bunds and sediment traps, particularly during periods of rainfall
- Strip, segregate and stockpile topsoil for reuse during reinstatement, with appropriate stabilisation of stockpiles to prevent erosion
- Undertake progressive rehabilitation and re-vegetation of disturbed areas using appropriate local species to stabilise soils and reduce erosion risk
- Integrate erosion control measures with existing drainage infrastructure across the wider industrial area to prevent cumulative sediment export

These measures will ensure that sediment mobilisation remains localised to active work areas and that cumulative erosion effects across the sub-catchment are minimised.

Cumulative Soil Compaction

To limit the cumulative spatial expansion of compacted soils resulting from additional traffic and construction activities, the following measures will be implemented:

- Restrict heavy vehicle movement and equipment operation to designated haul routes, work areas and laydown zones to confine compaction
- Establish clearly demarcated equipment parking and material storage areas to avoid unnecessary disturbance
- Avoid repeated trafficking over non-designated areas and minimise unnecessary vehicle movements
- Coordinate construction logistics with existing operations to prevent overlapping high-traffic zones across the industrial complex
- Undertake rehabilitation of temporarily compacted soils, including ripping, loosening, and reinstatement of topsoil where required

Through these measures, soil compaction will be contained to defined operational footprints and long-term degradation of soil structure outside permanent surfaces will be minimised

Cumulative Soil Contamination (Hydrocarbon, Chemical and Wastewater Spills/Leaks)

To prevent the increase in cumulative contamination pathways across the industrial area, the following measures will be implemented:

- Design and operate hazardous material storage areas with secondary containment capable of holding at least 110% of total storage capacity
- Restrict chemical and fuel handling, loading and unloading activities to designated, bunded areas with controlled drainage
- Implement and maintain a Spill Prevention, Control and Containment Plan (SPCCP), including provision of spill kits and trained personnel for rapid response
- Conduct routine inspection and maintenance of tanks, pipelines, valves and transfer infrastructure to prevent leaks
- Undertake periodic soil quality monitoring to detect contamination trends relative to baseline conditions
- Apply standardised environmental procedures across all facilities within the complex and maintain centralised incident reporting to manage cumulative contamination risk

These measures will reduce contamination risks to localised and manageable events and prevent cumulative deterioration of soil quality.

Cumulative Changes to the Soil-Water Balance

To address cumulative changes in infiltration, runoff and drainage patterns resulting from increased hardstanding and compaction, the following measures will be implemented:

- Design site grading and infrastructure to maintain controlled drainage patterns and minimise ponding or flow concentration
- Integrate Project drainage with existing stormwater systems within the industrial complex to ensure coordinated runoff management

- Minimise unnecessary hardstanding areas and maintain permeable or vegetated surfaces where practical
- Implement a Stormwater Management Plan addressing runoff control, erosion prevention, and drainage maintenance
- Limit soil compaction (as described above) to maintain infiltration capacity across non-operational areas
- Reinstate disturbed areas to support natural drainage and infiltration processes during rehabilitation

These measures will ensure that cumulative changes to the soil-water balance remain localised and manageable within the developed landscape.

Cumulative Impacts on Geology

No specific mitigation measures are required for cumulative impacts on geology, as:

- Excavations are shallow and confined to near-surface soils
- The Project Area is not characterised by geological instability or geotechnical sensitivity

Standard construction controls outlined in Section 9.2.6.1will be sufficient to maintain geological integrity.

Cross-Cutting Cumulative Management Measures

In addition to the impact-specific measures above, the following overarching measures will be applied to ensure effective cumulative impact management:

- Implementation of mitigation measures through a centralised ESMS and ESMMP, ensuring consistency across all Project phases and facilities
- Coordination of environmental management activities across the Indorama industrial complex
- Establishment of monitoring programmes for soils, drainage and contamination indicators to identify cumulative trends
- Application of adaptive management, whereby monitoring results inform corrective actions where cumulative effects are identified
- Alignment with IFC Performance Standards and World Bank Group Environmental, Health and Safety Guidelines

9.2.7 GROUNDWATER RESOURCES

9.2.7.1 PROJECT SPECIFIC MITIGATION MEASURES

Construction Phase

Mitigation measures for soils and geology (refer to Section 9.2.6) also apply to groundwater protection during construction. Additional measures should be implemented as follows:

Chemical and Hydrocarbon Spills

- Maintain all construction areas and associated facilities in a clean and orderly condition.
- Install bunding around vehicle parking areas and oil/silt traps in workshops.

- Provide oil/water separation at construction fuel and chemical handling areas, with sealed, impermeable hardstanding draining to the separators.
- Carry out routine integrity inspection of temporary tanks, pipework and bunds, and maintain a spill register with defined spill-response procedures and kits.
- Ensure proper disposal of waste materials to prevent contamination.
- Establish the groundwater monitoring network using existing boreholes, with baseline water quality and trigger levels set during construction.

Excavation and Dewatering

- Minimise the dewatering footprint, rate and duration, and phase earthworks to limit the area open at any one time.
- Pass dewatering effluent through settlement/treatment before discharge, with discharge to consent, quality monitoring, and controlled, non-erosive release.
- Monitor water levels in nearby wells during dewatering.
- Backfill and reinstate excavations promptly on completion.

Vertical Preferential Flow between Aquifers (Borehole Installation)

- Construct all new water-supply boreholes to standard, using a qualified drilling contractor under construction supervision/QA, with full grout annular seals isolating the shallow, intermediate and deep aquifers.
- Carry out casing/cement-bond (integrity) testing on completion of each borehole.
- Properly decommission and seal any redundant, failed or test boreholes to standard.
- Establish monitoring of paired shallow, intermediate and deep groundwater levels.

Operational Phase

Chemical and Hydrocarbon Spills

- Provide secondary containment (bunding to 110% of the largest vessel) at all chemical and fuel storage and transfer points, using the existing refuelling and storage infrastructure.
- Maintain sealed, impermeable hardstanding draining to oil/water separators at handling areas.
- Collect spilled process chemicals.
- Carry out routine integrity inspection and preventive maintenance of tanks, pipework and bunds, supported by spill-response procedures, kits and a spill register.
- Operate the groundwater monitoring network with periodic sampling against trigger levels and a defined response should triggers be exceeded.

Effluent from Treatment Plants – Malfunction or Failure

- Maintain effluent treatment plants according to recommended schedules to minimize malfunction risk.

- Operate treatment plants within design specifications to prevent failure.

Effluent from Treatment Plants – Overflow and Solid Waste Release

- Engineer retention ponds to accommodate surface runoff and maintain specified freeboard to manage flood events, with level monitoring and a high-level alarm.
- Confirm effluent quality against discharge criteria before any discharge during treatment-plant shutdown periods.
- Store operational solid waste on lined, bunded and covered hardstanding with leachate control.
- Dispose of solid waste through licensed contractors at approved facilities, with manifest tracking.
- Monitor downgradient groundwater quality.

Groundwater Abstraction

- Ensure new water supply wells are located away from community wells and drawdown cones do not materially overlap, reducing impacts on sustainable yields.
- Prior to commissioning, undertake constant-rate and step-drawdown pump testing of the new boreholes, monitored through dedicated observation wells, to establish site-specific transmissivity and storativity and confirm sustainable yield.
    - On the basis of these measured parameters, complete a quantitative drawdown assessment of the three new boreholes operating cumulatively with the existing production wellfield, in order to confirm the cone of depression geometry, the footprint-scale contribution of the new boreholes, and vertical drawdown propagation into the shallow and intermediate aquifers. Recalibration of the numerical groundwater model (Mogaba, 2025) should be undertaken where the pump test results or subsequent monitoring depart materially from modelled assumptions, or where cumulative abstraction changes significantly - consistent with the periodic model-update commitment below.
- Screen and install production wells at least 15 m below the static water level (community wells at least 10 m below static water level) to maintain supply during peak abstraction, and add no further boreholes without prior hydrogeological assessment and recalibration of the numerical model, which should be updated at least every two years or following major operational changes.
- Operate the new boreholes intermittently as back-up supply, capping abstraction within the confirmed sustainable yield and avoiding sustained continuous seasonal pumping where monitoring indicates that trigger levels are being approached.
- Meter abstraction and undertake dedicated long-term water-level (trend) monitoring of production and accessible community wells, with defined trigger levels and a response procedure.
- Implement a community grievance mechanism to address complaints related to water availability.

Establish a saline-intrusion early-warning protocol: routinely monitor electrical conductivity (EC) and total dissolved solids (TDS) in the boreholes nearest the river and creek, and adjust abstraction scheduling to reduce pumping stress near the southern boundary should an inland salinity trend be detected.

9.2.7.2 CUMULATIVE IMPACTS MITIGATION MEASURES

Cumulative groundwater impacts are relevant because the Project is located within the wider Indorama Free Zone, where groundwater is already used by existing industrial operations and where the hydrogeological setting comprises shallow, intermediate and deep aquifer systems. Existing abstraction has already created a localised drawdown footprint around the operational wellfield, and available information indicates that clay horizons may not fully isolate aquifer units in all areas. In this context, cumulative groundwater impacts are most relevant where additional Project-related back-up boreholes, accidental spills and leaks, wastewater-related incidents, and possible inter-aquifer hydraulic interaction are added to the existing industrial and local groundwater-use setting.

Mitigation of cumulative impacts will therefore be achieved through coordinated abstraction control, groundwater quality protection, borehole integrity management, and centralised monitoring and adaptive management across the wider Indorama complex. The Project ESMMP provides the mechanism through which these controls are implemented, monitored and

Cumulative reduction in groundwater availability and sustainable yield

To manage the cumulative reduction in groundwater availability and sustainable yield, the following measures will be implemented:

- Groundwater abstraction will be managed within approved abstraction limits and restricted to the confirmed sustainable yield of the boreholes.
- Prior to commissioning, the new back-up water-supply boreholes will be subject to constant-rate and step-drawdown pump testing, monitored through observation wells, to establish site-specific transmissivity, storativity and sustainable yield.
- A quantitative cumulative drawdown assessment will be completed for the three new back-up boreholes operating together with the existing production wellfield, in order to confirm the cone of depression geometry, footprint-scale contribution and drawdown propagation into the shallow and intermediate aquifers.
- New water-supply wells will be located away from community wells to reduce the potential overlap of drawdown cones and protect surrounding users' sustainable yields.
- The new boreholes will be operated intermittently as back-up supply, rather than as sustained continuous abstraction, and abstraction will be capped within confirmed sustainable yield limits.
- Metering of abstraction volumes and long-term water-level trend monitoring will be undertaken in production boreholes and accessible community wells, with defined trigger levels and response procedures.
- Where monitoring indicates increasing abstraction pressure or unexpected declines in groundwater levels, adaptive management measures will be applied, including

adjustment of pumping schedules, operational demand management, or reduction in abstraction rates.

- A grievance procedure will be implemented to capture and address complaints related to water availability.

Cumulative groundwater level drawdown and wellfield interaction

To manage cumulative drawdown and interaction between the existing and proposed wellfields, the following measures will be implemented:

- Groundwater levels and flow conditions will be protected through controlled abstraction and continuous monitoring of water levels in production and observation boreholes.
- Monitoring data will be used to verify that drawdown remains within predicted limits and that regional groundwater flow patterns are not adversely altered.
- The Project will maintain a centralised groundwater monitoring and reporting framework across the wider Indorama complex to review abstraction volumes, groundwater levels and long-term aquifer response collectively.
- The numerical groundwater model will be recalibrated where pump test results or subsequent monitoring depart materially from model assumptions, or where cumulative abstraction changes significantly.
- No additional boreholes will be added without prior hydrogeological assessment and model review / recalibration.
- Production well screening and installation depths will be designed to maintain supply reliability while limiting interference effects, consistent with the confirmed hydrogeological design basis.

Cumulative deterioration in groundwater quality

To manage cumulative groundwater quality deterioration arising from multiple contamination pathways, the following measures will be implemented:

- Engineered containment systems will be provided in operational areas, including lined / sealed handling areas, sealed drains, controlled effluent handling systems, and bunded hazardous material storage areas.
- Construction and operational areas will be maintained in a good and tidy condition, including bunding of vehicle parking areas and provision of oil and silt traps in workshop areas.
- Chemicals used on site will be stored in properly constructed areas with sealed floors, roofing and walls where applicable, and access control.
- The Project will implement the Spill Prevention, Control and Containment Management Plan and maintain spill response procedures, spill kits, spill registers, and routine inspection of tanks, temporary tanks, pipework, bunds and related infrastructure.
- Groundwater quality monitoring will be conducted periodically / routinely to provide early detection of changes relative to baseline conditions, with a groundwater monitoring programme in place before construction.

- Continued application of standardised spill prevention measures and environmental management systems across all facilities within the complex will be used to reduce cumulative groundwater quality degradation risk.
- Waste chemicals and contaminated materials will be disposed of at approved waste management facilities / suitable landfill sites, and hazardous waste will not be allowed to remain unmanaged on site.

Cumulative groundwater–surface water interaction effects

To manage the cumulative effects of abstraction and groundwater contamination on connected surface water systems, the following measures will be implemented:

- Abstraction will be controlled so that groundwater–surface water interactions and natural discharge patterns remain unaffected, with abstraction operations adjusted if monitoring indicates unexpected declines in groundwater levels or changes in flow regime.
- Long-term groundwater level monitoring and cumulative drawdown assessment will be used as early-warning tools to identify any widening of the drawdown footprint toward connected surface water receptors.
- Because contaminants may migrate downgradient toward the Okulu River and may also enter surface water via baseflow, groundwater contamination prevention and groundwater quality surveillance will form part of the Project's cumulative management response.
- The Project will maintain coordinated management of groundwater abstraction, effluent handling, spill prevention and environmental performance across Indorama operations, so that cumulative groundwater pathways to surface water remain controlled.
- Where relevant, groundwater and associated surface-water monitoring data will be reviewed together through the ESMS / ESMMP to inform corrective action where indirect cumulative effects are identified.

Cumulative vertical preferential flow between aquifers

To manage the cumulative risk of vertical preferential flow between aquifers, the following measures will be implemented:

- All new water-supply boreholes will be constructed to standard by a qualified drilling contractor under construction supervision / QA, with full grout annular seals isolating the shallow, intermediate and deep aquifers.
- Casing / cement-bond integrity testing will be carried out on completion of each borehole.
- Any redundant, failed or test boreholes will be properly decommissioned and sealed to standard.
- Monitoring of paired shallow, intermediate and deep groundwater levels will be established to provide early indication of possible cross-aquifer hydraulic interaction.
- Additional investigation of the shallow–intermediate aquifer relationship, including targeted hydraulic testing, cross-monitoring and appropriately sealed borehole

construction, will be used to refine understanding of vertical hydraulic connectivity where this remains uncertain.

Cross-cutting cumulative management measures

In addition to the impact-specific measures above, the following cumulative controls will apply:

- A Groundwater Management Plan will guide sustainable groundwater use through monitoring, abstraction control, water quality surveillance, spill prevention and adaptive management.
- The Project's ESMMP is intended to provide a practical, measurable and auditable framework for implementing and tracking groundwater mitigation and monitoring commitments.
- Monitoring requirements will be used to assess the effectiveness of mitigation measures and enable adaptive management where monitoring results or changing Project conditions indicate the need for corrective action.
- The cumulative management approach will align with Nigerian regulatory requirements, the IFC Performance Standards, and the World Bank Group EHS Guidelines as already reflected in the ESIA and ESMMP.

9.2.8 SURFACE WATER RESOURCES

9.2.8.1 PROJECT SPECIFIC MITIGATION MEASURES

Construction Phase

As outlined in 8.2.7.4, the predicted impacts associated surface water are anticipated to range from major to minor.

Accordingly, aside from the general soil mitigation and management measures included in the ESMMP (refer to Chapter 10), no additional design changes are proposed for the Project. The mitigation and management measures outlined for Surface water are applicable for soil and groundwater outlined in section 9.2.6 and 9.2.7 are also applicable to the management of surface water resources.

Key measures include:

- Erosion and Sediment Control Plan to be implemented prior to ground disturbance, including silt fences, sediment traps, contour drains and sediment ponds at strategic locations; progressive stabilisation and rehabilitation of disturbed areas.
- Temporary stormwater management with diversion drains and segregation of clean and potentially contaminated runoff; first-flush retention at refuelling areas, workshops and material laydowns.
- Bunded fuel and chemical storage with secondary containment sized to 110% of the largest container; refuelling restricted to designated hardstands. The existing refuelling facilities will be used in preference to new construction phase facilities.
- Spill response readiness site-specific Emergency Spill Response Plan, accessible spill kits, trained response personnel, and immediate reporting and remediation protocols for any release.

- Water conservation construction water sourced from treated reuse water from existing operations; metering of construction water draws and tracking current allocation.
- Sanitation workforce sewage routed to the existing IFF-Line 1 sewage network and treatment plant; no on-site discharge of greywater or blackwater.
- Camp and waste management segregated storage of hazardous and non-hazardous waste; offsite disposal to approved waste management facilities per the Waste Management Plan; routine inspection of storage areas.
- Traffic and dust controls wheel washes at site exits, sealed haul roads where practicable, road sweeping and dust suppression to limit pollutant tracking into drainage channels.
- Drainage continuity natural drainage paths to be maintained or temporarily diverted in a controlled manner; final layout to restore pre-construction flow patterns where possible.
- Construction phase water quality monitoring at upstream and downstream stations on the Okulu River, with action thresholds for sediment and hydrocarbon indicators; implementation of the Project grievance procedure to address any water quality complaints received.

Operational Phase

The mitigation and management measures outlined for Effluent from Effluent Treatment Plant for Groundwater Resources (refer to Section 9.2.7.1) apply to surface water resources during the operational phase.

Key measures include:

- Closed-loop water management: process condensates from the ammonia and urea plants treated in dedicated strippers and hydrolyser/stripper units, sent to the Polisher Unit and reused as boiler feed water; cooling tower blowdown routed to the wastewater recovery plant for treatment and reuse.
- Zero normal-operation discharge: wastewater from IFF-Line 2 processed, recovered and reused under normal operation; discharge to the Okulu River only during wastewater recovery plant shutdowns, via the existing IFZ1/IFZ2 holding and retention ponds, with quality confirmation prior to release and discharge only when the retention pond is full.
- Effluent quality verification: before any release event, against FMEnv and IFC EHS Guideline limits for ammoniacal nitrogen, nitrate, BOD/COD, TSS, oil and grease, pH and temperature.
- Stormwater segregation: process-area runoff separated from clean stormwater per IFC EHS Guidelines; first-flush captured and routed to treatment; vegetated swales and retention ponds used to reduce peak discharge.
- Oil/water separation: Where necessary, Coalescing Plate (CPI) separators and oil skimmers to be installed at refuelling, workshops, parking, fuel storage and first-rain sumps; periodic skimming and inspection.
- Chemical containment: bunded storage, secondary containment and dedicated neutralisation pit for the boiler chemical drain; spilled sulphuric acid washed with sufficient water and routed to effluent treatment; spilled MDEA and UF-85 collected and reused.
- Hazardous substance management: handling per SOPs and MSDS, proper labelling, MSDS display, spill control equipment availability and trained operators.

- Air emission controls limiting atmospheric deposition: ammonia recovery from purge and flash gas, low-NOx burners and selective catalytic reduction at the primary reformer; granulator exhaust dust recovery system limiting urea dust and ammonia to less than 50 mg/Nm³.
- Groundwater abstraction management: abstraction limited to the assessed sustainable yield of existing and three new back-up boreholes, supported by the independent hydrogeological study; ongoing groundwater level monitoring to confirm no impact on aquifer recharge or baseflow to local watercourses.
- Operational surface water monitoring programme at agreed upstream, downstream and reference stations on the Okulu River, with seasonal sampling and reporting against baseline conditions.
- Flood resilience: siting and elevation of retention pond outflow, discharge point and critical infrastructure to be confirmed against the client's floodline study (1:50 and 1:100 year events); freeboard and emergency overflow provisions reviewed accordingly.

9.2.8.2 CUMULATIVE IMPACTS MITIGATION MEASURES

Cumulative impacts on surface water are relevant because the Project is located within an established industrial complex and will utilise existing water management systems, including wastewater treatment facilities, stormwater drainage systems, and retention infrastructure. The principal receiving water body is the Okulu River, which is tidally influenced, hydrologically connected to the downstream Bonny Estuary and mangrove environments, and already shows evidence of industrial pressure and reduced assimilative capacity. In this context, cumulative impacts are most relevant where Project-related pollutant pathways, engineered drainage, and runoff are added to existing industrial discharges, stormwater pathways, and in-channel sediment disturbance within the wider catchment.

Mitigation of cumulative impacts will therefore be achieved through the continued application of robust surface water quality controls, integrated stormwater and wastewater management, sediment and erosion control measures, thermal discharge controls, and coordinated monitoring across the wider Indorama complex. These measures are to be implemented through the Project ESMS and ESMMP, including the existing surface water management framework.

Cumulative deterioration in surface water quality

To manage cumulative deterioration in surface water quality, the following measures will be implemented:

- Under normal operation, wastewater from the Project will be processed, recovered and reused, and no routine operational discharge to surface water is proposed for the Project. Discharge to the Okulu River would occur only under controlled circumstances, including wastewater recovery plant shutdowns and high retention pond levels, and only after quality confirmation.
- Before any release event, effluent quality will be verified against applicable FMEnv and IFC EHS Guideline limits for parameters including ammoniacal nitrogen, nitrate, BOD/COD, TSS, oil and grease, pH and temperature.

- Construction and operational areas will be maintained in a good and tidy condition, including bunding of vehicle parking areas, provision of oil and silt traps in workshop areas, and proper disposal of waste materials.
- Chemicals used on site will be stored in properly constructed areas with sealed floors, roofing and walls where applicable, and access control, and waste chemicals will be disposed of at suitable landfill sites or approved waste management facilities.
- Hydrocarbon storage and refuelling will be undertaken on bunded, impermeable surfaces with secondary containment, supported by spill kits and trained response personnel.
- Process-area runoff will be separated from clean stormwater, with contaminated or potentially contaminated runoff routed to treatment systems, including capture and treatment of the first flush where the majority of contaminants may be present.
- Where needed, coalescing plate separators, oil skimmers, oil/water separators and grease traps will be installed and maintained at refuelling areas, workshops, parking areas, fuel storage areas and first-rain sumps.
- A surface water monitoring programme will be implemented prior to construction and maintained during construction and operation, including monitoring at agreed upstream, downstream and reference stations on the Okulu River.
- The Project grievance procedure will be used to record and respond to water-quality complaints.

Cumulative changes to flow and runoff behaviour

To manage cumulative changes to flow and runoff behaviour, the following measures will be implemented:

- Stormwater will be managed in line with IFC General EHS Guideline principles, including separation of stormwater from process and sanitary wastewater streams and minimisation of runoff from process and storage areas where practical.
- The Project’s stormwater network will be integrated with the existing complex-wide drainage infrastructure, including lined open channels, culverts and the retention pond system that attenuates runoff before release.
- Runoff from areas without potential contamination sources will be minimised by reducing impermeable surfaces where practical and reducing peak discharge rates through measures such as vegetated swales and retention ponds.
- Drainage continuity will be maintained during construction, with natural drainage paths either maintained or temporarily diverted in a controlled manner, and final layouts designed, where possible, to restore pre-construction flow patterns.
- The retention pond and associated drainage system will continue to serve as the key attenuation feature, reducing flood risk on site and to surrounding land, and any intermittent discharge to the Okulu River will occur only in a controlled manner.
- Retention pond infrastructure will be appropriately sized and operated with the necessary freeboard and overflow provisions to manage storm events and maintain runoff control.

- Stormwater infrastructure will be inspected and maintained as part of the wider site water management system to preserve drainage capacity and manage any increased cumulative runoff associated with the existing industrial complex.

Cumulative sediment disturbance, turbidity and channel instability

To manage cumulative sediment disturbance, turbidity and channel instability, the following measures will be implemented:

- Construction activities will include traffic and dust controls, including wheel washes at site exits, sealed haul roads where practicable, road sweeping and dust suppression, in order to limit the movement of sediment and fines into drainage channels.
- Construction-phase runoff and erosion controls will be maintained to limit sediment-laden runoff from earthworks entering receiving waters, supported by water-quality monitoring at upstream and downstream stations on the Okulu River with action thresholds for sediment indicators.
- The Project drainage and retention infrastructure will be used to attenuate runoff before release, thereby helping reduce sediment mobilisation associated with construction and site runoff.
- Ongoing cumulative sediment pressure from sand mining and dredging in the Okulu River has been recognised in the baseline and cumulative impact assessment, and the Project's approach is therefore to minimise any additional Project-derived sediment load through runoff management, erosion control and controlled drainage.
- Surface-water and riverine-sediment monitoring will continue to provide an integrated basis for identifying whether Project activities are adding materially to existing sediment disturbance in the receiving environment.

Potential cumulative thermal and nutrient loading

To manage cumulative thermal and nutrient loading, the following measures will be implemented:

- Thermal discharge will be controlled through closed-circuit cooling towers, an engineered mixing zone, diffuser design, and continuous temperature monitoring, keeping the thermal load within design limits.
- The maximum temperature differential at the edge of mixing will be maintained at ≤ 3 °C above ambient, consistent with IFC EHS Guideline requirements and the Project-specific effluent standard.
- Nutrient-containing wastewater streams will be managed through the site treatment and recovery systems, including treatment, reuse and controlled discharge only where quality has been confirmed.
- Process condensates and cooling tower blowdown will be routed through the relevant treatment and recovery systems so that nutrient loads are reduced before any controlled release pathway is activated.
- Operational surface-water monitoring at agreed upstream, downstream and reference stations will be used to track temperature, nutrients and associated water-quality indicators against baseline conditions.

- Because the Okulu River is a sensitive, tidally influenced receiving environment with downstream ecological connectivity, the Project will maintain these controls as part of the wider complex-wide surface water management approach.

Cross-cutting cumulative management measures

In addition to the impact-specific measures above, the following cumulative controls will apply:

- The Project will implement mitigation through the existing Surface Water Management framework in the ESMMP, which is intended to ensure that activities during pre-construction, construction and operation minimise impacts on surface water resources and riverine sediment.
- Monitoring of effluent and stormwater quality will be undertaken against the Project-specific effluent standards, which are based on the more stringent applicable Nigerian and IFC benchmark values.
- Surface water monitoring will be undertaken during both construction and operation to confirm that surface water qualities remain statistically similar to baseline or that any deviations are identified and managed.
- The ESMS / ESMMP will provide the framework for implementation, monitoring, review and adaptive management of cumulative water-related impacts across the wider industrial complex.

9.3 BIOPHYSICAL ENVIRONMENT – MITIGATION MEASURES

9.3.1 CONSTRUCTION PHASE

- The mitigation and management measures for Soils and Geology, for Chemicals and Hydrocarbon Spills affecting Groundwater resources, and for Surface Water Resources during the construction phase are also applicable to the management of biodiversity and ecosystem services during the construction phase.
- During the design phase, ensure lighting designs are of such nature that they create minimal interference with nocturnal wildlife (i.e. down-lights, low lighting, as dimmed as possible, using hues that do not attract or interfere with fauna)
- All construction areas and associated facilities should be demarcated, and no activities are to take place outside of these.
- A Biodiversity management and monitoring plan shall be drafted, which will include, but not limited to:

- Alien Invasive Plant Control guidelines with implementation and monitoring rosters, also including a list of permissible herbicides to be used
- Monitoring parameters for terrestrial and aquatic fauna and flora. This will also focus on all observed threatened species. Where such are plants (trees), attempts will be made to retain such within the plant where possible or replant such species as part of the Site internal landscaping.
- Daily pre-site works inspection of construction areas to ensure no fauna are on or have become entrapped within the construction site. This would need to be cross-referenced

in the applicable earthworks procedure and supplemented with an appropriate faunal handling and release/relocation procedure.

- A faunal incidence register needs to be kept; indicating species, where and when observed or interacted with, any mitigation undertaken and outcomes of such.
- Landscaping and rehabilitation guidelines post-construction, aiming to create habitat of value for biodiversity within landscaped gardens, and ensuring only non-invasive plant species are used, preferably only indigenous species.
- This plan shall be carried over and adapted for the operational phase and reviewed and updated at least every 5 years.

- Adequate site drainage system to be designed to avoid flooding during raining seasonal.
- As far as possible, construction should be limited to daytime only.
- Threatened tree species should be demarcated and spared from clearing where possible.
- The waste-control plan should be fully aligned to biodiversity sensitivities, also ensuring that organic wastes are adequately secured to prevent access to scavenging fauna.
- The emergency response plan should be fully aligned to biodiversity sensitivities, also ensuring that post-emergency monitoring is implemented and aligned to the biodiversity management plan.
- Staff shall be given toolbox talks regarding fauna and flora and should be made aware that no illegal plant or animal collection (including snaring or trade from local communities) is allowed.

9.3.2 OPERATIONAL PHASE

- As indicated above, the biodiversity management and monitoring plan shall be updated post construction and carried over to the operational phase. This will include continued monitoring, auditing of the effectiveness of management actions and reviews at least every 5 years, with adaptive updates to management actions where required. The primary objectives will be to ensure landscaped areas are of value to indigenous biodiversity, surrounding landscapes and ecosystem processes (and services) are not adversely impacted due to the operations, and alien invasive species are strictly kept under control within and around site boundaries.
- The mitigation and management measures included for Effluent from Effluent Treatment Plant for Groundwater Resources and for Surface Water Resources during the operational phase are applicable for the management of biodiversity and ecosystem services during the operational phase.
- All Project staff are to be made aware that no illegal plant or animal collection is allowed, including snaring or trade from local communities.
- The waste-control plan will be fully aligned to biodiversity sensitivities, also ensuring that organic wastes are adequately secured to prevent access to scavenging fauna.

The emergency response plan will be fully aligned to biodiversity sensitivities, also ensuring that post-emergency monitoring is implemented and aligned to the Biodiversity management and monitoring plan.

9.4 SOCIO-ECONOMIC MITIGATION MEASURES

9.4.1 PROJECT-SPECIFIC IMPACT MITIGATION MEASURES

Project-specific socio-economic mitigation measures focus on direct impacts arising from construction and operation, including employment, labour influx, community expectations, and health and safety.

9.4.1.1 EMPLOYMENT, INCOME AND ECONOMIC OPPORTUNITIES

To maximise positive socio-economic benefits:

- Implement a Local Content and Procurement Plan prioritising local recruitment and contractor participation
- Prioritise hiring from host communities and Rivers State, where feasible
- Establish and maintain a local skills and SME database to support recruitment and procurement
- Promote skills development and vocational training programmes to enhance employability
- Ensure transparent recruitment processes, including:
  - Clear communication of job requirements and selection criteria
  - Communication of the temporary nature of construction employment
- Promote inclusion of vulnerable groups, including women and youth, in employment and supply chains
- Support local SMEs through contracting opportunities and capacity-building initiatives.

9.4.1.2 LABOUR INFLUX AND COMMUNITY PRESSURE

To manage labour influx and associated pressures:

- Develop and implement a Labour Influx Management Plan
- Prioritise local employment to reduce inward migration pressures
- Provide worker accommodation, where required and feasible, to reduce pressure on local housing
- Monitor and manage pressure on local infrastructure and public services
- Strengthen coordination with local authorities on service capacity and planning
- Promote contractor compliance with workforce management and community conduct requirements.

9.4.1.3 COMMUNITY EXPECTATIONS AND SOCIAL CONFLICT

To manage community expectations:

- Implement a transparent and clearly communicated recruitment process
- Clearly communicate employment limitations and timelines

- Strengthen stakeholder engagement and communication with host communities
- Engage proactively with traditional leadership structures and Community Development Committees (CDCs)
- Establish and maintain a grievance mechanism for community concerns
- Implement proactive expectation management strategies tied to employment and procurement opportunities.

9.4.1.4 SOCIO-ECONOMIC DEVELOPMENT AND COMMUNITY INVESTMENT

To enhance long-term benefits:

- Implement community investment programmes (SED / CSI) aligned with updated community MOUs
- Promote local procurement and supply chain participation
- Support SME development and capacity building initiatives
- Facilitate joint interventions (e.g. infrastructure and community development projects) with stakeholders
- Consider buffer zones and planning measures to manage settlement expansion around the site.

9.4.1.5 COMMUNITY HEALTH, SAFETY AND SOCIAL WELLBEING

To mitigate Project-related health and safety risks:

- Implement traffic and transport management measures to reduce accident risks
- Implement an emergency preparedness and response plan (EPRP) and a hazardous waste management plan (HWMP)
- Promote public health awareness, including communicable disease prevention
- Ensure contractor compliance with occupational health and safety (OHS) requirements
- Strengthen coordination with local authorities on health and emergency response capacity
- Maintain ongoing community engagement on safety risks and mitigation measures

9.4.2 SOCIO-ECONOMIC CUMULATIVE IMPACTS MITIGATION MEASURES

Cumulative impacts arise from the interaction of the Project with existing industrial activities, urban expansion, and broader socio-economic dynamics within the AoI.

9.4.2.1 CUMULATIVE EMPLOYMENT AND ECONOMIC PRESSURE

- Coordinate local hiring with existing developments to avoid labour market distortion
- Strengthen regional skills development initiatives to align supply and demand
- Promote inclusive economic participation beyond immediate host communities
- Support sustained SME development and diversification to avoid dependency on a single project

9.4.2.2 CUMULATIVE LABOUR INFLUX AND URBANISATION PRESSURE

- Coordinate with authorities to monitor and manage population influx trends

- Collaborate with government on housing, infrastructure and service planning
- Promote use of formal worker accommodation to reduce informal settlement growth
- Implement ongoing influx monitoring and reporting mechanisms

9.4.2.3 CUMULATIVE PRESSURE ON INFRASTRUCTURE AND SERVICES

- Engage with local authorities to support integrated infrastructure planning
- Monitor cumulative pressure on:
  - Water supply
  - Electricity
  - Waste management
  - Transport networks
- Explore co-investment or partnership opportunities in infrastructure development where feasible.

9.4.2.4 CUMULATIVE COMMUNITY EXPECTATIONS AND SOCIAL STABILITY

- Maintain continuous stakeholder engagement across the wider industrial area
- Align communication with other developments to reduce conflicting messaging
- Strengthen grievance management systems to track cumulative concerns and emerging risks
- Promote transparency and consistency in benefit-sharing mechanisms

9.4.2.5 CUMULATIVE HEALTH AND SAFETY RISKS

- Coordinate with regional stakeholders to manage traffic and road safety cumulatively
- Implement public health monitoring and awareness programmes at AoI level
- Align emergency preparedness with wider industrial response systems

9.4.3 SOCIO-ECONOMIC MONITORING FRAMEWORK

The monitoring framework is aligned with the Social Management Plan and provides measurable indicators to track mitigation effectiveness and cumulative trends.

TABLE 9-7: SOCIO-ECONOMIC MONITORING FRAMEWORK

Impact	Mitigation	KPI	Monitoring Method	Frequency	Responsibility	Reporting
Employment and Local Economic Participation	Local hiring and procurement	% local employment; % local procurement	Contractor records; HR audits	Quarterly	IFF / Contractors	Quarterly ESMS report
Skills Development	Training programmes	Number of trainees; training completion rates	Training records	Quarterly	IFF HR / Contractors	Quarterly
SME Participation	SME support initiatives	Number of SMEs contracted; value of local contracts	Procurement records	Quarterly	IFF Procurement	Quarterly
Labour Influx	Influx management plan	Number of in-migrant workers; accommodation usage	Workforce tracking; community surveys	Monthly	IFF / Contractors	Monthly summary
Infrastructure Pressure	Infrastructure monitoring	Number of community complaints; service disruptions	Stakeholder feedback; authority liaison	Quarterly	IFF Community Relations	Quarterly
Community Expectations	Stakeholder engagement	Number of engagement sessions; grievances raised/resolved	SEP records; grievance logs	Monthly	IFF Community Relations	Monthly
Grievance Management	Grievance mechanism	% grievances resolved within timeframe	Grievance register	Monthly	IFF	Monthly dashboard
Community Health & Safety	Health and safety controls	Number of incidents (traffic, health)	Incident reporting; audits	Monthly	IFF HSE	Monthly
Cumulative Impacts	Integrated monitoring	Trends in complaints, influx, service pressure	Integrated monitoring review	Quarterly	IFF ESMS	Quarterly

9.4.3.1 MONITORING APPROACH

- Monitoring will be implemented through the Project ESMS and Social Management Plan
- Indicators will be tracked across construction and operation phases
- Results will be used for adaptive management, ensuring mitigation measures remain effective and responsive to changing conditions
- Monitoring outputs will be integrated with:
  - Stakeholder engagement processes
  - Grievance mechanisms
  - Regulatory and lender reporting requirements

9.5 CULTURAL HERITAGE MITIGATION MEASURES

9.5.1 SUMMARY OF BASELINE FINDINGS AND IMPACT CONTEXT

The cultural heritage assessment undertaken as part of the ESIA confirms that no direct or indirect impacts to cultural heritage resources are anticipated for the Project. All identified tangible and intangible cultural heritage features are located outside the Project construction footprint, and therefore are not expected to be affected during either construction or operation.

The Project is located within a previously developed industrial area, and site surveys and stakeholder engagement did not identify any intact or significant cultural heritage resources within the immediate Project footprint.

However, consistent with IFC PS (Cultural Heritage) and GIIP, the assessment recognises that:

- Cultural heritage resources may be known, unknown, or previously disturbed, and
- The absence of identified resources does not eliminate the potential for chance finds during ground disturbance activities, particularly during construction.

Accordingly, a precautionary approach has been adopted, and a Chance Finds Procedure (CFP) has been developed and will be implemented as the primary mitigation tool.

9.5.2 MITIGATION AND MANAGEMENT MEASURES

Given the absence of predicted impacts, mitigation measures focus on impact avoidance, risk management, and procedural controls to ensure that any unforeseen cultural heritage resources are appropriately managed.

9.5.2.1 AVOIDANCE AND DESIGN CONTROLS

- The Project layout has been selected and confirmed such that no known cultural heritage resources occur within the construction footprint, thereby avoiding direct impact.
- The Project will not remove, alter, or damage any cultural heritage resources, in line with IFC PS8 requirements.

9.5.2.2 CHANCE FINDS PROCEDURE (CFP) IMPLEMENTATION

A formal Chance Finds Procedure will be implemented throughout the construction phase to manage any previously unidentified cultural heritage resources encountered during ground disturbance activities.

Key principles of the CFP include:

- Immediate cessation of work in the vicinity of any potential cultural heritage discovery
- Protection and demarcation of the find area to prevent damage, disturbance, or unauthorised access
- Prompt notification to Project management and relevant authorities (including the National Commission for Museums and Monuments (NCMM))
- Assessment by a qualified cultural heritage specialist to determine the significance of the find and appropriate management actions
- Controlled resumption of works only once clearance has been obtained from the relevant authority

The CFP ensures that previously unidentified archaeological, historical, or cultural materials are protected, even in the absence of baseline-defined impacts.

Training and Awareness

All personnel involved in ground-disturbing activities will receive cultural heritage awareness training and toolbox talks prior to and during construction

- Training will include:
  - Identification of potential chance finds
  - Procedures for reporting and managing discoveries
  - Awareness of cultural sensitivity and legal obligations
- Supporting materials (e.g. signage, reference guides) will be provided on site

These measures are intended to ensure early identification and appropriate response to any potential cultural heritage discovery.

Stakeholder Engagement and Cultural Sensitivity

- Ongoing engagement with local communities will be maintained to ensure that intangible cultural heritage values are understood and respected
- Access to any cultural heritage resources outside the Project footprint will not be restricted, unless agreed with stakeholders
- Should any culturally sensitive materials or sites be identified, the Project will undertake appropriate consultation and agreed management measures consistent with IFC requirements.

Compliance and Governance

The Project will ensure compliance with:

- National cultural heritage legislation (Nigeria)
- IFC PS8
- GIIP

Responsibility for implementation will lie with Indorama, with contractors required to comply through contractual obligations and site procedures

The relevant regulatory authority (NCMM) will be engaged where required.

9.5.3 RESIDUAL IMPACT SUMMARY

With the implementation of the above measures, including the Chance Finds Procedure and cultural heritage management controls:

- The residual impact on cultural heritage is expected to remain Negligible
- The Project will maintain compliance with IFC PS8 and national requirements
- Any unforeseen cultural heritage risks will be managed proactively and effectively through the CFP and ESMS framework.

9.6 TRAFFIC AND TRANSPORT MITIGATION MEASURES

This ESIA has considered the embedded controls documented as part of Indorama's established procedures, which include a vehicle maintenance checklist. In addition to the above, IFF shall develop a comprehensive Transportation Management Plan (TMP) for the Project. The TMP shall be an extension or expansion of TMPs developed for previous projects at the Indorama site. Consistent with international best practice, the TMP shall include the components described in Table 9-8.

TABLE 9-8: TRANSPORTATION MITIGATION RECOMMENDATIONS

Component Category	Purpose	Controls and Mitigations
Road infrastructure maintenance	Maintain road surfaces and bridges to allow safe travel near regulatory speed limits, to reduce noise and vibration, and to avoid continued pavement deterioration	▪ Maintain access roads in good condition. ▪ Require Project drivers to report observed instances of road degradation. ▪ Work with appropriate authorities to encourage maintenance of public roads near the Indorama Complex.
Active traffic management	Actively manage Project and public traffic during peak travel times	▪ Provide active traffic management during ODC and super ODC deliveries along the route from Onne Port to the Project site, especially at intersections on the East West Road.
Stakeholder engagement and education	Provide for greater awareness of problems and risks; promote positive community relationships; promote safety	▪ Maintain and enhance relationships with local stakeholders to understand risks specific to Project activities, ▪ Provide a grievance mechanism that is easy to access, transparent, and responsive.
Driver qualifications for Urea Bulk Truck owned by Indorama	Ensure all drivers have suitable driver training, both general and Project-specific	▪ Employ only drivers with the required driving licenses. ▪ Establish driver training program specific to the vehicles, roads and risks encountered for the tasks for Indorama drivers. ▪ Require regular truck driver safety training, defensive driving training, and testing for Indorama drivers. ▪ Enforce driver qualifications and training for all drivers, whether employees or sub-contractors. Include requirements in applicable contracts.
Driver behaviour	Require drivers to consistently display safe driving practices	▪ Establish and enforce rest and break standards that comply with industry and national standards. ▪ Structure contracts with truck contractors to avoid incentives for speeding or insufficient fatigue breaks. ▪ To the degree permissible by law, require daily or periodic drug and alcohol testing for all drivers. ▪ Equip trucks with speed governors and on-board GPS to monitor vehicle speed and location. ▪ Enforce driver quality through loss of jobs or contracts for individual drivers for drug or alcohol offenses and chronic or egregious speeding.
Vehicle Condition of Own trucks and	Ensure that haul vehicles are in good condition and safe to operate on public roads; provide for driver	▪ Require scheduled, preventative vehicle maintenance according to manufacturers' recommendations for all Project vehicles, whether owned by Project or a contractor. ▪ Complete a basic vehicle safety checklist daily prior to vehicle operation on public roads.

Component Category	Purpose	Controls and Mitigations
Construction equipment	communication in case of emergencies.	■ Provide uniform in-vehicle communications systems that enable contact with truck traffic controllers and other drivers. ■ Require that noise-controlling devices (silencers) be in good operating condition
Vehicle Cleaning and Loading	Ensure that haul trucks do not create a nuisance and visibility hazard by generating airborne dust or contributing to dirt on roads; prevent hazards and delays from spills	■ Securely cover loads on trucks to minimize spillage and dust. ■ Do not overload trucks ■ Use water trucks to reduce dust that would be carried onto the public roads by haul trucks and other vehicles, especially during construction. Provide a spray/cleaning station during construction for trucks entering the public road system. Indorama to continue the current practice of using wetting trucks.

10. ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MONITORING PLAN

As part of the environmental approval process for the proposed IFF Line 2 Fertilizer Project, a simple and easy to implement ESMMP is needed to address the issues identified in the ESIA. The ESMMP sets out a formal system by which the Project can manage mitigation commitments during the construction and operational phases of the proposed IFF Line 2 Project.

Note – a standalone ESMMP has been developed for the Project and has been included in this ESIA as Appendix C.

11. CONCLUSIONS AND RECOMMENDATIONS

11.1 INTRODUCTION

This Chapter presents the consolidated conclusions of the ESIA for the proposed IFF Line 2 Fertilizer Project, and provides recommendations to ensure that the Project is implemented in a manner that is environmentally and socially sustainable, compliant with applicable Nigerian regulatory requirements, and aligned with international GIIP, including the IFC PSs, AfDB's ISS and WBG EHS Guidelines.

The conclusions presented are based on the integration of findings from all specialist baseline and impact assessments, the structured evaluation of identified impacts across all Project phases, and the application of mitigation measures and management controls, as captured in the ESMMP. The ESIA has followed a systematic and transparent assessment process linking baseline conditions to impact identification, mitigation measures, and residual impact significance, ensuring a robust and auditable basis for decision-making.

11.2 OVERALL PROJECT ACCEPTABILITY

11.2.1 ENVIRONMENTAL AND SOCIAL ACCEPTABILITY

The ESIA finds that the proposed Project is environmentally and socially acceptable subject to the implementation of the mitigation and management measures defined in this ESIA and the associated ESMMP.

No environmental or social fatal flaws have been identified that would preclude the development of the Project. The Project is located within the established Indorama Free Zone, an existing industrial complex, which significantly reduces potential impacts associated with land acquisition, physical displacement, and encroachment into sensitive or undeveloped areas. The use of existing infrastructure and utilities further limits incremental environmental disturbance and supports efficient resource use.

11.2.2 COMPLIANCE WITH APPLICABLE STANDARDS

The ESIA has been undertaken in alignment with Nigerian regulatory requirements and applicable international standards, including IFC Performance Standards and AfDB Operational Safeguards. The findings confirm that the Project can achieve compliance with these standards, provided that the recommended mitigation measures, management systems, and monitoring programmes are effectively implemented.

The ESMMP, together with the broader Environmental and Social Management System (ESMS), provides the mechanism through which mitigation measures will be implemented, monitored and verified, ensuring ongoing compliance and performance improvement throughout the Project lifecycle.

Based on the ESIA findings and current Project design, the Project is not expected to result in physical or economic displacement and therefore IFC Performance Standard 5 and AfDB Operational Safeguard 5 (Land Acquisition and Involuntary Resettlement) is not triggered. Land required for the Project is located within the existing Indorama Free Zone and is under the control of the Proponent. The Project will, however, continue to apply good international industry practice to monitor and manage any potential land access restrictions or livelihood

disruptions, and any future changes will be addressed through the Management of Change process and assessed against PS5 requirements.

11.2.3 CONCLUSION STATEMENT

On the basis of the ESIA findings, the Project is considered acceptable for authorisation and financing, subject to the full implementation of the commitments outlined in this ESIA and the ESMMP, as well as the recommendations set out in this Chapter.

11.3 SUMMARY OF KEY ENVIRONMENTAL AND SOCIAL FINDINGS

11.3.1 POSITIVE IMPACTS

The Project is expected to generate significant positive environmental and social benefits, particularly at local and national levels. These include:

- Contribution to national fertilizer production and enhancement of food security
- Stimulation of economic growth and industrial development
- Creation of employment opportunities during construction and operation
- Increased local procurement and support for downstream economic activities
- Efficient utilisation of existing infrastructure within the Indorama industrial complex

These benefits are particularly important given the socio-economic context of the area, which is characterised by relatively high unemployment levels and limited income opportunities.

11.3.2 KEY ENVIRONMENTAL IMPACTS

The ESIA has identified a range of potential adverse environmental impacts, primarily associated with construction activities and process-related emissions during operation.

Air quality impacts may arise from construction dust emissions and operational emissions associated with ammonia and urea production processes. These impacts can be effectively managed through the implementation of appropriate process controls, emission abatement technologies, and monitoring systems.

Surface water impacts are associated with wastewater discharges, contaminated stormwater runoff, and thermal discharges from cooling systems. The receiving environment, including the Okulu River, is considered sensitive, and these impacts require careful management. Mitigation measures include engineered drainage systems, retention and treatment infrastructure, and compliance with applicable discharge standards and thermal limits.

Potential impacts to soils and groundwater are mainly related to contamination risks from spills, leaks, and handling of hazardous materials, as well as groundwater abstraction. These risks can be mitigated through engineering controls, containment systems, and monitoring of groundwater quality and abstraction rates to ensure sustainable use.

Given the brownfield nature of the site, direct impacts on biodiversity are expected to be limited. However, indirect impacts may occur through pathways such as water quality changes, which are addressed through the proposed mitigation measures.

Construction-related traffic, noise, and vibration are expected to result in temporary disturbances, including increased road safety risks and community nuisance impacts.

11.3.3 KEY SOCIAL IMPACTS

The ESIA identifies several key social risks, particularly during the construction phase, including:

- Labour influx and associated pressure on local infrastructure and services
- Community expectations regarding employment and economic opportunities
- Potential for community dissatisfaction where expectations are not met
- Community health and safety risks, including traffic-related incidents and communicable diseases
- Temporary disturbances related to noise, dust, and increased activity

These impacts are influenced by existing baseline vulnerabilities, including limited infrastructure capacity and socio-economic sensitivity in the Project Area of Influence.

The assessment identified a range of environmental and social impacts during the Project's construction and operation phases. Mitigation and management measures to avoid, minimise, mitigate, or compensate for these impacts are presented in the relevant specialist chapters and consolidated in the ESMMP, in line with the mitigation hierarchy and applicable national and international requirements. Key measures address air quality, noise, traffic, waste, biodiversity, health and safety, labour and working conditions, stakeholder engagement, cultural heritage, and emergency preparedness. Implementation of these measures is expected to reduce most impacts to acceptable levels.

11.3.4 CULTURAL HERITAGE

No significant cultural heritage resources have been identified within the Project footprint that would be directly impacted by the Project. However, cultural heritage resources exist within the wider Area of Influence.

The Project will be required to implement appropriate management measures in line with IFC Performance Standard 8, including the adoption of a chance finds procedure and continued engagement with local communities where relevant.

11.3.5 CUMULATIVE IMPACTS

The Project will contribute to cumulative environmental and social impacts in combination with existing industrial activities and ongoing development within the region.

Key cumulative pressures relate to environmental receptors such as air quality and water resources, as well as social receptors including infrastructure, services, and community wellbeing. Effective management of these impacts will require coordination with other stakeholders, including industry operators and government authorities, as well as ongoing monitoring and engagement.

11.4 RESIDUAL IMPACT PROFILE

Following the implementation of mitigation measures, the majority of identified impacts are predicted to reduce to minor or moderate levels of residual significance.

No impacts of critical residual significance have been identified under normal operating conditions. Residual risks are primarily associated with unplanned events, such as accidental

spills or process failures, as well as cumulative impacts and social dynamics related to labour influx and community expectations.

Overall, the residual impact profile is considered acceptable within the context of the receiving environment, provided that mitigation measures and management systems are effectively implemented and maintained.

11.5 KEY ASSUMPTIONS AND UNCERTAINTIES

The ESIA is based on the information available at the time of assessment and is subject to several assumptions and uncertainties.

Certain elements of the Project design remain at a conceptual level, and further detail will be developed during detailed engineering design. Some assessments are based on modelling approaches and assumptions regarding operational performance. In addition, baseline data reflects defined sampling periods and may require further refinement during ongoing monitoring.

Future cumulative developments within the region may also influence impact significance over time. In recognition of these uncertainties, a precautionary approach has been adopted, and the ESMS framework provides for adaptive management to address emerging risks and new information.

11.6 REQUIRED FOLLOW-UP ACTIONS

The ESIA identifies a number of follow-up actions to be undertaken across Project phases.

Prior to construction, detailed design specifications must be finalised, and any additional baseline data requirements addressed. The Environmental and Social Action Plan (ESAP) for lenders must be completed as agreed, and contractor management plans developed in alignment with ESIA commitments.

During construction, the Project must implement key management plans, including labour influx management, traffic management, and community health and safety measures. Monitoring and reporting systems must be operational to track performance and ensure compliance.

During operation, ongoing monitoring of key environmental parameters, including air emissions, water quality, and groundwater conditions, must be undertaken. Periodic reviews of cumulative impacts and ESMS performance are also required to support continuous improvement.

11.7 RECOMMENDATIONS

In order to ensure compliance with regulatory and lender requirements and to support sustainable Project implementation, the following recommendations are made:

- The ESMMP must be fully implemented and integrated into all phases of the Project, including contractor management and operational procedures
- A robust Environmental and Social Management System must be established and maintained, with clearly defined roles, responsibilities, and reporting arrangements
- The ESAP must be developed and implemented as a key tool for managing lender requirements, with defined actions, timelines, and accountability

- Stakeholder engagement must be maintained throughout the Project lifecycle, supported by an effective grievance mechanism and transparent communication
- Cumulative impacts must be actively managed through coordination with other industrial operators and relevant authorities
- Emergency preparedness and response systems must be developed and regularly tested to manage unplanned events and minimise associated risks

11.8 FINAL CONCLUSION

The ESIA concludes that the Indorama IFF Line 2 Fertilizer Project is environmentally and socially viable and can be developed in a sustainable manner.

The Project is expected to deliver substantial socio-economic benefits while maintaining environmental and social impacts within acceptable limits through the implementation of appropriate mitigation measures and management systems.

No fatal environmental or social constraints have been identified. All significant impacts can be effectively mitigated, and residual impacts are considered acceptable within the receiving environment.

Subject to the full implementation of the ESIA commitments, ESMMP, and the recommendations outlined in this Chapter, the Project is considered suitable for regulatory approval and international financing.

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APPENDIX A ESIA TERMS OF REFERENCE (TOR)

APPENDIX B STAKEHOLDER ENGAGEMENT PLAN (SEP)

APPENDIX C ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MONITORING PLAN



ERM HAS OVER 140 OFFICES ACROSS THE FOLLOWING COUNTRIES AND TERRITORIES WORLDWIDE

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India
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Japan
Kenya
Malaysia
Mexico
Mozambique
Netherlands
Panama
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