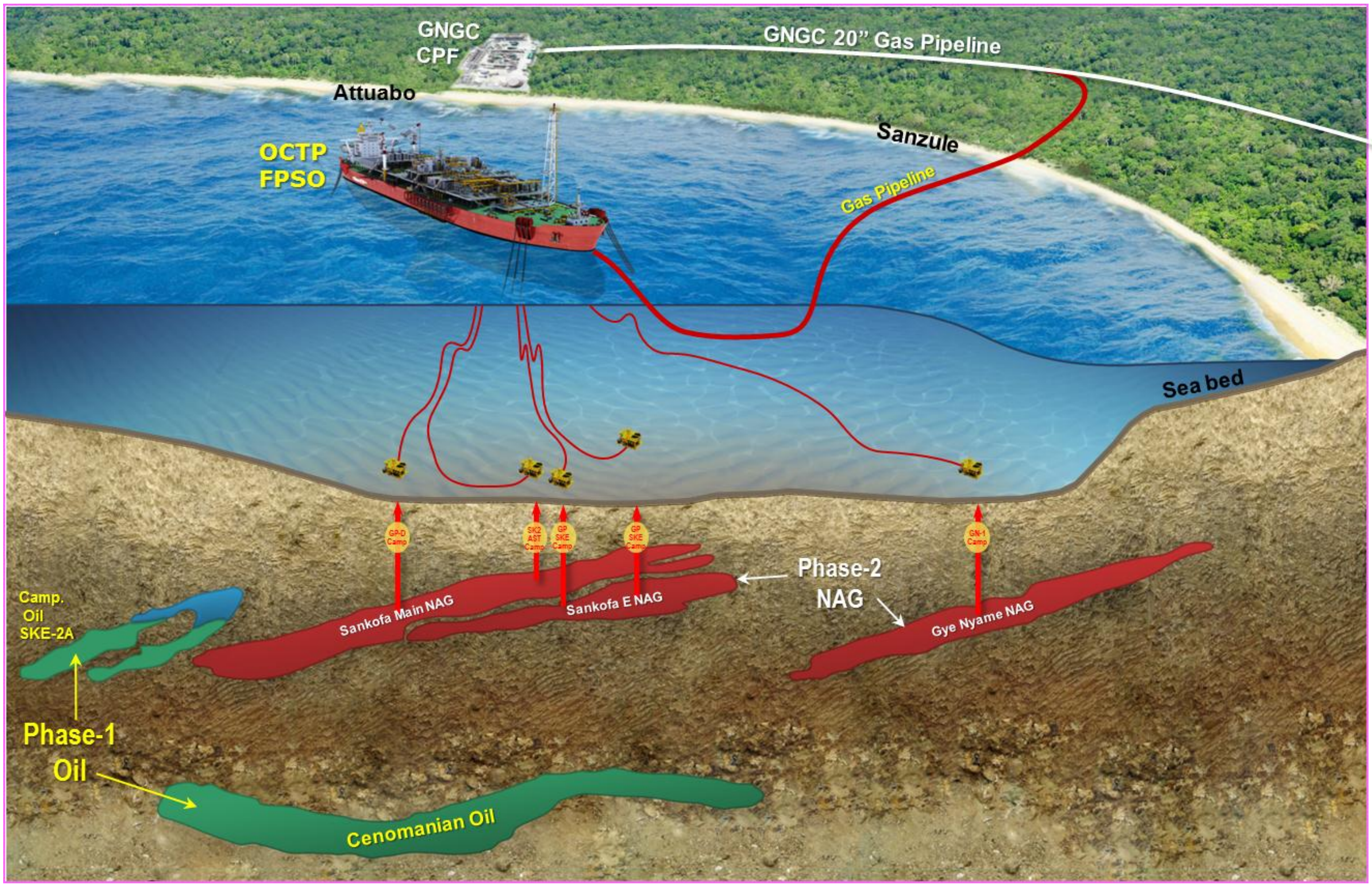

GHANA OFFSHORE CAPE THREE POINTS OIL BLOCK DEVELOPMENT

PHASE 2

FINAL ENVIRONMENTAL IMPACT STATEMENT

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Eni S.p.A.
Exploration & Production Division

ERM
SRC CONSULTING
ESL Consulting

JULY, 2015

ESHIA for GHANA OCTP BLOCK Phase 2

ABSTRACT

This Chapter includes a non-technical summary about the environmental, social, cultural and health impact assessment undertaken for the Ghana OCTP Block Phase 2 Project.

July 2015	06	Final Version	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

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ACRONYMS

Acronym	Definition
ABS	American bureau of shipping
AFDB	African Development Bank
AHTS	Anchor handling tug supply
AHV	Anchor handling vessel
ALARP	As low as reasonably practicable levels
ANC	Antenatal care
AoI	Area of influence
API	API Technical Standard 520 and 521
ART	Antiretroviral therapy
BA	Bachelor of Arts
BAT	Best Available Technique
Bbls/d	Barrels per day
BCG	meningitis and disseminated tuberculosis in children
BDT	Basic Design and Technology
BDVs	Blow down valves
BID	Background information document
BOD	Biological Oxygen Demand
BOP	Blow out preventer
Bsc	Bachelor of Science
BSCF	Billion Standard Cubic Feet
CBD	Convention on Biological Diversity
CBOs	Community based organisation
CBSV	Community-based surveillance volunteers
CCF	Congestive cardiac failure
CHN	community health nurse
CHO	Community health officers
CHPS	Community-based health planning and services
CLC	Convention on Civil Liability for Oil Pollution Damage
CLO	Community liaison officer
CMC	Carboxyl methyl cellulose
CMU	Concrete Masonry Units
cMYP	Comprehensive multi-year plan
CO	Carbon monoxide
CO_2	Carbon dioxide
COLREG	International Regulations for Preventing Collisions at Sea
CPF	Central processing facility
CPUE	Catch per unit effort
CRC	Coastal Resources Centre
CSR	Corporate social responsibility

Acronym	Definition
CVA	Cerebral vascular accident
DACF	District Assembly Common Fund
DANIDA	Danish International Development Agency
DAoI	Direct Area of Influence
DFI	Developmental Finance Institutions
DFID	UK department for International Development
DHIMS	District health information management system
DIF	Drill-In-Fluid
DNV	Det Norske Veritas
DP	Dinamically positioned vessel
DPT	diphtheria-pertussis-tetanus
EA	Environmental assessment
EAoI	Extended Area of Influence
ECC	Equatorial Counter Current
ECOWAS	Economic Community of West African States
EDA	Ellembelle District Assembly
EDF	Électricité de France
EDP	Ellenbelle Distric Profile
EEZ	Economic Exclusion Zone
EHS	Environmental, health and safety
EIA	Environmental Impact Assessment
EIS	Environmental impact statement
EMP	Environmental Management Plans
EN	Endangered
eni	Ente Nazionale Idrocarburi
EP	Environmental Permit
EPA	Environmental protection agency
EPA	Environmental protection Agency
EPFI	Equator Principle Financial Institutions
EPI	Expanded program on immunisation
EPs	Equator principles
ERM	Environmental Resources Management
ERP	Economic Recovery Programme
ERT	Emergency Response Team
ESD	Emergency Shutdown System
ESH	Environmental, social and health
ESHIA	Environmental and social impact assessment
ESHMP	Environmental, social and health management plan
ESIA	Environmental and social impact assessment
ESL	ESL Consulting
ESL	ESL Consulting
EU	European Union
EZZ	Exclusive economic zone
FADs	Fish Aggregating Devices

Acronym	Definition
FAO	Food and Agriculture Organization
FCM	Flow control module
FGD	Focus Group Discussions
FGDs	Focus group discussions
FIA	Fisheries Impact Assessment
FIR	Flight information region
FLETs	Flowlines end terminations
FMC	Flow Control Module
FoN	Friends of the Nations
FP	Family Planning
FPSO	Floating production storage and offloading vessel
FRHP	Ghana Focus Region Health Project
FUND	International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage
GACL	Ghana Airports Company Limited
GCAA	Ghana Civil Aviation Authority
GCLME	Guinea current large marine ecosystem project
GDHS	Ghana Demographic and Health Survey
GDP	Gross Domestic Product
GEF	Global environmental fund
GH	Ghana
GHG	Greenhouse gas
GHS	Ghana health service
GII	Gender Inequality Index
GIIP	Good international industry practice
GIS	Geographical Information System
GMA	Ghana Maritime Authority
GNGC	Ghanaian National Gas Company
GNPC	Ghana National Petroleum Corporation
GoG	Government of Ghana
GPHA	Ghana Ports and Harbours Authority
GPRTU	Ghana Private Transport Union
GSGDA	Ghana shared growth and development agenda
H&S	Health and safety
Ha	hectare
HIRD	High impact rapid delivery
HIV/AIDS	Human immunodeficiency virus / Acquired immune deficiency syndrome
HP	High pressure
HPI	HPI Llc. Company
HRDU	Human resource development unit
HTC	HIV testing and counselling
HVAC	Heating, Ventilating and Air Conditioning
IBA	Important bird area
ICCAT	International Commission for the Conservation of Atlantic Tunas

Acronym	Definition
ICSS	Integrated Controlled Safety System
ID	Inner Diameter
IDSR	Integrated disease surveillance and response
IEZ	Inshore Exclusion Zone
IFC	International Finance Corporation
IFG	Induced Gas Flotation
IGF	Internally generated fund
ILO	International labour organisation
IMF	International Monetary Fund
IMO	International Maritime Organisation
INTERVENTION	International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties
IPIECA	International petroleum industry environmental conservation association
IPT	Intermittent preventive treatment
ISPS	International ship and Port Facility Code
ITC	Information Communication Technology
ITCZ	Inter Tropical Convergence Zone
ITDP	Integrated Tourism Development Plan
ITNs	Insecticide Treated Net
IUCN	International Union for the Conservation of Nature
JHS	Junior High School
JV	Joint venture
KII	Key informant interviews
km	Kilometre
KP	Kilometre Point
KVIP	Kumasi Ventilated Improved Pit
LC	Least Concern
LEAP	Livelihood Empowerment against Poverty
LI	Legislative instrument
LN	Legislative Notice
LNG	Liquefied natural gas
LP	Low pressure
LPG	Liquid petroleum gas
m	metre
MARPOL	International Convention for the Prevention of Pollution From Ships
MDAs	Ministries Department and Agencies
MDGs	Millenium Development Goals
MEDEVAC	Medical Evacuation
MEG	Mono ethylene glycol
MMbbls	Millon barrels
MMboe	Million barrels of oil equivalent
MMcf/d	Million cubic feet per day
MMSCFD	Million Standard Cubic feet per Day

Acronym	Definition
MODU	Mobil offshore drilling units
MoH	Ministry of Health
MSc	Master degree
MTDP	Medium term development plan
MTN	MTN Group - Mobil telephone operator
MW	Megawatt
NAB	National Accreditation Board
NADF	Non-aqueous drilling fluid
NADMO	National Disaster Management Organization
NAFAG	National Fisheries Association of Ghana
NAG	Non associated gas
NAS	National ambulance service
NBTS	National blood transfusion service
NCA	National Communication Authority
NE	North East
NEAP	National environmental action plan
NECC	North Equatorial Counter Current
NEP	National environmental policy
NGO	Non-governmental organisation
NHIS	National health insurance scheme
nm	Nautical mile
NO_2	Nitrogen dioxide
NORSOK	Norsk Sokkels Konkuranseposisjon
NOx	Oxides of nitrogen
NPA	National Petroleum Authority
NRCD	National Redemption Council Decree
NT	Near Threat
NTP	National tuberculosis control program
NW	North West
OCNS	Offshore Chemical Notification Scheme
OCTP	Offshore cape three points
OD	Outer diameter
ODP	Outpatient department
OECD	Organisation of Economic Cooperation and Development
OGP	International association of oil & gas producers
OPRC	Oil pollution preparedness, response and co-operation
ORF	Onshore reception facility
OSPAR	Oslo-Paris Convention for the protection of the marine environment of the North-East Atlantic
OVC	orphan or vulnerable child
PAHs	Polycyclic Aromatic Hydrocarbons
PEAs	Preliminary environmental assessments
PLET	Pipeline end termination
PLONOR	Pose Little or No Risk

Acronym	Definition
PLWA	People living with HIV/AIDS
PM_{10}	Particulate matter less than 10 microns diameter
PMTCT	Prevention of mother to child transmission
PNC	Postnatal care
PNDCL	Marine Zones (Delimitation) Law
PoD	Plan of development
PPBME	Policy Planning Budgeting Monitoring and Evaluation
PPE	Personal protective equipment
PPP	Public-private partnership
PS	Performance Standards
PSA	Production Sharing Agreement
PSV	Process safety valves
PTA	Parent Teacher Association
PTR	Pupil per teacher ratio
PTTR	Pupil per trained teacher ration
PWD	Person with extreme disability
QA/QC	Quality Assurance and Quality Control
RCC	Regional Coordinating Council
RCH	Reproductive and child health
RDT	Rapid diagnostic testing
ROV	Remotely operated vehicle
ROW	Right of way
RPF	Resettlement policy framework
RSIM	Research Statistics Information Management
SAIPEM	Società Anonima Italiana Perforazioni E Montaggi
SBM	Synthetic oil based mud
SCADA	Supervisory Control And Data Acquisition
SCM	Subsea control module
SEP	Stakeholder engagement plan
SHS	Senior High School
SO_2	Sulphur dioxide
SOLAS	International convention for the Safety of Life At Sea
SOPEP	Shipboard oil pollution emergency plan
SO_x	Sulphur oxides
SPS	Subsea production system
SRC	SRC consulting
SSIV	Sub-sea isolation valve
STCW	International Convention on Standards of Training, Certification, and Watch keeping for Seafarers
STIs	Sexually transmitted disease
STMA	Sekondi-Takoradi Metropolitan Assembly
SURF	Subsea umbilicals, risers and flowlines
SWOT	Strengths-Weaknesses-Opportunities-Threats
TB	Tuberculosis

Acronym	Definition
TBA	Traditional birth attendant
TBC	To be confirmed
TBD	To be determined
TEN	Tweneboa, Enyenra and Ntomm
TH	Teaching hospital
ToR	Terms of reference
TPH	Total petroleum hydrocarbons
TSP	Total suspended particulate
TT	tetanus toxoid
TTC	Teacher Training Colleges
TWA	Time-Weighted Average
UNCLOS	United Nations Convention on the Law of the Sea
UNDP	United nation Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
UPS	Uninterruptable power supply system
US	United State
USAID	United States Agency for international development
USD	US dollar
UTM	Universal Transverse Mercator
VIP	Ventilation Improved Pit
VLCC	Very large crude carrier
VOCs	Volatile Organic Compounds
VU	Vulnerable
WACAF	West And Central Africa
WAGP	West African Gas Pipeline Company
WB	World Bank
WC	Water Closet
WD	Water Deep
WHO	World health organization
WHRU	Waste Heat Recovery Unit
WRCC	Western Region coordinating Council
WRSDF	Western region spatial development framework
XTs	Christmas trees

1 NON TECHNICAL EXECUTIVE SUMMARY

1.1 INTRODUCTION AND PURPOSE OF REPORT

1.1.1 Overview

The Offshore Cape Three Points (OCTP) Project involves the development of the Sankofa and Gye Nyame Fields located in the OCTP Block which is located approximately 60 km offshore the Western Region of the Republic of Ghana. The Project has two phases:

- **Phase 1**: Oil development project.
- **Phase 2**: Non Associated Gas (NAG) development project.

The Phase 2 Project components include five subsea gas production wells connected by subsea umbilicals, risers, and flowlines to the Floating Production Storage and Offloading (FPSO) unit installed for the Phase 1 project. During operations, well fluids will be collected at a dedicated production manifold located on the FPSO where the multiphase fluids will be sent to a slug catcher for initial separation. The gas separated from the other fluids (mainly condensates and water) will then be routed to a dew point control system to achieve the required export specification ensuring no flow assurance problems. The treated gas will then be exported to shore via a new subsea pipeline. Onshore, the gas will be received at an Onshore Receiving Facility (ORF) and then sent to the existing GNGC sales pipeline.

1.1.2 Project Justification

The Project represents a foundation for gas production in Ghana bringing new sources to market for the benefit of industries and the people of Ghana. The Project will support the wider Ghana Gas Infrastructure Development Project which is currently under development in the Western Region.

The development of the Project will also provide local employment and other economic benefits to the local communities as well as to the Western Region and Ghana in general.

1.1.3 EIA Process

Under the Ghana Environmental Assessment Regulations (1999), the Phase 2 Development Project has performed an Environmental Impact Assessment (EIA) study and submission of Report to the Ghanaian Environmental Protection Agency (EPA) for their decision on whether to issue an environmental permit for the Project, based on the Environmental Impact Statement (EIS) submitted.

The EIA for the Project was undertaken in accordance with the Ghana Environmental Assessment Regulations as well as the requirements of international lender environmental and social standards. An overview of the EIA process undertaken follows.

<u>Screening and scoping</u>

The Project was registered with the EPA on 12 December 2014. EPA screened the Project and determined that an EIA was necessary.

A scoping process was conducted and a Scoping Report was prepared. The Scoping Report provided a description of the Project, scoping consultation process, baseline information and a proposed Terms of Reference for the EIA. The Scoping Report was submitted to the Ghana EPA on 30 December 2014 for review. The Ghana EPA provided comments to the Scoping Report on 24 February 2015 and instructed eni Ghana to proceed with the EIA.

Baseline data collection

Available data on the existing environmental, social and health conditions was gathered as a basis against which the impacts of the project can be assessed. In addition to a desktop review, primary data was collected during field surveys. Surveys included offshore and onshore biophysical surveys undertaken in the wet and dry season and a socio-economic and health field survey undertaken in December 2014.

Stakeholder engagement

The stakeholder engagement process comprised the following activities:

- Identification of a preliminary list of stakeholders;
- Background information document (BID) for communicating with stakeholders;
- Meetings with government departments and stakeholder groups; and
- Meetings with local community members.

During scoping, meetings were held with 30 stakeholder groups. Stakeholders consulted included national, regional and district authorities, traditional leadership, non-governmental organisations (NGOs), international organisations and fisherman groups.

Stakeholder engagement continued through the EIA with formal and ad hoc communication with Project stakeholders through email and telephone and meetings between eni Ghana and local community members who engaged with the process.

A summary of the key issues and further details on the stakeholder consultation process are included in Chapter 1 and Stakeholder Engagement Plan (SEP) (Annex A).

Impact assessment

Using the baseline information gathered and a detailed description of the Project and planned activities, the impact assessment process followed four steps:

1. Prediction of what will happen as a consequence of project activities;
2. Evaluation of the importance and significance of the impact;
3. Development of mitigation measures to manage significant impacts where practicable; and
4. Evaluation of the significance of the residual impact.

The impact assessment considered both predictable and unpredictable impacts (such as accidents). Those that were assessed as significant were further rated as being of minor, moderate or major significance. For significant impacts, mitigation measures were developed to reduce the residual impacts to As Low As Reasonably Practicable (ALARP) levels. This approach takes into account the technical and financial feasibility of mitigation measures.

Management plans

The EIA process identified a range of mitigation measures, management actions and monitoring to be implemented during the project to eliminate or reduce adverse environmental, social and health impacts and risks and enhance positive impacts. Delivery of these will be through the Project's Environmental, Social and Health Management Plan (ESHMP).

Reporting and disclosure

The results of the EIA process are drawn together into an EIA report which is submitted to Ghana EPA for review. The EPA will disclose the EIS report to the affected communities, interested stakeholder, and to the public and facilitate public review and comment. The EIS will also under go technical review by the EPA and appointed experts.

Following review, the EPA will make a decision to grant or deny the Environmental Permit.

1.2 Legal and Policy Framework

1.2.1 Ghanaian Administrative Framework

The EPA, within the Ministry of Environment, Science, Technology and Innovation, is the leading public body responsible for the protection and improvement of the environment in Ghana. The EPA is responsible for issuing environmental permits and pollution abatement notices for controlling waste discharges, emissions, deposits or other source of pollutants and issuing directives, procedures or warnings for the purpose of controlling noise. EPA also directs the National Efforts for Tier 2 spillages and is one of coordination and provision of technical advice, logistic and maintenance support, materials and equipment, and training for Tier 3 spillages. EPA, in accordance with relevant Memoranda of Understanding and relevant International Conventions (such as Abidjan Convention), may also assist or receive assistance from neighbouring countries in relation to oil spill incidents.

Other authorities with responsibilities related to the project are:

- Ministry of Petroleum – represented through the Ghana Petroleum Commission and the National Petroleum Corporation (GNPC);
- Ministry of Transport – represented through the Ghana Maritime Authority (GMA), the Ghana Ports and Harbours Authority (GPHA) and the Ghana Civil Aviation Authority (GCAA);
- Ministry of Fisheries and Aquaculture Development – represented through the Fisheries Commission and the Regional Departments of Fisheries;
- Ministry of Food and Agriculture – represented through the Regional Directorate;
- Ministry of Defence - represented through the Ghana Navy and Ghana Air Force;
- Ministry of Finance;
- Ministry of Roads and Highways;
- Ministry of Water Resources, Works and Housing;
- Ministry of Lands and Natural Resources; and

- Ministry of Local Government and Rural Development – represented through the ten Regional Coordinating Councils.

1.2.2 National Law and Regulations

The Constitution of Ghana within Article 36 of Chapter 6 states that "*The State shall take appropriate measures needed to protect and safeguard the national environment for posterity; and shall seek co-operation with other states and bodies for purposes of protecting the wider international environment for mankind*". Within the Article 41(k) of the same Chapter 6, it is also requires that "*it shall be the duty of every citizen […] to protect and safeguard the environment*".

The Ghana EPA was established under the Environmental Protection Agency Act (Act No. 490 of 1994) as the leading public body responsible for the protection and improvement of the environment in Ghana. The EPA has the authority to require an EIA, is responsible for ensuring compliance with EIA procedures and is the lead EIA decision-maker.

Laws and regulations relevant to the Project are listed in Table 1.1. Further detail is provided in Chapter 3 of this EIS.

Table 1.1 List of Relevant National Environmental, Social, and Health Legislation

Applicable Legislative Instrument	Aspect
Environmental Protection Agency Act, 1994 (Act 490)	Environmental Protection
Environmental Assessment in Ghana, a Guide to Environmental Impact Assessment Procedures (EPA, 1996).	Environmental Protection
EPA Environmental Quality Guidelines for Ambient Air	Environmental Protection
EPA Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development (EPA, 2010)	Environmental Protection
EPA Sector Specific Effluent Quality Guidelines for Discharges into Natural Water Bodies	Environmental Protection
EPA General Environmental Quality Standards for Industrial or Facility Effluents, Air Quality and Noise Levels	Environmental Protection
Ghana Oil & Gas Operational Guidelines	Environmental Protection
Environmental Assessment Regulations, 1999 (LI 1652) Environmental Assessment (2002 Amendment) Regulations	EIA requirements and process
Wild Animals Preservation Act, Act 235 1964	Biodiversity
Wildlife Conservation Regulations 1971 (LI 685),	Biodiversity
Wild Reserves Regulations 1971 (LI 740)	Biodiversity
Wetland Management (RAMSAR sites) Regulation, 1999	Protected Areas
Water Resources Commission Act (Act 522 of 1996)	Water Resources
Water and Sewerage Corporation Act (Act 310 of 1965).	Water Resources
Beaches Obstructions Act, 1987 (CAP. 240)	Coastal and maritime legislation
Ghana Maritime Authority (Amendment) Act 2011 (Act 825)	Coastal and maritime legislation
Ghana Shipping Act	Coastal and maritime legislation
Ghana Maritime Security Act	Coastal and maritime legislation

Applicable Legislative Instrument	Aspect
The Maritime Zones (Delimitation) Law	Coastal and maritime legislation
Ghana Shipping (Protection of Offshore Operations and Assets) Regulations	Coastal and maritime legislation
Fisheries Act 2002, Act 625	Fisheries and Access to Fishing
Fisheries Regulation, LI 1968	Fisheries and Access to Fishing
Oil in Navigable Waters Act (Act 235 of 1964)	Pollution Control
Marine Pollution Bill (pending approval)	Pollution Control
Marine Pollution Prevention and Control Regulations (pending approval)	Pollution Control
Ghana National Petroleum Corporation Act (Act 64 of 1983)	Petroleum activities
Petroleum (Exploration and Production) Law (Act 84 of 1984)	Petroleum activities
National Petroleum Authority Act (Act 691 of 2005)	Petroleum activities
Petroleum Commission Act	Petroleum activities
Energy Commission Act (Act 541 of 1997)	Energy activities
Ghana Highways Authority (Act 540 of 1997)	Transport activities
Labor Act, 2003, Act 651	Labour and Social responsibilities
The Children's Act (Act 560) of 1998	Labour and Social responsibilities
Commission on Human Rights and Administrative Justice Act (Act No. 456 of 1993)	Labour and Social responsibilities
National Vocational Training Act (Act 351) of 1970	Labour and Social responsibilities
Local Government Act 462	Land management
National Development Planning Commission Act, 1994	Land management
National Development Planning (Systems) Act, 1994	Land management
National Building Regulation, 1996 (LI 1630)	Land management
Town and Country Planning Ordinance, 1945	Land management
Lands Commission Act, 1994 (Act 483)	Land management
Land Planning and Soil Conservation Act 1953 (Act 32)	Land management
Stool Lands Act, 1994 (Act 481)	Land management
State Lands Act. 1962 (Act 125)	Land management
Hospital Fees act, 1971 (Act 387)	Health
Mental Health Decree, 1972 (NRCD 30)	Health
Nurses and Midwives Decree 1972 (NRCD 117)	Health
Medical and Dental Decree 1972 (NRCD 91)	Health
Medical Profession (Professional Conduct and Ethics). Regulations, 1975 (LI 1023)	Health
The Ghana College of Physicians and Surgeons Act (635)	Health
Ghana Health Service and Teaching Hospital Act, 1996	Health
Traditional Medicine Practice Act (Act 575)	Health
Private Hospitals and Maternity Homes (No. 9) Act, 1958 (LN. 295)	Health
Pharmacy Act 1994 (Act 489)	Health
Environmental Protection Agency Act (Act 490);	Health

Applicable Legislative Instrument	Aspect
Infectious Diseases, (Cap 78)	Health
National Health Insurance Act 2003 (Act 650)	Health
National Health Insurance Regulation 2004 (L.I 1809)	Health

1.2.3 International Conventions

The Republic of Ghana is signatory to a number of international conventions and agreements relating to industry, development and environmental management. In certain cases, conventions and agreements have influenced policy, guidelines and regulations and therefore are relevant to planning, construction and operation of the Project.

1.2.4 Industry Best Practice

There are a number of industry good practice standards and guidelines for offshore oil and gas developments. Considering the oil and gas industry, one's of the most commonly used best practices references are the guidelines and best practices standards provided by the International Association of Oil and Gas Producers (OGP) and of the International petroleum Industry Environmental Conservation Association (IPIECA) of which eni is member. A detailed list of guidelines is provided in Chapter 3 of the ESHIA.

1.2.5 Financial institution Environmental and social performance standards

The ESHIA is aligned to comply with the relevant standards and guidelines for environmental and social performance set out and adopted by World Bank (WB) and International Finance Corporation (IFC).

In particular the Project takes into account the International Finance Corporation Performance Standards for Environmental and Social Sustainability (2012) (the 'Performance Standards) and the World Bank Group Environmental, Health and Safety (EHS) Guidelines. These are summarised in Table 1.2.

Table 1.2 WB/IFC Guidelines

PS 1: Assessment and Management of Environmental and Social Risks and Impacts	Performance Standard
PS 2: Labour and Working Conditions	Performance Standard
PS 3: Resource Efficiency and Pollution Prevention	Performance Standard
PS 4: Community Health, Safety, and Security	Performance Standard
PS 5: Land Acquisition and Involuntary Resettlement	Performance Standard
PS 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	Performance Standard
PS 7: Indigenous Peoples	Performance Standard
PS 8: Cultural Heritage	Performance Standard
EHS General Guidelines	EHS Guideline
EHS Guidelines for Shipping	EHS Guideline
EHS Guidelines for Offshore Oil and Gas Development	EHS Guideline

EHS Guidelines for Thermal Power Plants	EHS Guideline
World Bank Policy on Access to Information	Access to Information

1.2.6 Project Environmental Standards

The standards applied by the Project for environmental and social components are based on MARPOL, good industry practice and IFC EHS Guidelines. Many of these standards have now been adopted in the EPA's Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development (2010). Details of the standards applied by the Project are reported in Chapter 3 of the EIS.

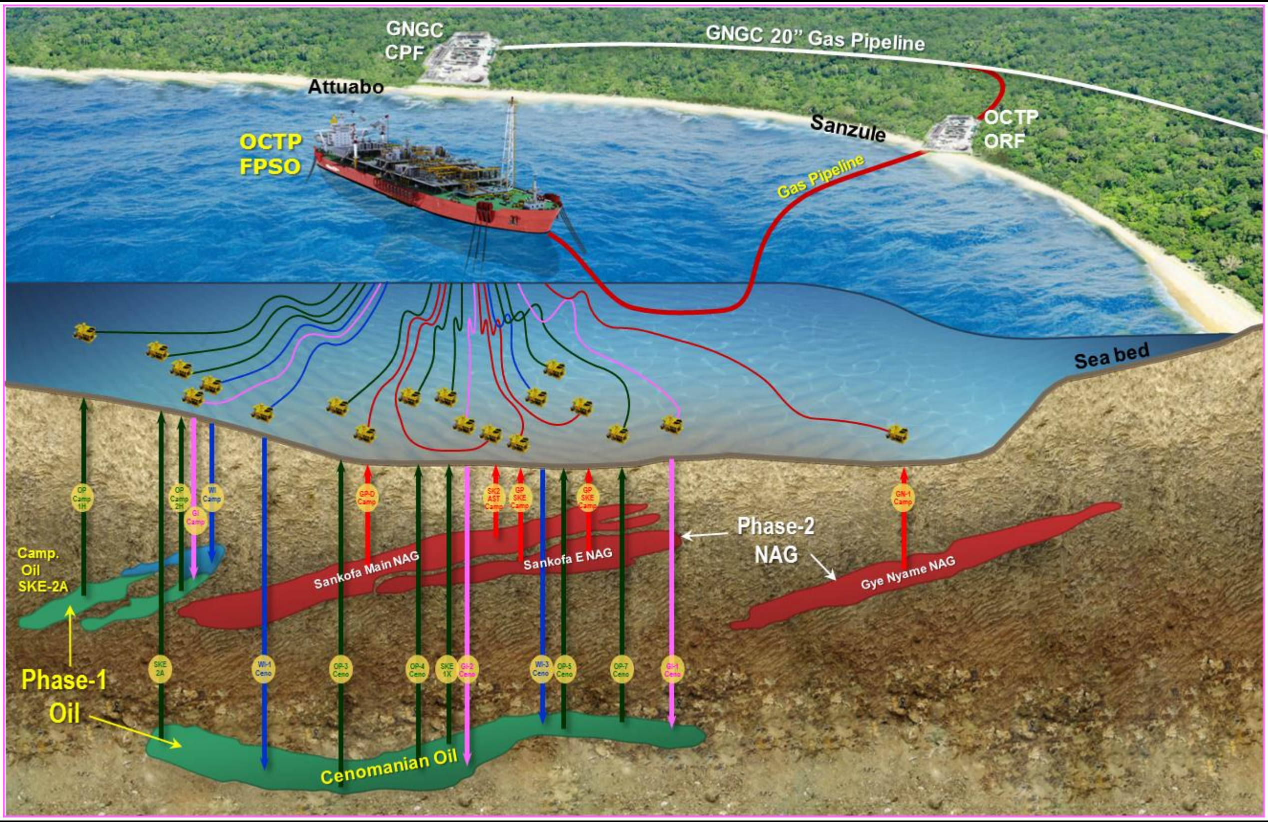
1.3 Project Description

The Project involves production of gas from subsea production wells located approximately 60 km offshore of Ghana. The Phase 2 Development (Non Associated Gas) is designed to be integrated with the Phase 1 Development (Oil).

The Phase 1 development includes eight oil production wells, three water injection wells, three associated gas injection wells, related subsea facilities and a Floating Production Storage and Offloading (FPSO) unit. The Phase 2 development consists of five (5) subsea wells, subsea facilities, minimal gas treating facilities located on the Phase 1 FPSO unit, 63 km subsea gas pipeline, onshore receiving facilities (ORF) and other onshore facilities.

Figure 1.1 presents a schematic of the integrated development scheme. Phase 2 components shown in red.

Figure 1.1 Schematic of the OCTP project



Source: eni, 2015

1.3.1 Project Location

The OCTP field is located at about 60 km south of the village of Sanzule on the Western Ghanaian coast. The fields are located in water depth of approximately 500 m to 1000 m.

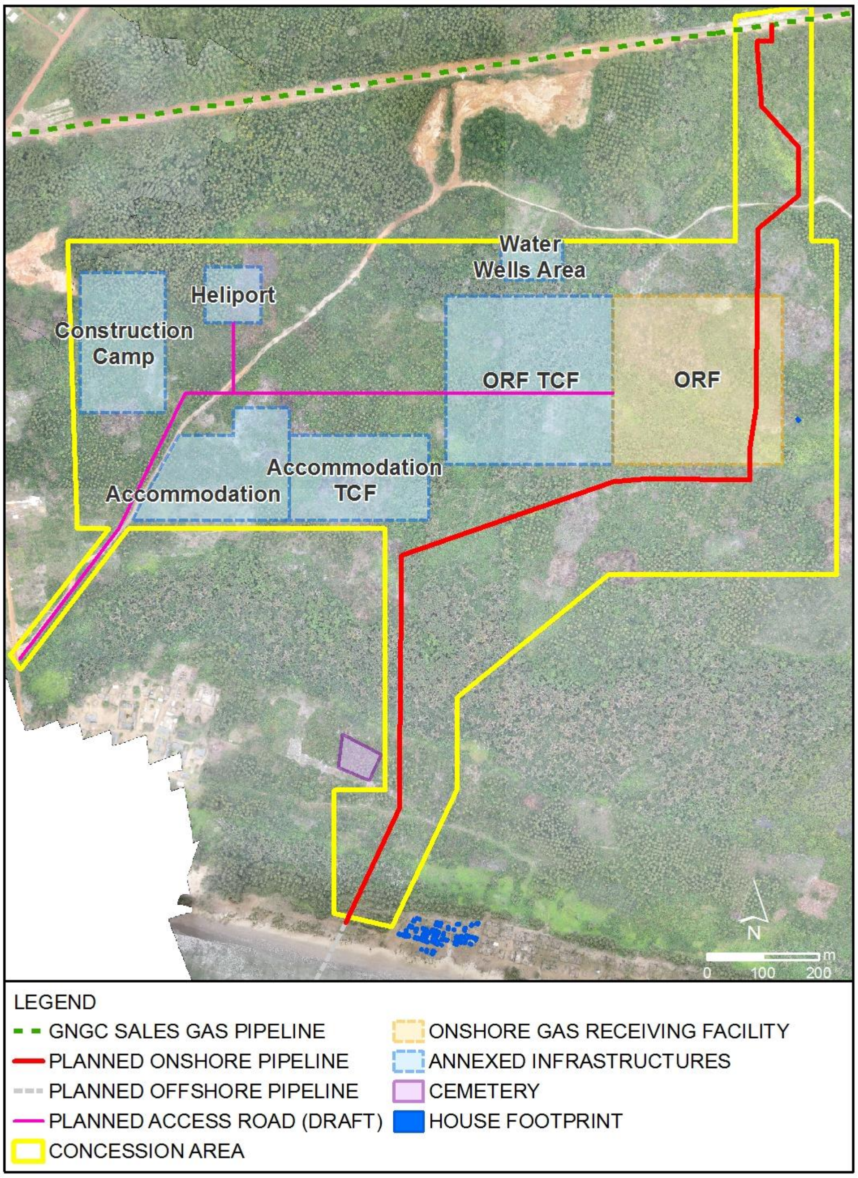
The gas wells, subsea infrastructure, and FPSO will be located in the OCTP Block. The gas pipeline will run from the FPSO to a shorelanding near Sanzule. The onshore components will be located near Sanzule, approximately 900 m northeast of the village (Figure 1.1).

The gas reservoirs are named Sankofa Main, Sankofa East and Gye Nyame. Four wells will be drilled in the Sankofa reservoirs, while the fifth will be drilled in Gye Nyame.

The FPSO will be located near the Sankofa reservoirs (Figure 1.3). The onshore concession area is shown in Figure 1.2. Rights to use the concession area will be acquired by eni.

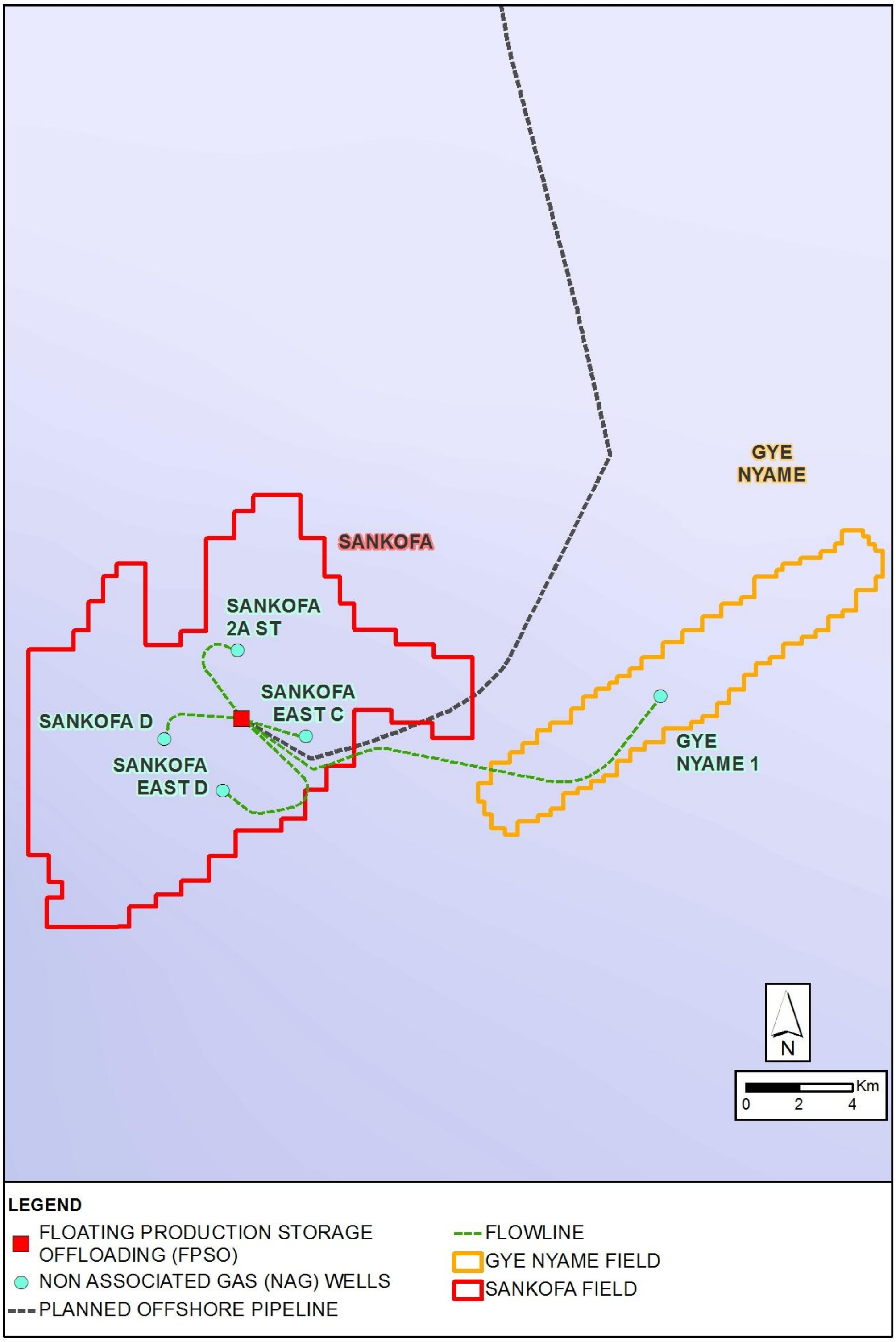
The onshore facilities will include permanent facilities such as the ORF (90000 m^2), the permanent accommodation camp (27000 m2), the helipad, roads and pipelines (outlined in pink and red) and temporary construction facilities (TCF), such as ORF temporary construction facility, temporary accommodation camp and construction camp (outlined in blue).

Figure 1.2 Onshore facilities layout



Source: eni, 2015

Figure 1.3 NAG wells and flowlines layout



Source: ERM, 2014

1.3.2 Project Schedule and duration

Project construction will last approximately three years commencing from the end of 2016 to the end of 2019. The Project will be phased with the aim to produce gas from two of the five wells in February 2018 with a raw gas rate of 190 MMSCFD. In order to maintain peak production, two new wells will be put in production during the fourth quarter of 2019 while the fifth well will be started in 2028.

Plateau duration is estimated for 13.5 years and the design life for new installations is set to be 20 years.

1.3.3 Project Activities

The Project will comprise the following main activities.

Site preparation

As a first step, the site of the onshore facilities will be prepared. This will involve equipment mobilisation, material transport, site clearance and infilling for the ORF, the onshore pipelines and temporary facilities and construction of internal roads for the ORF, the accommodation camp and temporary facilities.

Construction phase

For the offshore part of the project, this phase will include:

- Well drilling, re-entry, completion and testing;
- Subsea system installation;
- FPSO mooring and hook up;
- Gas export pipeline laying;
- Pre-commissioning and commissioning activities (FPSO commissioning, pipeline hydrotesting, subsea system testing).

The offshore construction phase will require the use of a drilling rig, pipeline laying barges for shallow and deep waters, support and supply vessels and tugs.

For the onshore part of the project, the following activities are foreseen:

- Gas export pipeline installation (underground);
- ORF construction;
- Permanent accommodation camp and helipad construction;
- Temporary facilities construction;
- Pipeline from ORF to GNGC pipeline (underground);
- Pre-commissioning and commissioning activities (ORF commissioning, pipeline hydrotesting).

This phase will require use of cranes, excavators, earthmoving equipment, trucks, vehicles, generators, concrete mixers.

Operation phase

During operations gas extracted from the wells will be treated on the FPSO and sent to the ORF through the gas export pipeline. At the ORF gas will be received, fiscally metered, compressed and delivered to the GNGC gas sales line through a tie-in.

The proposed Project has an operational lifespan of 20 years.

Maintenance of project facilities will be performed during normal operation. The maintenance will be performed on site, the machines will be equipped with dedicated systems including the remote condition monitoring and sparing philosophy, aimed to ensure the requested plant availability. Moreover, the design will allow easy access to the main equipment for major maintenance.

Decommissioning

After the 20 years lifespan of the project, the facilities will be decommissioned and abandoned in accordance with Ghana laws and regulations and international guidelines for abandonment of oil and gas facilities. A detailed programme of abandonment and decommissioning will be prepared.

1.3.4 Project Alternatives

Project alternatives were evaluated during design to maximize and ensure environmental and social sustainability of the project.

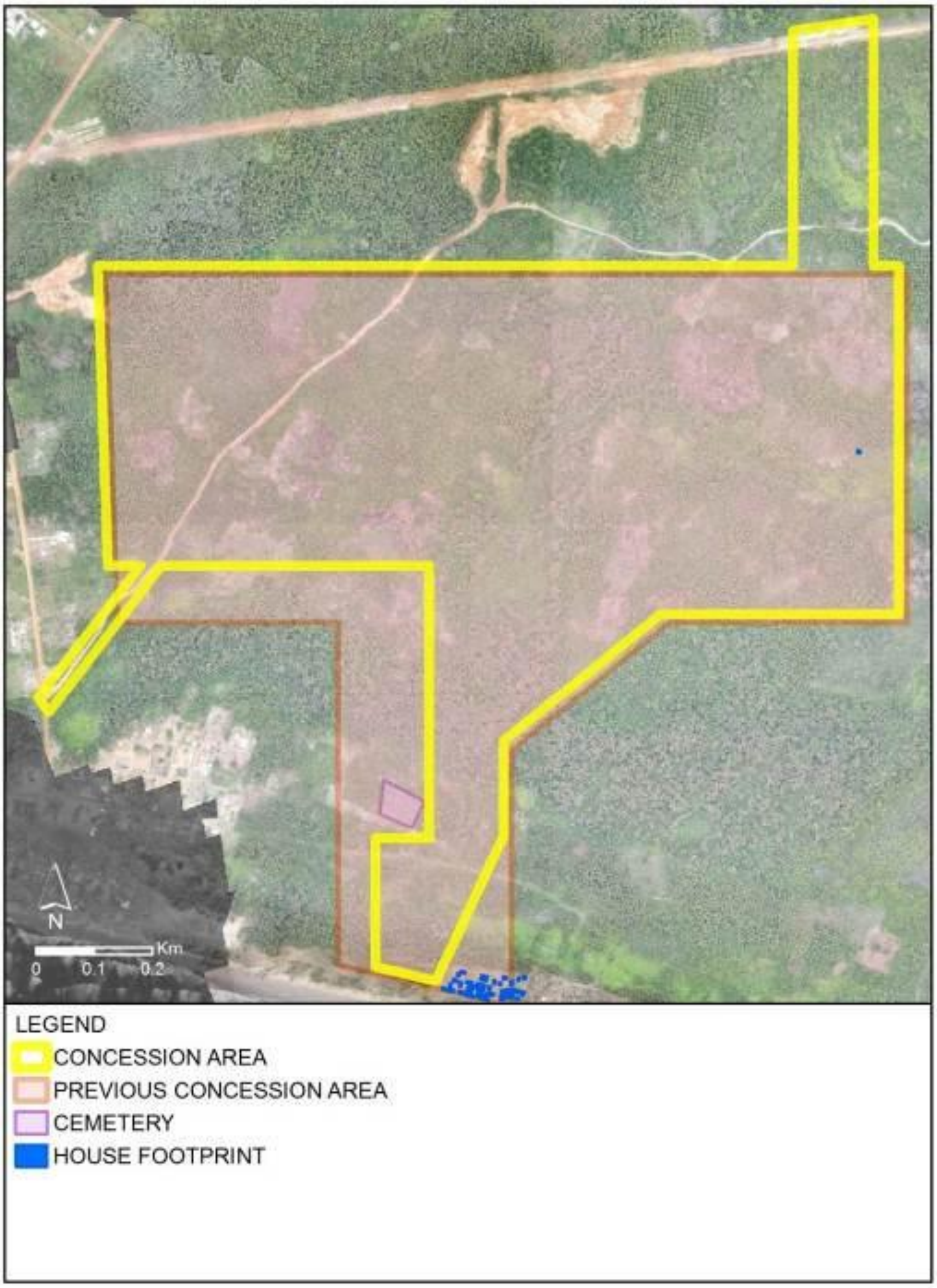
The no-project alternative was evaluated together with alternative designs, layouts and technologies. This alternative implies that only the oil reservoirs will be exploited (Phase 1), while gas reservoirs will be left in place, without additional benefits to the economy.

Locations for the FPSO were evaluated and the preferred option allows minimization of flowlines and umbilicals lengths. The spread mooring option was selected in order to allow the possibility to anchor the FPSO outside a subsea canyon (even if her location is exactly on the canyon) and assure a high level of flexibility in the plant configuration.

Locations of onshore facilities were deeply evaluated prior to selecting the proposed project location on the basis of environmental, social, technical and logistic data. The investigated area for the onshore plant runs along Ghanaian Western Coast from town of Takoradi to the Ivory Coast Border for 4-5 km inland. A desk-based study was performed and then site surveys were performed.

Moreover in the selected area near Sanzule, the onshore concession was selected in order to minimize physical resettlement of people and interferences with cultural sites. The final footprint was modified on the basis of detailed site surveys. Some areas were excluded from the concession in order to avoid impacts on inhabited areas located to the east of the gas export pipeline corridor (see houses footprints in blue) and the cultural heritage area (see cemetery footprint in pink) located to the West of the onshore pipeline section, as can be seen in Figure 1.4.

Figure 1.4 Onshore concession footprint reduction from 2014 to 2015



Source: ERM, 2015

Some design and layout options were evaluated:

- Rigid and flexible subsea flowlines, risers and umbilicals were considered. Flexible type was selected as it is able to accommodate irregularities of the seabed morphology.
- Two compression station operation conditions were selected in order to assure maximum flexibility to the compression station.

1.3.5 Emissions, Discharges and Wastes

Air emissions

During construction phase airborne emission will be pollutants from the exhausted gas of heavy equipment, vehicles and vessels. The main pollutants produced will be NO_X, CO, PM_{10} and SO_X. Dust will also be produced during earth moving, excavation and transport activities.

During well production tests, gas from the tested wells will be flared for a limited period (4.5 days).

During operation phase, offshore air emission sources are related to the FPSO operation such as gas turbines for power generation and gas compression. As the project has adopted a "zero flaring" design philosophy, flares will be used only in emergency or plant upset conditions and thus for very limited periods.

For the ORF main air emission sources will be gas turbines, diesel power generation units and gas compression. The vent at the ORF will be used only during commissioning, start-up, shut down and emergency conditions for the pipeline and plant depressurisation.

Wastewater discharges

During the construction phase, the vessels (including pipe laying barges and drilling rig) will adhere to MARPOL regulations and will be equipped with waste water treatment units for the treatment of civil wastewater.

Flowlines and risers will be leak tested after installation and hook up to the FPSO. The fluid used for leak test will be treated filtered seawater. The purpose of hydrostatic testing is to confirm the integrity of the onshore and offshore pipelines. The pipelines will be flooded with seawater (additives will be added) by injection via a temporary pig launcher to allow leak test from the FPSO or from the ORF once the riser and jumper of subsea system have been connected to the gas export PLET. Dewatering after leak test will be performed from ORF to PLET/SSIV in order to allow offshore water discharge.

Only environmentally friendly inhibitors will be used. The type inhibitor are not know at this stage but will be GOLD CHARM rated at a concentration of 500ppm (corrosion inhibitor/oxygen scavenger/Biocide mixture type RX5227); their discharge concentrations will be in line with local and international standards. The discharge flowrate will be approximately 0.5 m^3/s. The distance of discharge will not be known before detail engineering of T&I (Test & Inspection). MEG will be used for the line that will be dewatered and volume will be defined during detail engineering of T&I (Test & Inspection).

For onshore construction activities, no waste water discharge is foreseen as disposal off site is foreseen for any liquid produced during this phase.

During operation, FPSO will generate different streams: some of them, such as cooling water, domestic water, service water, bilge water will be discharged to the sea after treatment on the FPSO, while produced water will be re-injected in reinjection wells.

The waste water effluents from the ORF operation will be mainly civil water and storm water, as the ORF processes only the gas stream and thus no liquids will be generated and no chemicals will be added into the gas stream. Main industrial sources of wastewater will be accidental contamination with diesel (for emergency power generation) and lube oil (from turbines and compressors) and turbine blade washing. The wastewater effluents will be removed and disposed of in appropriate treatment plants.

<u>Noise</u>

During the offshore construction phase noise emission will be produced by drilling and completion activities and by the support vessels.

During onshore construction noise will be generated mainly by heavy equipment and ORF items installation.

During commissioning phase, noise sources are compressors and pumps for the hydrotesting.

During operations offshore noise will be generated mainly by the FPSO processing equipment, while onshore the ORF will generate continuous noise emission sources with gas turbines, diesel power generators and the compressors. Some discontinuous noise sources will be present in the ORF: operation valves, filters and air coolers.

The ORF design will be developed assuring that all the equipment is in compliance with the applicable limits and, where necessary, noise attenuation packages will be used.

<u>Waste</u>

In the OCTP project, only waste management companies approved by Ghanaian authorities will be used for transportation, recycling and disposal of produced wastes. A Waste Management Plan is in place at eni Ghana.

During offshore construction phase wastes are produced by drilling and completion activities (used drilling muds, drilling fluids, cuttings), domestic and other solid waste (oily rags, empty cans, batteries).

Seawater drilling mud will be discarded to the seabed, while Non Aqueous Drilling Fluid (NADF) will be treated on the rig and discharged at water depths equal or greater than 500 m. Discharge will be in compliance with Ghana EPA limits. A project's environmental assessment has provided a full and detailed justification of the proposed disposal option. As part of a drill cuttings study, modeling has been undertaken to quantify the transport, dispersion, and bottom deposition of discharge drill cuttings, and demonstrate that impact is not significant. All the other waste produced during the construction activities will be collected on the drilling vessel and brought onshore for appropriate treatment and disposal.

During onshore construction activities, all waste materials will be collected, stored and transported separately in appropriate and approved containers. For pipeline construction, most of the excavated soil will be used to backfill the trenches. Excess soil will likely be spread out and contoured along the route. Wastewater and solid waste from the work and construction sites will also be generated and disposed of accordingly with local and international standards.

During FPSO operations, limited quantities of waste will be produced mainly due to equipment maintenance and operation. Waste will be collected, unloaded and transported onshore to suitable facilities to be disposed in line with the local regulations and best practice.

During ORF operation, small quantities of waste will be produced from the ORF from equipment maintenance and operation. Domestic waste will also be generated. Both waste types will be handled accordingly to local regulations and best practice.

1.3.6 Personnel requirements

During construction phase a total peak of workforce demand for onshore construction will be approximately 400-600 people, while for offshore activities about 300 workers will be employed for drilling activities, 210 for FPSO mooring and 200 for gas export pipeline laying. During construction phase, Ghanaians will be involved mainly in ORF construction activities, while offshore activities will involve mainly expatriates.

During operations, permanent employee on the FPSO will be approximately 65, mainly Ghanaians (49 people), while in the ORF 45 people will be employed (20% expatriates, 80% Ghanaians).

Depending on professional profile and required skills, local people will be recruited. Preference will be given to people of the project area. If some profiles cannot be recruited in the project region, they will be recruited in other Ghana regions.

1.3.7 Health and Safety

The OCTP Project Phase 2 will be developed and will operate in compliance with safety requirements included in all applicable conventions and codes that cover maritime activities and Ghanaian legislation and regulations that cover onshore operations.

Moreover it will adhere to the eni Ghana HSE Integrated Management System (IMS), as well as eni HSE standards and project HSE documentation. The eni Ghana HSE IMS is compliant with ISO 14001 and OSHAS 18001 regulations.

Facilities design will aim to reduce risks for health and safety and miminise hazards, and thus the adoption of intrinsic safety principles will be maximized during design of project installations.

The process control system and the emergency system will be operated on functionally independent basis and the "fail safe" principle will be applied.

The principle of "double block and bleed" will be adopted in case of toxic fluids and flammable gases or when operators could be exposed to hazards due to high pressure/temperature.

A Supervisory Control And Data Acquisition (SCADA) system will be installed on the FPSO and in the ORF, in order to monitor and control plant processes.

Personnel transfer will occur typically by helicopter or boat. Specific safety procedures for helicopter and vessel transport of personnel will be implemented.

Safety equipment will be provided to all personnel at each project facility.

1.4 STAKEHOLDER CONSULTATION

The preparation of a Stakeholder Engagement Plan (SEP) is a key component of sustainable development and the ESHIA process. It is a requirement of the Ghana EIA regulations and it is also required by international lenders.

Stakeholder engagement involves those stakeholders interested in, or affected by a proposed development working to actively identify opportunities, risks and issues of concern. Stakeholder engagement assists in accounting for locally relevant conditions rather than imposing potentially insensitive processes and designs onto an existing social, health and biophysical environment.

For the Project, the primary objectives of stakeholder engagement are as follows:

- Ensure that adequate and timely information is provided to stakeholders;
- Provide sufficient opportunity to stakeholders to voice their opinions and concerns, and to ensure that these concerns influence Project decisions; and
- Establish a relationship and form of communication between the proponent, eni Ghana, and affected communities for the lifetime of the Project.

Stakeholders were identified on the basis that they would have an interest in the Project and would also have knowledge through which to provide insight into possible issues and concerns related to the Project. Further stakeholder groups were identified through consultation.

During scoping, numerous meetings were held with stakeholder groups. Stakeholders consulted included national, regional and district authorities, traditional leadership, Non-Governmental Organisations (NGOs), international organisations and fisher associations. A full list of the stakeholders consulted, including the stakeholder register, is provided in Annex A of this EIS.

1.5 ENVIRONMENTAL BASELINE

1.5.1 Onshore Biophysical Components

Climate and Meteorology

The regional climate of southwest Ghana is driven by the Inter Tropical Convergence Zone (ITCZ), resulting during the boreal (northern hemisphere) winter in a climate dominated by dry and continental air from the Sahara. On the contrary, humid and warm maritime air from the Atlantic Ocean is prevalent during the boreal summer. This alternation leads to the existence of two well-marked seasons: a dry season, between December and April; and a wet season, between May and July and September and November.

Air Quality

There are no major industrial activities in the Project area and thus no significant sources of air pollutant emissions. The majority of emissions to air arise from the smoke of cooking fires, exhaust of generators used for power supply, and vegetation burning to clear land for farming. The existing levels of NO_2, CO_2, TSP and VOC were generally within Ghana EPA and IFC limit values. High levels of SO_2 were instead monitored, as a result of the fish smoking process or waste burning.

Light, Noise and Vibration

Light and vibration levels in the Project area are currently low due to the general lack of industrial activities in the area. Current levels of noise are associated to domestic activities and natural sounds such as the ocean, waves, wind, and insect noise. Relatively high day-time noise levels for a rural location were measured in the Project area without significant variations between day time and night time.

The main contribution to the noise levels are reported to come from fishing activities (beach seine), which together with vehicle movements, occasional music and sea waves breaking at the beach were the main noise sources observed in the vicinity of the settlements.

Surface Water

The Western Region of Ghana is characterised by the presence of many brackish and freshwater lagoons and wetlands in the low lying coastal areas due to the high level of annual rainfall. In the Project AoI, the main watercourse is the Amansuri River which flows eastward from about 1.4 km northeast of the Project site until it enters the sea approximately 7 km east of the eni concession area.

Water quality in the Project area is as follows:

- The average turbidity recorded during the wet season was higher than that of dry season, indicating the presence of inorganic and organic particles from surface run-off from flooding and rains into water courses. .
- Elevated concentration of nutrients were sampled; this is an indication of run-off from agricultural soils and other agro-chemicals as well as organic matter contaminating the water.
- Concentrations of metals (Cu, Cd, Cr and As) in surface freshwater samples were within the WHO guideline limits, except for Hg. The source of Hg pollution remains unknown.
- There were no significant concentrations of TPH or oil and grease detected in the samples analyses.
- Generally, there was a widespread load of total coliforms and faecal coliforms in water samples as well as E.coli and total heterotrophic bacteria.
- The low values of chlorophyll a suggest better water quality in terms of organic pollution and eutrophication.

- Fresh water plankton analysis showed a relatively small number of taxa with small numbers of individual zooplankton species.

Ground Water

Two main hydrogeological provinces are found within Ghana, namely the Basement Complex (consisting of Precambrian crystalline igneous and metamorphic rocks and covering 54% of Ghana) and Voltain Formation (a Paleozoic consolidated sedimentary formation and covering 45% of Ghana).

Ground water quality in the Project area is as follows:

- The average BOD5 levels recorded for groundwater samples was higher than the EPA's permissible limit for industrial discharge into natural water bodies, and is an indication of organic matter contamination.
- High levels of phosphorus concentration show some level of impact on the groundwater in the area due to human activities in the area.
- For groundwater samples the concentrations of heavy metals were generally low with the concentrations of As, Cr, Cd and Cu all below detection limit and below the WHO guideline limits during both the wet and dry season sampling. Concentrations of Zn, Pb, Mn and Fe were found to be above the WHO limits at few monitoring points.
- There was no significant concentrations of TPH or oil and grease in either the dry or wet season.
- In terms of total and faecal coliforms, none of the water samples conformed to the WHO Guidelines and Ghana Standards.

Geology, Topography and Soils

Soils observed within the Project area are predominantly sandy soils indicating a well-drained substrate. The onshore Project area is a flat area of low altitude (0-10 m) with very few headlands or rocky outcrops. The ground elevation increases from the sea for several meters within the beach up to around 4 m high when it decreases again below 2m high resulting on the generation of flat and low-lying area that occupies the central section of the ORF site. The higher grounds are located at the north-western most corner of the ORF site with 8.9 m elevation, while the site generally varies between 3.9 and 4.6 m.

In the vicinity of the Project area, the coastal low lying areas extend inland for several kilometers. As a result little rock removal and little land levelling are expected for the development of the onshore Project facilities.

1.5.2 Offshore Biophysical Components

Oceanography

Water circulation in offshore Ghana is dominated by an eastward superficial flow known as the Guinea Current that runs parallel to the coast from Senegal to Nigeria.

The main oceanographic feature in the area is the existence of two periods of upwelling each year, one major upwelling between June and October and a minor one between January and

February. This phenomenon is considered key for the sustainability of marine life in the area as it contributes to an increase in productivity.

The bathymetry of the Project area ranges from a minimum depth of 0 m in the north at the landfall location to a maximum of 1,390 m in the south-west part. Seafloor is mostly flat with slope gradients that vary between 0.5º and 2º, with the only exception of the submarine canyons and the continental slope where gradients may reach more than 10º. Additionally, there are certain topographic features, including complex canyon systems, sedimentary mounds, scour features and high standing knolls.

Seabed Sediments

Seabed sediments along the pipeline route and in the vicinity of the wells ranged from poorly sorted, coarse silt to moderately sorted, coarse sand with a general trend showing more sandy sediments in shallower areas and more silty on greater depths. Metal concentrations in sediments were generally low, though in the vicinity of the proposed wells sediments present higher levels of metals, especially chromium, nickel and barium. Specifically, barium levels at station 41, located 340 m from the Gye Nyame-1 exploration well, are highly indicative of possible past drilling-related contamination from the drilling muds, however it is notable that other metals are not equally elevated at this location suggesting drilling muds used are not heavy contaminated with impurities.

Hydrocarbon concentrations in sediments are also generally low along the whole Project area. At Station 41 however, levels are considerable high (787 µg/g) probably as a result of past drilling activity.

Seawater

Seawater quality in the whole offshore Project AoI is generally good, showing low or very low levels including those samples taken in the intertidal area more subject to be influenced by anthropogenic pressure. Total hydrocarbon concentrations (THC) and aromatic hydrocarbons (PAH) were also low at all stations, though they were a bit higher in the area where the wells are planned and could be detected in the analysis suggesting certain degree of pollution, probably related to shipping activities or a dispersed effect arising from the numerous wells in the area. Nutrients, total dissolved solids, biochemical oxygen demand, phenol index, cyanide and faecal coliforms are also low at all stations and depths analyzed.

1.5.3 Onshore Biological Components

Habitats

The habitat within the concession area consists largely of modified habitats with a large proportion of the area covered by degraded coconut palm plantations, degraded vegetation and wet evergreen forest with palms. The coastal areas are dominated by regenerating vegetation comprising of palm trees and thorny shrubs.

To the east of the concession is a natural habitat that is classified as Swamp and Mangrove Forest. Sensitive habitat occurs along the coastal beaches where turtles nest.

Flora

Ghana forms part of the Upper Guinea forest ecosystem, a region once characterised by dense forests which have shrunk in response to human influence and the growth of cities. The coastal region also includes vegetation comprising of palm trees and thorny shrubs.

A total of 86 plant species belonging to 46 families and 79 genera were identified in the Project area during the wet season survey, with the dominant vegetation type being trees (44.19% of the total). During the dry season, a total of 148 plant species in 124 genera belonging to 56 families were recorded. The family *Euphorbiaceae* dominates the flora with 12 species. This was followed by *Papilionaceae* with 11 species, *Rubiaceae* (10 species), *Apocynaceae* (eight (8) species) and *Annonaceae* (six (6) species). Pioneer species formed the majority of the species present.

With regards to IUCN status, only three species encountered are listed as Vulnerable: *Albizia ferruginea*, *Coffea macrochlamys* and *Hallea stipulosa*. The majority of the species in the Project area have not yet been assessed by the IUCN.

Fauna

Ghana has large and viable populations of wildlife and a natural environment that support a growing ecotourism industry to complement the nation's strong cultural and historical attractions. Most of these wildlife sanctuaries are located in the Western Region due to the suitable microclimate and diverse habitats provided by the evergreen forest found in most parts of the Region.

A field survey was conducted across the ORF site and at various locations within the AoI to identify fauna.

There were eight individuals of three species of small mammals belonging to the order *Rodentia* (rodents) identified through live-trapping. The species captured were Temminck's pygmy mouse (*Mus musculoides*), soft-furred rats (*Praomys tullbergi*) and the multimammate mouse (*Mastomys erythroleucus*). No large mammals and very few spoor were directly observed. The information on large mammals came mainly from interviews conducted with the locals of the area, that report the presence of five orders of large mammals (*Pholidota, Primates, Carnivora, Artiodactyla* and *Hyracoidea*) consisting of 21 species. The majority of the large mammals recorded are listed as Least Concern by the IUCN. The exception are two pangolin species *(Phataginus tricuspis* and *Smutsia gigantea)* and the hyrax *(Dendrohyrax dorsalis),* listed as Near Threatened by the IUCN.

Amphibians and reptiles (herpetofauna) are common and widespread throughout Ghana. During the surveys, 29 herpetofaunal species belonging to 15 families were recorded at the Project site.

The west coast of Africa forms an important section of the East Atlantic Flyway, an internationally-important migration route for a range of bird species, especially shore birds and seabirds. The highest concentrations of seabirds are experienced during the spring and autumn migrations, around March and April, and September and October.

Protected and Designated Areas

The Ankasa Conservation Area and the Cape Three Points Forest Reserve are the most significant protected areas in the general area of the Project (25 and 42 km respectively).

The Ankasa Conservation Area hosts at least nine primate species, viable populations of large mammals such as the forest elephant, bongo and yellow backed duiker, giant forest hog, giant pangolin, water chevrotain and leopards. It also has a diverse avifauna population and up to 600 butterfly species.

The Cape Three Points Reserve was designated to protect the last remnant of primary coastal forest, in which in the past extended along major segments of the coastline of the Gulf of Guinea (CRC-URI, 2010). It is known to provide habitat for over 170 species of birds (Dowsett-Lemaire, 2005; Ntiamoa-Baidu et al, 2001).

In addition to the officially designated areas, the onshore components of the Project area lie within the boundaries of the Amansuri wetland Important Bird Area (IBA). An IBA is an area considered relevant due to its natural values, and especially for their importance for the avifauna. The main element of interest of the IBA is the Amansuri Lake (located 15km northwest of the site). However, the IBA also includes the floodplains of the Amansuri River up to the coast and the beach (where the project is located), the coastal Amansuri River lagoon and estuary, and the sandy Esiama beach, between the Amansuri and Ankobra Rivers.

1.5.4 Offshore Biological Components

Plankton

The phytoplankton community is dominated by microflagellates and diatoms. Phytoplankton abundance is generally greater at 1 m and 100 m sample depths and denuded at 200 m as a result of reduction in light. Zooplankton community is dominated by copepods. Both phytoplankton and zooplankton biomass seem lower in offshore stations may be due to the lower phosphate concentrations, compared to the inshore sites.

Benthos, Corals and Seagrass

Benthic macrofauna is characterized by low abundance and low diversity assemblages in the wells area and moderate diversity and abundance along the pipeline route in the shallower stations. Annelida is the dominant group, representing half the abundance recorded. The total number of species at each station appears to be negatively correlated with depth.

No important benthic communities were identified along the proposed pipeline route, in the vicinity of the wells and in the nearshore area. As a result no critical habitats, such as coral reefs, seagrass beds or chemiosynthetic communities, are present in the area surveyed. Communities recorded are therefore related to muddy and sandy bottoms and mainly formed by annelida followed by crustaceans and molluscs.

The presence of corals, according to the several surveys conducted, is limited to isolated individuals, including two in the vicinity of the pipeline route

Fish

Ghanaian waters host several species of fish, including some of important commercial value. The distribution, abundance and composition of the fish assemblages is largely influenced by the seasonal upwelling that occurs in this area, as it increases nutrient availability and plankton production which allows to sustain larger populations of fishes that are attracted to the area. .

Marine Mammals

The AoI of the Project may also host up to 18 cetacean species belonging to five families. Their distribution and ecology in the area remains widely unknown, though it has been considered that most of them could be present throughout the year and specially during the upwelling season when food availability increases. It is known, however, that the humpback whale migrates to Ghanaian continental shelf for breeding, remaining in the region mainly from August to December.

Turtles

The Gulf of Guinea serves also as an important migration route, feeding ground, and nesting site for sea turtles, where five species may be observed, though only three are known to regularly nest in the AoI of the Project, as whole coastline between Ivory Coast border and Axim is considered as a suitable site for nesting turtles. As a result the beaches in the area are considered a critical habitat for the conservation of turtles, with the exception of the beach sections where fishing activities take place, that usually correspond to the area where the villages are located. Nesting activity in the area is reportedly more intense between October and January.

1.6 Fisheries Baseline

1.6.1 Marine Fish Landings

The composition and distribution of fish species found in Ghanaian waters, and the wider Gulf of Guinea, is influenced by the seasonal upwelling. The transport of colder, dense and nutrient-rich deep waters to the warmer, usually nutrient-depleted surface water during periods of upwelling stimulates high levels of primary production in phytoplankton. This primary productivity in turn increases production zooplankton and fish.

The fish species found in Ghanaian waters can be divided into groups, namely:

- Small pelagic species;
- Large pelagic species (tuna and billfish);
- Demersal (bottom dwelling) species;
- Molluscs and crustaceans; and
- Deep sea species.

In general, marine fish landings in Ghana are declining, especially landings of small pelagics. The landings of large pelagics have remained fairly stable, demersal species show a general increase, while landings of molluscs and crustaceans have remained consistently low.

The key small pelagic fish species found in the Ghanaian waters are sardinella, anchovy and chub mackerel. These species are commercially important and represent approximately 80% of the total catch landed in the country.

The large pelagic fish species include the tuna, billfish and some sharks. These species are highly migratory and occupy the surface waters of the entire tropical and sub-tropical Atlantic Ocean. They are important species in the ecosystem both as predators and prey, as well as providing an important commercial resource for industrial fisheries.

The most important demersal species commercially (in terms of catch volumes) are cassava croaker, bigeye grunt, red pandora, Angola dentex, Congo dentex and West African Goatfish.

A variety of molluscs and crustaceans are known to be present offshore Ghana. These include the common cuttlefish, pink cuttlefish, common squid, common octopus and the royal spiny lobster, deep-sea rose shrimp and other shrimps.

1.6.2 Marine Fishing Fleet

The Ghanaian marine fishing fleet can be classified into four main groups: artisanal, nearshore and inshore, industrial/offshore and tuna. Additionally there is a group of vessels dedicated to the fishing of sharks for their fins.

The vast majority of vessels operating in Ghana are involved in the artisanal sector (more than 95%), highlighting its importance in terms of employment.

1.6.3 Fish Catch Surveys

Two fish catch surveys have been conducted in Sanzule and Bakanta, near where the onshore Project area, in April 2014 (dry season) and October 2014 (wet season)..

In April 2014 a total of 34 different species of fish, cephalopods and crustaceans was caught, including 26 species at Bakanta and 22 species at Sanzule. Most common species of fish of commercial importance include the two species of sardinella (round and flat), pompanos, croakers, bumpers, and groupers. The catch included also rays, flounders, crabs and puffer fishes. In October 2014, three hauls were sampled, one in Sanzule and two in Bakanta, with a total of 21 species recorded. Only three fish species, namely, *Caranx chrysus*, *Sphyraena sphyraena*, and *Trichirus lepturus* were common to all the three catches.

None of the species captured in any of the surveys were of conservational importance as listed in IUCN in Ghanaian waters.

1.6.4 Socio-Economic Aspects of the Fishing Sector

The fishing industry in Ghana is based on fishery resources from the marine and to a lesser extent, inland or freshwater fisheries and aquaculture. There is a long tradition of both artisanal and distant-water fishing fleets. The fisheries sector contributes 4-5% to agricultural Gross Domestic Product (GDP) and offers employment to about 10% of the population and their dependents.

Fishing, fish processing and fish trade are among the most important sources of livelihood not only in coastal communities of the Western Region but also in communities inland.

Fish and fish products provide the greatest proportion of animal protein in the country contributing over 60% of the total animal protein intake. Average per capita consumption is estimated to be between 27 kg and 31 kg annually, thus, rating Ghana as the 3rd highest consumer of fish worldwide. Marine fisheries contributes over 80% of all fish consumed and exported in and from the country and approximately 75% of the total domestic production of fish is consumed locally. Thus, the extensive population dependency on fishing constitutes a critical factor; consequently, impact on fisheries should be seen as one of the main potential impacts of this project.

A 2010 rapid assessment of 89 selected fishing communities in the six coastal districts of the Western region, including 17 fishing communities in the Ellembelle district, indicated that fish landings in most of the fishing communities like Sanzule, Atuabo, Bakanta etc., have declined in recent years, and this has led to declining fishery livelihoods in the fishing communities. The decline in fish catch is attributed, among other issues, to increasing population leading to over-fishing, and use of damaging or illegal fishing methods.

1.7 Socio-Economic Baseline

The Project is located in the Ellemebelle District of the Western Region Ghana. A socio-economic study was undertaken in the communities of Sanzule, Bakanta, Krisan, Eikwe and Atuabo and was based on a review of available secondary information and primary data collected from key informant interviews, village level surveys and focus group discussions. The geographic focus of the socio-economic Direct Area of Influence (DAoI) has been defined based on the location of the Project and description of the Project components. It consists of the communities of Sanzule, Bakanta, Krisan and Eikwe located within a 3km radius of the ORF site as well as Atuabo as it is a larger or better serviced settlement likely to be impacted by the Project.

1.7.1 Administrative Structures

There is a dual system of governance in Ghana made up of formal government structures and traditional leadership structures. These systems of authority are recognised as complementary structures with different responsibilities.

The government administration in Ghana is decentralised and is made up of ten administrative Regions. Regions are further subdivided into Metropolitan, Municipal or District areas. Each District has an administrative assembly (known as the District Assembly) comprised of a combination of appointed and elected officials.

The project is located in the Western Region and in the Ellemebelle District. The District is administered by the Ellembelle District Assembly (EDA) headed by the District Chief Executive. The EDA is, therefore the highest administrative and political body in the District.

Traditional Authority Structures

Traditional Authorities are the custodians of local tradition, morals, and traditional practices. The traditional system of authority is managed at a national level through the Ministry of Chieftaincy and Culture. At the local level, the Paramount Chiefs is the traditional head of the people and custodian of the land. The Paramount Chief carries great influence locally.

Despite changes and challenges to the traditional structures, in most cases the Chief continues to wield considerable authority, respect and influence at the local level, including in a quasi-judicial role.

The Nzema East, Ellembelle and Jomoro Distrucst constitute the Nzema Manle Council in the District House of Chiefs. The Ellembelle District is covered by the Eastern Nzema Traditional Council. The Paramount Chiefis Awulae Amehere Kpanyinle II who is situated in Atuabo.

Local Administrative Structure

The Paramount Chief of the Eastern Nzema Traditional Area exerts control over the divisional and sub-chiefs. The traditional structure is hierarchical and inheritance is by matrilineal descent. In each town in the DAoI, there is traditional council that assists the Chief to administer his area of jurisdiction. The Council is typically comprised of the Chief, the Queen Mother, various family heads and a linguist. The Council is the supreme organisation of the stool and must approve all decisions taken by the Chief.

1.7.2 Macroeconomic Context

As a result of the economic challenges of the 1970s, 80s and 90s, Ghana struggled with the huge foreign debt and until recently was regarded by the World Bank as "poor", with a per capita annual income of less than 1 USD per day. On 1 July 2011 the World Bank reclassified Ghana from a low-income to lower middle income status country, in response to the recent discovery and production of oil in Ghana (World Bank, 2011). Ghana is reportedly positioned as the fastest growing economy in Sub-Saharan Africa for 2012, with a forecast GDP growth of 13.4 percent (World Bank, 2012).

The Western Region is the highest contributor to the country's GDP (55 percent) (Ghana Government Portal, 2012), with a wide variety of mineral deposits and the largest producer of various agricultural products. The discovery of oil off the coast of the Western Region has already enhanced its significance within the National economy. This Project will help to focus development in the Ellembelle District as an industrial node.

1.7.3 Land Tenure and Land use

Ghana maintains a dual land tenure system, comprised of customary and statutory land tenure. Customary tenure is based on local practices and norms, which are flexible and vary according to location. Such tenure is typically unwritten and is managed by a traditional ruler (the paramount chief or local chiefs); a council of elders; or family or lineage heads.

Under the 1992 Constitution, three distinct land tenure systems are recognised: public lands, stool or customary lands and private freehold lands. Public lands are owned by the government and are for public use. Stool Customary lands are communal and are held by traditional communities or groups thereof and are characterised by various land tenure. Finally, Private Freehold land is not owned by government or a traditional authority, but rather an individual or entity and includes the building and the land it is built on.

The land acquisition area is customary land and the land in the DAoI is in the "customary ownership" of chiefs, who dispense and allocate it on behalf of their people.

Land uses within the DOaI primarily include infrastructure (households, schools, hospitals) and farming. There is a small settlement, Anwolakrom, located adjacent to the south-eastern border of acquisition area. The housing structures in the settlement are temporary in nature, constructed from raffia poles and leaves. The remainder of the acquisition area consists primarily of cultivated palm groves, croplands or the remains of natural vegetation and water bodies.

1.7.4 Demographics and Settlements Patterns

According to the 2010 Population and Housing census, Ghana had an estimated population of 24 658 823 people, with a population density of 114 people per km2 (Ghana Statistical Service, 2013). The Western Region comprises nine percent of the total population (2.3 million people) and has a population density of 97 people per km2.(Ghana Statistical Service, 2012). The Ellembelle District has a population of 95 306, with a population density of 80 people per km2, lower than both the national and regional population density.

The Western Region has a larger proportion of the population living in rural areas than the national average, with 57.6 percent of the population living in rural areas (Ghana Statistical Service, 2012). The Ellembelle District is considered largely rural, with 84 percent of the population living in rural areas.

Populations of the communities in the DAoI vary in population size, and are generally between 700 and 1600 in size.

1.7.5 Ethnicity and Religion

Akan is the dominant ethnic group in the Region and represents 89 percent of Ellembelle's population with Twi and Fante being the dominant languages. In the DAoI Nzema is the dominant group and the major language spoken is Nzema; other dialects like Evalue and Gwira, Fante and Twi are also widely spoken. Another language, Ewe, is spoken by the settlers in the fishing community. The ability to speak Nzema is also emphasised as important for cultural continuity.

Nationally, Christianity is the main religion practiced by the majority of the population, and this trend is reflected in the three communities by the high number of churches in the Project affected communities. There are also small numbers of Muslims present in the communities in the DAoI. People also reported that there many traditional rituals and beliefs remain even those people following monotheistic religions.

1.7.6 Migration

There is a significant amount of internal migration within the Western Region with people migrating to areas with employment opportunities such as Ahanta West, Takoradi (Modern Ghana, 2012) and Cote d'Ivoire. The Ellembelle District experiences a surge of in-/out-migration related to seasonal fishing activities and mining and a similar migration trend exists across the Study Area. The population figures swell during peak fishing season (July-October) when migrants from the north of Ghana and even from Cote d'Ivoire, mainly men, come to work in the area. There are also two refugee camps in the Western Region and one in Krisan.

The population of coastal towns in the DAoI continues to increase from natural and influx growth. Atuabo and Anochi in particular have seen in-migration of workers and job seekers into their community because of activity associated with the development of the GNGC gas plant at Atuabo. These migrants exert pressure on the limited social services especially, water, sanitation and housing.

In terms of out-migration, youth are reported to be leaving to take menial jobs in bigger towns like Abidjan, Takoradi, Sekondi, Tarkwa. This is perceived to be a result of declining community livelihoods (declining farming yields and fish catch) and rising poverty in local communities.

1.7.7 Utilities and Social Infrastructure

Education

All communities in the DAoI have a public primary school financed by the government. However, not all communities with public primary schools have Junior High Schools. For example, Bankanta does not have a JHS. There are no SHS or tertiary educational facilities in the communities.

The education sector faces numerous challenges in the DAoI. These include finances as government grants are often inadequate; lack of trained teachers; inadequate school facilities (classrooms, equipment, teacher accommodation); school attendance (pupils often leave to cost of schooling).

Water and Sanitation

There are three major sources of drinking water: piped (inside, outside, tanker supply), well (well, borehole) and natural (spring, river, stream, lakes, rainwater, dugout). There is a huge difference in access between the urbanised and rural households. The Western Region has a low access to piped water (32 percent). In Rural areas over 60 percent of households use rivers, streams, wells, spring or rainwater as their main source of water. Access to water and sanitation in the Ellemebelle District has improved in recent years, however water access still centres on bore holes wells. In terms of sanitation, approximately 70 percent of Ellembelle households do not have toilets.

The majority of households in the DAoI obtain drinking water from a source considered to be 'improved' (ie, private or public tap/borehole). Typically females are responsible for collecting drinking water, however, it is also not uncommon to see children (either male or female) collecting drinking water for the household.

Energy

Ghana has an installed power generating capacity of approximately 2,100 MW, 59 percent of which is generated by hydroelectric plants, and 41 percent from fossil fuels. In the Western Region, electricity and kerosene lamps are used as the main sources of lighting. Rural households are also gradually gaining access to electricity through a rural electrification programme. Charcoal and fuel wood are the main sources of cooking fuel in the Region (including urban dwellers).All the towns within the DAoI are connected to the national electricity grid and most households are also reportedly connected.

Waste Disposal

Waste disposal is a challenge in Ghana, particularly in the rural areas. In the Western Region and the Ellembelle District, the most common way of disposing of household waste is to dump it at specified community dumping sites or in the absence of such sites, ad hoc disposal on open land. The Ellembelle District has limited waste handling facilities and equipment and inadequate capacity. It has only two formal waste disposal sites for both solid and liquid wastes at Aiyinase.

Some towns in the DAoI have specifically allocated waste sites. These are informal in structure, unlined, and once full they are covered over and a new area is opened for use. Zoomlion (waste removal company) is contracted to remove waste in the DAoI however, the service does not extend in to all the communities adequately.

Telecommunications

Fixed line and mobile telephone systems are in operation in Ghana, as well as wireless, radio telephone and satellite communication systems. According to the National Communication Authority (NCA), in August 2012, the total cellular/mobile subscriber base in Ghana stood at 24 438 983, which was 98 percent of the population at the time (Ghana Statistical Service, 2013). Mobile telephone network coverage received in most of the communities and most adults reported owning a cellular phone.

1.7.8 Economic Activity and Livelihoods

Farming, fishing and fish mongering and agro-processing are the key livelihood activities in the Study area, and most communities report consuming small amounts for subsistence, while selling the larger proportion for cash. There are very few formal employment positions.

Fishing and Fish Mongering

The largest income-generating livelihood activity in all of the DAoI communities is fishing and therefore the primary livelihood activity with both men and women involved, although they are divided by gender in their roles. There are two fishing seasons, towards the end of June and peaking during August and September and towards the end of November, peaking between late January and March. April to May is a rest period for mending nets, boat repair and fishermen engage in onshore artisanal work to supplement their income.

Fish mongering is also an important livelihood activity for women who process fish by salting and drying or smoking. The women buy fish locally and transport for sale at Aiyinasie. Large catches are also sold to hotels in Axim. Income from fish mongering is reduced due to lack of cold storage such that fish prices are lowered by the high levels of supply during fishing seasons.

Fishermen reported locally declining catches over the past number of years, attributed to increased human populations and consumption, increase in fishing activities, increase in fishing canoes working the area and illegal fishing. Many community members in the Study Area believe that the offshore oil production activities have contributed to the decline in fisheries.

Farming

Almost every household in the towns participates in small-scale and subsistence agricultural activities, with men clearing and preparing fields and women involved in the sowing of seeds and in harvesting. Some individuals (generally the elderly or unwell) employ labourers. Cultivation is done manually and the size of plots depends on the strength of the individual or family. There are no irrigation systems and farming is done using slash and burn methods. The majority of planting is done in March and April before the rainy season in June and July and a second smaller season of planting takes place in September and October with two seasons of planting (March-April and September-October).

The major crops cultivated are maize, pineapple, cassava, plantain, rice and other staples. Vegetables such as garden eggs, pepper and tomatoes are also cultivated. Coconut and oil palm are grown on mainly commercial scales.

Livestock

Pig rearing is a main commercial livestock activity, in particular in the town of Atuabo.
Livestock at a community level is generally for subsistence. Almost everybody in the community will keep at least one type of animal (goat, pig or poultry) predominantly for domestic consumption. The grassland area between Atuabo and Asemdasuazo is used for grazing in the dry season by Fulane Hersdman.

Trade, Employment, Industry and other Livelihood Strategies

Small scale or petty trading is undertaken, mainly on the side of the main roads, and is focussed on fishing and agriculture products but also includes some manufactured goods, household goods, medicines, clothing and food and beverages. A small number of local residents are formally employed in the Study Area in jobs including District assemblyman, teachers, waste management activities, fishing crews, farm labourers as well as hairdressers, carpenters, drivers and electricians.

The major industrial projects in the area are the GNGC gas plant at Atuabo and Anochi and the export pipeline. There is also liquefied petroleum gas (LPG) terminal at Anochi. A small number of local residents are employed at these facilities

Other livelihood strategies include remittances from migrant workers/ family members, rent from land or property, and pensions.

Tourism

Tourism in Ghana has become a major socio-economic activity and an important and fast growing sector of the Ghanaian economy. The tourism potential in the Western Region is related to the number and extent of tropical beaches as well as wildlife parks, forests and game reserves, inland lakes, and rivers. Currently none are being exploited for tourism in the DAoI. The Nzulezu stilted village is a prominent tourist attraction near the project on Lake Tadane about 3.5 km inland of Atuabo (on the UNESCO World Heritage Site tentative list). Other tourists sites, include estuaries, forts and natural fauna and flora.

There are hotels in the area which have been built to serve tourists visiting these sites as well to meet growing demand for accommodation from the oil and gas industry.

Income, Expenditure and Financial Services

Household income in the DOaI are mainly derived from fishing and fishing related activities, followed by farming, waged employment, petty trading, artisanal work, livestock, rent and remittances in order of importance. The two main areas of expenditure for households in the project area are food and education. There are no banking institutions in or near to the DAoI except for Eikwemanle microfinance

1.7.9 Marine Infrastructure

The nearest port to the DAoI is the Port of Takoradi. The Port receives high traffic volumes and in 2012 handled 31 percent of national sea borne traffic. Major import commodities include clinker, wheat, and quicklime and major exports are cocoa, bauxite, and manganese.

In addition, there are several existing and planned submarine cables and pipelines offshore Ghana. There is an existing subsea pipeline from the Jubilee Field to the Ghana Gas Plant at Atuabo.

1.7.10 Safety and Security

Politically, Ghana is a stable democracy that has had five elections since 1992 and two peaceful transitions of power between political parties. The last elections took place in 2012 and while there was some sporadic election-related violence, it took place in a relatively peaceful context. Road safety is a concern in Ghana due to poorly maintained and unpredictable driving habits. In addition, Ghana to date has not been subject to any major acts of piracy. However, with the discovery of oil its coastline is now at increased risk.

At community level; common crimes reported to occur in the area are break-ins and petty thievery. Most of the communities however, reported fairly low crime rate except Atuabo. The community agreed that the petty crime has increased at Atuabo since the onset of the GNGC Gas Plant project. There no police stations in the DAoI, therefore to report crimes one must travel to Ayinasie or Beyin.

1.7.11 Community, Identity, and Relationships

The majority of the people living in the DAoI are Nzema. Like most Akans, the Nzema culture is manifest in its traditional rites and practices, music and dance, cuisine, religion, chieftaincy system, and livelihood activities. Nzema society is hierarchical. People are respected because of their age, experience, wealth and/or position. Young address their elders as mother or father. Older people are viewed as wise and are respected in the community. Though Christianity and Islam are being practiced among majority of the Nzemas, African Traditional Religion is still actively practised. Deities in the form of trees, islands, water bodies are worshipped, and shrines, sacred groves and fetish priests are still patronised today.

1.7.12 Cultural Heritage

In Ghana, the National Commission on Culture and the Museums and Monuments Board are responsible for administering cultural sites.

Known tangible resources in the Project area include places of formal religious worship (churches, mosques) as well as places and locations associated with traditional religious practices (sacred forest groves, lagoons, the sea). Also identified in the Project area are places of burial and worship. This includes the Branvien Shrine and cemeteries at the coastline at Sanzule and one to the east of the community, designated for burial of relations of the traditional royal family.

1.7.13 Vulnerable Groups

Vulnerable groups in the Project area include the elderly, children, women (particularly Female-headed households), disabled people, and orphans. Children and the elderly are the most vulnerable in respect of their susceptibility to malnutrition as a result of being reliant on others to provide for them, and to diseases such as malaria.

Baseline engagement suggests that sharecroppers, crop farmers, refugees and fishermen are potentially also vulnerable in this area, due respectively amongst other reasons, to their lack of formal rights to land and their sensitivity to changes in climate and reportedly declining farming yields and fish catch. Finally, migrant fishing communities in the area should be considered especially vulnerable given they have little or no formal security of tenure, limited access to land for farming and are almost solely dependent on marine fishing for their incomes and subsistence.

1.8 Health Baseline

A health study was undertaken for the communities within the DAoI: Eikwe, Krisan, Sanzule, Anwolakrom and Bakanta and was based on a review of available secondary information and primary data collected from key informant interviews, village-level surveys, focus group discussions and direct observations.

1.8.1 Health Infrastructure

The health facilities within the Area of Influence include: one hospital at Eikwe (St Martin de Porres hospital) and two CHPS compounds (one in Atuabo and the other in Sanzule). In addition, there are six active traditional birth attendants assisting the communities.

The St Martin the Porres hospital was established in 1959 and currently serves as the District hospital, covering a population of over 100,000. The hospital is specialised in obstetrics and gynaecology but also offers other services. It has 200 beds with an overall bed occupancy rate of 93% in 2013. The Atuabo CHPS compound serves Atuabo and Asemda-Suazo while the Sanzule CHPS compound serves Sanzule, Bakanta and Anwolakrom communites. Krisan community goes to St Martin de Porres hospital in Eikwe to seek medical attention.

1.8.2 Traditional Medicine

Traditional medicine in the Area of Influence is mainly practiced by spiritualist (also known as faith healers) and Herbalist. Healers use non-timber forest products as medicine to cure various ailments, including malaria, typhoid, fever, diarrhoea, arthritis, rheumatism, and snake bites.

The dominant faith healers operate under the 12 apostle Church locally called "Nakaba". These operate prayer camps where healing is sought from.

From the key informant interviews performed with health professionals and focus groups it emerged that the use of traditional medicine is high in the Area of Influence as there is a high tendency for people to associate certain illnesses to spirits. Thus, at the initial stage, people resort to traditional remedies from spiritualists and herbalists before seeking medical care at the CHPS or hospitals. Cases may therefore present late with potentially avoidable complications.

1.8.3 Common illnesses and Associated Issues

The most common diseases treated at the hospital and in the CHPS compounds in the Area of Influence are: malaria, respiratory infections, anaemia and diarrhoea.

With regards to communicable diseases, the tuberculosis notification rate was of 278/100,000 population in 2013 which is much higher than the overall case notification rate in Ghana (63/100,000 population) for all forms of Turbeculosis. Pneumonia and other Acute Respiratory Infections constitute 4.2 % of morbidities seen at St. Martin de Porres hospital (2013). In both CHPS zones, Atuabo and Sanzule, it is second to malaria among the top five causes of morbidity which is consistent with the regional pattern for the period 2011-2013. Hyper-tension, asthma and cardiovascular diseases are the most common non-communicable diseases in the DAoI.

The national HIV prevalence in 2013 is 1.3% and the prevalence in the Western Region in 2013 was 2.4% (2013 HIV sentinel survey report in Ghana). According to the KII performed in the area, HIV /AIDS are relatively common in the Area of Influence. One of the reasons for this is its proximity to Ivory Coast which has a higher prevalence of HIV/AIDS. During the community meetings and KIIs it emerged that there is a concern between the population for a potential increase of the prevalence of HIV/AIDS and other Sexually Transmitted Infections (STIs) related to increased influx of people associated to the current and future developments in the area.

1.8.4 Sanitation Conditions and Associated Diseases

The provision of sanitation facilities is poor in all the communities within the DAoI. All the communities have access to shared toilet facilities but only a very few of households has their own improved sanitation facility. Open defecation (in the bush and on the beach) was reported in focus groups within all the communities surveyed. Drinking water is obtained from boreholes or purchased (processed water from private providers). Some communities reported their concerns regarding the number and conditions of the existing boreholes. Groundwater availability was also reported to be limited during the months of November, to January.

There is no public waste collection or formal disposal waste system, instead waste is dumped either at specified sites or indiscriminately.

Regarding diseases associated with poor environmental sanitation, it is worth noticing that malaria and diarrhoeal disease are among the top ten causes of admissions to St Martin the

Porres hospital and among the top five causes of morbidity in the two CHPS zones (Atuabo and Sanzule).

1.8.5 Maternal and Child Health

The millennium development goal 4 (MDG4) demands governments to reduce by two-thirds the under-five mortality rate by 2015 (ie. less than 50 deaths per 1,000 births). According to the State of The World's Children 2015 Country Statistical (Unicef, 2013), the under-five mortality rate in Ghana reduced from 128% in 1990 to 78% in 2013 (most recent data available). The only data available on reproductive and child health in the Area of Influence are the indicators provided by the Eikwe sub-District hospital, St Martin de Porres. The % under five years who are underweight in 2013 was of 2.9% and the number of under-five deaths over the number of under-five admission at the Hospital was of 4.8% in 2013.

1.9 Impact Identification and Assessment

Identification and assessment of the Project's environmental and social impacts has been conducted in a phased approach applied throughout all the different phases of the Project (construction, operation and decommissioning) as well as unplanned events.

The significance of each impact (positive or negative), has been assessed through the application of the following criteria:

- Temporal scale of the impact (i.e. temporary, short-term, long-term, permanent);
- Spatial scale of the impact (i.e. local, regional, national, trans-boundary);
- Sensitivity, resilience and/or importance of the receptor/resource that is being impacted;
- Number of elements (including individuals, households, enterprises, species and habitats) that could be affected by the impact.

Many impacts arising from the onshore/offshore project operation phase, and listened below, have been classified as medium, this is mainly due to the temporal scale of the operational impacts, that the *eni standard impact methodology* classified as Critical, as life of the project is more than 10 years.

Proper mitigation measures have been identified and taken into account in the definition of residual impacts for each environmental and social components analysed in the impact assessment.

1.9.1 Environmental Impacts

<u>Onshore Environmental Impacts</u>

The construction of the onshore part of the Project will lead to medium residual impacts on all environmental components, with the remaining impacts being of low significance due to the temporary nature of the construction activities and the low and medium sensitivities of the onshore biophysical aspects.

The impacts expected to occur during the onshore Project operation and maintenance phase are summarised below. It should be noted that impacts that are continuous across the operations phase of the project are classified (at least) as Medium due to impact duration. This is a reflection of the methodology's conservative approach, where eni wants to ensure that adequate management, monitoring and control measures are applied to impacts that have a duration of over 10 years. .

- Medium impacts on local air quality due to the airborne pollutant emissions from ORF facilities (power generators and compressors) and vehicles exhaust emissions are foreseen. The resulting Medium impact significance is mainly a consequence of the duration of the impact. However, it has to be noted that, as clearly apparent from the Air Quality Modelling Study results (Annex H), predicted pollutant concentrations widely comply with AQS.

- Medium impacts on ambient acoustic conditions due to the noise emissions from ORF facilities (e.g., generators, compressors, pumps) and from vehicles movements are foreseen. The resulting Medium impact significance is mainly a consequence of the duration of the impact. However, it has to be noted that, as clearly apparent from the Air Quality Modelling Study results (Annex H), predicted pollutant concentrations widely comply with AQS.

- It is not expected the production of significant GHG emissions during the normal operation activity, in particular from flaring that may be required to deal with process upsets (i.e., facilities start-up). Moreover, the Project will implement a Zero-Permanent Flaring policy which will limit the GHG emissions from flaring to the process upsets and usually relatively short in duration.

- Low significance impacts on surface water resources associated with improper waste handling and spills.

- Medium impacts on groundwater resources are expected during operation, namely, reduction of groundwater resources, lowering of groundwater levels, reduction in water quality due to improper waste handling (all low) and unplanned spills (medium) of fuels or chemicals.

- Medium impacts on soil resources are expected related to potential contamination and compaction impacts. The resulting Medium impact significance is mainly a consequence of the <u>duration</u> of the impact.

- Low impacts on flora are foreseen as a result of degradation of the abiotic environment and introduction of alien species.

- Low and Medium landscape and visual impacts are foreseen due to the presence of the onshore infrastructure and offshore activities, including lighting. The resulting Medium impact significance is mainly a consequence of the <u>duration</u> of the impact.

- Medium impacts on fauna are expected and as a result of the negative effects of pollution, traffic risks and hunting. The resulting Medium impact significance is mainly a consequence of the <u>duration</u> of the impact.

Offshore Environmental Impacts

The impacts due to atmospheric emissions on the offshore component of the Project have been assessed as **low** for construction and **medium** for the operation phase given the duration of the impacts.

The impacts on the seawater component, due to Project installation/construction activities have been assessed as **low** given the moderate sensitivity of the receiving environment in terms of water quality, the volumes to be discharged and the localised areas expected to be affected with regards to drill cuttings and muds discharges and sediment re-suspension.

The project works on the seabed such as pipeline laying, deposition of drill cuttings and especially seabed intervention works and well drilling, will lead to impacts in terms of increase of seawater turbidity and potential release of contaminants and nutrients, including Cr, Zn and As recorded in in several sampling locations. The impact of the cutting piles on the seabed will be limited to the vicinity of the well and any potential toxicity introduced will likely remain deposited there. Impact to seabed has been assessed as **medium**.

The deposition of cuttings in the seabed is also expected to lead to smothering of benthic communities in the vicinity of the wells, though impact is considered **low** given the absence of known relevant benthic communities and the expected quick recovery of them after a first re-colonization by opportunistic species.

Underwater noise disturbance related to drilling, vessels and FPSO installation phase is expected to be **low** during construction phase and *medium* on the operation phase given its semi-continuous nature along the duration of planned activities. However, its direct negative effect on marine fauna are excepted to be restricted to behavioural changes and avoidance patterns of a few individuals of marine mammals and turtles given noise levels expected and mobility nature of the species.

During the project operation phase the production of solid and liquid waste and air emissions from the FPSO and the discharge from vessel operations will lead to **medium** residual impacts on seawater and air quality. Similarly, impacts on seabed in terms of potential contamination of soil by hazardous and non-hazardous spill and waste, and of sediment accumulation and/or scouring/erosion during the operation phase are assessed as **medium.** It has to be noted that these impacts are not significant and have been classified as medium mainly for the duration of the impacts due to project lifespan.

Potential alteration of coastal processes, such as accretion and erosion of sand beaches due to the installation of the pipeline have been assessed as **low,** given the temporary interruption of existing sediment transport dynamics and the mitigation measures considered.

1.9.2 Social Impacts

The socio-economic impacts have been discussed for the three main phases of the Project in this ESHIA, namely, construction, operation and decommissioning. However, impact significance ratings have only been assigned to impacts for the construction and operation phases. These impacts are summarised below. In most instances, decommissioning impacts are expected to be similar to those of construction, however there will also be negative economic impacts associated with the demobilisation of the workforce. The significance of impacts associated with decommissioning cannot accurately be determined at this stage, therefore they have not been assessed as part of this ESHIA.

Employment and Economy

The Project will have a range of positive impacts for employment and the economy; these have been identified as the following:

- Increased government revenue;
- Employment opportunities and skills enhancement;
- Increased procurement; and
- Enhanced hospitality and tourism business potential.

While these impacts will have an overall positive impact on employment and the economy at a national level, the impact at the local level may not be felt as intensely. The lack of skills and education, and formal business opportunities with the DAoI will limit the extent to which local community members will be able to benefit from employment and procurement opportunities. Through the implementation of enhancement measures, the benefits for communities in the DAoI can increased.

During construction, the impacts of increased government revenue, and increased procurement have been assigned a **high positive** significance rating, while employment opportunities and skills enhancement are anticipated to be of **medium significance** and the impact of enhanced tourism potential of **low significance**.

During the operation phase increased government revenue will have a **critical positive** significance, employment opportunities and skills enhancement, as well as increased procurement will have a **high positive** significance rating, while the impact of enhanced hospitality and tourism business potential is foreseen to have a medium significance.

The negative impact of increased price inflation and economic vulnerability has been assigned a significance rating of **medium** during the construction and operation phase, while the impact of workforce demobilisation at the end of the construction phase has been assigned a significance rating of **medium.**

Land and Livelihoods

The Project will lead to the economic displacement of land-based livelihoods in the land acquisition area (crop cultivation, animal rearing, and aqua-culture) and the economic displacement of marine fishing-based livelihoods due offshore pipeline construction and reduced access to fishing grounds as result of exclusion zones around offshore Project infrastructure. The following impacts on land and livelihoods were assessed as part of this ESHIA:

- Economic displacement of farming in land acquisition area;
- Restricted access to offshore fishing grounds due to exclusion zones;
- Disruption of onshore and near-shore fishing activities;
- Damage to fishing gear; and
- Infrastructure lighting.

Of all affected communities in the DAoI the households of Sanzule will be proportionally the most vulnerable to loss of livelihoods due to loss of access to 213 acres of farmland used by approximately 180 farmers. The exact proportions of the loss this land take will represent, relative to the total population of those farming and to the total agricultural land available to the Sanzule community, cannot yet be quantified.

An assessment of the proportional scale of livelihoods losses to Sanzule, along with information on the availability of alternative agricultural land in the DAoI to allow for like-for-like replacement of acquired farmland, will be confirmed following supplementary baseline livelihoods survey work to be conducted by ERM in parallel with the resettlement planning process in April 2015. For the moment, other alternatives such as compensation of both the leased land and the assets, and future alternative livelihood training activities and specific development measures to support and enable affected farmers in Sanzule to reestablish their livelihood are foreseen. With information available, economic displacement during construction and operation has been assigned a **high** significance.

With the correct implementation of mitigation measures, none of the remaining above mentioned impacts are anticipated to have a high or critical significance rating during the construction and operation phase. The disruption of onshore and near-shore fishing activities, and damage to fishing gear have been assigned a significance of **medium** mainly for the <u>duration</u> of the impacts due to project lifespan. On the other hand, restricted access to offshore fishing grounds due to exclusion zones and the impact of infrastructure lighting are anticipated are anticipated to have a **low** significance.

<u>Changes to Cultural and Social Norms</u>

An oil and gas project of this nature is expected to bring about some change to DAoI. There will be an influx of Project workers and jobseekers into the DAoI, each with their own associated cultural and social norms. The impacts identified in this regard are:
- changes to cultural and social norms;
- increased anti-social behaviour; and
- tension and conflict between villages.

The impacts listed above are all been assigned a significance rating of **medium** during both construction and operation after the implementation of mitigation measures. The rating during the operation phase is driven mainly by the <u>duration</u> of the impact.

<u>Cultural Heritage</u>

Project will be located in rural setting and an industrial project of this kind will alter the sense of place for local residents who may value the rural characteristics. Communal and religious cemeteries as well as shrines are found in across the DAoI and may be disturbed or damaged by the Project. The Project may have impacts on:
- cultural heritage resources; and
- sense of place.

eni had re-aligned the land acquisition area to avoid the Royal Cemetery near Sanzule. This has resulted in the impact on cultural heritage resources being assigned a **low** significance rating during construction, while the impact on sense of place is anticipated to be of **medium** significance.

During the operation phase both impacts have been assigned a significance rating of **medium**. However, this is largely due to the extended duration of the impacts, and not the sensitivity of the receptors.

Social Infrastructure

The Project will increase the population in the DAoI during construction, and to a lesser extent during operation, largely through introduction of a migrant workforce but also through other economic in-migrants settling in the area with the intention of securing employment with the Project or seeking other economic opportunities. This has the potential increase demand on services and existing infrastructure in the DAoI. The Project will result in impacts on:

- social infrastructure;
- road infrastructure;
- health infrastructure; and
- marine traffic and infrastructure.

The Project will be self-sufficient during all phases, which will reduce the negative impact it could potentially have on social infrastructure in the DAoI. This, together with the correct implementation of the mitigation measures has resulted in the impacts listed above being assigned a **medium** significance during both construction and operation phases. The significance rating of medium for operation is however, largely due to the extended duration of the impacts, and not the sensitivity of the receptors.

Security

Finally, the use of public and private security forces to police the ORF, the FSPO and the pipelines RoW to prevent encroachment from other uses could cause conflict, in particular with local fishermen.

In conclusion, the only Phase 2 Project negative impact associated with the social environment that has received a significance rating higher than medium is economic displacement. The positive impacts associated with the Project range from medium positive significance, to critical positive significance, indicating that the Project will have an overall positive impact on employment and the economy.

1.9.3 Health, Safety and Security Impacts

Community Health and Safety and Security

The impact assessment undertaken on community health and safety indicates that there are a number of impacts on health and safety that are considered to be medium after mitigation during both construction and operation phases.

The presence of an external workforce and the increased of economic migrants could lead to the increased transmission of STIs including HIV/AIDS as well as communicable diseases or even introduction of new ones within the communities. Furthermore, poor quality housing and sanitation facilitate the transmission of diarrhoeal disease, especially in children. The existing health resources to deal with STIs and communicable diseases are limited in the Project Area of Influence.

The increased traffic and presence of heavy vehicles on local roads increase the risk of road traffic accidents occurring which could result in injuries or fatalities to drivers and passengers.

Moreover, even if the worker camp will have its own medical facility, the potential increased transmission of diseases, increased accidents and increased numbers of people accessing care for routine activities may lead in an increased in pressure on health care resources mainly during the construction phase, where the influx of workers will be higher.

The impacts on community health, safety and security associated with the Project range from medium to low significance.

Worker's health and Safety and Rights

Due to the nature of the activities being undertaken during construction, worker health and safety is a key risk with the potential for accidents that may result in injuries and fatalities as well as lost man-hours. Within Ghana, companies do not always meet national and international standards around worker health and safety. Workers may also be at risk of acquiring communicable diseases, vector borne diseases in particular malaria and sexually transmitted infections due to the existing baseline health conditions of communities in the Project area and the potential for worker community interactions.

Although Ghana labour laws are in line with international labour laws and Ghana has ratified the eight core ILO conventions, enforcement of labour laws is hampered by a lack of capacity within companies as well as within the labour inspectorate and judiciary. Furthermore, due to the employment situation in Ghana there is evidence that workers are willing to sacrifice their rights in order to find and maintain employment. As such, there is a risk that contractors and suppliers will not be operating in line with national or international best practice.

Despite improvements in recent years, child labour, especially in its worst forms remains a major concern for the Government of Ghana. In this regard there is the potential that nationally based suppliers (who may form part of the supply chain) could be using child labour in their operations or are employing under 18's to undertake hazardous activities. Again, this is a particular risk in companies where the use of informal and day workers is more prevalent.

The correct implementation of the mitigation measures has resulted in the impacts listed above being assigned a low significance during both construction and operation phases.

A number of mitigation and monitoring measures to minimize health impacts have been included in the EIS and will be implemented by eni Ghana when granting with the environmental authorisation for the project. For instance: provision with primary health care and basic first aid at construction camps / worksites, conduct pre-employment screening protocols and regular health screenings to all employees, training on Security and Human Rights and driving codes, development of a Traffic Management Plan, road maintenance and the implementation of a grievance mechanism as part of the programme of stakeholder engagement.

1.9.4 Unplanned Impacts

Formal risk assessment tools are to be developed to identify assess and mitigate risks in subsequent stages of engineering design. However, partial assessments have been undertaken.

For the offshore component, the events with the most significant potential consequences are, blow out of a well with gas and or oil spills, and rupture/failure of pipes/flow lines at different sections.

In terms of gas blow out, given the very low probability of this event happening and the relatively low expected consequences, good engineering practices (standard well monitoring and control etc) are to be implemented at this stage. For the rupture/failure of pipelines, a combination of some engineering measures has been identified as needed to be implemented, in order to decrease the fire risk. This includes the installation of a Subsea Safety Isolation Valve, already implemented.

In terms of spills of hazardous materials, given the extremely low probability of blow outs involving massive oil spills, the overall risk derived from this unplanned event has been assessed as Medium. Mitigation for this type of accidental events can be those that decrease the probability of the event, in general adoption of industry standard systematic operational and maintenance practices and procedures, and those aimed at reducing the consequences of a potential oil spill, such as an Oil Spill Contingency Plan (OSCP).

For the onshore component of the project (ORF and pipelines), at this stage and based on the preliminary data available, it is not expected to pose a significant risk to humans or the environment from accidental events. The segment of pipeline immediately onshore from the landfall will deserve a focused attention given the short distance to Sanzule and Awonakrom (final route not defined, distance expected hundreds of meters) The distance from the ORF to the nearest settlement is one order of magnitude higher, the nearest human habitation will in fact be the project's permanent camp. In case of need, several engineering and management measures are available to design the pipeline to appropriate safety standards. The ORF will be designed to maintain the highest level of safety to the permanent camp and the Emergency Response Plan will be designed to manage any accidental event.

1.9.5 Cumulative and Transboundary Impacts

In line with best practices and IFC standards, particular attention is paid in this EIS to potential cumulative and transboundary impacts. A cumulative impact of major significance has been identified on livelihoods and ecosystem services, in particular related to fisheries and farming based livelihoods. Moreover, the following impacts assessed as of medium significance have been identified:

- Surface water pollution related to the additive effects of changes to the surface water flow and unplanned spills which could affect the Amansuri River sytem;
- Increased pressure in social infrastructure and service delivery;
- Increased price inflation.

- Increased potential for habitat degradation / land use change.
- Physical and social sense of place.
- Economic and psychological cumulative impact resulting from post-decommissioning.
- Health community and safety.

No significant transboundary impacts are expected to occur as a result of construction and normal operations. The only potential transboundary impact would occur in case of an accidental large oil spill (blow out). As previously mentioned, the overall risk of these spills has been assessed as Medium risk.

In order to mitigate the negative cumulative impacts of the development of oil and gas projects in the DoI, it is recommended that the Project in conjunction with other projects in the area and local/regional and national government work together for a sustainable resources management, spatial planning and land development as well as efficient land administration. In addition, it is recommended the development with other operators and public authorities of an Influx Management strategy and the design of a national or regional Oil Spill Prevention Plan, including the port, which could benefit from coordinated plans and actions to manage any accident.

1.10 Decommissioning and Abandonment

At the end of the economic life of the Project, it will be decommissioned to restore the site to a safe condition that minimises potential residual environmental impacts and permits reinstatement of activities such as fishing, unimpeded navigation at the offshore site, and agriculture onshore. The decommissioning activities are planned to be completed in two years.

Decommissioning will be performed according to the Petroleum (Exploration and Production) Law (Act 84 of 1984), that is the main current legislation covering oil and gas developments within Ghana, and to Ghana environmental and marine laws and regulations that are in place at the time of decommissioning.

A project-specific Decommissioning and Abandonment Plan (DAP) will be prepared, including decommissioning methods and procedures for individual components of the OCTP Project facilities and infrastructure and waste management requirements. The plan will address potential environmental and social impacts, as well as health and safety issues identified by a risk assessment. It will also include details on a post-decommissioning survey and monitoring programme.

1.11 Environmental, Social and Health Management Plan

The Project has used the EIS process as a tool to identify mitigations and draft the framework Environmental, Social and Health Management Plan (ESHMP). The framework ESHMP is based on available design information and provides a delivery mechanism for environmental, social and health mitigation and monitoring.

Eni Ghana will develop two separate OCTP Phase 2 Project ESHMPs (for the construction and operation phase) following the guidance of this framework ESHMP and will integrate the two project phases (oil and gas). The OCTP Phase 2 Project ESHMPs will become parts of eni Ghana's overall HSE IMS. They will also be subject to annual review and re-issue, or as required, such as in the event of any significant changes to the project's environmental and social/health impacts occur. The key elements of the OCTP Phase 2 Project ESHMPs will be a series of Environmental, Social and Health Management and Monitoring Tables.

Following is a list of the management plans to be developed by eni Ghana for the OCTP Phase 2 Development Project and that will be applicable for all project phases:

Already developed in the eni Ghana HSE IMS

- HSE Plan
- Emergency Response Plan
- Waste Management Plan
- Oil Spill Contingency Plan
- Medical Emergency Response Plan

To be developed and integrated in the HSE IMS

- Worker's Management Plan
- Influx Management Plan
- Community Health Management Plan
- Security Management Plan
- Project Procurement Plan
- Project Recruitment, Employment and Training Plan
- Livelihood Restoration Plan
- Stakeholder Engagement Plan
- Cultural Heritage Management and Monitoring Plan
- Fisheries Management Plan
- Pollution Prevention and Control Plan
- Biodiversity Management Plan
- Water Management Plan
- Local Content Development Plan
- Social and Environmental Investment Plan
- Traffic Management Plan
- Marine Traffic Management Plan
- Decommissioning Plan
- Well Control Plans for each well.

Following is a list of the monitoring programs to be developed by eni Ghana for the OCTP Phase 2 Development Project and that will be applicable for all project phases:

- Ecological Monitoring Program including marine mammal observation monitoring program and a sea turtle monitoring program.
- Participatory Fisheries Monitoring Program.
- Environmental Monitoring Plan including sub-plans for each topic:
    - Offshore: sea water quality, marine fauna, FPSO air emissions, seabed monitoring, routine effluent and discharge monitoring.
    - Onshore: emissions and ambient noise, ORF air emissions and ambient air quality, vegetation and alien species, biodiversity and ecosystem services, water quality/quantity.

eni Ghana is committed to providing resources and establishing the systems and components essential to the implementation and control of the ESHMP including appropriate human resources and specialised skills, training programs, communication procedures, documentation control, communications with authorities and communities as well as a procedure for the management of change. Eni Ghana has a HSE & CI department which has responsibility for both HSE and Community Investment with dedicated staff, competent on the basis of appropriate education, training and experience.

Monitoring will be conducted to ensure compliance with regulatory requirements as well as to evaluate the effectiveness of operational controls and other measures intended to mitigate potential impacts. Beyond the routine inspection and monitoring activities conducted, audits will be carried out internally by both eni Ghana and its Partners (including the Government of Ghana) to ensure compliance with regulatory requirements as well as their own EHS standards and policies.

1.12 Summary and Conclusions

The findings of the EIS presented in Chapter 10 indicate that there are no issues of Major significance that could not be mitigated such that the proposed project was not acceptable from an environmental and socio-economic and health perspective. The significance of all negative impacts could be reduced to Medium or Minor significance through design, use of control technology and operational management controls with the exception of the economic displacement of farming in land acquisition Area

For this impact, an assessment of the proportional scale of livelihoods losses to Sanzule, along with information on the availability of alternative agricultural land in the direct area of influence to allow for like-for-like replacement of acquired farmland, will be confirmed following supplementary baseline livelihoods survey work to be conducted in parallel with the resettlement planning process in April 2015.

For the moment, other alternatives such as compensation of both the leased land and the assets, and future alternative livelihood training activities and specific investment projects at Sanzule are foreseen.

For other impacts, the residual effect of a number of activities from the construction and operation phases is expected to remain Medium despite the mitigation measures proposed. For this reason, eni Ghana will pay special attention to these activities and ensure that practicable, feasible and cost-effective mitigation is implemented wherever practicable.

The EIS also identified a number of positive impacts. Increased government revenue was assessed as having the potential benefit of High significance during construction and Critical positive during operation. Other positive impacts of High significance are increased procurement during construction and operation phases and employment and skills development during operation phase.

Granting of environmental authorisation for the eni Ghana OCTP Block Phase 2 Project by the EPA will be contingent on a series of conditions. These are likely to include the implementation of the safeguard measures described in the EIA and a programme of monitoring for potential environmental, social and health impacts.

ESHIA for GHANA OCTP BLOCK Phase 2

ABSTRACT

Chapter 2 provides an introduction to the Project and describes the purpose of the ESHIA Report.

July 2015	06	Final version	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

Summary of Revisions

July 2015	05	Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
April 2015	04	Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
March 2015	03	Interim Draft Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
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20-02-2015	01	Issued for comments	ERM	eni SEQS/SAL	G. Nicotra
21-01-2015	00	-	Cristina O.	Henry C.	Daniele S.
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

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2 INTRODUCTION AND PURPOSE

2.1 PROJECT OVERVIEW

The Offshore Cape Three Points (OCTP) block is located approximately 60 km off the coast of the Western Region of the Republic of Ghana. The block is licensed for oil and gas exploration and development by a joint venture (JV) composed of eni Ghana Exploration and Production Limited ("eni Ghana") holding 47.222% participating interest, Vitol Upstream Ghana Limited ("Vitol") holding 37.778% participating interest, and GNPC holding 15% participating carried interest. eni Ghana is the operator.

The JV has made three non-associated gas (NAG) discoveries: Sankofa Main Field in 2009, Gye Nyame Field in 2011, and Sankofa East Field in 2012. In addition, two oil discoveries have been made: Sankofa East Field Cenomanian and Snakofa East Campanian, both in 2012 ("Oil Discoveries"). The estimated reserves associated with the discoveries are 236 MMboe of NAG and 132 MMbbls of oil.

The JV intends to develop the fields in two phases to optimize the exploitation in synergy of the oil and gas discoveries:

- **Phase 1: Oil Development Project.** This phase would consist of 14 subsea wells (8 oil producers, 3 water injectors and 3 associated gas injectors), subsea facilities, and a new conversion, double-hull floating production, storage and offloading (FPSO) unit that would be located about 60 km offshore, south of Sanzule;
- **Phase 2: Non Associated Gas (NAG) Development Project**. This phase would consist of five (5) subsea wells, subsea facilities, minimal gas treating facilities located on the Phase 1 FPSO unit, 63 km subsea gas pipeline, an Onshore Receiving Facility (ORF), and other associated onshore components.

The Phase 1 Oil Development Project Environmental Impact Assessment (EIA) process was undertaken by ESL Consulting (ESL). The Submission of the Final EIS to the Ghana Environmental Protection Agency (Ghana EPA) was done on July 8th 2015 and the Environmental Permit for the Phase 1 Development released on July 9th.

This EIA study focuses on the Phase 2 NAG Development Project, although cumulative impacts of the two phases are also addressed.

In addition, it should be noted that the FPSO is a common facility to both project phases: it will be installed as part of the Phase 1 development, and it will be equipped to support the processing of Phase 2 NAG. Therefore, impacts associated to the FPSO are discussed in both EIA. However, in the Phase 2 EIA impacts associated to the FPSO from both phases have been integrated for completeness.

2.2 PROJECT JUSTIFICATION

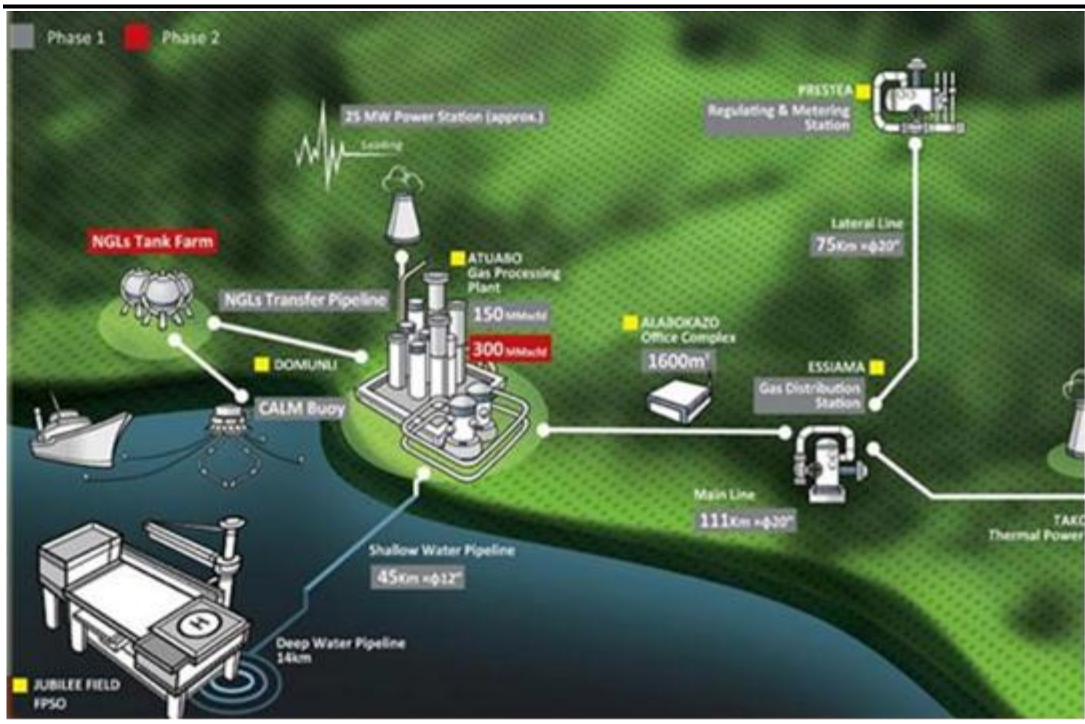
According to the US Energy Information Administration (EIA, 2014) Ghana imported 22 Bcf of natural gas in 2012. Ghana imports natural gas via the West African Gas Pipeline (WAGP), which runs from Nigeria to Ghana. WAGP was shut down from August 2012 to July 2013 for repairs following damage to the Togolese section of the pipeline. Gas flows through the pipeline have decreased since 2011 and remain unreliable, forcing Ghana to use heavy oil to supply its dual-fuelled power plants.

Ghana's energy ministry is considering plans to build a regasification terminal to import liquefied natural gas (LNG) in case imports from WAGP and domestic gas production are not enough to meet power generation demand in the medium to long term. According to Ecobank, Ghana is projected to need more than 800 MMcf/d of natural gas by 2017 for power generation and for reinjection into wells to enhance oil production.

As of the end of 2012, Ghana had an installed electricity capacity of almost 2.3 megawatts according to Ghana's national energy statistics. Ghana generated 12 billion kilowatt-hours (kWh) of power in 2012 of which 67% were from hydroelectricity and the remainder from fossil-fuel powered generation. Many Ghanaians, particularly in rural areas, rely on traditional biomass and waste, particularly firewood, for household cooking and heating. Firewood accounts for slightly more than 40% of Ghana's total primary energy consumption, according to Ghana's national energy statistics. Ghana must expand its installed electricity capacity and distribution system to provide electricity to almost 30% of its population that does not have access to electricity, according to the latest World Bank data.

The Project is a next step in the growing energy sector in Ghana. It represents a foundation for production of natural gas in Ghana, bringing new sources to market for the benefit of industry and the people of Ghana. The Project will support the wider Ghana Gas Infrastructure Development Project which is part of the Western Region Spatial Development Framework (WRSDF). This development initiative includes the gas processing plant at Atuabo and other facilities. Figure 2.1 shows a summary of the overall project.

Figure 2.1 Overview of the Ghana Gas Infrastructure Development Project



Source: Offshore Energy Today, 2014

The Project will also provide local employment and other economic benefits to local communities as well as to the Western Region and Ghana more broadly to assist in ensuring economic benefits from the oil and gas industry.

2.3 Purpose of the EIA

eni Ghana recognizes that comprehensive planning and management of environmental, socio-economic and health issues are essential to the execution of any successful project and, therefore, intends to fully integrate environmental, socio-economic and health considerations into the Project's lifecycle. A key objective of the EIA is to assess the potential impacts of the Project and Project-related activities on the environmental, socio-economic and health resources and receptors, and where necessary to design mitigation measures to anticipate, avoid, minimize, or compensate for negative impacts and enhance benefits.

eni Ghana commissioned Environmental Resources Management (ERM) to conduct the EIA for the Project. ERM worked in collaboration with ESL Consulting (ESL) and SRC Consulting (SRC) (all together referred to as the "EIA team").

The purpose of an EIA is to provide information to regulators, the public and other stakeholders to aid the decision-making process. The objectives of the EIA are as follows:

- To define the scope of the project and the potential interactions of project activities with the environment (biophysical, social and health);
- To identify relevant national and international legislation, standards and guidelines and to ensure that they are considered at all stages of project development;
- To provide a description of the proposed project activities and the existing environmental socio-economic and health conditions that the project activities may interact with.
- To predict, describe and assess impacts that may result from project activities and identify mitigation measures and management actions to avoid, reduce, remedy or compensate for significant adverse effects and, where practicable, to maximise potential positive impacts and opportunities;
- To provide a plan for implementation of mitigation measures and management of residual impacts as well as methods for monitoring the effectiveness of the plan; and
- Furthermore, this EIA aims to achieve an acceptable level of conformance with international lender standards in order to provide potential lenders with assurance that environmental, social and health risks are comprehensively understood by eni Ghana and that management systems and processes are in place.

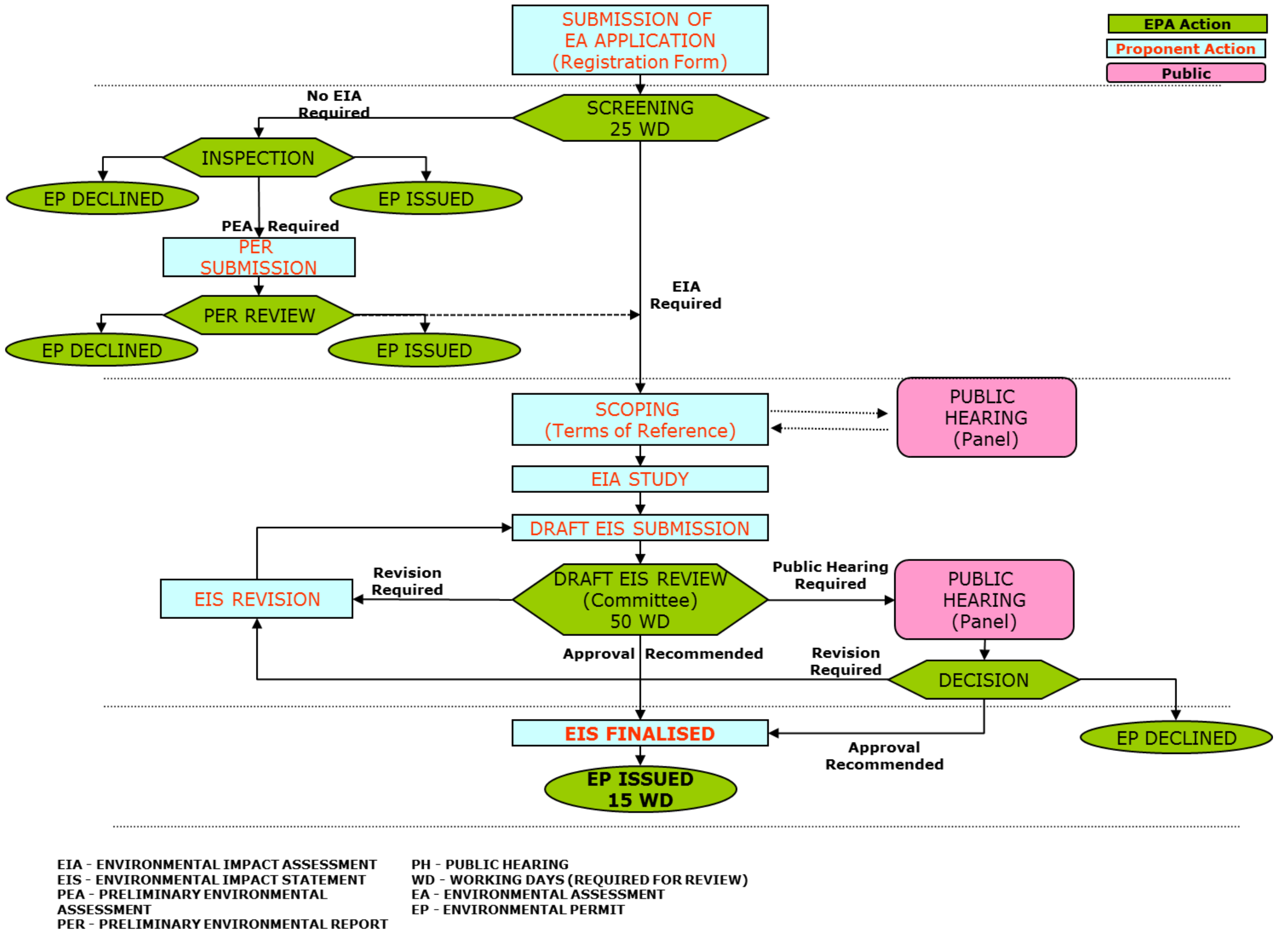
2.4 EIA Process

The EIA process in Ghana is regulated by the Environmental Assessment Regulations (1999) (the "EA Regulations"). The process is shown schematically in Figure 2.2.

The EIA process for this Project followed applicable regulations and also requirements of international lenders, as described in section 3.7 of Chapter 3.

This Section provides a summary of the process that was undertaken.

Figure 2.2 Overview of Administrative flowchart of the EA procedure



Source: Ghanaian Environmental Assessment Regulations (1999) and Environmental Assessment in Ghana Guidelines (1995)

2.4.1 Registration and Screening

An undertaking listed in Schedule 2 of the EA Regulations and/or one that EPA deems likely to have an adverse effect on the environment must be registered and have an environmental permit issued by the EPA before commencing.

The Project was registered with the EPA on 12 December 2014.

According to the EA Regulations, within 25 days from the time a registration form is received, the EPA will determine the appropriate level of assessment. Based on the nature of the proposed activities, the EPA has determined that the Project will require a full EIA.

2.4.2 Scoping

One of the main objectives of scoping is to identify the potentially significant environmental, social and health issues relating to the implementation, operation and decommissioning of the proposed development that should be addressed as part of the EIA. This enables the developer to address the key issues from the outset and allows early recognition of these issues in the design and evolution of the scheme. The process also facilitates the 'scoping out' of aspects that would not be expected to experience significant adverse impacts. Ultimately, it helps define the scope for the EIA, which will examine and report the full suite of impacts associated with the Project.

Scoping is an iterative process and the scope of the EIA may change during project development, for example, as a result of the findings of technical studies or information supplied by stakeholders. The main objectives of the scoping phase were as follows:

- Provide an overview description of the Project;
- Develop an understanding of the legislative, environmental, socio-economic and health context for the Project (using secondary data);
- Obtain early input from key stakeholders in the identification of potential impacts and mitigation measures; and
- Define a proposed Terms of Reference (ToR) for an EIA study and define an appropriate program for consultation with stakeholders for approval by EPA.

A Scoping Report, including ToR for the EIA, was submitted to the EPA on 30 December 2014. The letter of response from EPA to the Scoping report, including EPA's comments and suggestions for the TOR, was received on 24th February 2014. The comments received will be implemented and the final version of the Scoping Report will be disclosed together with the EIA (see section 2.4.8 on reporting and disclosure).

2.4.3 Baseline Data Collection

The EIA report provides a description of the existing environmental, socio-economic and health conditions as a basis against which the impacts of the Project can be assessed. The baseline includes information on receptors and resources that were identified during scoping as having the potential to be significantly affected by the proposed Project. The description of the baseline has the following main objectives:

- to identify the key environmental, socio-economic and health resources and conditions in areas potentially affected by the Project;
- to describe, and where possible quantify, their characteristics (i.e. their nature, condition, quality and extent);
- to provide data to aid the prediction and evaluation of possible impacts;
- to inform judgements about the importance, value and sensitivity or vulnerability of resources and receptors; and
- use as a reference for future monitoring of impacts of the Project.

For the current Project, baseline data collection was obtained from existing sources including the following:

- stakeholders consulted during the Project including government agencies, local communities and Non-Governmental Organisations (NGOs);
- local experts and research and academic organisations; and
- published sources.

Additional primary baseline data was collected as follows:

- Onshore Environmental field surveys were carried out to assess baseline soil, geology, water, sediment, air quality, noise, fauna and flora conditions. Three campaigns were

undertaken: dry season survey (April, 2014); wet season survey (October, 2014), and final campaign to fill in gaps identified during previous campaigns (see Chapter 6 for details);
- Offshore Environmental field surveys were carried out to assess marine water quality, planktonic and zooplanktonic, fish and fisheries, marine sediment quality and benthic macro fauna;
- Fisheries baseline studies including a fish catch study, focus group discussions and stakeholder engagement.
    - Catch study of the coastal fisheries at Sanzule and Bakanta in April, 2014 and October, 2014 (upwelling season).
    - Focus Group Discussions to the chief fishermen and fishermen of some of the fishing towns in the six coastal districts of the Western Region, undertaken from November, 2013 to March, 2014.
    - Stakeholder engagement with chief fishermen and fishermen of the extended AoI and consultation with Fishers of the 10 communities within the Direct Area of Influence in December, 2014.
- Socio-economic and health field surveys were carried out in December, 2014. These surveys involved focus group discussions and key informant interviews with different groups and organisations in Project's direct Area of Influence (see Chapters 8 and 9 for details).

2.4.4 Stakeholder Engagement

The objective of the stakeholder engagement undertaken was to present the proposed Project and EIA process as well as identify associated issues, concerns and opportunities. Further details on the stakeholder consultation and engagement process during the Project's life are included in Chapter 5 and in the Stakeholder Engagement Plan (SEP) included in Annex A.

2.4.5 Quantitative Assessment

The following quantitative studies were undertaken by the EIA team and eni to support the impact assessment:

- Preliminary estimations of greenhouse gases emissions have been performed and can be made available upon request; and
- A model of coastal processes was performed by SAIPEM and can be made available upon request.
- Modelling of oil spills potentially resulting from accidental events, using SINTEF's Oil Spill Contingency And Response (OSCAR) software. Results are summarised in the OSCP presented in Annex F;
- A detailed assessment of the noise potential impacts of the construction and operations phases of the onshore facilities (ORF and onshore pipeline) was performed by means of modelling tools (SoundPLAN) in April 2015. Results are presented in Annex I.
- A detailed assessment of the potential impacts on air quality during the FPSO and ORF operations phase was performed by means of modelling tools (CALMET-CALPUFF) in April 2015. Results are presented in Annex H.
- A visual impact assessment of the onshore component (ORF and Accomodation Camp) of the project was performed in April 2015. Results are presented in Annex J.

- A drilling cuts deposition modelling was performed in March 2015. Results are presented in Annex K.

2.4.6 Impact Assessment

Impact assessment and development of mitigation measures is an ongoing process that commences during the scoping stage and continues throughout the EIA process. The key objectives of this process are as follows:

- to analyse how the Project may interact with the baseline in order to define, predict and evaluate the likely extent and significance of environmental, social and health impacts that may be caused by the Project;
- to develop and describe acceptable and cost effective mitigation measures that avoid, reduce, control, remedy or compensate for negative impacts and enhance positive benefits;
- to evaluate the predicted positive and negative residual impacts of the Project;
- to develop a system whereby mitigation measures will be integrated with the Project and will be taken forward as commitments. This is achieved through the development of a framework Environmental, Social and Health Management Plan (ESHMP);

The impact assessment process has the following four main steps:

1. Prediction of what will happen as a consequence of Project activities;
2. Evaluation of the importance and significance of the impact;
3. Development of mitigation measures to manage significant impacts where practicable;
4. Evaluation of the significance of the residual impact.

Where significant residual impacts remain, further options for mitigation may be considered and impacts re-assessed until they are reduced to as low as reasonably practicable (ALARP) levels. This approach takes into account the technical and financial feasibility of mitigation measures.

In addition to predicted impacts from planned activities, those impacts that could result from an accident or a non-routine event within the Project (such as a pollution event from a petroleum product spill or explosion/fire) are taken into account. In these cases the likelihood (probability) of the event occurring is considered. The impact of non-routine events is therefore assessed in terms of the risk, taking into account both the consequence of the event and the probability of occurrence.

The methodology used for the assessment of the environmental social and health impacts identified is included in Chapter 10 of this Report.

2.4.7 Management Plans

The range of measures to mitigate impacts identified through the EIA process is reported in the EIA report within the project description and mitigation chapters. These have been brought together in a framework ESHMP for the Project (see Chapters 10 and 12). eni Ghana will develop two separate OCTP Project ESHMPs (for the construction and operation phase) which will replace this framework ESHMP.

The ESHMP consists of the set of management, mitigation and monitoring measures to be taken during implementation of the Project to eliminate adverse environmental, social and health impacts, offset them, or reduce them to acceptable levels. The plan details the specific actions that are required to implement the controls and mitigation measures that have been agreed through the EIA process. It also presents the commitments acquired to develop detailed construction phase and operations phase ESH management and monitoring plans.

2.4.8 Reporting and Disclosure

The outputs of the above tasks are drawn together into the draft EIA report and submitted to the EPA for review.

Regulatory Requirements

Once the draft EIA report is submitted, this is subjected to a review by a panel of experts constituted by the EPA. The EPA distributes the draft EIA to the relevant experts and Ministers and following the review period, their findings are presented to the Project team for revision of the report to produce the final EIA Report.

Public Disclosure

At this stage, as part of the formal regulatory process, the EPA will make a public notice of the opportunity for information and comment on the draft EIA report for the Project. The EPA will publish a notice concerning the details of the EIA report (together with the Scoping Report) in mass media and announce it in local media of the Western Region of Ghana for a period of 21 days. In addition, a Reconnaissance Survey will be carried out throughout 6 coastal regions, the Western Regional House of Chiefs and engagement of CSOs, Media and other Governmental Institutions. During the Reconnaissance Survey, all engaged stakeholders will be informed of the public hearing venues and where to access the copies of the EIA (to be located mainly in District Assemblies, Regional EPA Offices, Main Libraries etc.).

Public hearings have initially taken place in Takoradi-Sekondi on 8th, 9th, and 10th April. Public hearings were be divided in three venues, by type of stakeholders:

- Civil Societies (CSOs, represented by the Relevant Ministries, Agencies and Department Heads), Media and the General Public;
- Six (6) Coastal Districts, represented by Municipal Chief Executives, District Chief Executives, Presiding Members of the six coastal Districts an Assembly Members; and
- The Western Regional House of Chiefs (Traditional Leadership).

During these initial public hearings, copies of the non-technical summaries were made available for the general public, facilitating the general access to the project.

In addition, a dedicated workshop was held at the Community of Sanzule on 31st March, where the project was presented to the Community and better interaction could be achieved. Copies of the presentation were made available to facilitate visual access to the information.

Decision Making

Comments received on the draft EIA report from the EPA and stakeholders' written comments are addressed in the final EIA report which is submitted to the EPA for their decision on whether to issue certification for the EIA, which provides environmental authorisation for the Project in the form of an Environmental Impact Statement (EIS).

Lender Requirements

The EIA Report will also be disclosed in line with potential lender requirements and timeframes (see section 3.7.4 for details). This will include disclosure of the full ESHIA on the relevant institutions website (http://www.epaoilandgas.org) for public review and comment. Copies of non-technical summary will be provided to stakeholders.

2.5 EIA TEAM

2.5.1 Consultants

The core EIA team members that are involved in this EIS are listed in Table 2.1.

Table 2.1 The EIA Team

Name	Role	Qualifications, Experience
Daniele Strippoli (ERM)	Project Director	MSc, 14 years
Cristina Ortuño (ERM)	Project Manager	MSc, 12 years
Henry Camp (ERM)	Technical Director	BA, 30 years
Karen Opitz (ERM)	Environmental Lead	BSc (Hons), MPhil, 9 years
AK Armah (ESL Consulting)	Marine specialist	MSc, MPhil, 20 years
Belinda Riley (ERM)	Social specialist	MSc, 11 years
Daniel Abbrey (SRC Consulting)	Socio-economics specialist	BA (Hons), MSc, 6 years
Callie Phillips (ERM)	Health specialist	MSc, 9 years
Marco Rusmini (ERM)	GIS Specialist	MSc (Hons), 6 years

EIA team primary contact details are as follows:

Project Director	**Mr. Daniele Strippoli**
Address:	ERM Italia S.p.A. Via San Gregorio 38 Milan, 20124 Italy
Tel:	+39 0267440168 / +39 3483173404
Email:	daniele.strippoli.erm.com

2.5.2 eni Team

The EIA was carried out with input from specialists from the eni's team. Input included providing details on the project's technical aspects as well as with the development of mitigation measures and environmental management plans. eni's Environment Health and Safety (EHS) and Corporate Social Responsibility (CSR) teams also provided support and input, in particular during fieldwork.

Key contributors include the following:

Name	Role
Juan Deffis	eni Ghana HSE & CI Manager
Giuseppe Nicotra	HSE reference

Name	Role
Elena Pavanel	Environmental specialist
Yina Xiao	Health specialist
Simone Mortara	Health specialist
Erasmo Macera	Health specialist
Maurizio Pedercini	Social specialist

2.6 ACKNOWLEDGEMENTS

Acknowledgements go to the Ghana EPA for providing guidance on the EIA process and to those consultees listed in Attachment I that provided information for the EIA, raised issues and made comments on the project.

In addition, information from studies undertaken by eni, SAIPEM and ESL have been used in this EIA and are gratefully acknowledged (full reference list provided in Chapter 14).

2.7 STRUCTURE OF THIS REPORT

The structure of the EIA Report is as follows;

Chapter 1	Non-Technical Executive Summary
Chapter 2	Introduction and Purpose of the Report
Chapter 3	Legal and Policy Framework
Chapter 4	Project Description
Chapter 5	Stakeholder Engagement
Chapter 6	Environmental Baseline
Chapter 7	Fisheries Baseline
Chapter 8	Socio Economic Baseline
Chapter 9	Health Baseline
Chapter 10	Summary of Assessment of Potential Impacts and Mitigation Measures
Chapter 11	Decommissioning and Abandonment
Chapter 12	Environmental, Social and Health Management Plan
Chapter 13	Summary and Conclusions
Chapter 14	References

The main report is supported by the following annexes;

Annex A	Stakeholder Engagement Plan
Annex B	Baseline Reports
Annex C	Maps and Figures
Annex D	Terms of Reference of the EIA
Annex E	Issues Trail from Scoping Consultation
Annex F	eni Ghana Management Plans (OSCP, HSE Plan, Waste Management Plan)
Annex G	Detailed Assessment of Potential Impacts and Mitigation Measures
Annex H	Air Quality Modelling
Annex I	Noise Modelling
Annex J	Visual Impacts Assessment

Annex K Drilling Cuts Deposition Modelling

ESHIA for GHANA OCTP BLOCK Phase 2

ABSTRACT

This Chapter presents an overview of the national legislation and policies regarding environmental, social and health applicable to the Project, as well as the relevant international treaties, conventions and best practices.

Date	Revision	Revision Description	Prepared	Checked	Approved
July 2015	06	Final version	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago

Summary of Revisions

Date	Revision	Revision Description	Prepared	Checked	Approved
July 2015	05	Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
April 2015	04	Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
March 2015	03	Interim Draft Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
27-02-2015	02	Issued for submission to Authorities	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
23-02-2015	01	Issued for comments	ERM	eni SEQS/SAL	G. Nicotra
19-01-2015	00	-	Cristina O.	Henry C.	Daniele S.

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3 LEGAL AND POLICY FRAMEWORK

3.1 INTRODUCTION

This Chapter presents an overview of the national legislation and policies regarding environmental, social and health applicable to the Project, as well as the relevant international treaties, conventions and best practices (e.g. international treaties and conventions to which Ghana is party and financial institution standards).

In addition, the development of this project involves funding that requires conformance with lender standards. Being a private-sector project, both the World Bank and IFC are using the Performance Standards (hereinafter "WB/IFC Performance Standards").

3.2 GHANAIAN GOVERNMENT AND ADMINISTRATION FRAMEWORK

An overview of Ghanaian government ministries and the key administrative bodies (i.e. authorities, agencies and commissions) with responsibilities related to the project is given below.

- Ministry of Environment, Science, Technology and Innovation represented through the Environmental Protection Agency (EPA);
- Ministry of Petroleum – represented through the Ghana Petroleum Commission and the National Petroleum Corporation (GNPC);
- Ministry of Transport – represented through the Ghana Maritime Authority (GMA), the Ghana Ports and Harbours Authority (GPHA) and the Ghana Civil Aviation Authority (GCAA);
- Ministry of Food and Agriculture – represented through the Directorate of Fisheries the Fisheries Commission and the Regional Departments of Fisheries;
- Ministry of Defence - represented through the Ghana Navy and Ghana Air Force;
- Ministry of Finance and Economic Planning;
- Ministry of Roads and Highways;
- Ministry of Water Resources, Works and Housing;
- Ministry of Lands and Natural Resources; and
- Ministry of Local Government and Rural Development – represented through the ten Regional Coordinating Councils.

3.2.1 Environmental Protection Agency (EPA)

The EPA was established under the Environmental Protection Agency Act (Act No. 490 of 1994) as the leading public body responsible for the protection and improvement of the environment in Ghana.

The EPA is responsible for issuing environmental permits and pollution abatement notices for controlling waste discharges, emissions, deposits or other source of pollutants and issuing directives, procedures or warnings for the purpose of controlling noise. EPA also directs the National Efforts for Tier 2 spillages and is one of coordination and provision of technical advice, logistic and maintenance support, materials and equipment, and training for Tier 3 spillages. EPA, in accordance with relevant Memoranda of Understanding and relevant International Conventions (such as Abidjan Convention), may also assist or receive assistance from neighbouring countries in relation to oil spill incidents.

The EPA has the authority to require an EIA, is responsible for ensuring compliance with EIA procedures and is the lead EIA decision-maker.

3.2.2 Ministry of Petroleum

The Ministry of Petroleum is responsible for developing and implementing energy sector policy in Ghana and for supervising the operations of a number of government institutions, including the Petroleum Commission and *GNPC.*

Petroleum Commission

The Petroleum Commission was established in 2011 under the Petroleum Commission Act (Act 821) for the regulation and management of petroleum resources and to coordinate the policies in relation to these resources.

Specifically, the Commission was established to: promote petroleum activities for the benefit of Ghana; recommend national policies related to petroleum activities; monitor compliance with national policies, laws, regulations, agreements on health, safety and environmental standards in petroleum activities; monitor and carry out inspections and audits of petroleum facilities; promote local content and local participation; receive and store petroleum data; receive applications and issue permits for specific petroleum activities; assess and approve appraisal programmes; advise the Ministry of Petroleum related to activities including development plans and decommissioning plans for petroleum fields; issue an annual report on petroleum resources and activities; analyse economic information related to petroleum activities and submit forecasts to the Ministry; and perform any other function related to the object of the commission.

Ghana National Petroleum Corporation (GNPC)

The GNPC was established in 1983 by the Ghana National Petroleum Corporation Law (PNDCL No. 64 of 1983). The GNPC is a corporate body established under the Ministry of Petroleum to responsible for the exploration, development, production and disposal of petroleum in Ghana. The GNPC is empowered to conduct petroleum operations and partner with foreign investors to promote the economic development of Ghana. The GNPC is a Partner in the OCTP NAG Development Project. The regulatory and advisory functions of the GNPC with regards to upstream petroleum activities have, howefver, been repealed in favour of the Petroleum Commission since the approval of the Petroleum Commission Act (Act 821).

Ghana National Gas Company (GNGC)

The GNGC's mission is to contribute to Ghana's rapid industrialisation process by building the infrastructure required for gathering, processing and delivery natural gas resources to industry in a safe, cost effective, responsible and reliable manner. The GNGC has been established to manage the Ghana Gas Infrastructure Project which involves plans to transport gas from the Jubilee project to shore.

Energy Commission

The Energy Commission was set up by an Act of Parliament, the Energy Commission Act, 1997 (Act 541) with functions relating to the regulation, management, development and utilisation of energy resources in Ghana. The Energy Commission is the technical regulator of Ghana's electricity, natural gas and renewable energy industries, and the advisor to Government on energy matters.

3.2.3 Ministry of Transport

The Ministry of Transport manages infrastructural development and service delivery for the maritime and rail transport subsectors and to complement the other modes of transport for the socio-economic development of the country. The GMA and GPHA fall under the national Ministry of Transport.

With the assistance of the GMA and the GPHA, the Ministry aims to ensure the provision of an efficient, safe, and reliable movement of goods and people using the rail and maritime systems and ensure that rail, inland waterways, ports and harbours contribute significantly to the socio-economic development of the country.

The Ghana Maritime Authority

The GMA was established under the Maritime Authority Act (Act No. 630 of 2002) and is responsible for monitoring, regulation and coordination of all maritime activities for the Republic of Ghana. The purpose of the GMA is to ensure the provision of safe, secure and efficient shipping operations and protection of the marine environment from pollution from ships. With assistance from the GMA and GPHA, the ministry aims to ensure the provision of an efficient, safe, economic and reliable movement of goods and people using the rail and maritime systems and ensure the rail, inland waterways, ports and harbours contribute significantly to the socio-economic development of the country.

Ghana Ports and Harbour Authority

The GPHA is responsible for planning, managing, building and operating Ghana's seaports. The GPHA owns Ghana's two main seaports (Takoradi and Tema) and has the following functions with regard to their operation, maintenance and control:

- regulate the use of ports and of the port facilities;
- provide, maintain, extend and enlarge port facilities as required for the efficient and proper operation of the port;
- maintain and deepen the approaches to, and the navigable waters within and outside the limits of any port;
- maintain lighthouses and beacons and other navigational service and aids as necessary;
- provide facilities for the transport, storage, warehousing, loading, unloading and sorting of goods passing through any port, and operate or provide access to road haulage service providers; and

- provide stevedoring and porterage services.

Takoradi is the main seaport closest to the NAG fields and has been used to support exploration and appraisal drilling and the OCTP development and will be used for support of the NAG Project's activities.

Ghana Civil Aviation Authority

The GCAA was established in 1930 and the Civil Aviation Act (Act No. 678 of 2004) provided for the establishment of a Civil Aviation Authority which focuses on the core functions of airspace management and safety regulations whilst allowing for a different organisation to handle airport development and operations. The Civil Aviation Authority was restructured into the Ghana Civil Aviation Authority (GCAA) and the Ghana Airports Company Limited (GACL) in 2007.

Under the Civil Aviation Act, the functions of GCAA include the following: licensing and certification of air transport operators; licensing and certification of aerodromes and the construction, operation, maintenance and managements of navigation sites; provision of air navigation services (air space management) within the Accra Flight Information Region (FIR); regulation of air transport services; promoting the development of civil air transport industry in Ghana; advising Government on all matters concerning civil aviation, among other functions; and provision of oversight for all activities related to civil aviation.

3.2.4 Ministry of Fisheries and Agriculture (Fisheries Commission)

The Ministry of Fisheries and Aquaculture Development is the ministry charged with the promotion of sustainable management, development and growth of the fisheries and aquaculture sectors. Its primary roles are the formulation of appropriate policies for the regulation, management and development of the fisheries sector, planning and coordination, monitoring and evaluation within the overall national economic development. The Fisheries Commission fall under this ministry.

Fisheries Commission

The Fisheries commission is responsible for policy formulation and implementation, management and control of the fishing industry under the general guidance and direction of the Fisheries Commission.

The Fisheries Act (Act No. 625 of 2002) established the Fisheries Commission as a body to regulate and manage the utilisation of the fishery resources of Ghana and co-ordinate the related policies. The commission also advises the Minister on all matters pertaining to the fishery industry. The Commission's functions among other things are to ensure the proper conservation of the fishery resources through the prevention of over fishing.

The Commission's mission is *'…to promote sustainable exploitation and responsible utilisation of fishery resources of Ghana through sound management practices, research, appropriate technological development for both culture and capture fisheries, effective extension and provision of other support services to fish farmers, fishermen, fish processors and traders for improved income and fish food security'.*

The functions of the Commission are:

- to prepare and keep under continual review, plans for the management and development of marine and freshwater capture fisheries and aquaculture;
- to carry out research for the assessment for fisheries resources; and
- to ensure that monitoring, control and surveillance of the fishery waters of Ghana.

The Commission has a number of operational divisions for marine fisheries management, namely: inland fisheries management (and aquaculture); marine fisheries research; monitoring; control and surveillance; and finance and administration.

The regional Departments of Fisheries carry out and implement policies of the Fisheries Commission particular to the different regions. The regional office for the Western Region is based in Takoradi and this office covers most of the fishing activities in the coastal waters nearest to the offshore OCTP NAG Development Project area.

3.2.5 Ministry of Defence and Ministry of Interior

The Ministry of Interior has ultimate authority to police Ghanaian waters and enforce Ghanaian legislation through the Marine Police Service. The Ghana Air Force and Navy that depend on the Ministry of Defence will provide additional capacity to the GMA for marine search and rescue operations if required. They would also be available to provide assistance in the event of an emergency such as a major accident offshore, including oil spills. The Ghana Navy is responsible for maritime security at offshore hydrocarbon installations.

3.2.6 Ministry of Finance and Economic Planning

The Ministry of Finance and Economic Planning is responsible for the following activities: mobilisation of external and internal resources; allocation of resources to all economic sectors; ensuring sustainability of public debt; preparing and implementing Ghana's annual budget and financial statements; management of public expenditure; and development and implementation of financial sector policies.

As part of its objectives, the Ministry aims to promote sustainable economic growth and development of Ghana and its people (Ministry of Finance and Economic Planning, 2012). As part of the Ghana public private partnership programme, the Ministry has also compiled a draft resettlement policy framework which sets out the requirements for project developers with regard to physical and economic resettlement of Ghanaians potentially affected by their Projects.

In order to reduce administrative procedures, improve the service to the citizens and ensure an holistic approach in the management of taxes, in 2009 the Ghanaian government created the Ghana Revenue Authority (GRA), an institution that is in charge of assessing and collecting taxes, promoting tax compliance and combat tax fraud.

Although all forms of physical resettlement are being avoided by the proposed Project, there will be economic resettlement as a result of the Project. The resettlement planning and implementation will need to take cognizance of this policy.

3.2.7 Ministry of Roads and Highways

The Ministry of Roads and Highways is mandated to provide and maintain an integrated, cost-effective and sustainable road transport network. The main objective of the ministry is to create and sustain an accessible and efficient transport network and to integrate land use, transport and development planning with effective service provision.

The Ministry of Roads and Highways has four departments/agencies under it, namely: Ghana Highway Authority; department of Feeder Roads; department of Urban Roads; and Ghana Road Fund Secretariat.

3.2.8 Ministry of Transport

The Ministry of Transport is mandated to ensure safe, secure, efficient, reliable, effective and accessible transport system with the provision, expansion and maintenance of transport infrastructure and services to make Ghana a transportation hub in the sub-region as well as to review, develop and strengthen the appropriate legal, environmental and regulatory framework that will ensure an efficient transport system.

Several agencies lie under the jurisdiction of the Ministry of Transport, including the Ghana civil Aviation Authority, the Ghana Maritime Authority and the Ghana Ports and Harbour Authority.

3.2.9 Ministry of Water Resources, Works and Housing

The Ministry of Water Resources, Works and Housing has as its main functions the formulation and co-ordination of policies and programmes for the systematic development of the country's infrastructure requirements in respect of Works, Housing, Water Supply and Sanitation and Hydrology. The Ministry co-ordinates and supervises, by way of monitoring and evaluation of the performance of both public and private agencies responding to and participating in the realisation of the policy objectives established for the sector.

The Ministry has four directorates: Policy Planning Budgeting Monitoring and Evaluation (PPBME); Human Resource Development Unit (HRDU); Research Statistics Information Management (RSIM); and Administration and Finance.

Within the Ministry, responsibilities are shared out by different departments and agencies. Amongst other the Department of Hydrology is responsible for programming and co-ordination of coastal protection and major drainage works and the monitoring and evaluation of surface water bodies in respect of floods. The Water Resources Commission, meanwhile, has the mission to regulate and manage the utilization of water resources and to coordinate relevant government policies related to these resources.

3.2.10 Ministry of Lands and Natural Resources

The Ministry of Lands and Natural Resources manages the lands, forests, wildlife and mineral resources of Ghana. Their aim is to ensure the sustainable management and utilisation of Ghana’s natural resources for socio-economic growth and development. In order to achieve this goal the ministry has set out the following objectives, namely to:

- develop and manage sustainable lands, forest, wildlife and mineral resources;
- facilitate equitable access and benefit sharing;
- promote both public awareness and local communities participation as well as private sector involvement;
- review, update, harmonise and consolidate existing legislation and policies and support and lead research initiatives; and
- develop institutional capacity at the national, regional, district and community levels.

In addition, the Land Commission was established under the Ministry Lands and Natural Resources to oversee all land issues. The commission comprises four divisions:

- Land Registration Division (Formerly Land Title Registry and the Deeds Registry);
- Land Valuation Division (Formerly Land Valuation Board);
- Survey and Mapping Division (Formerly Survey Department); and
- Public and Vested Lands Management Division (Formerly Lands Commission) (Common wealth of nations, 2012).

The Land Commission governs land acquisitions, as will be required for the Project. An overview of the procedure for compulsory land acquisition is presented in section 3.4.12.

3.2.11 Ministry of Local Government and Rural Development

The Ministry of Local Government and Rural Development is responsible for the ten Regional Administrations in Ghana. These regions each have a Regional Coordinating Council and are sub-divided into 216 metropolitan, municipal and district areas each with an administrative assembly. Further details of the structure of the administrative assemblies are provided in the Socio-economic baseline in Chapter 5. These include the six coastal districts in the Western Region: Jomoro, Nzema East, Ellembelle, Ahanta West, Sekondi-Takoradi Metropolis and Shama.

Western Region Administration

The local government system, as defined under the Local Government Act 462 of 1993, is made up of the Regional Coordinating Council (RCC), four-tier Metropolitan and three-tier Municipal/District Assemblies with Urban/Town/Area/Zonal Councils Unit Committees. The RCC is the head of the local government system and is the highest decision-making body. There are ten RCCs corresponding to ten Regions within Ghana.

The RCC is made up of the following: regional minister as chairman, and his deputies; presiding member of each district assembly; district Chief Executive of each district in the region; two chiefs from the Regional House of Chiefs; regional coordinating director (secretary to the RCC and the head of the civil administration of the region); and regional heads of decentralised ministries.

The RCCs under Act 462 are non-executive bodies responsible for monitoring, coordinating and evaluating the performance of the district assemblies and any agency of the central government, rather than a political and policy-making body.

The Western region Administration is the regional administrative body in the province associated with the Project and will have decision-making powers in terms of infrastructure development and planning.

Ellembelle District

The Western Region has 19 parliamentarians at the Parliament representing the 19 Constituencies and 22 District Assemblies within the region. The Project site falls within the Ellembelle District, which comprises one constituency with seven area councils and 31 electoral areas. The district capital is Nkroful. These area council authorities complement the functions of the district assemblies. The Project site falls within the Atuabo Area Council.

Until 2007, the Ellembelle District Assembly (EDA) was part of the Nzema East District. In December 2007, the EDA was created by Legal Instrument 1918, and was inaugurated in February 2008.

3.3 RELEVANT DEVELOPMENT POLICY AND PLANS

The following is a summary of known strategies, policies and plans with relevance to the Project.

3.3.1 Relevant National Strategies, Policies and Plans

<u>The National Environmental Policy (NEP)</u>

The National Environment Policy was set out in 1991 from the National Environmental Action Plan (NEAP). The Plan seeks to redirect national development into more environmentally sustainable programmes and practices through:

- the protection and preservation of the resource base;
- prior assessment of the potential environmental impacts of development projects;
- alternative or multi-purpose uses of land and water resources; and
- the promotion of popular participation in planning, evaluating, and implementing environmental and development strategies.

The latest National Environment Policy was launched in 2012 and revised in 2014; however, the main requirements are still under development.

<u>National Biodiversity Strategy</u>

Ghana signed (1992) and ratified (1994) the Convention on Biological Diversity and developed a National Biodiversity Strategy in 2002 for the sustainable use of its biological resources. Forest reserves, national parks and other wildlife reserves including various traditional forms of conservation have been set established to protect biological conservation. These areas occupy approximately 16% of Ghana's land surface, approximately 31% of the

Western Region and approximately 17% of Ellembelle district. No forest reserves, national parks and other wildlife reserves are located within the project area of influence.

It is recognised that there is a lack of information on biological resources in Ghana and there is a need to address these data gaps. It is further recognised that for sustainable development there is a need to integrate biodiversity issues into national development planning programmes. The strategy recommends the establishment of a National Biodiversity Commission to coordinate policy and the implementation of the strategy among the relevant agencies under the Ministries as well as NGOs, CBOs and local communities.

National Wetlands Conservation Strategy

The National Wetlands Conservation Strategy, implemented in 1999 by the Ministry of Lands and Forestry, provides the formalised guidelines, recommendations and frameworks necessary to ensure the conservation of Ghana's wetlands and their associated ecosystem goods and services. The Government of Ghana has recognised the importance of wetlands in maintaining the water table, mitigating floods as well as in the process of water purification. In order to conserve these functions this strategy seeks to discourage:

- the physical draining of wetland water;
- draining of streams and water courses feeding the wetlands;
- human settlements and their related infrastructural developments in wetlands;
- disposal of solid waste and effluents in wetlands; and
- mining in wetlands.

The policy also seeks to promote the use of wetlands for farming, grazing, fishing, timber production and salt-winning, provided that such uses also serve to conserve the ecosystem, biodiversity and sustainable productivity of the wetlands.

The strategy identifies the major threats to wetland systems as water loss through drainage, salt water intrusion in coastal areas (as a result of drainage or excessive use of the water resources) and pollution through discharge of contaminated effluent, including sewage.

Through this strategy, Ghana has initiated a number of conservation projects to conserve and restore wetlands and is part of the RAMSAR convention which recognises environmentally important wetlands throughout the world.

The wetlands conservation strategy aims to achieve the following five objectives:

- promote the participation of local communities, traditional authorities, and other stakeholders in sound management and sustainable utilisation of Ghana's wetland resources;
- maintain the ecological, cultural, recreational and aesthetic values of wetlands;
- ensure that national policies, local knowledge, regulations and activities contribute to the sound management of Ghana's wetland resources;
- ensure that capacity-building and appropriate legal and institutional frameworks are in place for effective wetland conservation; and

- create awareness on the importance of wetlands and encourage a commitment from the people of Ghana to conservation and wise use of wetlands.

The term 'wetland' refers to a "wide range of habitats that share common features, the most important of which is continuous, seasonal or periodic standing water or saturated soils" (National Wetlands Conservation Strategy, 1999). According to the definition above, the closest wetland to the project area are the Amansuri Wetland areas (classified as freshwater swamp forests), of which specific limits are not defined.

The baseline studies indicate that the majority of the concession area is prone to flooding, so relevant areas for the ORF development will be raised approximately 3m.

The Project design and operation will need to minimise the removal of seasonally inundated areas on the Project site as well as possible disturbance to the neighbouring wetland areas. This principle is aligned with the National Wetlands Conservation Strategy, as it aims to maintain the ecological, cultural, recreational and aesthetic values of wetlands.

The National Energy Policy and Energy Sector Strategy and Development Plan

The Policy, which was approved by Cabinet in March 2010, is intended to guide the development and management of Ghana's energy sector, especially the emerging oil and gas sector. Section 7 provides Policy Direction for energy production and utilisation in an environmentally sound manner. Under the policy, the government of Ghana will, amongst other objectives:

- support and actively participate in international efforts and cooperate with international organisations that seek to ensure sustainable delivery of energy to mitigate negative environmental impacts and climate change;
- ensure effective disposal of all hazardous substances and materials associated with the production, transportation and use of energy; and
- facilitate environmental protection awareness programmes.

National Oil Spill Contingency Plan

The National Oil Spill Contingency Plan (NOSCP) has been in operation since 1986 and has seen a number of revisions with the latest revision done in November 2009. The aim of this plan is to outline the national arrangements for responding to oil spills in the environment, with the aim of protecting it from oil pollution or, where this is not possible, to minimise its effects. According to the Plan, the Environmental Protection Agency has the overall responsibility to deal with any incident involving oil installations, oil pipelines or shipping.

The National Oil Spill Contingency Plan aims to achieve the following objectives:

- Identify high-risk areas to oil pollution.
- Develop appropriate systems for monitoring, rapid detection and reporting of spillage of oil or incidents related to the operation of shipping, oil pipelines and all other installations, storage and transport facilities for oil, which could result in such a spillage.

- Ensure prompt response to prevent pollution and or restrict the spread of the contaminants
- Ensure that adequate protection is provided for public health and welfare and the marine and inland environment.
- Ensure that the appropriate response techniques are used to clean up the pollutant and that disposal of recovered material is carried out in accordance with the EPA guidelines and regulations on waste disposal.
- Ensure that complete and up-to-date records are maintained of all expenditures to facilitate cost recovery.
- Ensure that personnel and equipment are in a state of readiness
- Ensure there are adequate funds provided to meet the other objectives of the plan.
- Ensure that the plan is tested at least every two years.

The National Oil Spill Contingency Plan is established to respond to oil spills of any size in Ghanaian waters. It is based on a three-tiered approach to all aspects of oil spill preparation and response in line with established international practice and standards. Per the plan, the three-tiered responses are based on the following spill scenarios:

- Tier 1 - up to 10 tonnes – a small spill requiring a local response: The Combat Agency will generally be able to respond to and clean up a spill utilising its own resources.
- Tier 2 - between 10 and 1000 tonnes – a medium spill requiring regional and/or national assistance: The resources of the Combat Agency will need to be supplemented by other resources from adjacent region, or from adjacent industry operators under mutual aid arrangements.
- Tier 3 - above 1000 tonnes – a large spill requiring national assistance: The Combat Agency will require local, regional, national and possibly international assistance. National and international resources will be facilitated by the EPA.

<u>Local Content Regulation</u>

The Ghanaian Local Content and Local Participation Regulations, 2013 (LI 2204) was passed in November 2013.

The primary objective of the law is to ensure a minimum percentage of the monetary value of goods and services is sourced from Ghana (90%) within the ten years of the commencement of a Project and the minimum level of Ghanaian equity ownership within the industry. Priority should be given to Ghanaian citizens for the ownership of concession areas such that local participation by the Ghanaian private sector should be at least 5 percent in petroleum licenses, permits and contract operators and at least 10 percent for providers of supplies and services. The policy also outlines the need to submit a detailed annual recruitment and training program for Ghanaians within 12 months of receiving a grant or license.

The regulation is intended to assist with the sustainable development of the oil and gas industry in Ghana and help to avoid social and political instabilities, by promoting and requiring involvement of Ghanaian citizens, goods and services.

The regulation provide also a monitoring system to meet the objectives of the government's local content policy.

Other Relevant Policies and Plans

Tourism Development Policy: Ghana's National Tourism Policy focuses on promoting in-bound international tourism, regional tourism and domestic tourism.

Land Management Policy: This policy seeks to promote the judicious use of the nation's land and all its natural resources by all sectors of the Ghanaian society in support of various socioeconomic activities undertaken in accordance with sustainable resource use and maintenance of viable ecosystems. The policy indicates that land for private use must be accessed either through negotiation or compulsory acquisition.

Forest and Wildlife Conservation Policy: This policy is aimed at conservation and sustainable development of the nation's forest and wildlife resources for maintenance of environmental quality and perpetual flow of optimum benefits to all segments of society. The policy provides for additional basis to develop a national forest estate and a timber industry that provides the full range of benefits required by society in a manner that is ecologically sustainable and that conserves the environmental and cultural heritage.

A number of national plans have been formulated to address these areas of coastal management. All the plans and programs are meant to provide for the preservation and sustainable use of fragile ecosystems, such as those that include mangroves or coral reefs. These plans and studies include the following:

- The Coastal Zone Management Indicative Plan (1990);
- The National Environmental Action Plan (1994);
- The Integrated Tourism Development Plan (ITDP) (1996-2010); and
- The Draft Integrated Coastal Zone Plan (1998).

3.3.2 The Coordinated Programme of Economic and Social Development Policies, 2010 – 2016

In 2011, Ghana's Parliament adopted a report by the Committee on Poverty Reduction Strategy entitled The Coordinated Programme of Economic and Social Development Policies for 2010-2016. The strategy was dubbed "Agenda for Shared Growth and Accelerated Development for a Better Ghana (2010 – 2016)" (hereafter called "Agenda") and was designed to address historical economic and social challenges that are seen to have hampered national development. The Agenda is driven by a medium-term vision of shared growth via policy measures that the government plans to pursue in order to "*transform the economy from its over-dependence on primary raw materials to a diversified and prosperous 21st Century nation*" (President Atta Mills, State of the Nation Address, 2010).

The GoG, in further exploring the country's various strengths, has recognised the discovery of oil and gas and its associated activities as a major development opportunity that has introduced a potential paradigm shift for the nation's development prospects, policy dynamics and potential risks. As the world economy hinges on oil and gas, the GoG has asserted that all policy decision-making at all levels should be designed to take advantage of this strategic resource. The international community's interest in Ghana as a result of this discovery could bring in significant investment and catalyse the anticipated industrial development and increased employment opportunities, with concomitant spin-offs.

The Agenda as a national policy document thus recognises that all programmes and initiatives should be developed in a strategic manner in light of planned exploitation of the newly discovered oil and gas and other natural resource endowments. This position has driven the World Bank to reclassify Ghana from a low-income status country to lower middle-income status.

3.3.3 Land Commission Guidelines for Considering Large-Scale Land Transactions for Agricultural and other Purposes

In February 2012 the Land Commission released a policy document aimed at providing guidelines when faced with acquisitions of tracts of land larger than 50 acres (20.2 hectares). The Commission points out that most land in Ghana is owned by traditional leaders (from chiefs to family heads) who generally have no experience in managing such large transactions. In addition, the Commission highlights that most of the land users in rural areas (such as the Project Area) are smallholder farmers without registered title deeds or interests on those lands. Most of these farmers only have rights to use the land and are thus vulnerable to negotiations undertaken by a higher interest holder (e.g. chief) over the release of the land.

The Policy outlines processes that should be followed during such transactions and emphasises the participation of all stakeholders in the process to ensure first-hand access to information on all aspects of the acquisition and the ability to express concerns. Furthermore, it emphasises the need for the full range of participants to find solutions to address those concerns (Land Commission Policy Document, February 2012).

3.3.4 Resettlement Policy Framework (RPF)

This draft framework was developed in 2011 by the Ministry of Finance and Economic Planning as part of the Government of Ghana's Public-Private Partnership (PPP) programme. This programme was established to increase investment in public service delivery and infrastructure in support of the country's growing development needs. The developments and projects proposed by the PPP are likely to involve land acquisition and resettlement impacts which are addressed by the RPF.

The RPF has been developed in line with the World Bank/IFC Performance Standards (See Section 3.7.2) and as part of a World Bank f funding application for support of the PPP programme. The RPF guidelines and requirements must be adhered to during the planning, construction and operation of any PPP project.

This Project will be developed and operated by eni Ghana, with the Government of Ghana as a shareholder in the Project. As such, the Project can be considered as PPP, and these guidelines will be taken into consideration in the planning and implementation of the resettlement aspects related to land acquisition.

3.3.5 Western Region Spatial Development Framework (WRSDF)

The Western Regional Spatial Development Framework (WRSDF) is a project funded by NORAD under its "Oil for Development Programme Agreement" together with the Government of Ghana. The WRSDF is a spatial plan and platform for the integration of social, economic and environmental policies and plans for the region and was approved on the 12th if November 2012 and launched by the Ministry of Environment, Science, Technology and Innovation on February the 5th, 2013. The key focus areas of the WRSSDF are settlements, economic development, infrastructure and the environmental protection.

Settlements: The WRSDF has identified that the Western Region has an uneven population distribution with the majority of high grade settlements (Grade 1: metropolitan cities, Grade 2: regional capitals) within the coastal districts. In order to balance the distribution, the WRSDF proposes to enhance the capacity of market towns (Grade 3) in the western and northern districts (by linking them to district capitals) which would then provide increased access to the neighbouring smaller Grade 4 and 5 settlements.

Economic Development: The WRSDF lays out planning provisions for economic development and divides the regional economy into four key sectors, laying out the following priorities for the region:

- Agriculture: the WRSDF highlights the importance of understanding food production potential, storage, processing and exporting and maximising land use by increasing the yields of industrial crops (e.g. cocoa). The document recognises the importance of protecting forest reserves for future timber crops and biodiversity.
- Mining: The WRSDF proposes the delineation of all mineralised areas, marking areas for future mining concessions over approximately 20 years and to avoid resettlement.
- Oil and gas: In order for the oil and gas sector to become a key employment and business opportunity for Ghanaians, the WRSDF recommends the establishment of training and business facilities in growth nodes throughout the Western Region and that oil and gas activities be confined within two specified zones.
- Tourism: For tourism development, the document recommends support of top-end tourism and the protection of high biodiversity, cultural and conservation sites.

Infrastructural Development: The WRSDF recommends an Integrated Transport Policy for the Western Region compliant with the National Plan and including road, rail, port and harbours and airports. The energy supply of the region is expected to be boosted by the developing oil and gas exploration and future production although a high level of investment is required to develop water resources to meet expected future requirements.

Environmental Protection: The WRSDF includes implementation measures for environmental protection, including measures against illegal logging and delineation and protection of remaining pockets of high biodiversity such as primary forests and wetland areas. The WRSDF identifies the need for better monitoring of land rehabilitation following gold mining operations and improvements in measuring and monitoring pollution sources. The report determines that future developments be constructed outside the 100 year flood line of rivers and 1 m above the 100 year rise in sea level.

Of significance to the Study Area is the WRSDF's recognition of the discovery of oil and gas as a key driver of development in the region. This is seen in the following plans for onshore oil and gas developments including:

- the Western Corridor gas infrastructure project comprising the construction of a gas processing plant at Atuabo and onshore trunk pipelines;
- an oil refinery and a large scale facility that would store Liquefied Petroleum Gas and other petroleum products at Pumpuni (Ahanta West);
- gas powered electricity generation at Domini Lagoon/ Bonyere (Jomoro), Aboadze (Shama) and Prestea (Prestea Huni Valley); and
- a specialist oil and gas harbour with associated supply facilities at Atuabo.

As mentioned above, a key objective driving this Regional sector and which will apply to this Project, is the recognition that maximising employment opportunities requires long term strategic plans for training as well as wide access to business procurement in institutional, structural and future land use and infrastructure terms.

The NAG Development Project will be important for the development of the oil and gas sector within the Western Region.

3.3.6 Ellembelle District Assembly Medium-Term Development Plan (2014-2017)

The Ellembelle District Assembly (EDA) was carved out of the then Nzema East District (now Nzema East Municipal) and was created in December 2007 by Legal Instrument 1918. The District was inaugurated in February 2008. The Medium Term Development Plan (MTDP) 2014 – 2017 was prepared through the consultation (i.e. workshops, meetings and community interface) of all key stakeholders (i.e. community members, opinion leaders, Assembly members, NGOs, DPCU members, political parties and the private sector).

The overarching goal of the Ellembelle District through the MTDP is to: "*coordinate social services and environmental sustainability, improve security and develop accessibility to production areas and strengthen local institution for equitable growth and sustainable development*" (Ellembelle MTDP, 2014-2017).

The strategies have been aligned within the context of the Ghana Shared Growth and Development Agenda (GSGDA 1) 2010-2013. The Medium Term Development Plan (MTDP) 2014 – 2017 includes the following priorities and thematic areas:

- Accelerated Agriculture Modernization and Sustainable Natural Resource Management;
- Oil and Gas Development;
- Infrastructure and Human Settlement Development;
- Human Development, Productivity and Employment;
- Transparent and Accountable Governance.

Also a comprehensive monitoring and evaluation plan has been developed to ensure the effective and smooth implementation of the MTDP (2014 – 2014).

As shown above, the Ellembelle MTDP also takes into account and prioritises oil and gas-related development, through a variety of associated thematic areas. Thus, the current Project is likely to profit from a focus in the Project area on improved infrastructure as well as concerted administrative efforts to create a socially and physically enabling environment. When designing the Project and planning for impact mitigation and the maximisation of opportunities, eni Ghana would benefit by engaging with these national, regional and district development policy documents – particularly when identifying non-core activities, like corporate social responsibility (CSR) projects that could partner with broader regional and district programmes to ensure sustainability beyond the life of the Project.

3.4 Relevant Ghanaians laws and regulations

3.4.1 Overview of National Legislation

The fundamental political principles, establishing the structure, procedures, power and duties of the Ghana government, structure of the judiciary and legislature, and fundamental rights and duties of citizen are defined by the Constitution of Ghana, approved in 1992. Further details on the Constitution of Ghana are presented in Section 3.4.1 below.

With regards to the environment, the NEP (See Section 3.3.1) provided a framework for the implementation of the National Environmental Action Plan (NEAP) as well as a number of other policies relating to conservation and environmental management.

The key legislation governing general environmental protection in Ghana is the Environmental Protection Agency Act 490 of 1994 and the Environmental Assessments Regulations, 1999 (and 2002 amendments). The Environmental Protection Agency Act set the creation of the Environmental Protection Agency (EPA), establishes a National Environment Fund and gives provisions for administration and operations and the Environmental Assessments Regulations define the EIS approval process. Further information on the Ghanaian environmental regulations is included in Section 3.4.4.

The sector of hydrocarbon exploration, development and production is under the jurisdiction of the Ministry of Petroleum and the activities are governed by the Petroleum Law of 1994. Regarding the contractual procedure, the basic contract between the State, the Ghana National Petroleum Corporation (GNPC), and private companies is a Production Sharing Agreement (PSA). Further details on the Petroleum related legislation is provided in Section 3.4.3.

3.4.2 The Ghanaian constitution

The Constitution of the 4th Republic of Ghana was adopted in 1992 and came into force in January 7th, 1993. The Constitution is the fundamental law of Ghana and provides the framework on which all other laws stand.

In particular, within Article 36 of Chapter 0 - Directive principles of State policy, the Ghana Constitution states that "*The State shall take appropriate measures needed to protect and safeguard the national environment for posterity; and shall seek co-operation with other states and bodies for purposes of protecting the wider international environment for* *mankind*". Within the Article 41(k) of the same Chapter 0, it is also stated that "*it shall be the duty of every citizen […] to protect and safeguard the environment*".

The right to information is guaranteed by the Constitution under Chapter 5 – Fundamental human rights and freedoms, Article 21(1) (f) stating that "*All persons shall have the right to information subject to such qualifications and laws as are necessary in a democratic society*". This principle is shown also in the stakeholder consultation requirements within the EIS process.

Based on the framework established by the Constitution of the 4th Republic of Ghana, the government initiates policy actions and legislation to promote sound environmental protection and management. It is also in response to the provisions of the Constitution that the Parliament promulgated the Environmental Protection Agency Act 1994 which establishes the EPA who is responsible for enforcement of environmental laws.

3.4.3 Petroleum and Energy Legislation

Ghanaian Petroleum and Energy legislation relevant for the Project includes the following Act and laws:

- the Ghana National Petroleum Corporation Law, 1983 (Act 64);
- the Petroleum Exploration and Production (PNDCL) Law, 1984 (Act 84);
- the Energy Commission Act, 1997 (Act 541);
- the National Petroleum Authority Act, 2005 (Act 691); and
- the Petroleum Commission Act, 2011 (Act 821).

The Ghana National Petroleum Corporation Law (Act 64 of 1983) established the Ghana National Petroleum Corporation (GNPC) as mandated, to promote exploration and planned development of the petroleum resources of the Republic of Ghana. Apart from allowing the GNPC to engage in petroleum operations and associated research, the law empowers the GNPC to advise the Minister of Energy on matters related to petroleum operations. The GNPC has, however, lost all its regulatory and advisory functions in relation to upstream petroleum activities since the approval of the Petroleum Commission Act (Act 821 of 2011), still hosting its duties with relation to downstream operations.

The PNDCL Law (Act 84 of 1984) establishes the legal and fiscal framework for petroleum exploration and production activities in Ghana. The Act sets out the rights, duties and responsibilities of contractors; details for petroleum contracts; and compensation payable to those affected by activities in the petroleum sector. According to the PNDCL Law, all petroleum operations are required to be conducted in such a manner as to prevent adverse effects on the environment, resources and population. According to the Petroleum Act the following documents have to be produced:

- a Plan of Development (PoD), to submit and be approved by the Ministry of Petroleum, with the advice of the Petroleum Commission, before development of the field; and
- an Environmental, Health and Safety Manual, containing details on environmental, health and safety (EHS) issues, policies and procedures, to submit to the GNPC for review before

commencement of development activities. In addition, EHS audits of the operations by the EPA and the GNPC are required.

Moreover, the Petroleum Act requires that emergency plans for handling accidents and incidents are discussed and agreed upon with the GNPC and the EPA before the commencement of operations.

The Energy Commission Act (Act 541 of 1997) established the Energy Commission as the technical regulator of Ghana's electricity, natural gas and renewable energy industries. The act also set a series of regulations with regards to the supply and distribution of natural gas and a series of provisions related to petroleum products.

For petroleum exploration and development, the Modern concession system, a hybrid between a Production Sharing Agreement (PSA) and the traditional concession system, is the basic contract between the State, the Ghana National Petroleum Corporation (GNPC), and private companies.

The National Petroleum Authority (NPA) is established by the National Petroleum Authority Act (Act 691) of 2005. It is a statutory body whose objective is to regulate, oversee and monitor the Ghanaian petroleum industry.

Finally, the Petroleum Commission Act (Act 821 of 2011) establishes the Petroleum Commission aiming to manage Ghana's petroleum resources. The Act establishes its responsibilities, functioning and governance, as well as the interaction of this commission with other government bodies in relation to petroleum resources.

3.4.4 Environmental Legislation

<u>The Environmental Protection Act</u>

The authority, responsibility, structure and funding of the Ghana Environmental Protection Agency (EPA) is established by Environmental Protection Agency Act (Act 490 of 1994).

Part I of the Act mandates the EPA with the formulation of environmental policy, issuing of environmental permits and pollution abatement notices and prescribing standards and guidelines. Furthermore, the Act establishes and mandates the EPA to seek and request information on any undertaking that in their opinion can have adverse environmental effects and to instruct the proponent to take the necessary measures to prevent the adverse effect.

It also defines the possibility of the Board to appoint committees and establish the Hazardous Chemicals Committee, which plays a vital role in the management of chemicals in Ghana.

The Act (Part II) empowers the EPA to request that an EIS process be undertaken and set the requirements for and responsibilities of the Environmental Protection Inspectors.

Part III of the Act establish the national Environment Fund, and defines its objective and management.

Finally, Part IV of the Act sets the administration and general provisions of the EPA.

Environmental Assessment Regulations

In Ghana, the Environmental and Social Impact Assessment process is established by the Environmental Assessment Regulations (Legal Instrument [LI] 1652, 1999), as amended in 2002. The Environmental Assessment Regulations constitutes the principal enactment within the Environmental Protection Act (Act 490 of 1994). According to the LI 1652, all activities likely to have an adverse effect on the environment must be subject to environmental assessment and issuance of a permit before commencement of the activity. The Environmental assessment may be produced through the development of different type of studies, whose requirements are defined within the Environmental Assessment Regulations:

- Preliminary Environmental Assessments (PEAs);
- Environmental Impact Assessments (EIAs);
- Environmental Impact Statement (EIS) (also termed the EIS Report);
- Environmental Management Plans (EMPs);
- Environmental Certificates; and
- Environmental Permitting.

Schedules 1 and 2 of the Environmental Assessment Regulations also provide the list of activities for which an environmental permit is required and EIS is mandatory, respectively. For the activities listed below, an environmental assessment is mandatory:

- agricultural (including fishing) and related services;
- all forms of mining;
- manufacturing;
- construction;
- communication and other utilities; and
- power generation and transmission.

The regulations require that an application for an environmental permit be submitted to the Agency. The Agency will then screen this application and compile a report stating whether the application has been approved, is objected to, requires submission of a preliminary environmental report or requires the submission of an environmental impact statement. This decision will be communicated to the applicant within 25 days from the date of receipt of the permit application.

The regulations also provide specific requirements for stakeholder engagement within the EIS process.

According to the Environmental Assessment Regulations (Schedule 2), this Project requires a full EIS process to obtain the environmental permit. It should be noted that the Registration Form was submitted to the EPA the 12th December 2014 in order to initiate the EIS approval process.

Environmental Guidelines

The EPA has developed several documents providing guidance on regulatory requirements for environmental protection and, in particular, the EIS process.

In particular, the EPA provides guidance and outlines procedures to be followed by the operator during the EIS process within the document "Environmental Assessment in Ghana, a Guide to Environmental Impact Assessment Procedures" (EPA, 1996).

Other guidelines issued by the EPA and relevant for the Project are listed below:

- Environmental Quality Guidelines for Ambient Air (EPA);
- EPA Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development (EPA, 2010);
- Sector Specific Effluent Quality Guidelines for Discharges into Natural Water Bodies (EPA); and
- General Environmental Quality Standards for Industrial or Facility Effluents, Air Quality and Noise Levels (EPA).
- Ghana Oil & Gas Operational Guidelines (EPA).

The design, construction and operation of the Project will comply with the standards set by these guidelines.

Biodiversity Legislation

The main legislative texts which regulate biodiversity in Ghana are:

- the Wild Animals Preservation Act, 1961, (Act 43);
- the Wildlife Conservation Regulations 1971 (LI 685); and
- the Wild Reserves Regulations 1971 (LI 740).

The Wild Animals Preservation Act, 1961 (Act 43), amended in 1983, allows the Minister to appoint honorary game officers. The Act addresses the collection of specimens for scientific purposes and prohibits anyone from exporting any trophy from Ghana. The act also identifies the (wholly or partially) protected faunal species.

Regulation on trophy hunting, exporting, and penalties are written in the Wildlife Conservation Regulations 1971 (LI 685), as amended in 1989. The Regulations also provides other provisions for the conservation and protection of faunal species in Ghana.

The Wild Reserves Regulations 1971 (LI 740) allow for the designation and proclamation of protected areas, in various categories. The regulations prohibit certain activities (e.g. hunting, removal of faunal or floral species) allowed within the various reserves without a permit. The regulations forbid the pollution of water resources and littering within a protected area.

Finally, it should be noted that the Forestry Commission Act, 1999 (Act 571) establishes a Forestry Commission that is responsible for protection, development, management and regulation of forests and wildlife.

3.4.5 Water Resources legislation

The legal framework for water resources in Ghana is based on two main legislations: the Water Resources Commission Act, 1996 (Act 522); and the Water and Sewerage Corporation Act, 1965 (Act 310). Note that Marine Legislation has been covered in a separate section (See Section 4.7).

The Water Resources Commission Act of 1996 sets the establishment and functions of the Water Resources Commission, provides the composition of the Board and related provisions on the regulation and management of the utilisation of water resources in Ghana. The main objective of the Water Resources Commission is to establish comprehensive plans for the use, conservation, protection, development and improvements of Ghana's water resources. Water rights must be obtained for the use of water resources, on application from the Commission, who has the competence to grant rights for the exploitation of water resources.

The Water and Sewerage Corporation Act, 1965 (Act 310), amended in 1969, establishes the Ghana Water and Sewerage Corporation, defines its composition, functions and maintenance, and repeals the previous Waterworks Ordinance (Cap. 67). The object of the Corporation is the provision, distribution and conservation of the supply of water in Ghana for public, domestic and industrial purposes and the establishment, operation and control of sewerage systems of such purposes. In addition, the Water and Sewerage Corporation is authorized to formulate regulations regarding the prevention of water pollution.

The Project will need to ensure that any associated water use as well as effluent and sewage released into the environment complies with the requirements under these Acts.

3.4.6 Coastal and Maritime legislation

Beaches Obstructions Ordinance 1897 (CAP. 240)

The Beaches Obstructions Ordinance, 1897 (CAP. 240) details the permissions and authorisations required prior to the removal of sand from the beach and coastal areas as well as digging of channels etc. The legislation also details repercussions for any activities or persons causing obstructions for navigation.

Ghana Maritime Authority (Amendment) Act 2011, (Act 825)

The Ghana Maritime Authority Act (2002) established the Ghana Maritime Authority (GMA) as responsible for the regulation and coordination of activities in the maritime industry and for the implementation of the provisions of enactments on shipping.

Due to the discovery of oil within Ghanaian waters, the GMA was confronted with many new challenges. In particular, it became necessary to develop the necessary policy, administrative, legislative and human capacity to support offshore oil and gas development.

Thus, the objective of this amendment is to make specific provision for the Minister to promulgate regulations for the purposes of fixing specific levies, fees and charges, to cover the administrative costs associated with the discharge of the functions and duties specified in the Ghana Maritime Authority Act, 2002.

Ghana Shipping (Amendment) Act, 2011, (Act 826)

The Shipping Act (Act 645 of 2003) regulating trade in Ghanaian waters was amended by the Ghana Shipping Amendment Act, 2011 (Act 826). The amendment was intended to inject local content into the oil and gas development by encouraging Ghanaians to participate in the shipping activities relating to offshore business. The Ghana Shipping Act, 2003 (Act 645) imposed restrictions on the trading of foreign registered ships in Ghanaian waters by preserving local trade in Ghanaian waters to Ghanaian ships. However, the current definition of Ghanaian waters is limited to the 12 nautical mile territorial sea.

The main objective of this amendment is to extend the definition of Ghanaian waters to include the waters within the 500 meter safety zone generated automatically under the United Nations Convention on the Law of the Sea (UNCLOS) around installations in the exclusive economic zone beyond the territorial sea. This amendment would in effect extend the scope of local trade to include the trade from shore to the any oil and gas installations that will be established beyond the 12 nautical miles territorial sea.

The amendment also makes provision for the grant of permit to foreign vessels to trade in Ghanaian waters in instances where there are no Ghanaian vessels available or capable of providing those services so as not to create operational bottlenecks.

Ghana Maritime Security (Amendment) Act, 2011 (Act 824)

The Maritime Security Act, 2011 (Act 824), amendment of the previous Act 675 of 2004 gives effect to Chapter XI-2 of the International Convention for the Safety of Life at Sea (SOLAS, 1974). The amendment intends to extend the previous application of the Ghana Maritime Security Act to offshore installations. The Act aims to enhance maritime safety and security; to create a legal framework for effective compliance with the International Ship and Port Facility Code (ISPS), defined under the International Convention; and to provide for related matters.

In addition to the legislation mentioned above, other maritime legal instruments relevant for the project include:

- Ghana Shipping (Protection of Offshore Operations and Assets) Regulations 2011.
- Ghana Maritime Authority (Maritime Safety Fees and Charges) Regulations 2012 (L.I 2009).

The Maritime Zones (Delimitation) Law (PNDCL 159 of 1986)

The extent of the territorial sea and Exclusive Economic Zone (EZZ), in Ghana, is defined by the Maritime Zones (delimitation) Law (PNDCL 159), of 1986. According to the PNDCL 159, the territorial sea corresponds to the 12 nautical miles (approximately 24 km) of the low waterline of the sea, whereas the EZZ is defined by the area beyond and adjacent to the territorial sea, less than 200 nautical miles (approximately 396 km) from the low waterline of the sea.

The Act also grants the rights, to the extent as permitted by international law, to the government of Ghana for the purposes of: "*exploring and exploiting, conserving and managing the natural resources, whether living or non-living, of the waters superjacent to the sea-bed and of the sea-bed and its subsoil, and with regard to any other activities for the economic exploration and exploitation of the zone, such as the production of energy from the water, currents and winds…*"

Ghana Shipping (Protection of Offshore Operations and Assets) Regulations

The Ghana Shipping (Protection of Offshore Operations and Assets) Regulations (LI 2010, 2012) stipulate conditions for offshore installation safety zones including the protection of such zones and entry conditions; the establishment of exclusion zones and protection mechanisms; and pipeline protection areas and cable protection areas. The regulations include specific conditions for mobile offshore drilling units (MODUs) requirements for the operation of MODUs (e.g. requiring a safety operating permit and a design, construction and equipment meeting the requirements of IMO resolutions A.414 and A.649); and requirements for the safety permit. The regulations also set out miscellaneous provisions including offenses and penalties.

Fisheries Act

The Fisheries Act, 2002 (Act 625), repealing the former Fisheries Commissions Act, 1993 (Act 457), aims to consolidate and amend the law on fisheries. The Act provides for the regulation, management and development of fisheries and promotes the sustainable exploitation of fishery resources.

Part I of the Fisheries Act (2002) deals with the establishment, functioning and responsibilities of the Fisheries Commission, and its mandate to manage national fishery resources. Part II establishes the composition and the functioning of the administration. Part III regulates the management and development of fishery resources, including conservation measures, while Part IV relates to jurisdiction and evidence related to non-compliance with the Fisheries Act.

Amongst other, Section 91 allows for the establishment of marine reserves and prohibits fishing, dredging and removal of sand or gravels and the disturbance of natural habitat without permission of the Minister. Section 92 prohibits the pollution of water such that there is an adverse effect on aquatic resources and provides details of penalties.

Section 93 requires that the Fisheries Commission be informed of any activities likely to have substantial impact on fishery resources before commencement of the activity and allows the Fisheries Commission to require reports and recommendations by the proponent on the likely impact of the activity and possible means of preventing or minimising adverse impacts which shall be taken into account in the planning of the activities.

With reference to fish production and fisheries management, the Fisheries Act conforms to the relevant sectors of the United Nations Food and Agriculture Organisation (FAO) Code of Conduct for Responsible Fisheries with particular emphasis on gear selectivity and an effective institutional framework. The Fisheries Act also gives legislative backing to the recently established Monitoring, Control and Surveillance Division (including the Ghanaian Navy) with clearly defined legal powers to regulate fishing operations.

Fisheries Regulations

The Directorate of Fisheries under the Ministry of Food and Agriculture has developed fishery management plans for marine fisheries. The Fisheries Regulation (LI 1968 of 2010) further sets up the specific rules and regulations for the implementation of the Fisheries Act. The Fisheries Regulations address prohibited fishing methods (e.g. lights to attract fish, explosives and poisons, and pair trawling), fishing within oil and gas infrastructure exclusion zones, minimum mesh sizes, the use of Fish Aggregating Devices (FADs), and fishing vessel licensing requirements.

3.4.7 Protected Areas and Species

The following is a summary of the status of protected areas in Ghana, including those identified as environmentally sensitive areas, terrestrial protected areas, coastal and marine protected areas and protected species.

Nationally Recognised Sensitive Areas

In terms of LI 1652 (the EIA regulations), the following are recognised as environmentally sensitive areas (underlined those applicable to Project Area of Influence):

- all areas declared by law as national parks, watershed reserves, wildlife reserves and sanctuaries including sacred groves;
- areas with potential tourism value;
- areas which constitute the habitat of any endangered or threatened species of indigenous wildlife (flora and fauna);
- areas of unique historic, archaeological or scientific interests;
- areas which are traditionally occupied by cultural communities;
- areas prone to natural disasters (such as geological hazards, floods, rainstorms, earthquakes, landslides, volcanic activity);
- areas prone to bushfires;
- areas classified as prime agricultural lands;
- recharge areas of aquifers; and
- water bodies characterised by one or any combination of water tapped for domestic purposes, water within the controlled and/or protected areas and water which support wildlife and fishery activities.

The Project Area would therefore be considered an environmentally sensitive area in terms of LI 1652 (see Chapter 5 for details). As such, the EIA process aims to understand existing conditions on the Project site, the sensitivity of the receptors to Project-induced changes and assess the significance of the impact of the Project on the receptors. The results of the sensitivity analysis and impact assessment are presented in Chapter 6.

Coastal and Marine Protected Areas

Ghana subscribes to a number of international conservation programmes. However, Ghana has at present no nationally legislated coastal or marine protected areas and there are no international protection programmes specifically covering the Project Area.

Ramsar Sites

The Wetland Management (Ramsar Sites) Regulations (1999) are developed under the Wild Animals Preservation Act (Act No. 43 of 1961) and provide for the establishment of Ramsar sites within Ghana. For designated sites, activities that are not permitted include pollution of water, use of chemicals, hunting wild animals, grazing livestock, fishing using certain gear and in certain seasons and other activities that may have an adverse effect on the environment. Nevertheless, the Minister of Forestry can designate areas within a Ramsar site where certain activities can be carried out (e.g. sand and soil removal).

There are five designated Ramsar wetland sites along the coast of Ghana including: Keta Lagoon Complex; Densu Delta; Muni-Pomadze; and Sakumo; and Songor.

There is a sixth Ramsar site (Owabi Wildlife Sanctuary) situated inland which does not lie close to the Project Area.

The neighbouring wetlands to the project area (Amansuri Wetlands) have been proposed (but not designated) wetland site under the Ramsar Convention based on Criterion 4[1] and 6[2] of Ramsar Convention[3]. Limits of this proposed RAMSAR site are not yet publicly available and, therefore, the distance from the onshore project components to the proposed RAMSAR site is unknown.

Other Protected Areas

In Ghana, the protected areas are administered through the Department of Game and Wildlife, Ministry of Lands and Natural Resources. There are three types of protected areas, namely national parks, game production reserves, strict nature reserves and wildlife sanctuaries.

Ghana also has one UN Biosphere Reserve and two World Heritage Convention sites. The World Heritage Convention sites include the Asante Traditional Buildings, located near Kumasi, as well as Forts and Castles, most of which are located along the coast in the Central

[1] Criterion 2: A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.

[2] Criterion 6: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.

[3] Source: http://www.birdlife.org/datazone/userfiles/file/IBAs/Ramsar/IBAs_Ramsar_Africa/Ghana.pdf

and Western Regions (UNESCO, 2012). Ghana has more than 1,000 IUCN-management protected areas including 317 Forest Reserves, five Game Production Reserves, seven National Parks, two Resource Reserves, one Strict Nature Reserve, and four Wildlife Sanctuaries (World Resource Institute 2003).

Two of these protected areas are situated within the Western Region, namely the Ankasa Resource Reserve and Bia National Park, also designated as a UNESCO Biosphere Reserve. These protected areas are located approximately 65 km west and 150 km north-east of the Project Area respectively, and as such are not expected to be directly impacted by the development of the Project (Chapter 9).

Protected and Endangered Flora and Fauna

At least 26 species of marine mammals and five species of sea turtles occur in the region, including several endangered, critically endangered, or vulnerable species (see Chapter 6). Endangered and threatened flora and fauna are protected through national law. There are eight globally threatened bird species in Ghana, but none are specifically associated with coastal habitats, and are therefore unlikely to be associated with the Project site.

Ghana's coastal wetlands provide feeding and roosting sites for thousands of resident and migratory birds including at least 11 species of tern. Thirty-six sites in Ghana have been designated as Important Bird Areas, of which five are along the coast. Two sites, the Anlo-Keta and Songor Lagoons, each support over 100,000 shore birds as well as internationally important numbers of several species of wading birds.

The Important Bird Area (IBA) named "Amansuri wetlands" is rated A4i[1] and includes the Amansuri wetlands and the coastal area (where the onshore project components are located). The main reason for the inclusion of the coastal area is that it is the habitat of the two most relevant species of the IBA. Those bird species are only present during winter and do not breed in the area.

The concession area is classified as modified habitat. The beach (where the landfall will be located) is considered potentially containing critical habitats (due to potential turtle nesting). Further details on habitat classification are provided in Chapter 6.

Although IBAs are not officially designated by national or international authorities, they are considered relevant due to their natural values and especially for their importance for the avifauna, and they are internationally recognized as areas of high biodiversity value that will likely qualify as critical habitat under IFC Performance Standards 6. Project activities will need to be planned and designed to minimise impacts on this IBA (see Chapter 10 and Annex G for details).

[1] Criteria A4i: Site known or thought to hold, on a regular basis, >1% of a biogeographic population of a congregatory waterbird species.

3.4.8 Pollution Control

There is currently no single integrated pollution legislation in Ghana. Pollution control exists as part of the environmental and water resource legislation and marine pollution is dealt with by the Oil in Navigable Waters Act (Act No. 235 of 1964) (see below).

Section 2(f) of the Environmental Protection Act (1994) enables the EPA to issue pollution abatement notices for: "*controlling the volume, types, constituents and effects of waste discharges, emissions, deposits or other source of pollutants and of substances which are hazardous or potentially dangerous to the quality of the environment or any segment of the environment […]*"

Section 2(h) of the Act also allows the EPA to prescribe standards and guidelines relating to air, water, land and other forms of environmental pollution. And, Section 2(j) requires the EPA to co-operate with District Assemblies and other bodies to control pollution.

The Water Resources Commission Act (see Section 3.4.5 above) also addresses the control of water pollution. Section 24 of the Act prohibits the interference, altering, pollution or fouling of water resources beyond levels prescribed by the EPA and prescribes penalties for non-compliance.

Two additional texts are currently in draft stages of the legislative process:

- A Marine Pollution Bill which, when enacted, will empower the GMA to regulate marine pollution and will provide a legal framework to prevent and control marine source pollution. This bill will incorporate international conventions such as the International Convention for the Prevention of Marine Pollution from ships, 1973 as modified by the protocol of 1978 relating to it (MARPOL) 73/78 (Annexes I-IV), and the Oil Pollution Preparedness Response, among others. Additionally it will include non-convention provisions: a duty to report discharges of oil, insurance for operators of oil rigs and platforms, provisions regulating the transfer of oil and provision for the Minister of Transport to make Regulations. It seeks to repeal the oil in Navigable Waters Act of 1996, (Act.235).

- Marine Pollution Prevention and Control Regulations which will provide rules for offshore installations to prevent pollution of the marine environment by substances used or produced in offshore petroleum exploration and exploitation.

Currently in Ghana there no specific regulation covering disposal of waste material, produced water and drilling fluids, emissions to air (NOx, VOC, Flaring, CO_2 separated from produced gas), use and discharge of chemicals or injection of cuttings or CO_2, water containing oil.

<u>Oil in Navigable Waters Act</u>

The pollution control within the marine environment is established by the specific Oil in Navigable Waters Act, 1964 (Act 235). The Act was enacted in 1964 to give effect to the International Convention for the Prevention of Pollution of the Sea by Oil (1954) and also addresses oil pollution in inland waters.

Section 1 of the Act seeks to regulate the discharge of oil into prohibited areas of the sea. It establishes the prohibition to discharge oil in prohibited sea areas, and to discharge any mixture containing more than 100 ppm of oil. Those acts are considered as an offence. The Act extends the prohibition of pollution to the high seas by ships registered in Ghana and requires that Ghanaian ships be fitted so as to prevent oil fuel leakages or draining of oil into the bilges (unless the oil in the bilges is not discharged).

Section 3 of the Act deals with the responsibility for the discharge of oil into Ghanaian waters, defined by sub-section 2 as:

'(a) the whole of the sea within the seaward limits of the territorial waters of Ghana, and (b) all other waters (including inland waters) which are within those limits and are navigable by sea-going ships.'

The responsibility for the discharge is on the owner or master of the ship, or the occupier of the land, or person in charge of the apparatus from where the oil was discharged. They may be charged and found guilty of the offense.

As per sub-section 3, ballast water of vessels may be discharged in specific areas and under specific conditions to be established by the Port Authority.

Section 5 establishes that all Ghanaian ships which use oil as fuel shall be fitted to prevent oil fuel from leaking or draining into bilges, unless effective means are provided to ensure that that oil is not discharged.

Section 7 sets that the master of every Ghanaian ship of 80 tons gross tonnage of over which uses fuel oil shall maintain a record of security oil discharged, oil discharged as a result of ship damage, and other discharges (i.e. ballast, oil-water separation, etc). Those records shall be maintained for a period of two years.

Section 8 establishes that vessels that may carry more than five tons of oil shall maintain a record relating to the transfer of oil to and from the vessel while within the limits of the territorial waters of Ghana.

3.4.9 Marine State, Conventions and Classification Requirements

The regulatory requirements for an offshore vessel are generally set out by the coastal state or shelf state, the flag state, international conventions and the classification society. The dredging vessels and tug boats will need to satisfy all of the requirements from these authorities before they are approved fit for purpose.

<u>Coastal State Regulations</u>

All countries have full sovereignty to regulate activities on their continental shelves. As the dredging vessels will be operational within Ghanaian waters, Ghana regulations, as administered by the Ghana Maritime Authority (GMA), are the governing regulations and take precedence over all flag state and class requirements. However, many jurisdictions, including Ghana, refer to maritime codes, rules and standards related to flag and classification requirements as described below.

GMA refers to the regulations of the nominated flag state. In the case of the eni Ghana FPSO, the flag state will be the Singapore Maritime Authority before entering Ghana waters.

Flag State Regulations

Ships or offshore facilities trading internationally have to comply with the safety regulations of the maritime authority from the country whose flag the unit is flying. A dredging vessel does not need a flag unless required by the coastal state (i.e. GMA in Ghana) or when in transit through international waters. Flag states require classification and implementation of the safety regulations such as those of the International Maritime Organisation (IMO). Regarding ballast water management, in addition to the ballast water management guidelines established by the IMO, Ghana Maritime Authority has adopted a National Ballast Water Management Strategy.

The relevant maritime authority will require commercial vessels registered in the flag state to be surveyed, certified and undergo verification by a recognised organisation. Flag state legislation will require that the FPSO is to be satisfactorily inspected on an annual basis.

Classification Societies

Flag states require flagged units to be classed and most coastal states refer to class as the recognised standard for maritime aspects of FPSOs. The dredging and drilling vessels will be classed by a classification society that is recognised by the maritime administrator of the flag state. In this particular case, the drilling vessel Maersk Voyager will have a Singapore Flag and American Bureau of Shipping (ABS) Class. In the case of the dredging vessel, this information is not available at the time of writing this report.

Classification provides assurance that a ship or offshore installation has been designed, constructed and maintained in accordance with sound principles.

3.4.10 Air and Road Transportation

The Ghana Highways Authority Act (Act 540 of 1997) is in place to establish and authority responsible for the administration, control, development and maintenance of trunk roads and related facilities. The Act places the responsibility for the upkeep, management and construction of bridges, road closures, trunk road excavations and toll roads on the Ghana Highways Authority.

3.4.11 Labour and other social responsibility laws

Labour Act

The Labour Act (Act 651), of 2003 consolidates and updates the various pieces of former legislation and introduces provisions to reflect International Labour Organisation (ILO) Conventions ratified by Ghana (see Section 3.5). The Labour Act covers all employers and employees except those in strategic positions such as the armed forces, police service, prisons service and the security intelligence agencies.

Major provisions of the Labour Act include the following:

- establishment of public and private employment centres;
- protection of the employment relationship;
- general conditions of employment;
- employment of persons with disabilities;
- employment of young persons;
- employment of women;
- fair and unfair termination of employment;
- protection of remuneration;
- temporary and casual employees;
- unions, employers' organizations and collective agreements;
- strikes;
- establishment of a National Tripartite Committee;
- forced labour;
- occupational health and safety;
- labour inspection; and
- establishment of the National Labour Commission.

Provisions specifically related with occupational health, safety and environment are included with the Part XV of the Labour Act. These include general health and safety conditions, exposure to imminent hazards, employer occupational accidents and diseases reporting.

Children's Act

The Children's Act (Act 560) of 1998 defines a child as a person below the age of eighteen years. It is stated within the Sections 12 and 87 of the Act 560, that child must not be engaged in exploitative labour. Exploitative labour is defined by a labour depriving the child of its health, education or development.

Commission on Human Rights and Administrative Justice Act

The Commission on Human Rights and Administrative Justice Act (Act No. 456 of 1993), establishes a Commission on Human Rights and Administrative Justice to investigate complaints of violations of fundamental human rights and freedoms, injustice and corruption, abuse of power and unfair treatment of persons by public officers in the exercise of their duties, with power to seek remedy in respect of such acts or omissions.

National Vocational Training Act

All employers are obliged to provide training for their employees for the attainment of the level of competence required for the performance of their jobs and to enhance their career, according to the provisions of the National Vocational Training Act (Act 351) of 1970 and the National Vocational Training Regulations (Executive Instrument 15).

3.4.12 Land and Planning laws

Town and Country Planning

Under the local government act, 1993 act 462, the Town and Country Planning Department, which forms part of the Physical Planning Department of the Assemblies is mandated with the overall planning and development of the District Assemblies. Other legislative instruments from which the Town and Country Planning Department derives its mandate include:

- the Local government act 1993, (Act 462);
- National Development Planning Commission Act, 1994 (Act 479);
- National Development Planning (Systems) Act, 1994 (Act 480);
- National Building Regulation, 1996 (LI 1630); and
- Town and Country Planning Ordinance, 1945 (Cap 84).

The Town and Country Planning Department was created as a government institution to assist government in the formulation of overall government goals for the integration of social, economic and physical development for the country.

- Assist government to formulate and implement policies on human settlement developments and other related issues in Ghana.
- Coordinate the diverse/various types of uses and development of land undertaken by various departments and agencies of government as well as private developers.

It can be found at the District, Municipal, Metropolitan, Regional and the National level.

The provisions of the Civil Service Law (PNDC Law 327) and the Local Government Act,(462), decentralized the Department in 1993 with its former Regional and District branches integrated into regional coordinating councils, Metropolitan, Municipal and District Assembly.

Land

Relevant land related legislation includes:

- The State Lands Act. 1962 (Act 125) and its amendments establish the principles for compulsory acquisition of land1. After the submission of an application to acquire land, a 'Site Advisory Committee'' is set up in order to assess the application. The application is then assessed by the Ministry to a Land Commission, which prepare an executive instrument. Once this instrument is accepted and endorsed by the Minister, it is published in the newspapers and claims can be submitted by property owners. The valuation board estimates the corresponding compensation. Compensation is then made to the property owners and sometimes resettlement is followed. Administration of Lands Act. 1962 (Act 123) empowers the Minister responsible for lands to manage stool lands in accordance with the provision of the law.

(1) [1] Compulsory land acquisition is the right and power entrusted in government to attain private lands without a determined consent of the owner for societal development.

- Lands Statutory Wayleaves Act. 1963 (Act 186) was enacted to facilitate the entry on any land for the purposes of construction, installation and maintenance of public utility works and creation of right of ways and other similar right for such works. The Act and its accompanying Regulation, the Lands Statutory Wayleave Regulation 1964 (LI 334) provides the modalities and procedures for the acquisition of the Statutory right of ways.
- The Ghana Land Policy 1999. It was put in place to serve as a broad framework and policy guidelines for land administration and utilization. The main objective is to provide guidelines aimed at enhancing land management systems, land use, conservation of land resource and enhancing environmental quality.
- The Lands Commission Act, 1994 (Act. 483) detailing the management frameworks for public and other lands and which establishes a commission to assist and advise the government, local and traditional authorities on land related issues, usage and management concerns.
- The Stool Lands Act, 1994 (Act 481) which establishes the management and administrative processes applicable to Stool land and describes the appropriate distribution of any revenue accrued from stool lands.
- The Land Planning and Soil Conservation Act, 1953 (Act 32) enacted to ensure better utilization of land and to allow for proper land use planning through the establishment of committees. These committees are formed in order to avoid land degradation.

The Project will need to adhere to the regulations previously mentioned and ensure the project is implemented according to the management structures in place in the region. This is particularly relevant if resettlement and livelihood restoration are needed.

3.4.13 National Health legislative framework

Ghana has passed significant legislation regarding health in the forms of both laws and acts. A few of the most important legislative acts include:

- Hospital Fees act, 1971 (Act 387);
- Mental Health Decree, 1972 (NRCD 30);
- Nurses and Midwives Decree 1972 (NRCD 117);
- Medical and Dental Decree 1972 (NRCD 91);
- Medical Profession (Professional Conduct and Ethics). Regulations, 1975 (LI 1023);
- The Ghana College of Physicians and Surgeons Act (635);
- Ghana Health Service and Teaching Hospital Act, 1996;
- Traditional Medicine Practice Act (Act 575);
- Private Hospitals and Maternity Homes (No. 9) Act, 1958 (LN. 295);
- Pharmacy Act 1994 (Act 489);
- Environmental Protection Agency Act (Act 490);
- Infectious Diseases, (Cap 78);
- National Health Insurance Act 2003 (Act 650); and
- National Health Insurance Regulation 2004 (L.I 1809).

3.4.14 Ghanaian Legislation under Preparation

With the objective of developing the emerging oil and gas industry, a number legislation are at the draft stages of the legislative process. This includes the Petroleum (Exploration and Production) Act and a new Health Safety and Environment Regulations for the oil and gas industry. Other new environmental and marine regulations and guidelines, expected to be considered in a near future by Parliament are listed as follows:

- Draft Oil and Gas Policy for Ghana (2008);
- Ghana Petroleum Regulatory Authority Bill;
- Hazardous and Electronic Waste Control and Management Bill, 2011;
- Marine Pollution Bill, 2010;
- Marine Pollution Prevention and Control Regulations; and
- Ghana Shipping (Manning Agents) Licensing Regulations.

3.5 Relevant International Agreements and Conventions

The Republic of Ghana is signatory to a number of international conventions and agreements relating to industry, development and environmental management. In certain cases, conventions and agreements have influenced policy, guidelines and regulations and therefore are relevant to planning, construction and operation of the Project.

Table 3.1 lists the relevant international conventions and protocols to which Ghana is signatory. Those most pertinent to the project are explained in further detail below.

Table 3.1 International Convention and Agreements signed by Ghana

Date of adoption	Name of the Convention / Agreement
1972	London Convention on the Prevention of Marine Pollution by Dumping of Waste and Other Matter. Acceded by Ghana on July 2010.
1989	The Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention). Acceded by Ghana on May 2003.
1930/1948/ 1958/1999	The International Labour Organisation (ILO) Fundamental Conventions related to forced labour, freedom of association, discrimination and child labour. • Forced labour convention was ratified by Ghana on May 1957 • Freedom of association and protection of the right to organise convention was ratified by Ghana on June 1965. • Discrimination (employment and occupation) convention was ratified by Ghana on April 1961. • Worst Forms of Child labour convention was ratified by Ghana on June 2000.
1966	International Covenant on Economic, Social and Cultural Rights. Signed and ratified by Ghana on September 2000.

Date of adoption	Name of the Convention / Agreement
1966	International Covenant on Civil and Political Rights. Signed and ratified by Ghana on September 2000.
1999	Guinea Current Large Marine Ecosystem Project (GCLME)
1998	Memorandum of Understanding Concerning Conservation Measure for Marine Turtles of the Atlantic Coast of Africa. Signed by Ghana on November 1999.
1992	United Nations Framework Convention on Climate Change (UNFCCC). Signed and by Ghana on June 1992 and ratified by Ghana on 1995.
1992	Convention on Biological Diversity (CBD). Signed by Ghana on June 1992 and ratified by Ghana on 1994.
1991	Convention on the Ban of the Import into Africa and the Control of Transboundary Movement of Hazardous Wastes within Africa – Bamako Convention. Signed by Ghana on July 2004.
1991	Convention on Fisheries Cooperation among African States Bordering the Atlantic Ocean
1981	African Charter on Human and People's Rights. Ratified by Ghana on January 1989 and signed by Ghana on July 2004.
1987	Montreal Protocol on Substances that deplete the Ozone Layer. Signed by Ghana on January 1989 and ratified by Ghana on July 1989.
1979	Convention on the Conservation of Migratory Species of Wild Animals. Entered into force in Ghana on April 1988.
1977	Convention Concerning the Protection of Workers against Occupational Hazards in the Working Environment due to Air Pollution, Noise and Vibration (ILO No 148). Ratified by Ghana on May 1986.
1985	Vienna Convention for the Protection of the Ozone Layer. Acceded by Ghana on July 1989.
1982	United Nation Convention on the Law of the Sea (UNCLOS), Montego Bay, Jamaica. Signed by Ghana on 1982 and ratified by Ghana on 1994.
1981	Convention for Cooperation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region (Abidjan Convention). Signed by Ghana on March 1981 and ratified by Ghana on July 1989.
1972	Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention), Paris. Ratified by Ghana on July 1975.
1973/1978	International Convention for the Prevention of Pollution from Ships (MARPOL 73/78). The protocol of 1997 was signed by Ghana on October 2010. Annexes I and II were ratified by the Ghana government in 2010, and the remaining Annexes III to VI came into force in January 2011
1988	Ramsar Convention on Wetlands of International Importance, especially Waterfowl Habitats (Ramsar, Iran). Entered in to force in Ghana on June 1988.
1971	International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (FUND). Ratified by Ghana on April 1978.

Date of adoption	Name of the Convention / Agreement
1969	International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (INTERVENTION). Ratified by Ghana on April 1978.
1969	International Convention on Civil Liability for Oil Pollution Damage (CLC). Ratified by Ghana on April 1978.
1968	African Convention on Conservation of Nature and Natural Resources. Signed by Ghana on September 1968 and ratified by Ghana on May 1969.
1958	Geneva Conventions on the Law of the Sea (removal of offshore installations). Signed by Ghana on April 1958.
1944	Convention on International Civil Aviation (Chicago Convention). Ratified by Ghana on May 1957.

3.5.1 United Nations Convention on the Laws of the Sea

Ghana is signatory to the United Nations Convention on the Laws of the Sea (UNCLOS). Under this convention Ghana claims rights within a 12 nautical mile (Nm)) territorial sea and a 200 Nm Exclusive Economic Zone (EEZ). EEZs and territorial seas are defined by UNCLOS and specific rules apply within them.

The eni Ghana OCTP Project is located approximately 32 Nm offshore and, therefore, outside Ghana's territorial water but inside the 200 Nm EEZ. Clearance for project vessels travelling into the territorial waters (e.g. to and from the onshore base) must be obtained from the GMA and notification should also be made to the Ghanaian Navy.

Within the Ghanaian legislation, the Ghana Shipping (Amendment) Act, 2011, (Act 826) aims to extend the definition of Ghanaian waters to include the waters within the 500 metres safety zone generated automatically under the United Nations Convention on the Law of the Sea (UNCLOS) around installations in the exclusive economic zone beyond the territorial sea.

Furthermore, the UNCLOS Convention provides guidelines for the removal of offshore installations in the exclusive economic zone. In particular, Article 60 states that: "Any installations of structures [in the exclusive economic zone] which are abandoned or disused shall be removed to ensure safety of navigation, taking into account any generally accepted international standards established in this regards by the competent international organization. Such removal shall also have due regard to fishing, the protection of marine environment and the rights and duties of the other states. Appropriate publicity shall be given to the depth, position and dimensions of any installation or structures not entirely removed".

3.5.2 International Maritime Organisation Conventions

The IMO is the marine affairs organisation of the United Nations and develops and maintains conventions that provide safety regulations for ships and mobile offshore units operating internationally.

Of the conventions defined by IMO the following are relevant to FPSOs and to mobile offshore drilling units:

- International Convention for the Safety of Life at Sea (SOLAS), 1974;
- International Convention for the Prevention of Marine Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78);
- International Convention on Load Lines; and
- International Convention on Tonnage Measurement of Ships.

In addition, the IMO has developed guidelines for offshore decommissioning: IMO Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone (1998). According to these guidelines all the new platforms designed after the 1st January 1998 should be designed for the entire removal of the structure. It should be noted that there are no international guidelines on the decommissioning of disused sealines.

The degree to which these are enforced depends on the flag state. Further details on the international conventions relevant to the EIA (e.g. MARPOL) are provided are provided below.

The MARPOL Convention

The International Convention for the Prevention of Pollution from Ships, known as "MARPOL Convention", of 1973 and as amended in 1978 provides requirement related with the control of waste oil, engine oil discharge as well as grey and black waste water discharges. The MARPOL Convention is composed by several Annexes including:

- Annex I - Regulations for the Prevention of Pollution by Oil (entered into force 2 October 1983);
- Annex II - Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk (entered into force 2 October 1983);
- Annex III - Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form (entered into force 1 July 1992);
- Annex IV - Prevention of Pollution by Sewage from Ships (entered into force 27 September 2003);
- Annex V - Prevention of Pollution by Garbage from Ships (entered into force 31 December 1988); and
- Annex VI - Prevention of Air Pollution from Ships (entered into force 19 May 2005).

Annexes I and II entered into force in Ghana in September 1991, and the remaining Annexes III to VI came into force in January 2011.

The EPA's Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Industry (2010) and International Finance Corporation's (IFC) EHS guidelines for offshore oil and gas development require compliance with MARPOL and its annexes.

Moreover, a draft Marine Pollution Bill (See Section 3.4.14) is being prepared to adopt the remaining four annexes of the MARPOL standards into Ghanaian legislation (Annexes I to IV).

Table 3.2 Relevant MARPOL 1973/78 Provisions

Environmental Aspect	Provisions of MARPOL 1973/78	Annex
Drainage water	Ship must be proceeding en route, not within a 'special area' and oil must not exceed 15 parts per million (ppm) (without dilution). Vessels must be equipped with oil filtering, automatic cut-off and an oil retention systems.	I
Accidental oil discharge	Shipboard Oil Pollution Emergency Plan (SOPEP) is required.	I
Bulked chemicals	Prohibits the discharge of noxious liquid substances, pollution hazard substances and associated tank washings. Vessels require periodic inspections to ensure compliance. All vessels must carry a Procedures and Arrangements Manual and Cargo Record Book.	II
Sewage discharge	Discharge of sewage is permitted only if the ship has approved sewage treatment facilities, the test result of the facilities are documented, and the effluent will not produce visible floating solids nor cause discoloration of the surrounding water.	IV
Garbage	Disposal of garbage from ships and fixed or floating platforms is prohibited. Ships must carry a garbage management plan and shall be provided with a Garbage Record Book.	V
Food waste	Discharge of food waste ground to pass through a 25 mm mesh is permitted for facilities more than 12 nm from land.	V
Air pollutant emissions	Sets limits on sulphur oxide and nitrogen oxide emissions from ship exhausts and prohibits deliberate emissions of ozone-depleting substances including halons and chlorofluorocarbons. Sets limits on emissions of nitrogen oxides from diesel engines. Prohibits the incineration of certain products on board such as contaminated packaging materials and polychlorinated biphenyls.	VI

The Project will need to ensure that all port vessels and visiting vessels to comply with MARPOL requirements.

The International Convention of Oil Preparedness, Response and Co-operation Convention

The International Convention of Oil Preparedness, Response and Co-operation (OPRC Convention) was adopted by the Ghanaian government in 1990 and came into force in 1995. It requires signatory parties to establish measures for dealing with major incidents or threats to marine pollution, either nationally or in co-operation with other countries. Ships are required to carry a shipboard oil pollution emergency plan and to report incidents of pollution to coastal authorities. Offshore operators are required to have oil pollution emergency plans or similar arrangements which must be co-ordinated with national systems for responding promptly and effectively to oil pollution incidents.

In order to integrate OPRC Convention's requirements, Ghana has developed a National Oil Spill contingency plan in 2010. It is important to note that the Project activities will have to consider the requirements included within this plan.

The convention calls for the establishment of stockpiles of oil spill combating equipment, the holding of oil spill combating exercises and the development of detailed plans for dealing with pollution incidents. 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.

3.5.3 Guinea Current Large Marine Ecosystem (GCLME)

Established in 1999 after the end of the Global Environmental Fund's (GEF) pilot Gulf of Guinea Large Marine Ecosystem project, this is an eco-system based effort to assist countries associated with the Guinea current to move towards environmental and resource sustainability (http://gclme.org/). The project involves establishing long-term management objectives and frameworks to sustain the production potential of the system as a whole.

3.5.4 Convention on Biological Diversity (CBD)

The activities proposed by the Project presents potential effects (albeit not to large extent) on local marine resources and users. Thus, several sections of the Convention on Biological Diversity (CBD) are relevant to the Project.

In particular, it should be considered the following articles:

- Article 8: sets that each contracting party, as far as possible and as appropriate should (Art. 8a)"*establishes a system of protected areas or areas where special measures need to be taken to conserve biological diversity" and (Art. 8j) "Subject to its national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge, innovations and practices*";
- Article 10: sets that each contracting party, as far as possible and as appropriate should (Art. 10c) "*Protect and encourage customary use of biological resources in accordance with traditional cultural practices that are compatible with conservation or* sustainable *use requirements" and (Art. 10d) "Support local populations to develop and implement remedial action in degraded areas where biological diversity has been reduce*"
- Article 11: sets that "*each Contracting Party shall, as far as possible and as appropriate, adopt economically and socially sound measures that act as incentives for the conservation and sustainable use of components of biological diversity*".

3.6 INDUSTRY BEST PRACTICES

There are a number of industry good practice standards and guidelines for offshore oil and gas developments. Considering the oil and gas industry, one's of the most commonly used best practices references are the guidelines and best practices standards provided by the International Association of Oil and Gas Producers (IOGP) and of the International petroleum Industry Environmental Conservation Association (IPIECA), of which eni is member.

Those relevant, but not limited to, for the project development include:

- OGP (2007) - Environmental, Social Health Risk and Impact Management Process;
- OGP (1997) - Environmental Management in Oil and Gas Exploration and Production;
- OGP (2010) - HSE Management Guidelines for Working Together in a Contact Environment;
- OGP (1993) - Waste Management Guidelines;
- OGP (2008) – Guidelines for Waste Management with special focus on areas with limited infrastructure;
- OGP (2011) - Deepwater wells: global industry response group recommendations;
- OGP (2010) - Guidelines for produced water injection;
- OGP (2009) - Environmental aspects of the use and disposal of non-aqueous drilling fluids associated with offshore oil & gas operations;
- OGP (2006) - Guideline for managing marine risks associated with FPSOs;
- IPIECA ((2010) - Alien invasive species and the oil and gas industry;
- IPIECA (2011) - Guidance on Improving Social and Environmental performance: Good practice Guidelines for the Oil and Gas Industry;
- IPIECA (2005) - A Guide to Health Impact Assessments in the oil and gas industry;
- IPIECA (2015) - Community grievance mechanisms in the oil and gas industry;
- IPIECA & OGP (2009) - Drilling fluids and health risk management;
- IPIECA & OGP (2013) - Oil spill risk assessment and response planning for offshore installations;
- IPIECA (2008) - Creating Successful, Sustainable Social Investment for the oil and gas industry;
- E&P Forum (1996) – Decommissioning, Remediation and Reclamation Guidelines for Onshore Exploration and Production sites (E&P Forum Report Nº 2.70/242);
- API (1993) – Environmental Guidance Document: Onshore Solid Waste Management in Exploration and Production Operations;
- API (2007) - Management System for Onshore Oil and Natural Gas Production Operations and Associated Activities;
- API (2009) – Environmental Protection for Onshore Oil and Gas Production Operations and Leases; and

- IMO (1989) – Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone.
- Joint Industry Subsea Well Control and Containment Task Force (2012) - Final report on Industry recommendations to improve subsea well control and containment.

3.7 FINANCIAL INSTITUTION ENVIRONMENTAL AND SOCIAL PERFORMANCE STANDARDS

This section outlines the most important environmental and performance standards generally required by financial institutions and which the project will take into consideration for the development of the proposed activities.

Potential financial institutions that have specific requirements for environmental and social performance may include; commercial banks that have adopted the Equator Principles, as well as Finance institutions such as the International Finance Corporation (IFC).

3.7.1 The Equator principles

The Equator Principles (EPs) are an approach by financial institutions to determine, assess and manage environmental and social risk in project financing. The EPs emphasize that lenders will seek to ensure that the Project is developed in a manner that is socially responsible and reflects sound environmental management practices.

These Principles have been adopted by a wide range of banks and lenders all over the world in order to manage the social and environmental risks associated with their potential investments, and are listed below:

- Principle 1 - Categorization of projects;
- Principle 2 - The borrower has to conduct an Environmental and Social Impact Assessment (EIA);
- Principle 3 - Applicable Social and Environmental Standards;
- Principle 4 - Action Plan and Management System;
- Principle 5 - Consultation and Disclosure;
- Principle 6 - Grievance Mechanism;
- Principle 7 - Independent Review;
- Principle 8 - Covenants;
- Principle 9 - Independent Monitoring and Reporting; and
- Principle 10 - Equator Principles Financial Institutions (EPFI) Reporting.

3.7.2 WB/IFC Performance Standards

As defined within the World Bank Operational Policy 4.03, the Performance Standards are adopted by the Bank for projects (or components thereof) that are designed, owned, constructed and/or operated by a Private Entity. IFC will only finance investment activities that are expected to meet the requirements of the Performance Standards within a reasonable period of time. The Performance Standards establish standards that the client is to meet throughout the life of an investment by IFC. The Performance Standards, are listed below:

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

Moreover, the IFC Sustainability Framework articulates the IFC's strategic commitment to sustainable development and is an integral part of the IFC's approach to risk management. The Sustainable Framework of the IFC consists of:

- The Policy on Environmental and Social Sustainability, which defines IFC's commitments to environmental and social sustainability.
- The Performance Standards, which define clients' responsibilities for managing their environmental and social risks.
- The Access to Information Policy (see Section 3.7.4), which articulates IFC's commitment to transparency.

Specific guidance is contained in the Guidance Notes to the WB/IFC Performance Standards. The IFC's set of Guidance Notes provide guidance on the requirements contained in the WB/IFC Performance Standards, including reference materials on good sustainability practices to improve Project performance. The following IFC handbooks are also relevant to the Project:

- Stakeholder Engagement: A Good Practice Handbook for Companies Doing Business in Emerging Markets;
- Strategic Community Investment: A Good Practice Handbook for Companies Doing Business in Emerging Markets; and
- Projects and People: A Handbook for Addressing Project-Induced In-Migration.
- Good Practice Handbook - Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets.
- Good Practice Note: Addressing Grievances from Project-Affected Communities.

3.7.3 IFC Environmental, Health and Safety (EHS) Guidelines

The EHS Guidelines are technical reference documents that address IFC's expectations regarding the industrial pollution management performance of projects. This information supports actions aimed at avoiding, minimizing, and controlling EHS impacts during the construction, operation, and decommissioning phase of a project or facility.

In the context of the proposed project, the most relevant EHS Guidelines to be considered are:

- EHS General Guidelines (World Bank Group, 2006);
- EHS Guidelines for Shipping (World Bank Group, 2007);
- EHS Guidelines for Offshore Oil and Gas Development (World Bank Group, 2007); and
- EHS Guidelines for Thermal Power Plants (World Bank Group, 2008).

<u>EHS General Guidelines (World Bank Group, 2007)</u>

The Environmental, Health and Safety (EHS) General Guidelines are technical reference documents, which promote Good International Industry Practice (GIIP). The General EHS Guidelines contain information on cross-cutting environmental, health, and safety issues potentially applicable to all industry sectors and should be used together with the relevant IFC industry sector guidelines.

When a member of the World Bank Group is involved in a project, the General EHS Guidelines are to be used in conjunction with the appropriate industry sector EHS Guidelines. Recommendations for the management of EHS impacts typical to most large industrial facilities are included in these Guidelines (World Bank Group, 2007a).

<u>EHS Guideline for Waste Management Facilities (World Bank Group, 2007)</u>

The Environmental, Health and Safety (EHS) Guidelines for Waste Management Facilities is applicable to facilities that are committed to the management of municipal solid waste and industrial waste, including waste collection and transport, waste receipt, unloading, processing and storage; landfill disposal, physicochemical and biological treatment and incineration projects. The guidelines identify EHS issues that can arise during the operational and decommissioning phases of waste management and provide recommendations of their management in relation to the environment, occupational health and safety as well as community health and safety. These guidelines request the implementation of monitoring against identified performance indicators of all the activities that have been identified to have potentially significant impacts in order to monitor these impacts over time and to compare them to Industry Benchmarks (World Bank Group, 2007b).

<u>EHS Guidelines for Shipping (World Bank Group, 2007)</u>

The Environmental, Health and Safety (EHS) Guidelines for Shipping relate to the operation and maintenance of ships used for the transportation of bulk cargo and goods and only to fossil-fuel-operated vessels. These Guidelines identify EHS issues associated with the shipping industry which occur during the operation and decommissioning phase and provide management recommendations in relation to the environment, occupational health and safety as well as community health and safety. These EHS Guidelines request the implementation of monitoring according to identified Performance Indicators of all the activities that have been identified to have potentially significant impacts in order to monitor these impacts over time (World Bank Group, 2007c).

EHS Guidelines for Offshore Oil and Gas Development (World Bank Group, 2007)

The EHS Guidelines for Offshore Oil and Gas Development include information relevant to seismic exploration, exploratory and production drilling, development and production activities, offshore pipeline operations, offshore transportation, tanker loading and unloading, ancillary and support operations, and decommissioning. It also addresses potential onshore impacts that may result from offshore oil and gas activities (World Bank Group, 2007d).

An updated version of these guidelines is currently disclosed as draft for Public Consultation (April 2014), and is anticipated to be made effective in the short term.

3.7.4 World Bank Policy on Access to Information

The World Bank Policy on Access to Information takes effect from July 2013, and describes how the World Bank makes information available to the public. Underlying the new policy is the principle that the World will disclose any information in its possession that is not on a list of exceptions.

The Access to Information Policy is based on the following five principles: 1) maximizing access to information; 2) setting out a clear list of exceptions; 3) safeguarding the deliberative process; 4) providing clear procedures for making information available; and 5) recognizing requesters' right to an appeals process.

The disclosure, review and approval process of the OCTP Phase 2 Development project EIS will meet specific requirements of the Bank through a process that is integrated with the Ghana EIA process. The process is as follows:

- The Terms of Reference of the EIS were reviewed by the Ghana EPA and by the E&S specialists from the IFC and World Bank against the lender requirements.
- Following completion of the EIS report, the draft EIS report was reviewed by E&S specialists from the IFC and World Bank and the report revised as required.
- At the same time that the EIS is submitted to Ghana EPA, it will be submitted to the lender group for disclosure under their process. This involves publishing the EIS on the World Bank Groups disclosure system (Infoshop) and notifications. The EIS will be disclosed for 60 calendar days as required by the World Bank Group's procedures.
- Following the conclusion of the disclosure period, comments and questions received will be responded to and the EIS updated accordingly.
- The Ghana EPA led disclosure and comment/response process will occur concurrently (see details in Annex A, Stakeholder Engagement Plan).

3.8 PROJECT ENVIRONMENTAL STANDARDS

The following water, air and noise standards are based on Ghana EPA guidance (EPA's Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development - 2010) and MARPOL, good industry practice such as the Oslo-Paris Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) and IFC EHS Guidelines.

3.8.1 Water Quality

Table 3.3 provides industry good practice standards for effluent discharges from offshore oil and gas developments based on MARPOL, IFC and OSPAR standards. These standards are also in line with the effluent discharges guidelines adopted in the EPA Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development (2010).

Table 3.3 Industry Good Practices for Effluent Discharges (1)

Source	Industry Good Practice Standard
Drilling fluids and cuttings	*In addition to EPA guidelines and as per IFC Guidelines, disposal of spent NADF or of cuttings from wells drilled with NADF by discharge to the sea must be avoided. Instead, they should be transferred to shore for recycling or treatment and disposal. If discharge of cuttings is necessary, they should be treated before discharge to meet the following guidelines:* • *Oil concentration lower than 1% by weight on dry cuttings* • *Hg max 1 mg/kg dry weight in stock barite* • *Cd - max 3 mg/kg dry weight in stock barite* • *Discharge via a caisson at least 15 m below sea surface*
Completion and Workover Fluids	*Discharge to sea if oil and grease do not to exceed 42 mgl-1daily maximum and 29 mgl-1 monthly average. Any spent acids to be neutralised (to attain a pH of 5 or more) as per IFC EHS guidelines.*
Cooling water	The effluent should result in a temperature increase of no more than 3°C at the edge of the initial mixing/dilution zone. Where the zone is not defined, use 100 m from point of discharge as per EPA and IFC EHS guidelines.
Produced water	Oil and grease not to exceed 40 mgl-1 daily max and 29 mgl-1 monthly average as per EPA guidelines (2)
Produced sand	No discharge unless residual oil less than 1% by weight on dry sand as per EPA guidelines
Sewage	Treat with approved marine sanitation unit (achieve no floating solids, no discolouration of surrounding water) as per MARPOL Annex IV requirements. Minimum residual chlorine of 1 mgl-1as per IFC EHS Guidelines.

Source	Industry Good Practice Standard
Food waste	Macerate to acceptable levels and discharge in compliance with MARPOL 73/78 Annex V requirements.
Bilge water	Treat to 15 ppm oil concentration as per MARPOL 73/78 Annex I requirements.
Storage Displacement Water (Ballast Water)	Compliance with the International Convention for the Control and Management of Ship's Ballast Water and Sediments.
Deck drainage	Treat to 15 ppm oil concentration as per MARPOL 73/78 Annex I requirements.
Desalination brine	Mix with other discharge streams if feasible.

(1) EPA Guidelines have been considered. However, additional IFC standards have been included in *italics.*

(2) Not applicable because produced water will be re-injected.

Source: Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development (EPA, 2010). Reference: MARPOL 1973/1978: International Convention for the Prevention of Pollution from Ships. Legend: PPM: parts per million

3.8.2 Air Quality

The Ghana Environmental Protection Agency (EPA) has established legislation and guidelines governing air emissions and common air pollutants specific for industrial and residential areas (Table 3.4).

Table 3.4 Ghana EPA Air Quality Standards

Substance	Average-time	Time-Weighted Average (TWA) [µg/m³]	
Sulphur Dioxide (SO_2)	1 h	900	Industrial
		200	Residential
	24 h	150	Industrial
		100	Residential
	Calendar year	80	Industrial
		50	Residential
Nitrogen oxides (Measured as NO_2)	1 h	400	Industrial
		90	Residential
	24 h	150	Industrial
		60	Residential
	Calendar year	100	Industrial
		30	Residential
Total Suspended Particulate	1 h	230	Industrial

(TSP)		150	Residential
	24 h	75 60	Industrial Residential
Particulate Matter PM_{10}	24 h	70	--
Carbon Monoxide (CO)	24 h 1 h	60 mg/m^3 10 mg/m^3	

Source: Environmental Quality Guidelines for Ambient Air (EPA, 1996)

Additionally, key provisions of the IFC EHS guidelines for offshore oil and gas developments, IFC EHS Guidelines for Thermal Power Plants and IFC Performance Standards 3 relating to air emissions are outlined in Table 3.5. These standards are also in line with the guidelines adopted in the EPA Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development (2010).

Table 3.5 Industry Good Practices for Air Emissions

Source	**Industry Good Practice Standard**
General	All reasonable attempts should be made to maximise energy efficiency and design facilities for lowest energy use. The overall objective should be to reduce air emissions and evaluate cost effective options for reducing emissions that are technically feasible.
Exhaust gasses	Guidance for the management of small combustion sources with a capacity of up to 50 megawatt-hours thermal, including standards for exhaust emissions, is provided in the IFC's General EHS Guidelines. • For engines using liquid fuels these are as follows. o Particulate matter: 50 mgNm-3 (up to 100 if justified by project-specific conditions) (approximately 24 and 49 ppm respectively). o Sulphur dioxide: 1.5% of sulphur (up to 3% if justified by project-specific conditions). Consideration to using low sulphur fuels or secondary treatment to meet 1.5% sulphur. o Nitrogen oxides: 1,460 mgNm-3 if bore size diameter <400 mm (up to 1,600 mgNm-3 if justified to maintain high energy efficiency) and 1,850 mgNm-3 if bore size diameter >400 mm. These normalised gas concentrations equate to approximately 711, 779 and 901 ppm respectively. o Dry gas, excess oxygen content: 15%. • For gas-fired engines these are as follows. o Nitrogen oxides: 200 mgNm-3 for spark ignition, 400 mgNm-3 for dual fuel and 1,600 mgNm-3 for compression ignition. o Dry gas, excess oxygen content: 15%. IFC Environmental, Health, and Safety Guidelines for Thermal Power Plants establishes exhaust emission guidelines for Combustion Turbines of more

Source	Industry Good Practice Standard

	than 50 MWth:
	• Natural Gas:
	  ○ Nitrogen Oxides (NOx): 51 mg/Nm^3 (25 ppm)
	  ○ Dry Gas, Excess 15% O_2 content.
	• Fuels other than Natural Gas:
	  ○ For Non-degraded airshed:
	    ▪ PM: 50 µg/m^3 (24 ppm)
	    ▪ SO_2: NDA Use of 1% or less S fuel
	    ▪ NO_X - 152 (74 ppm)
	    ▪ Dry Gas, Excess O2 Content (%): 15%
	  ○ Degraded airshed (poor air quality):
	    ▪ PM: 30 µg/m^3
	    ▪ SO_2: Use of 0.5% or less S fuel
	    ▪ NO_X - 152 (74 ppm)
	    ▪ Dry Gas, Excess O2 Content (%): 15%

Greenhouse gasses	Significant (>25,000 t tonnes CO_2 equivalent per year) greenhouse gas (GHG) emissions from the facilities owned or controlled within the physical project boundary, as well as indirect emissions associated with the off-site production of energy used by the project should be quantified annually in accordance with internationally recognized methodologies and good practice
Venting and flaring	Measures consistent with the Global Gas Flaring and Venting Reduction Voluntary Standard (part of the World Bank Group's Global Gas Flaring Reduction Public-Private Partnership should be adopted when considering venting and flaring options for offshore activities). The standard provides guidance on how to eliminate or achieve reductions in the flaring and venting of natural gas. Continuous venting of associated gas is not considered current good practice and should be avoided.
Well testing	During well testing, flaring of produced hydrocarbons should be avoided, especially in environmentally sensitive areas. Feasible alternatives should be evaluated for the recovery of these test fluids, while considering the safety of handling volatile hydrocarbons, for transfer to a processing facility or other alternative disposal options. An evaluation of alternatives for produced hydrocarbons should be adequately documented and recorded.
Fugitive emissions	Methods for controlling and reducing fugitive emissions should be considered and implemented in the design, operation, and maintenance of offshore facilities. The selection of appropriate valves, flanges, fittings, seals, and packing should consider safety and suitability requirements as well as their capacity to reduce gas leaks and fugitive emissions.

Source: EHS guidelines for offshore oil and gas developments (World Bank Group, 2007), IFC EHS Guidelines for Thermal Power Plants (World Bank Group, 2007) and IFC Performance Standards 3 (World Bank Group, 2012).

The IFC General Environmental EHS guidelines (World Bank Group 2007a) defer to the World Health Organisation (WHO) air quality guidelines standards (WHO 2005). The international standards presented in Table 3.6 include guideline values and interim targets levels. The latter, in excess of the guideline values [1], have been set by WHO to promote a steady progress towards meeting the air quality guideline value in developing countries where ambient air quality often exceed the guideline values.

The WHO guideline standards have been followed in this EIS as they are more stringent than the EPA ambient air quality guidelines for Ghana. However, the EPA standards have also been used to compare the monitored levels with national legislation (see Chapter 5).

Table 3.6 WHO Ambient Air Quality Standards

Substance	**Averaging period**	**Guideline value [µg/m³]**
Sulphur Dioxide (SO_2)	24 h	125 (Interim target-1) 50 (Interim target-2) **20 (guideline)**
	10 minute	500 (guideline)
Nitrogen Dioxide (NO_2)	Calendar year	**40 (guideline)**
	1 h	**200 (guideline)**
Particulate Matter PM10	Calendar year	70 (Interim target 1) 50 (Interim target 2) 30 (Interim target 3) **20 (Guideline)**
	24 h	150 (Interim target 1) 100 (Interim target 2) 75 (Interim target 3) **50 (Guideline)**
Particulate Matter PM2.5	Calendar year	35 (Interim target-1) 25 (Interim target-2) 15 (Interim target-3) **10 (guideline)**

[1] "WHO air quality guidelines global update 2005", Report on a working group meeting, Bonn, Germany, 18-20 October 2005.

Substance	Averaging period	Guideline value [μg/m³]
	24 h	75 (Interim target-1) 50 (Interim target-2) 37.5 (Interim target-3) **25 (guideline)**
Ozone	8-hour daily maximum	160 (Interim target-1) **100 (guideline)**

Source: IFC General EHSs Guidelines: Environmental Air Emissions And Ambient Air Quality (IFC, 2007)

3.8.3 Ambient noise levels

The Ghana EPA maximum permissible noise levels during day and night time hours are presented in Table 3.7.

Table 3.7 Ghana EPA Ambient Noise Level Standards

Zone	Description of Noise Receptor	Permissible Noise Level [dB(A)]	
		Daytime 06h00 – 22h00	**Night time 22h00 – 06h00**
A	Residential areas with negligible or infrequent transportation	55	48
B1	Educational (school) and health (hospital clinic) Facilities	55	50
B2	Area with some commercial or light industry	60	55
C1	Area with some light industry, place of entertainment or public assembly and place of worship such as churches and mosques	65	60
C2	Predominantly commercial areas	75	65
D	Light industrial areas	70	60
E	Predominantly heavy industrial areas	70	70

Source: General Environmental Quality Standards for Industrial or Facility Effluents, Air Quality and Noise Levels (EPA).

The IFC General Environmental EHS Guidelines (World Bank Group 2007), which implement the "Guidelines for Community Noise" established by the World Health Organization (WHO) in 1999, prescribe the absolute noise levels reported in for day time and night time to be achieved. These standards are also in line with the guidelines adopted in the EPA Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development (2010).

In environments where the ambient noise levels already exceed a level of 55 dB(A) daytime and/or 45 dB(A) night time the IFC includes a guideline stating that noise emissions should not cause the ambient noise level in a residential area to rise by 3 dB(A) or more, determined during the noisiest hour of a 24 hour period.

Table 3.8 IFC Guidelines for Ambient Noise Levels

Receptor	**Maximum Ambient Noise Level 1-hour Leq [dB(A)]**	
	Daytime 06h00-22h00	**Night time 22h00-06h00**
Residential, Institutional, Educational	55	45
Industrial, Commercial	70	70

Source: IFC General EHSs Guidelines: Noise (IFC, 2007)

The Project will need to take these ambient noise level standards into account for the planning of construction and operation phase activities to ensure that these are not exceeded.

Underwater noise levels

The IFC guidelines for minimising underwater noise are applicable to the offshore oil and gas production operations including production activities and offshore and near shore structural installations. It is noted that a number of these measures are intended for noisy operations such as seismic surveys and pile driving that are not part of the activities being assessed in this EIS.

These guidelines recommend the following measures:

- Identifying and avoiding areas sensitive for marine life such as feeding, breeding, calving, and spawning areas.
- Planning seismic surveys and offshore construction activities around sensitive times of the year (e.g. breeding season).
- Identifying fishing areas and reducing disturbance to these areas by planning for seismic surveys and construction activities to be undertaken at less productive times of the year, where possible.
- Reducing operation time, where possible.
- Monitoring the presence of sensitive species (if expected to be in the project area) before the onset of noise creation activities and throughout the seismic program or construction. Experienced observers should be used where significant impacts to sensitive species are anticipated.

ESHIA for GHANA OCTP BLOCK Phase 2

ABSTRACT

Chapter 4 of the EIS is aimed at describing the project and its phases.

July 2015	06	Final version	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

Summary of Revisions

July 2015	05	Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
April 2015	04	Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
March 2015	03	Interim Draft Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
26-02-2015	02	Issued for comments	ERM	eni SEQS/SAL	G. Nicotra
09-02-2015	01	Issued for comments	ERM	eni SEQS/SAL	G. Nicotra
20-01-2015	00	-	Cristina O.	Henry C.	Daniele S.
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

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4 PROJECT DESCRIPTION

This Chapter provides a technical description of the Project and the Project activities. The information in this chapter was developed from information provided by the Project's technical team.

4.1 INTRODUCTION

4.1.1 Project Overview

Integrated Development

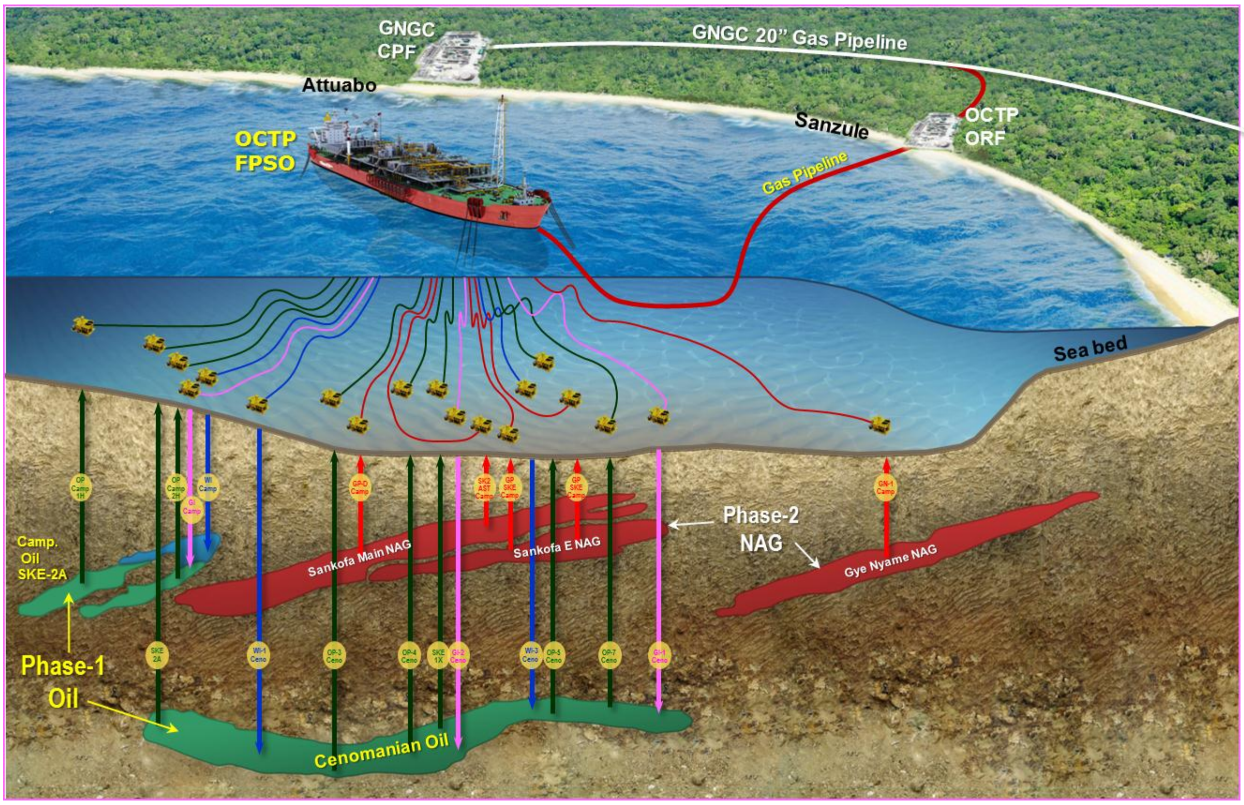
Development of the hydrocarbon reserves in the OCTP will be done in two phases in order to optimize the exploitation of the oil and gas discoveries:

- **Phase 1: Oil Development Project.** This phase would consist of 14 subsea wells (8 oil producers, 3 water injectors and 3 associated gas injectors), subsea facilities, and a new conversion, double-hull floating production, storage and offloading (FPSO) unit that would be located about 60 km offshore, south of Sanzule.
- **Phase 2: Non Associated Gas (NAG) Development Project**. This phase would consist of five (5) subsea wells, subsea facilities, minimal gas treating facilities located on the Phase 1 FPSO unit, 63 km subsea gas pipeline, onshore receiving facilities (ORF) and other onshore facilities.

For OCTP Phase 2, total estimated development costs (Capex) are 2.7b US $ (in constant values) and total operating expenditures for the ORF are 0.3b US $ (in constant values). The Phase 1 costs related to the FPSO are for Capex 117 US M$, Lease (as Capex) are 2.44b US $ (for 15+5 years) and running Opex are about 1.99b US $.

Figure 4.1 presents a schematic of the integrated development scheme. Components related to the Phase 2 NAG Development are shown in red.

Figure 4.1 Integrated Development Scheme (Phase 2 elements in red)



Source: eni, 2015

<u>Phase 2 NAG Development Project</u>

The Phase 2 NAG Development Project components will consist of:

- five (5) NAG wells;
- subsea systems including umbilicals, risers and flowlines to connect the wells to the FPSO;
- gas pre-treatment system on the FPSO;
- subsea pipeline from the FPSO to shore;
- onshore pipeline from the shore approach to an onshore receiving facility (ORF);
- ORF with receiving and compression systems and associated infrastructure such as, access road, offices, and maintenance facilities;
- Accommodation Camp and Heliport; and
- onshore pipeline for gas export connecting to the existing GNGC gas sales line.

The EIS covers Project construction, operation, and decommissioning.

Note that this EIS focusses on the Phase 2 NAG development project (the Project). The Phase 1 development is covered under a separate EIS process. The FPSO will be installed as part of the Phase 1 development and is covered in the EIS for the Phase 1 development. However, the FPSO is also part of the phase 2 development as it will be equipped to support the processing of Phase 2 NAG: separation of condensates, control of hydrocarbons and water dew point, and export of gas to the ORF.

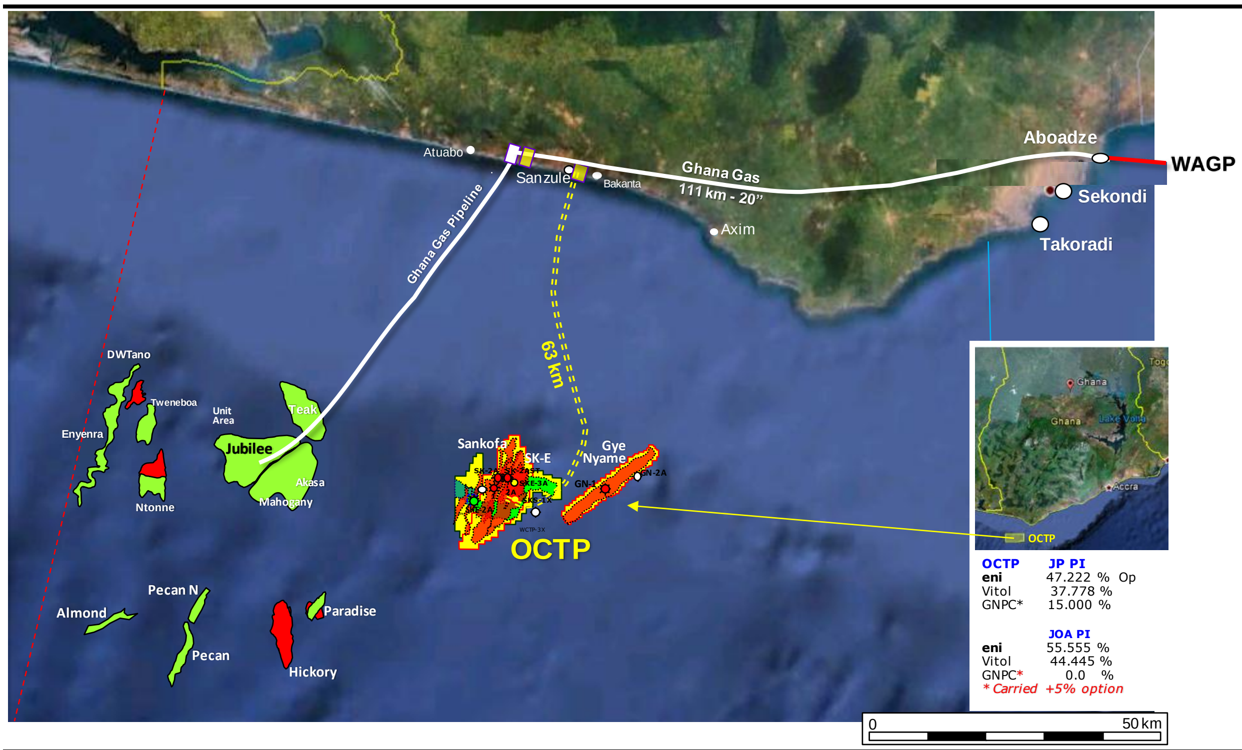
4.1.2 Project Location

The Project includes both offshore and onshore components. The NAG wells, subsea infrastructure, and FPSO will be located in the OCTP Block. The subsea pipeline would run from the block to a shore landing near the town of Sanzule. The onshore components would be located on a piece of land the east of the town of Sanzule.

The OCTP block is located approximately 60 km south of the town of Sanzule. Water depths in the block range from approximately 520 m to 1014 m. Natural gas was discovered in the block in three fields: Gye Nyame, Sankofa Main, and Sankofa East. The Gye Nyame Field is located about 55 km from shore in water depths of ca. 519 m. The Sankofa Fields are located about 54 km from shore in ca. 880 m of water depth.

Figure 4.2 presents a schematic of the overall development and approximate location.

Figure 4.2 Project Location (Phase 2 elements in yellow)



Source: eni, 2014

The shore crossing and the onshore facilities would be located near the town of Sanzule. Sanzule is about 10 km east of the GNGC gas plant near the town of Atuabo (Table 4.1).

Table 4.1 Preliminary Coordinates of Shore Approach and ORF

Facility	Easting [m]	Northing [m]
Export Pipeline Shore Approach	561099.19	548075.19
Export Pipeline End at ORF	561644.28	548873.50
ORF	561794.31	549023.51
Reference System: UTM WGS 84 30 N		

Source: eni, 2014

4.2 PROJECT SCHEDULE

Project construction is projected to last approximately three years, from the end of 2016 to the end of 2019. First oil production in the OCTP Phase 1 project is foreseen in August 2017, while first Non Associated Gas production will happen in February 2018. Table 4.2 provides a summary of the expected timescales for the construction of the major Project components.

Table 4.2 Duration of Construction of Project Components (OCTP Phase 2)

Project Component	Duration of Construction
Well drilling Re-entry and completion	**25 months (with suspensions):** • Drilling of three wells: 3 months, from 14/12/2016 to 18/03/2017. • Re-entry and completion of first two wells: 3 months, from 13/07/2017 to 11/10/2017. • Re-entry and completion of last two wells: 2.5 months, from 20/10/2018 to 05/01/2019. From end 2016 until beginning 2019.
FPSO (OCTP Phase 1)	**30 months for construction** (from 01/12/2014 to 30/06/2017). 40 days for sailing from docks to OCTP Block. 15 days for mooring. Ready for hook up in June 2017.
Subsea system, risers and flowlines installation	**5 months for first 2 wells** (end in February 2018) and **3 months for last 2 wells** (end in November 2019) (Gye Nyame well is not considered at this stage of the project)
Subsea Gas Export pipeline (construction and pre-commissioning)	**4 months** From November 2017 to February 2018
Onshore Receiving Facility	**39 months** • Early works: from Nov 2015 to Aug 2016. • Construction: from Feb 2016 until Feb 2018

Source: eni, 2014

4.3 PRODUCTION PROFILE

4.3.1 Overall Production

The Project will be phased with the aim to produce gas from two of the five wells in February 2018. Sankofa East C and Sankofa Main D) with a raw gas rate of 190 MMSCFD.

In order to maintain peak production, two new wells will be put in production fourth quarter of 2019 (Sankofa 2A ST and Sankofa East D). The Gye Nyame 1 well will be started in 2028. To support peak production, a compression phase is foreseen starting from 2026. The arrival raw gas pressure on the FPSO will be switched from the initial 70 bar to the lower pressure of 20 bar.

Raw gas and condensates peak production is projected to end in 2031. The total hydrocarbon recovery of this phase of the project is summarised in Table 4.3.

Table 4.3 Cumulative Recovery of Gas and Condensates

Raw gas and raw condensates recovery	
Cumulative raw gas [BSCF]	1134
Cumulative raw condensates [MMSTB]	25,4
Total Recovery [MMBOE]	226
Gas recovery Factor [%]	77
Condensate recovery Factor [%]	34

Source: eni, 2014

4.3.2 Reservoir Fluid Composition

For design purposes, the following reservoir fluid compositions have been considered:

- reservoir pressure: 70 bar until 2032, then 20 bar (both Sankofa and Gye Nyame); and
- maximum Reservoir Flow Rates:
  - Sankofa: 215213 kg/h; and
  - Gye Nyame: 61056 kg/h.

Table 4.4 provides the composition and specification of raw gas and Table 4.5 presents the planned composition of the reservoir fluids.

Table 4.4 Composition and Specification of Raw Gas

Parameter	Unit	Raw Gas
Standard Density	kg/m^3	0.93
Water Content Max	lb/MMSCF	200.00
Methane	% mol	85.90
Ethane	% mol	4.44
Propane	% mol	2.86
Butane + Paraffin	% mol	5.96
(C4+)		0.00
H_2S	ppm vol	0.00
Total Sulphur	ppm vol	0.00
CO_2	% mol	0.43
N_2	% mol	0.40
O_2	ppm vol	0.00
Wobbe Index	MJ/m^3	55.20
Arrival Temperature	°C	25.00
Arrival Pressure	bar	20.00
Mass Flow	kg/h	214939.26
Molar Flow	kgmole/h	9845.88
Molecular Weight		21.83

Source: eni, 2015

Table 4.5 Composition of Produced Non Associated Gas

Component	Sankofa (Max Gas in 2022)	Gye Nyame (Start-up 2028)
	Molar fraction	Molar fraction
H_2O	0.0008	0.0050
CO_2	0.0043	0.0052
N_2	0.0040	0.0039
C_1	0.8598	0.8464
C_2	0.0443	0.0535
C_3	0.0283	0.0282
C_4-C_{20}	0.0552	0.0569

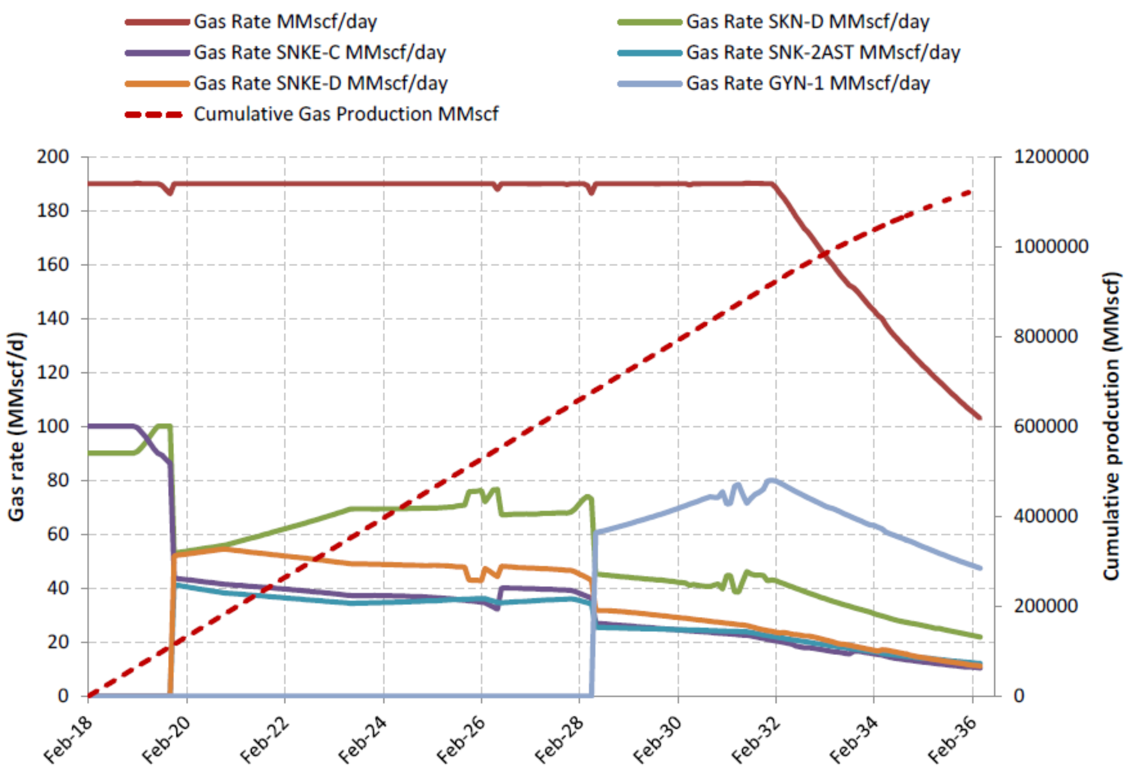
Flow Rates	213411 kg/h	24361 kg/h

Source: eni, 2014

NAG in OCTP project will not contain H_2S as the expected H_2S content is 0 ppm and thus NAG will not pose any H_2S risk to people and environment.

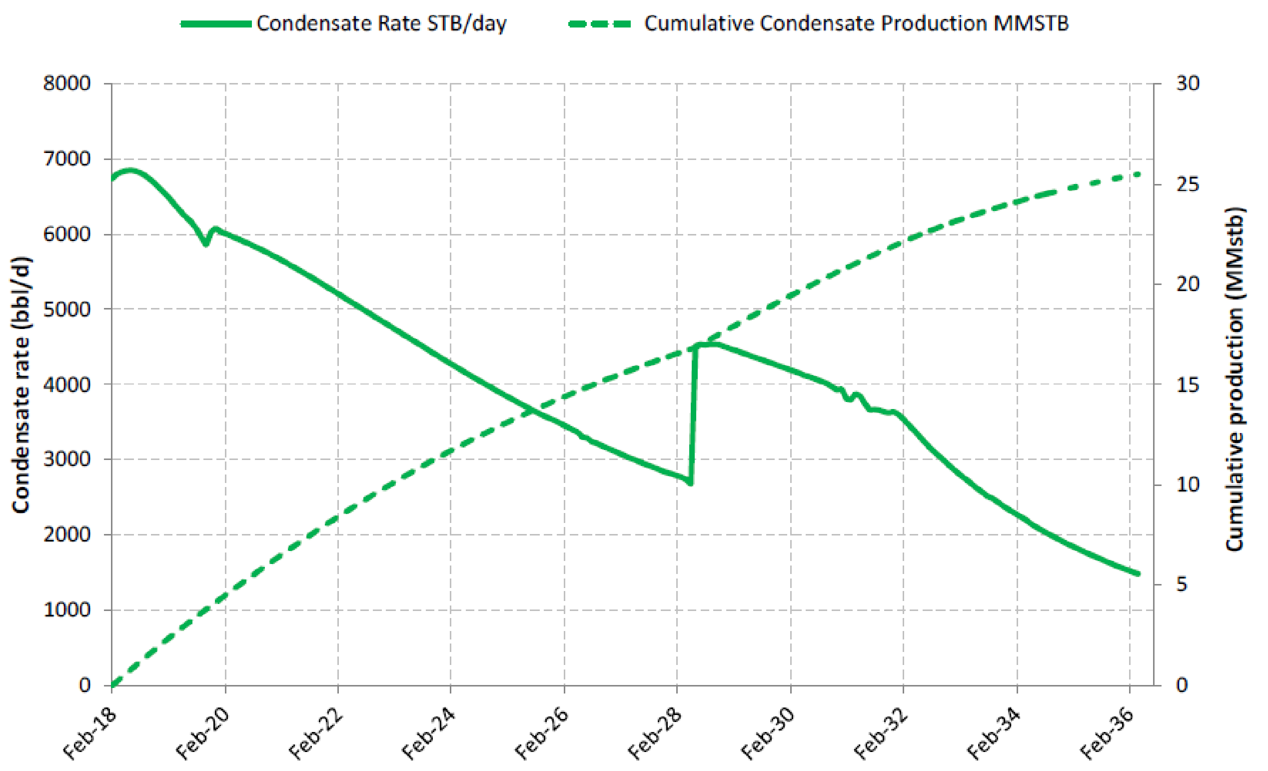
Maximum raw gas production will be about 190 MMSCFD. Figure 4.3 and Figure 4.4 present the production profiles of raw gas and condensates respectively.

Figure 4.3 Profile of Raw Gas Production



Source: eni, 2014

Figure 4.4 Profile of Condensates Production



Source: eni, 2014

4.4 PROJECT DESIGN SPECIFICATIONS

4.4.1 System Capacity

Offshore Facilities

The production flowrate is 190 MMSCFD. The offshore top side facilities, including gas pre-treatment system on the FPSO have been designed to be capable to treat 190 MMSCFD plus a 10%overdesign. Plateau duration is estimated for 13,5 years

The stabilised condensate will be treated on the FPSO mixed with crude oil and then exported together.

Subsea Pipeline

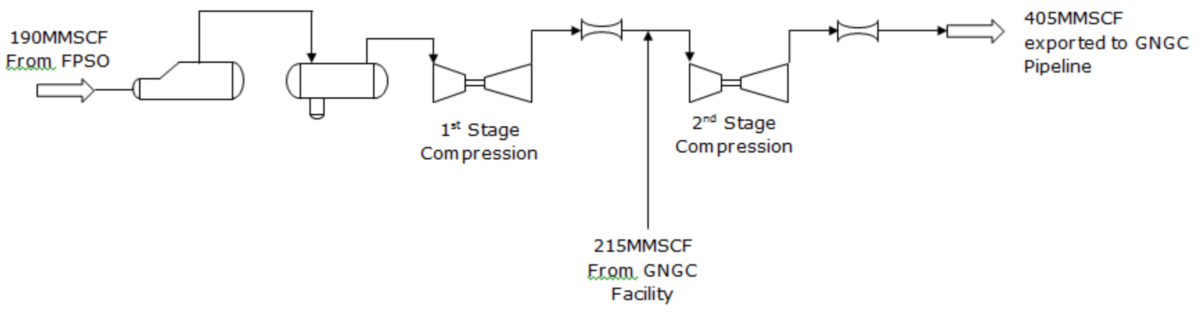
The subsea pipeline connecting the FPSO to the onshore ORF will be capable of delivering up to 320 MMSCFD (including overdesign) of gas.

ORF

The ORF will be designed to compress a maximum of 405 MMSCFD, to handle the gas from the FPSO (190 MMSCFD plus 10% overdesign) in addition to gas potentially arriving into the export sealine from another pipeline in charge to potential other operators. This pipeline will be linked to eni's gas sealine by an already installed inlet T and it is outside of the scope of work of this project. The ORF will be designed to receive and compress also lean gas coming from the GNGC Atuabo gas plant, through the existing pipeline that will be commingled at Sanzule and sent again to the GNGC pipeline, allowing the necessary pressure to arrive at

Aboadze Power Plant. Centrifugal compressors will be in two stages: 1st stage compressor: 2x100% with a capacity of 210 MMSCFD and 2nd stage compressor 3x50% with a capacity of 405MMSCFD.See additional details in the ORF Section.

Figure 4.5 ORF flow diagram



Source: eni, 2015

The 190 MMSCFD arriving from the FPSO will be compressed up to 50 bar in the first stage and then, after metering station, together with an additional 215 MMSCFD of gas coming from GNGC plant in Atuabo, will be compressed in the second stage to 100 bar and exported.

4.4.2 Gas Specifications

Non associated gas will be treated on the FPSO to separate condensates and to dry the gas. The treated "rich gas" will be sent to the ORF where it will be compressed in order to comply with national grid pressure specifications.

The gas will meet the following specification (from the FPSO):

- hydrocarbon/water dew point: - 5°C (about 10°C lower than the minimum sea water temperature of 5°C);
- export Pressure: 56.0 bar; and
- gas composition: no limits to other contaminants.

Table 4.6 Composition and Characteristics of Sales Gas

Composition	Units	Minimum	Maximum
Hydrocarbon Dew Point	°C	-	10 a 41 bar
H_2O (max)	lbs/MMSCF	-	7
CO_2	% vol	-	4
N_2	% vol	-	3
C_1	% vol	85	95
C_2	% vol	-	10
C_3	% vol	-	8
Composition	**Units**	**Minimum**	**Maximum**

C_4-C_{20}	% vol	-	5
H_2S	ppm vol	-	-
Total sulphur	ppm vol	-	28
Delivery Temperature	°C	10	49
Delivery Pressure	bar a	100	100

Source: eni, 2014

4.4.3 Design Life

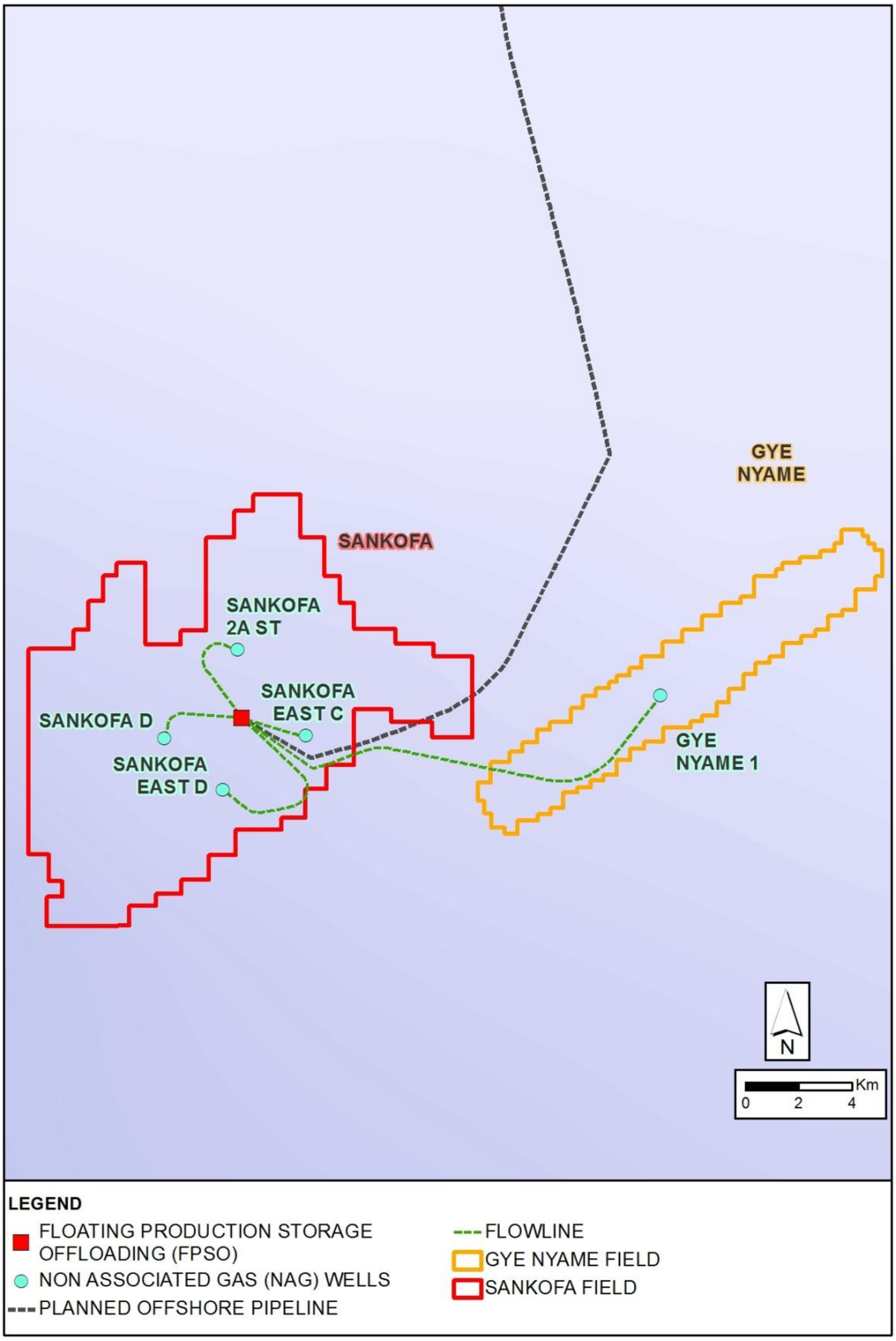
The design life for new installations is set to be 20 years.

4.5 PROJECT COMPONENTS

This Section provides a detailed description of the various Project components.

There will be three new gas production wells drilled. Two of the wells will be re-entered, as they were already drilled during the exploration phase. Well coordinates are provided in Table 4.7 and wells locations are provided in Figure 4.6.

Figure 4.6 NAG Well Locations



Source: ERM, 2014

Table 4.7 NAG Well Locations

Wells	Easting [m]	Northing [m]	Water depth [m]	Status
Sankofa Main D	546627,50	493271,72	947,00	New
Sankofa East C	551976,94	493375,52	811,00	New
Sankofa East D	548847,18	491336,56	948,00	New
Sankofa Main 2A ST	549396,50	496615,96	863,00	Re-entry
Gye Nyame 1	565340,77	494894,25	520,00	Re-entry
Universal Transverse Mercator, WGS 1984, Zone 30N, 6 W to 0 W.				

Source: eni, 2014

4.5.1 Subsea Systems

Overall Description and Design Criteria

The Subsea production system includes subsea umbilicals, risers and flowlines (SURF).

The SPS includes christmas trees (XTs) (also known as production trees), flowlines end terminations (FLETs),gas export Pipeline End Termination (PLET) and subsea isolation valves (SSIVs). SURF includes the flexible connecting lines as well as the rigid 63 km subsea pipeline from FPSO to ORF.

The SPS is tied back (ie, connected) through SURF components to the spread moored Floating Production Storage and Offloading (FPSO) unit.

The main drivers affecting the choice of field architecture are the distance between the wells (they are widely separated) and the presence of two subsea canyons, one bisecting the Sankofa Fields and the other between the Sankofa Fields and the Gye Nyame Fields). The subsea umbilicals and flowline routes will be designed to ensure the feasibility of the project and to give the best flexibility with respect to possible mitigation measures against geohazards. Flexible flowlines, umbilicals and risers will be the preferred option in order to accommodate potential minor seabed irregularities and to allow canyon crossing.

The SPS final design will take into account the following criteria:

- avoiding, if feasible, crossings of flowlines and umbilicals;
- utilisation of well-proven reliable technology and standard qualified equipment;
- use of modular and interchangeable subsea components;
- allowance for future expansion of the system;
- optimization of umbilical and flowline lengths;
- adapt flowline and umbilical routing to the soil bathymetry; and
- possibility of pigging of the flowlines.

Subsea Production System

Gas production wells from the Sankofa Fields will be arranged in a satellite configuration around the FPSO, while the Gye Nyame 1 well will be located 17 km to the north east of the FPSO.

The SPS consists of the following main components:

- five XTs, one for each well (Gye Nyame 1 XT is future and will be installed only when production from Gye Nyame 1 well will start);
- five FLETs, one for each well (Gye Nyame 1 one is future);
- two Gas Production SSIVs (from wells Sankofa East D and Gye Nyame 1);
- one Gas Export SSIV; and
- one gas export Pipe Line End Termination (PLET).

XTs will all be horizontally type to achieve optimization and standardization. They will all be similar in terms of wing block and spool body with the same subsea control module (SCM), flow control module (FCM) and chemical injection porting.

The main purpose of SSIV system is to prevent accidental release of hydrocarbons from the flowlines in case of emergency. For this Project, each SSIV will have a single piggable header with connections for flowline and riser, except the gas export SSIV, whose header is not piggable. The SSIV will be hydraulically controlled with a dedicated control panel located on the FPSO. .In case of maintenance remotely operated vehicle (ROV) intervention will be possible.

During normal operating conditions, production data and supervision will be acquired and controlled by the electro-hydraulic production control system. The hydraulic system loop will contain biodegradable hydraulic fluid, mainly composed of water and glycol. The system will be open loop and its venting line will return to the FPSO.

There will be continuous injection of mono ethylene glycol (MEG) into the Subsea Production System to prevent hydrate formation risk.

A study to identify which kind of material shall be foreseen has shown that sour service material will needed for gas export, and thus equipment material and manufacturing specification and operational protocols will account for this. The same studies highlight that gas souring is not due to H_2S but to CO_2 increase..

SURF

Table 4.8 summarizes the key characteristics of the SURF components.

Table 4.8 SURF Characteristics

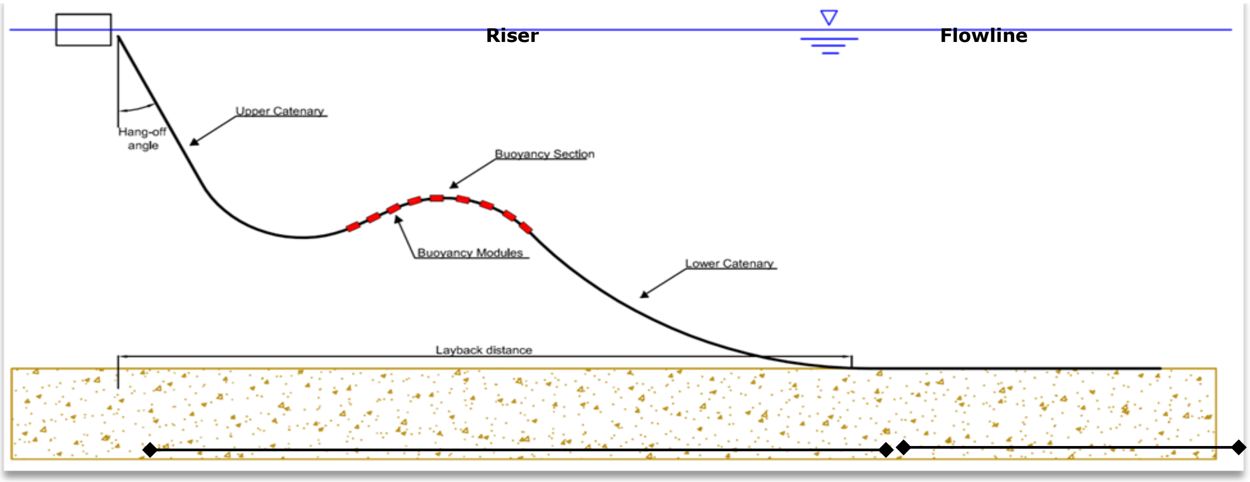
Route	Type	Length (m)	Diameter (")
Sankofa D to FPSO	Gas Production Riser	2703	8
	Gas Production Flowline	1333	8
Sankofa East C to FPSO	Gas Production Riser	2952	8
	Gas Production Flowline	109	8
Sankofa East D to FPSO	Gas Production Riser	3258	8
	Gas Production Flowline	4842	8
Sankofa 2A ST to FPSO	Gas Production Riser	2509	8
	Gas Production Flowline	2442	8
Gye Nyame 1 to FPSO	Gas Production Riser	3775	8
	Gas Production Flowline	14782	8
FPSO to the ORF	Gas Export Riser	3568	10
	Gas Export Riser	3571	10
	Gas Export Pipeline	62700	18

Source: eni, 2014

The use of unbounded flexible umbilicals, risers and flowlines will allow canyon crossing and will minimize seabed and soil geohazards as well as possible dangerous impacts due to turbidity currents flows along canyons. The flowlines and risers design will consider environmental conditions, seabed profile and operating conditions. Water depth ranges from 500 m to 950 m and 20 years of life service is planned. For these subsea infrastructures, water depth is enough to avoid any interference with fishing activities and thus no protection of equipment is required.

Risers will be installed with the so-called "lazy wave" configuration (see Figure 4.7) in order to obtain a touch down point outside the canyon. Thus, a series of synthetic foam buoys will be clamped to the riser. In Figure 4.7 riser (part of pipeline that connects the FPSO with the seabed) and flowline (laying on the seabed) are shown.

Figure 4.7 Lazy Wave Configuration



Source: eni, 2014

4.5.2 Floating Production Storage and Offloading (FPSO) Unit

Overview

The FPSO unit will be installed as part of the Phase 1 development, for which it has the following main purposes:

- separate, process to export specification, store and offload oil;
- separate, dehydrate, compress and re-inject associated gas;
- separate, treat and re-inject produced water; and
- lift, treat and inject sea water.

The FPSO unit will be located in the OCTP Block (Table 4.9).

Table 4.9 FPSO Location

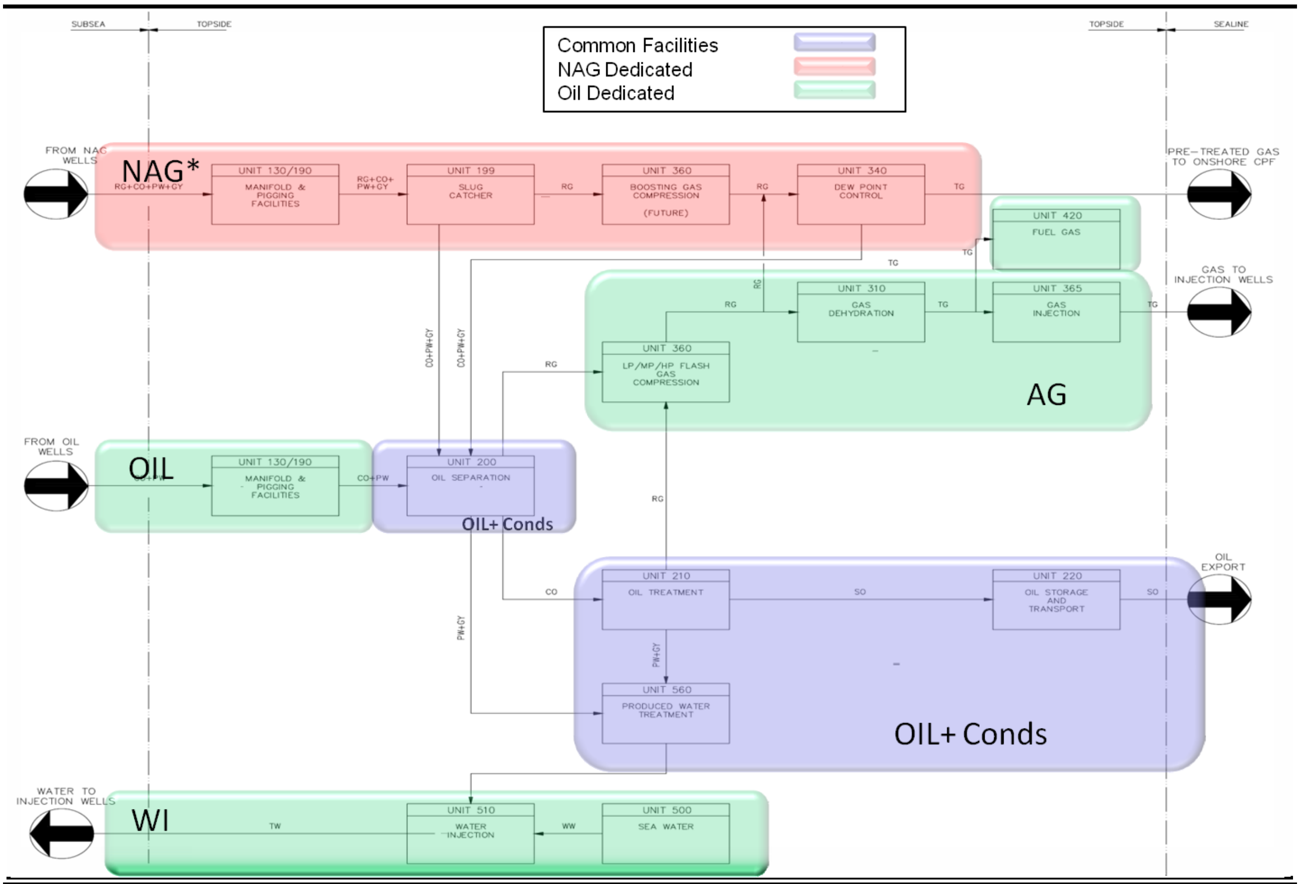
Item	Easting [m]	Northing [m]	Water Depth [m]
FPSO Centre	549548,85	494023,11	1000

Source: eni, 2014

The FPSO will be equipped to support the processing of Phase 2 NAG: separation of condensates, control of hydrocarbons and water dew point, and export of gas to the ORF.

Utilities will be common for the two phases of the project and will be designed accordingly.

Figure 4.8 FPSO Unit Schematic Layout



Source: eni, 2014

The FPSO will be constructed through the conversion of an existing very large crude carrier (VLCC). The FPSO will be a double hull and will be classified with DNV that will ensure all the hull requirements are in accordance to international and local standards. FPSO will be inspected as per DNV class requirements. The design, the positioning and the configuration of the FPSO is according to worst meteo conditions (wind – 100 years, wave 100 years, current 10 years, squall) return period.

FPSO hull is designed to withstand the 20 years of operation considering the plate thickness at conversion year. Moreover, in order to mitigate tank corrosion, a corriosion protection coating will be applied to all ballast tanks and upper and bottom cargo tanks surfaces.

The FPSO will have a double balcony in order to avoid risers and flowlines crossings on the canyon. In fact if the FPSO were in a single balcony configuration some of the risers would have crossed the FPSO underwater passing the canyon. A double balcony configuration avoids this crossing. The two configurations have been investigated and because the level of risk in the two cases is the same, the double balcony case has been chosen to reduce the field fluids inventory and to make simpler the configuration of the risers and in general the Subsea Production System. The FPSO mooring design is based on the worst sea and weather conditions taking into account the squall conditions of the region; moreover, the site is classified by DNV as having benign conditions. The FPSO will be classed for uninterrupted service, without needs for dry-docking (moving from operations location) during the expected service life of 20 years. The FPSO unit will have all necessary utilities for safe operation during most harsh weather conditions reported in the basis of design.

The FPSO will be able to accommodate a total of 136 persons on board (POB), with 120 persons in permanent beds and 16 persons in temporary beds. Temporary beds will be fitted in single cabin.

The following figure shows a schematic of a double-balcony FPSO.

Figure 4.9 Schematic of a Double Hull and Double Balcony FPSO

Source: eni, 2014

FPSO safety design criteria are discussed and presented in Section 4.11.1, together with personnel safety equipment.

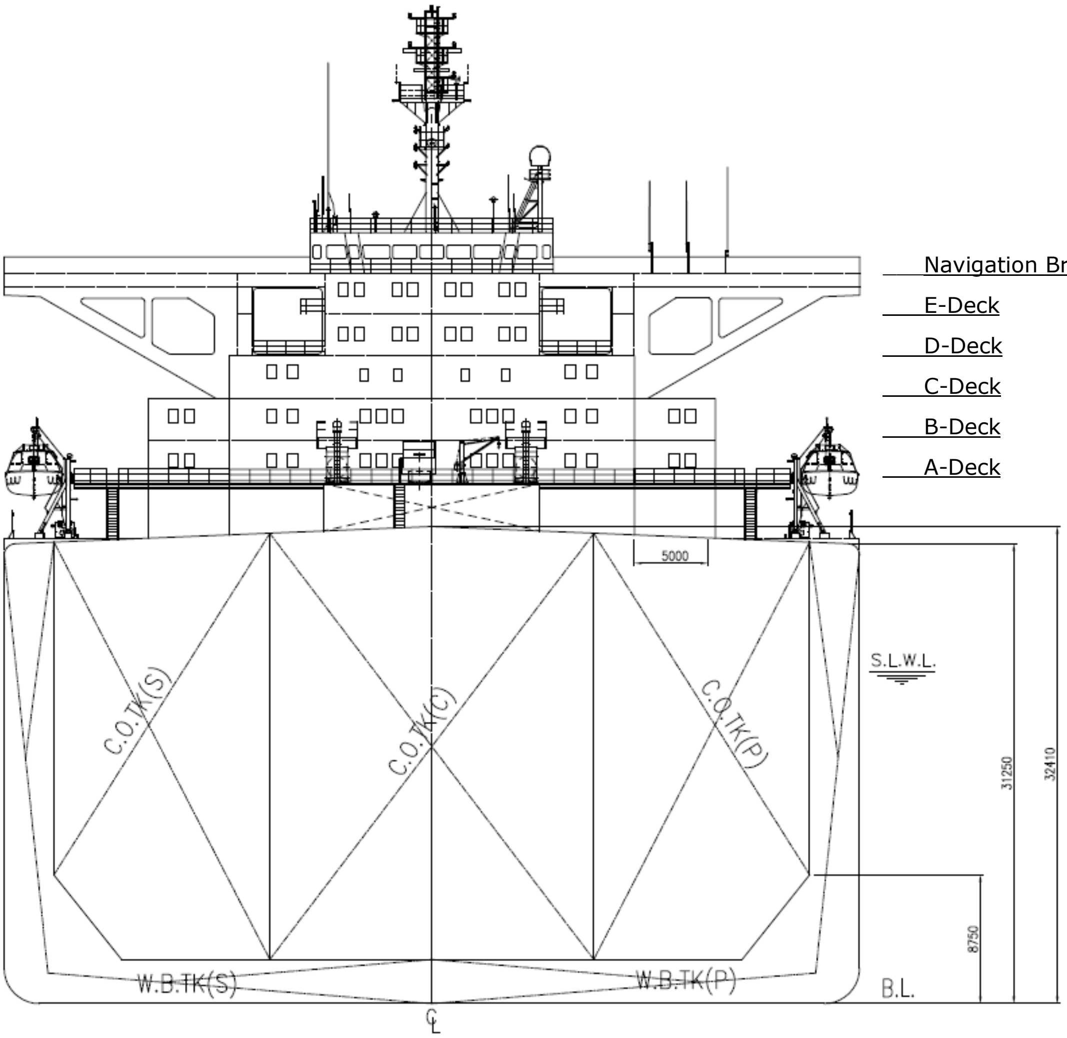
Accommodation on the FPSO

The FPSO accommodation consists of two parts: forward existing living quarters, and aft new living quarters. A typical living quarters view is reported in Figure 4.10.

- Forward existing LQ: will be modified with the existing block being extended approximately 5m outboard on both sides for upper deck, A-deck and B-deck. The forward LQ is designed for 40 persons in permanent beds, and 16 persons in temporary beds. All the decks of existing accommodation will be refurbished in accordance with eni related standards.
    - Upper deck will include cold rooms, dry provision store, 6-men dormitory, laboratory, extended HVAC room, instrument equipment room, UPS room, battery room, existing machinery rooms (foam room, HPU room, fire control station), changing room and laundry.
    - A-deck will include extended mess room, new galley, main lounge, extended Central Control Room and smoking room.
    - B-deck will include new offices, new conference room, existing lounge, gymnasium and laundry, new recreation rooms, new store and cabins.
    - C-deck existing layout is retained and mainly consists of cabins.
    - D-deck is dedicated to Client occupancy and consists of 4 single occupancy cabin and 1 double occupancy cabin.
    - E-deck existing layout is retained.
    - Navigation bridge layout is retained except a new Telecommunication Equipment Room is fitted at the starboard aft corner.

- Aft new living quarters: A new 4-deck living quarters able to accommodate 80 persons will be installed on the sunken deck, aft of engine casing. The new LQ block will include medical room of 100 m^2 (in compliance with applicable international standards and in particular NORSOK) recreation room, changing rooms, laundry, heli-lounge, HVAC room and walkway access to helideck.

Figure 4.10 FPSO Typical Living Quarters view



Source: eni, 2015

FPSO Construction activities

FPSO construction activities will be carried out outside Ghana. The FPSO unit will be constructed in an onshore construction yard in Singapore and then will navigate under its own engine to the selected installation site (8500 km). eni will assure compliance of the construction yard of the FPSO with Company's policies through audits regarding HSE, human resources, human rights, as foreseen in the ESMP framework. In particular HSE requirements for the FPSO construction contract (eni standard 1_3_1_30_Contract HSE requirements for Abroad Activities) will require the compliance of contractor HSE management system to eni HSE integrated management system. An HSE disciplinary policy is also foreseen for this specific project.

Risk will be assessed for all project activities, including FPSO navigation from construction yard to OCTP Block, as required by eni standards and HSE contract requirements set for all the contracts within the framework of Ghana OCTP project.

Only mooring and installation activities of the FPSO will take place in the offshore of the Ghana Western Coast. The OCTP FPSO will be installed in the project area during the OCTP Project Phase 1.

FPSO Topside Facilities

The FPSO topside layout is presented in the following Figure 4.11.

The main bases of design for the topside layout are:

- segregation between personnel accommodation and process modules;
- process modules location in order to locate high hydrocarbon inventories in the centre of the FPSO and high pressure and high toxicity modules far from low pressure and low toxicity modules. The flare will be located in the high pressure/high toxicity area, while the accommodations are located on the other end of the FPSO.

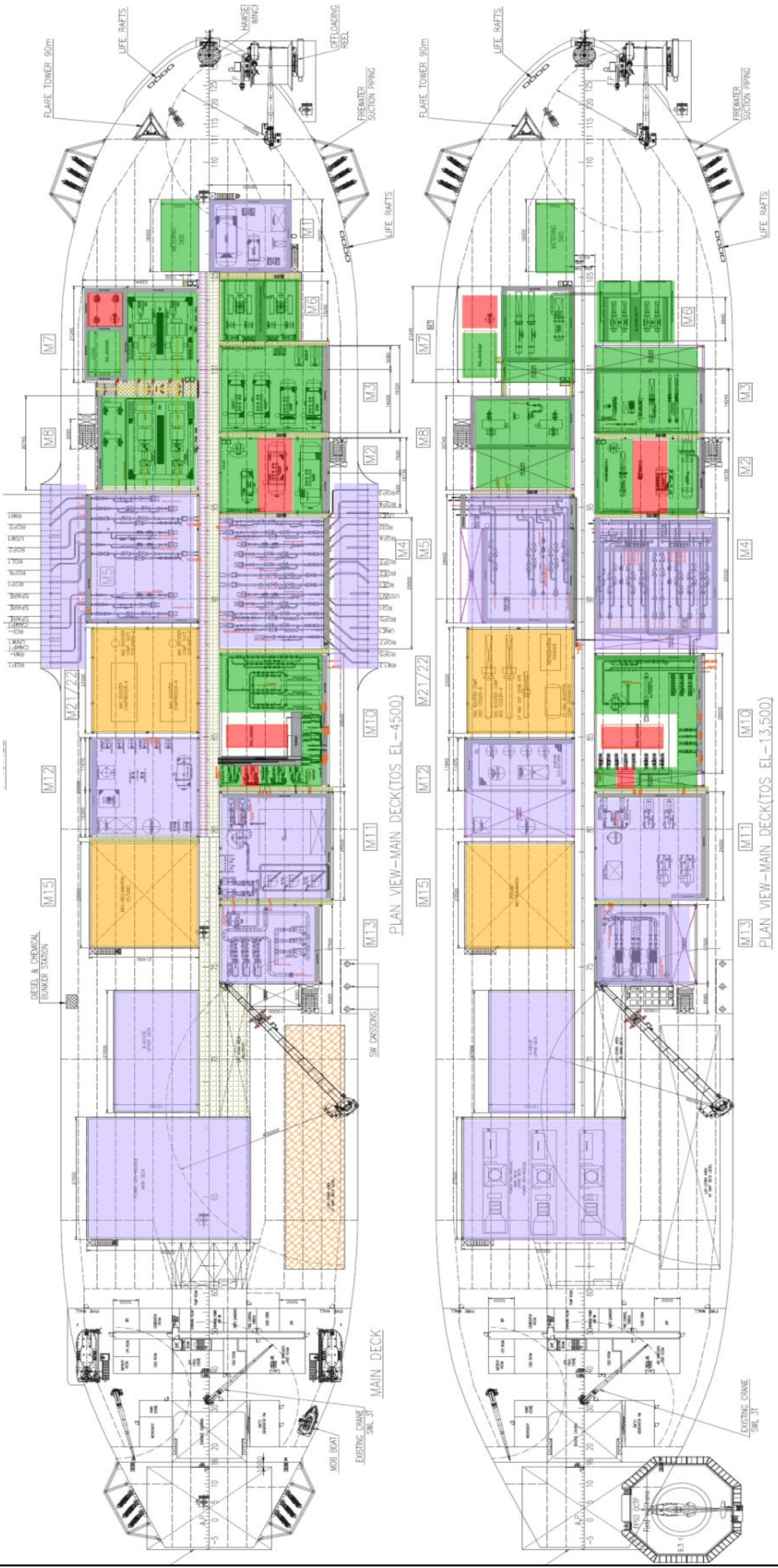
The FPSO NAG design capacities are as follows:

• gas production	210 MMSCFD (including overdesign)
• condensate production	8000 bblsd
• water production	1000 bblsd
• gas treatment capacity	210 MMSCFD (including overdesign)
• booster compressor capacity	210 MMSCFD (future installation)

The FPSO oil design characteristics are:

• total liquid capacity	75,000 bblsd
• oil treatment capacity (including condensates from NAG)	58,000 bblsd
• produced water treatment capacity	45,000 bblsd
• gas injection capacity	150 MMSCFD
• water injection capacity	55,000 bblsd

Figure 4.11 FPSO Unit Overall Layout



OIL&AG

NAG & CONDENSATE (BASE SCOPE)

NAG & CONDENSATE (FUTURE)

COMMON FACILITY

Source: eni, 2014

FPSO Process

The production fluids from the Campanian age reservoirs will be produced separately in dedicated production flowlines and risers before being routed to a separate gas production manifold. This manifold will transport the fluids from five gas production risers to the Slug Catcher initially operating at 20 Barg. The Slug Catcher will be designed to separate gas, condensate and a mixture of MEG and water. The liquid condensate stream will be sent to Slug Catcher Condensate Heater before being reduced in pressure. It is then commingled with the liquid hydrocarbon before it is sent to HP Separator Inlet Heater. The MEG separated is sent to the MEG Regeneration System. From year 2032 onwards, when the saline produced water production commences in the gas condensate, the MEG from the Slug Catcher will be sent separately to a future MEG Reclamation System. The gas stream is sent to the NAG Gas/Gas Exchanger before pressure dropped across the JT Valve for dew point control. The cooled gas is then sent to Low Temperature Separator for removing the condensate and the MEG injected in the NAG Gas/Gas Heat Exchanger. MEG flow rate for hydrate suppression will be adequate to wet all the tubes in the heat exchanger by proper spraying. The MEG is co-mingled with the MEG from Slug Catcher and sent to MEG Regeneration System. The gas from Low Temperature Separator will exchange heat with the inlet gas in the NAG Gas/Gas Heat Exchanger before being sent to shore in order to avoid HC/water condensation in the sealine.

In the future years when the reservoir pressure declines to 20 Barg, LP NAG Booster Compression System will be installed to compress the gas to 70 Barg before it is sent to J-T valve.

Additionally, the MEG from future NAG Compression Separator will be routed to a future MEG Reclamation package, as produced water break through is predicted to occur at the end of field life (2034). Condensate will be routed to the MP Separator whilst the gas will be routed to the future Booster, overall the system is designed to meet the following battery limit specifications:

- Export gas pressure (BL) = 56 bara
- HC dew point = -6 °C

FPSO Utilities

FPSO utilities will be designed and operated in common for the two project phases. They are summarised here.

Chemical injection system will consist of all equipment and piping associated with chemical injection, including storage tanks, injection pumps, transfer pumps and all required instrumentation up to injections points on the FPSO or subsea. The main scope of chemicals injection will be to provide chemicals to meet production specification or to avoid corrosion and hydrates plugging.

Flare, vent and blowdown system will be designed to satisfy the zero flaring philosophy adopted for the entire OCTP project. It will provide safe relief when pressures increase above operation levels as they allow the outflow of hydrocarbon fluids relieved from process equipment and relief valves during start-up or process upset conditions. The FPSO will be equipped with two independent flare systems, one for high pressure (HP) flows and one for low pressure (LP) flows that can operate simultaneously. It will be designed for emergency burning. The HP flare will be equipped with a sonic flare tip, while the LP flare will have a pilot flare tip. All the flare system will be designed and constructed in compliance with API Technical Standard 520 and 521. The flares will be designed not to exceed allowable noise and thermal radiation limits, when continuously burning the full gas production rate of the FPSO or blowing down all the process trains. Continuous flaring will not be allowed during normal operations, with the exception of flare pilots and blow-down header purge. Flaring will be allowed only for emergency and maintenance services. Inert gas for cargo tank blanketing system will be used, during loading and offloading operations the gas will be safely vented with no operational flaring foreseen.

Monoethylene glycol regeneration for hydrate inhibition unit will be involved only in NAG treatment and production and it will be a future unit, to be installed only if and when there will be presence of free water in the reservoir fluids. Provisions of space, utilities and tie-ins are already foreseen in current topside FPSO design. MEG will be injected in subsea wells to inhibit hydrate formation and in the water separation process. During the early years of production, when formation water break-through has not yet occurred, no MEG regeneration will be required.

Fuel gas conditioning system will provide clean, superheated natural gas to gas turbines and each other end user on the FPSO. The fuel gas system will be designed for an operational flowrate of about 30 MMSCFD.

Inert gas will be used for **blanketing** process equipment and purging flare stack. Inert gas is used to avoid contact between combustive and combustible gases and therefore the formation of explosive mixtures. Also cargo tanks will be blanketed with inert gas in order to mitigate risks of possible explosions due to the tank space and complex confined geometry of the double hull FPSO.

Main power generation The FPSO will have 3x50% Gas turbines (each of 34 MW ISO, type LM2500+ G4) for main power generation purposes. All 3 units will be equipped with a Waste Heat Recovery Unit (WHRU) for recovery of exhaust heat for the heating medium Electrical power generation will ensure adequate capacity to feed vessel and topside loads in all operating conditions with a minimum sparing philosophy of N+1.

Essential power generation will be assured by diesel generators. It will cover loads necessary for life support, accommodation, communication, safe navigation, emergency and safety, start-up of the first main power generation

A diesel power generator will provide **Emergency power supply** to all topside and vessel end users. It will be independent from the other power generators and will be located in a dedicated shelter. It will ensure safe emergency shutdown of the production facilities together with emergency control and life support system. It will guarantee a minimum autonomy of 24 h.

Produced water treatment to remove oil and solids from produced water to comply with reinjection requirements and, in case of injection system unavailability, overboard discharge regulations. The treatment system will be sized to process 45000 bblsd of produced water to reach an oil content in treated water of 20 ppm. Table 4.10 presents the produced water requirements for reinjection or overboard discharge in compliance with local legislation and international standards. The project will involve the total reinjection of produced water. It will be discharged into the sea, after treatment to reduce the oil content to 20 ppm, only in case of unavailability of the water injection system. This will be in compliance with IFC EHS Guidelines for Offshore Oil and Gas Development that require reinjection and allow discharge to the sea with a maximum oil and grease content of 42 ppm for maximum one day and an oil and grease content of 29 ppm on a 30-day average.

The Produced Water Treatment System will receive production water from the high pressure, medium and low pressure separators. The water treatment system will consist of the following steps:

- Degasing in the Produced Water Treating System;
- Cooling in the Produced Water Cooler;
- Two stage oil/water separation in two Slop Tanks connected in series; and
- Hydrocyclone system to further de-oiling.

Table 4.10 Produced Water Characteristics after treatment

Analyte	Concentration (mg/L)
Salinity as NaCl	22,100
Na	8,500
K	110
Ca	260
Mg	70
Ba	55
Sr	23
Cl	13,400
Br	55
SO_4	2
Alkalinity	840
H_3BO_3	50
Oil	20
Grease	Not applicable: no presence foreseen in produced water.

Source: eni, 2014

The produced water characteristics will be also in line with the guidelines adopted in the EPA Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development (2010).

The produced water treatment process will encompass collection of produced water from separators and 1st and 2nd stage desalter and its treatment in the produced water degasser, operated at low pressure. Produced water will be then pumped from degasser to produced water hydrocyclone, where bulk entrained oil is separated under centrifugal action. This typically will allow oil in water content reduction to less than 100 ppm.

Produced water will be then cooled by produced water cooler before entering produced water induced gas flotation (IGF) vessel, where the induced gas bubbles coalescence and float oil droplets in produced water.

The produced water will be then pumped to produced water nutshell filters, used to further reduce the oil and suspended solids content. After filtration water will be suitable for reinjection.

Then the treated produced water will be feed into treated produced water buffer tank and routed to water injection pump. Treated produced water buffer tank will also serve as a reservoir for jet water pumps (used for sand jetting at the separators and desalters).

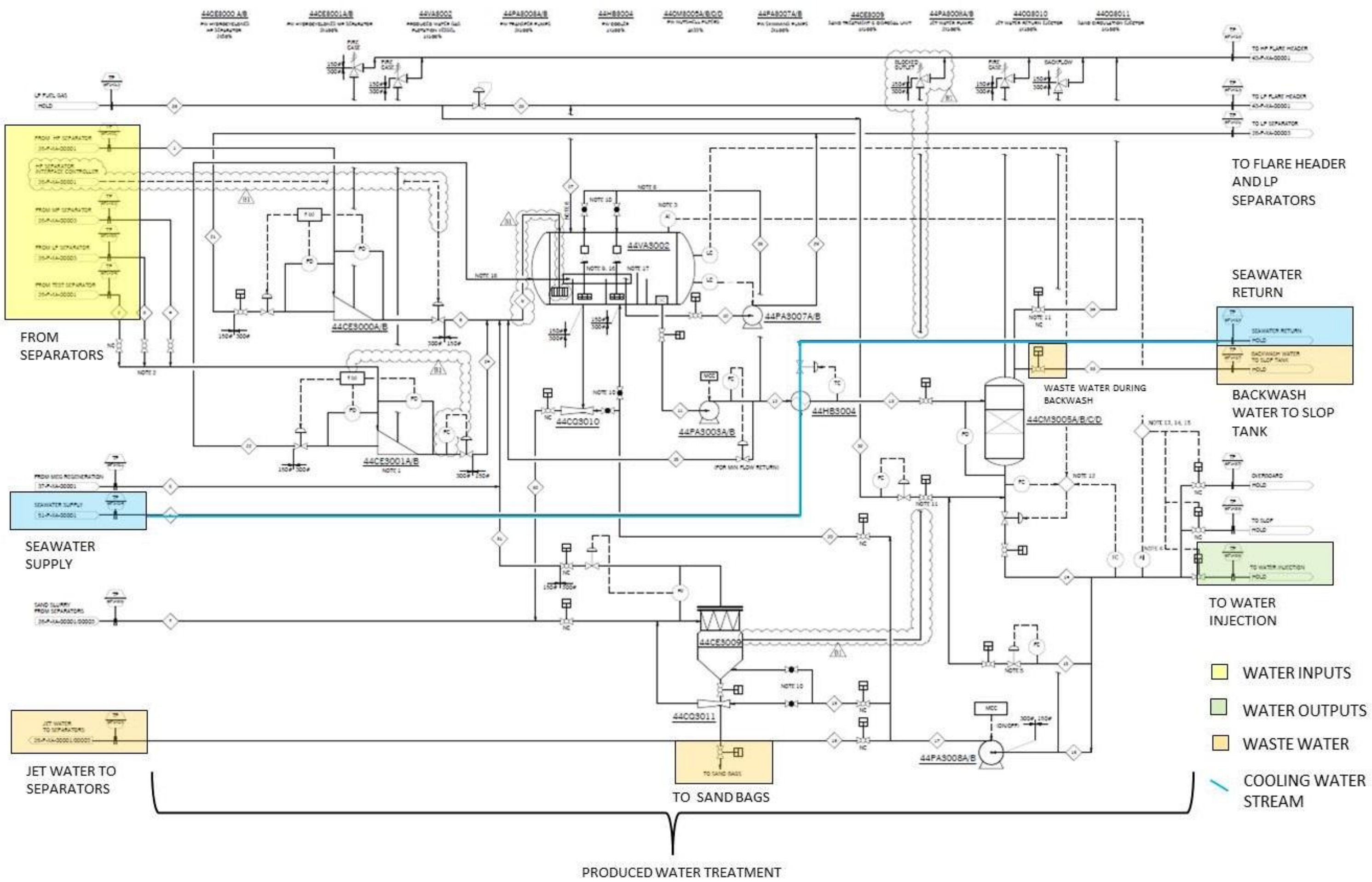
Nutshell filter backwash water will be feed into nutshell filter backwash water receiver, which will accumulate the high flow rate of backwash water and will allow reduced flow rate to the centrifuge. The solid particles will be separated from the backwash water by nutshell filters backwash water centrifuge.

Sand washing vessel with desander hydrocyclone will be used to separate sand from jet water from various separators and desalters. When the sand level will reach a certain level in the vessel, the sand slurry will be recirculated across the desander hydrocyclones. The cleaned sand will be discharged from the vessel into polypropylene bags for transport to shore.

The produced water treatment is shown in the flow diagram reported in Figure 4.12. The flow diagram highlights in yellow the water inputs to the entire process and in green the output. Cooling water stream (sea water) is highlighted in cyan. Produced wastes (highlighted in orange in the flow diagram) are:

- Sands, that will be discharged from the vessel into polypropylene bags for transport to shore.
- Collected oily waters, that will be separated from oil fraction in a separator. Recovered oil will be filtered and collected in a tank for offshore disposal as waste.
- Treated water, that will be sent to liquid waste collection tank and then discharged to the sea.

Figure 4.12 Produced Water Treatment Flow Diagram



Source: eni, 2015. Modified by ERM.

Fire-fighting systems on the FPSO will depend on the location and associated risks in the protected area. Topside modules will be protected by a pressurized water and foam deluge system, activated manually by the control room or automatically by fire detectors, depending on protected areas. Cargo tank, deck, helideck and offloading station will be protected by low expansion foam system, while high expansion foam systems or clean agent extinguishing systems will protect machinery and equipment spaces.

Cooling water in the way of seawater will be used. It will be supplied from the sea using lift pumps, treated with antibiofouling and biocides and filtered. Intake water will have a temperature of 16°C and discharged water will reach about 31°C. This temperature increase will assure a temperature increase of no more than 3°C at the boundary of the initial mixing zone. This temperature increase was calculated on the basis of Hysis model. The boundary of the mixing zone can be identified with results of the mixing model. Approximately 1700 m^3/h of cooling water will be discarded. Typical antifouling/biocides concentration will range between 2 to 5 ppm during normal operations, if operational problems are experienced a batch treatment will be performed with higher doses of around 400 ppm. Selected chemicals for cooling water will be non-toxic for marine biota and environment: in particular Bactron K31 will be used on the FPSO. This chemical is classified as Gold and thus as least toxic of classification levels: in its only component is Glutaraldehyde that is moderately toxic to aquatic animals and moderately to highly toxic to algae. Due to its short life (degraded within days) in the environment, glutaraldehyde has minimal impact on the environment.

Drainage systems will be provided to handle effluent produced from the topside facilities:

- non-hazardous open drain system, collecting drainage from deck areas;
- hazardous open drain system; and
- closed drain system, collecting drainage from equipment, used only for maintenance purposes.

The closed drain drum will have sufficient capacity to accommodate the largest single liquid inventory. Hazardous open drain will be designed to collect drainage from open areas within hazardous areas of the process where oil spills are possible. Non-hazardous open drain system will collect drainage from the non-hazardous areas.

Collected oily waters will be separated from oil fraction in a separator. Recovered oil will be filtered and collected in a tank for offshore disposal as waste. Treated water will be sent to liquid waste collection tank and then discharged to the sea.

4.5.3 Export Pipeline

This pipeline is designed to transport NAG, after treatment on the FPSO, to the ORF. A section of about 63 Km of the pipeline is offshore, while the last portion (approx.1.5 km) is onshore. The gas export pipeline is made up of the following:

- A first section (riser) made of flexible pipeline from the FPSO to the SSIV, in a lazy wave configuration;
- A second section made of 20" ID/22" OD rigid pipeline from the PLET to the onshore approach. For this section burial is foreseen only in the near shore part (Figure 4.18); and

- A third section made of 20" ID/22"OD rigid buried pipeline from shore approach to the ORF.

This pipeline will have the following characteristics (Table 4.11).

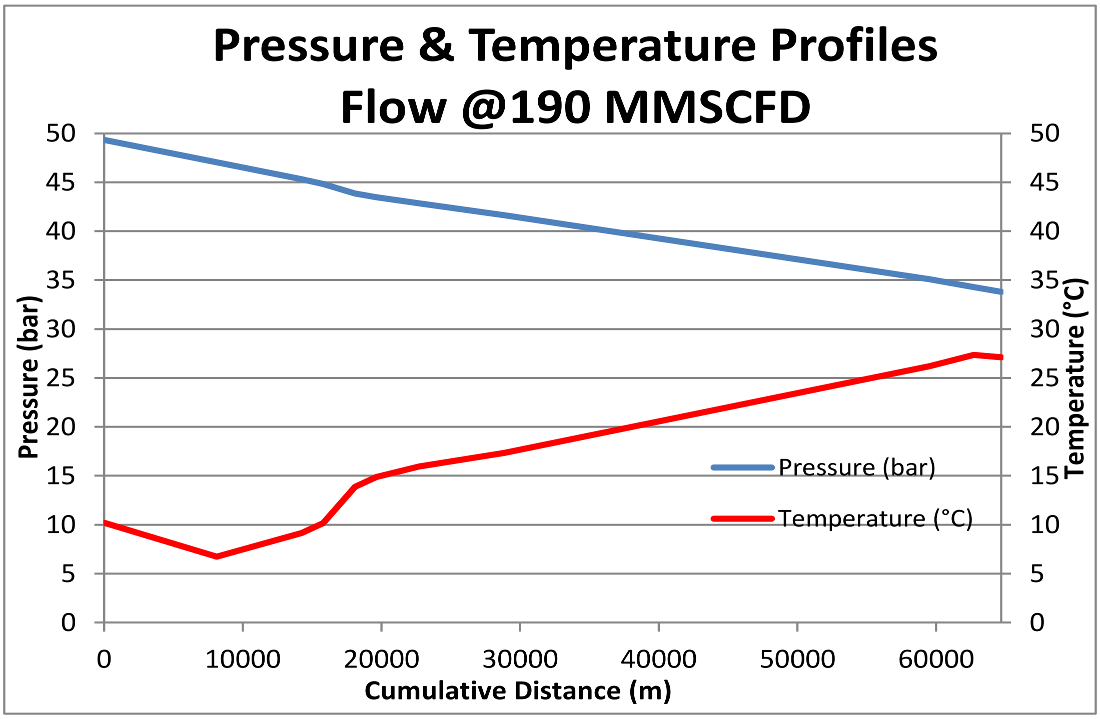
Table 4.11 Gas Export Pipeline main characteristics

DESCRIPTION	GAS EXPORT SEALINE
External Diameter (inch)	22
Design Pressure (bara)	80
Design Temperature (°C)	50
Maximum operating pressure at shut-in (bara)	70
Operating pressure profile (bara)	see Figure 4.13 below
Operating temperature profile (°C)	
Maximum operating pressure (bara)	50
Maximum operating Temperature (°C)	27
Minimum design temperature (°C)	0
Pipe thickness [mm]	23,83(1) and 26,97 (1) (26,97 mm for approximately 5 km from shore)
Anticorrosion Coating	See Table 4.12 below
Cathode protection	Sacrificial anodes
Maximum design for the linear velocity of the gas in the gas-pipeline [m/s]	12
Design Flow rate [MMSCFD]	210
Operating Flow rate [MMSCFD]	190

(1) Mainly due to the pipeline protection versus fishing activities respect to the effects of the internal, external pressure and temperature for all phases of the project.

Source: eni, 2015

Figure 4.13 Pressure and Temperature profile at 190 MMSCFD



Source: eni, 2015

Table 4.12 Gas Export pipeline external coating

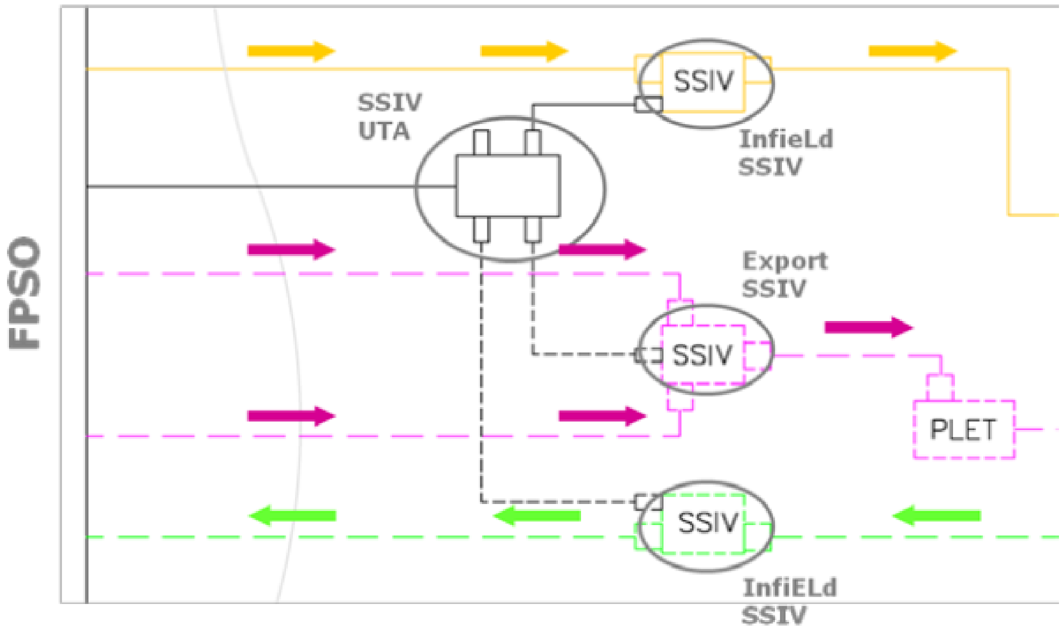
Diameter (inch)	Linepipe	Type	Min. Thickness	Density
		(-)	(mm)	(kg/m^3)
22" ID Gas Export Sealine	No Concrete Coated Pipe	High Density Three Layer Polyethylene	4.2	950
	Concrete Coated Pipe	High Density Three Layer Polyethylene with Rough Coat	4.2	950

Source: eni, 2015

The pipeline wall thickness will be designed to take the stress resulting from the inner gas pressure and the expected external loads during its operation. This pipeline will be in compliance with relevant standards (e.g., European Standard EN1594). A proper pipeline design factor will be selected in compliance with European Standard EN1594.

Offshore Pipeline Section

Figure 4.14 Subsea Isolation Valve System



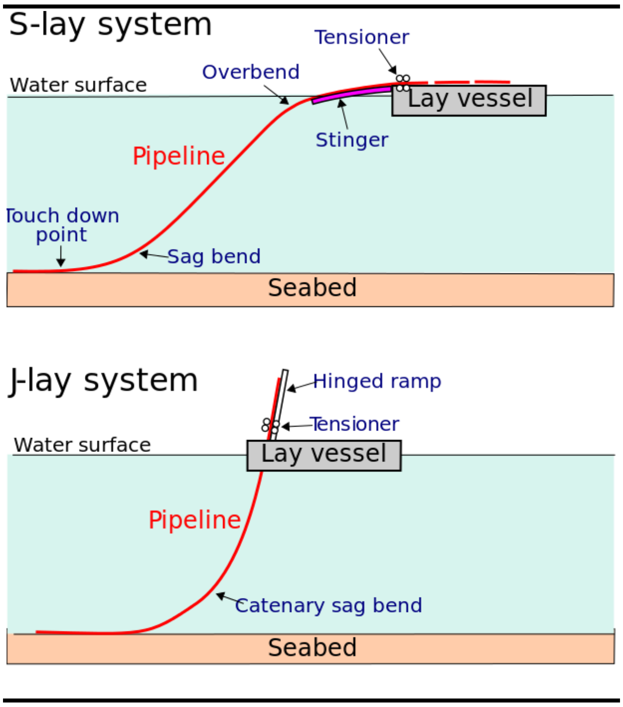
	Gas Injection
	Gas Production
	Gas Export

Source: eni, 2014

Due to the presence of very rough features on the seabed in shallow water along the continental shelf, the pipeline will cross outcropping formations, and thus several intervention works will be necessary to manage pipeline stress. Such works will be carried out mostly before the pipeline is laid by levelling portions of outcrops that are unsuitable for pipeline laying. In some cases, post trenching works with the same purpose will be carried out after pipeline laying.

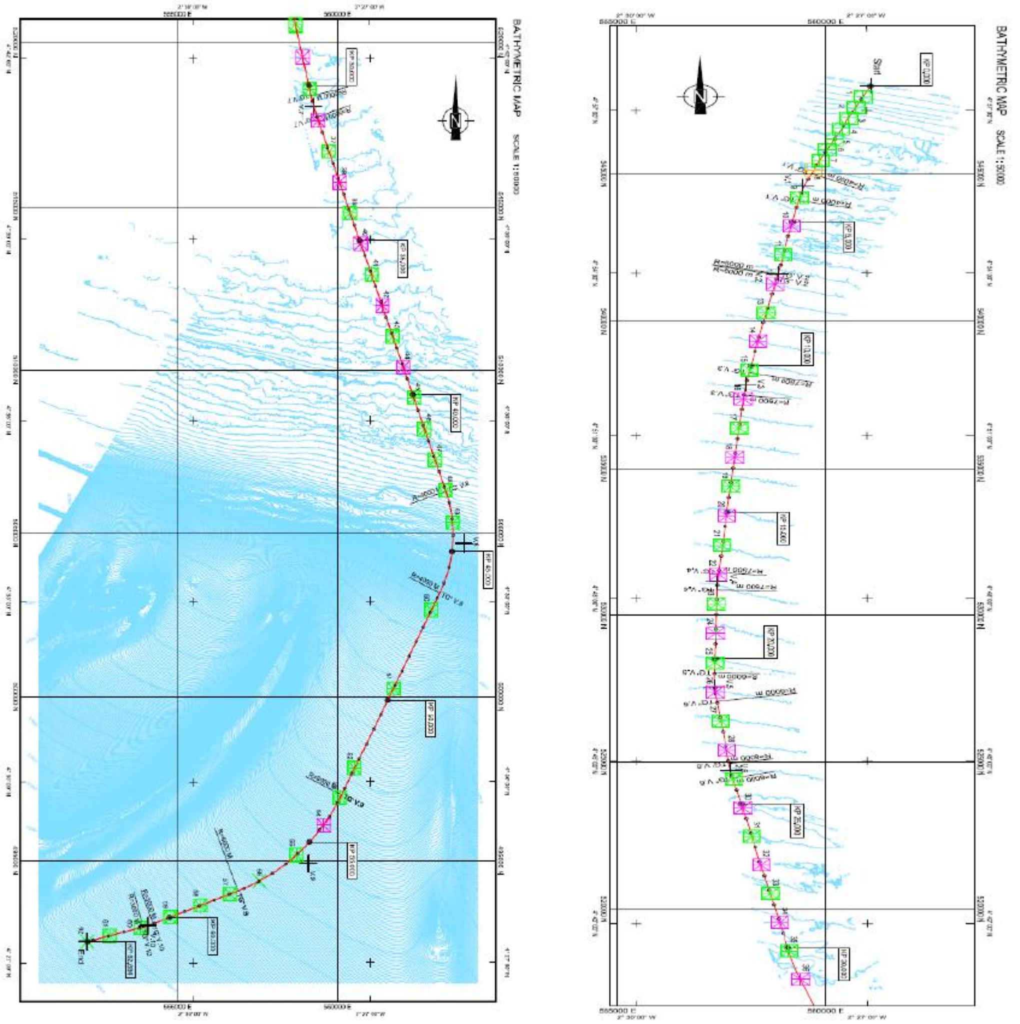
The main subsea pipeline will be laid down by two lay barges using the S laying mode for shallow water section and J laying mode, for the deepest water. The two laying methods are showed in the next Figure 4.15.

Figure 4.15 S-lay and J-lay methods



Source: ERM, 2015

Figure 4.16 Export Gas Pipeline Route Left: Deepwater. Right: shallow Water.

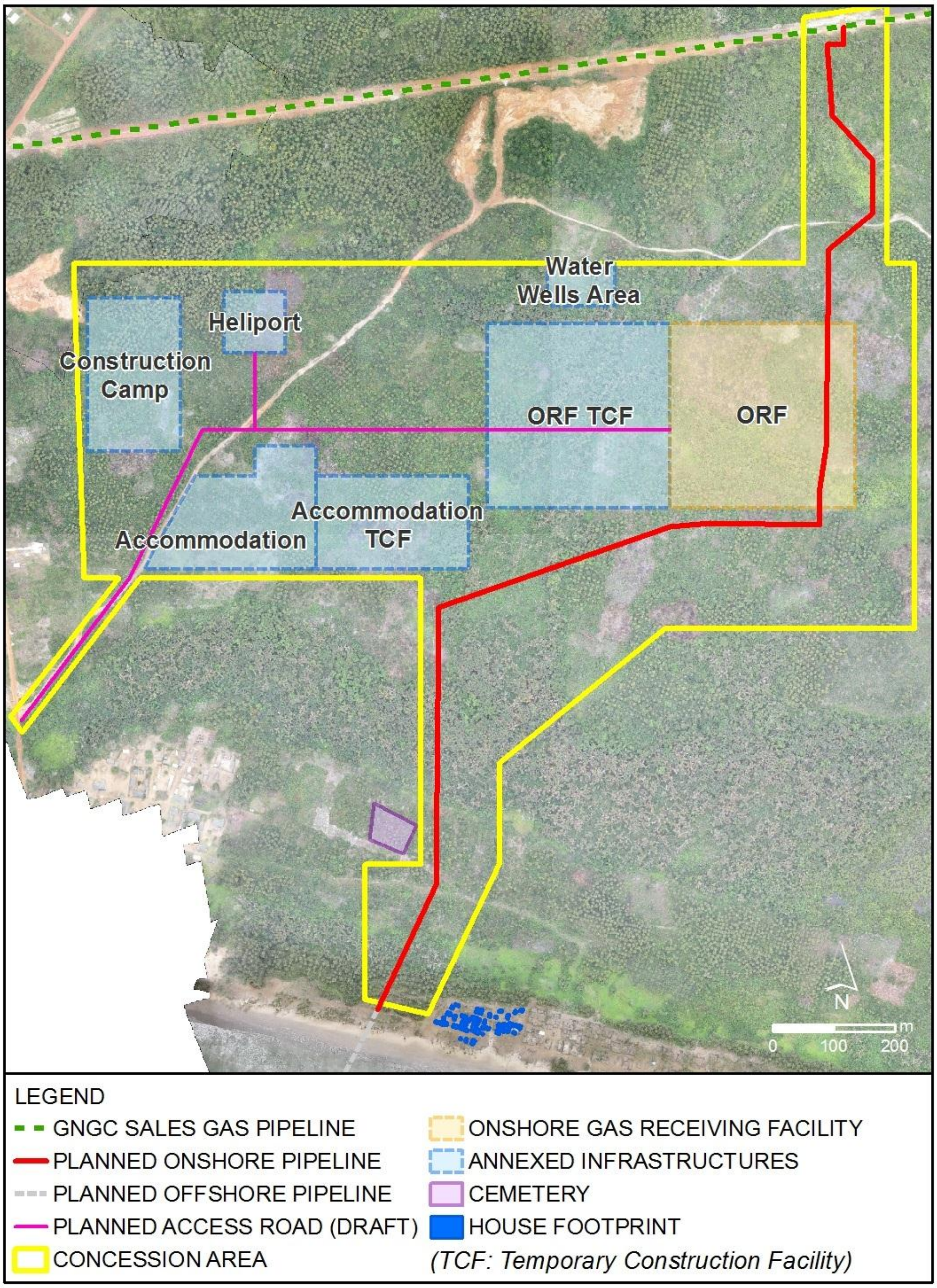


Source: eni, 2014

<u>Shore Crossing and Onshore Pipeline Section</u>

The exact landfall location is being selected on the basis of technical, social, environmental and logistics studies and in particular to avoid or at least minimize impacts on the area. The landfall corridor, approximately 100 m wide will be located near Sanzule, as shown in Figure 4.17.

Figure 4.17 Gas Export Pipeline Landfall Location under Investigation

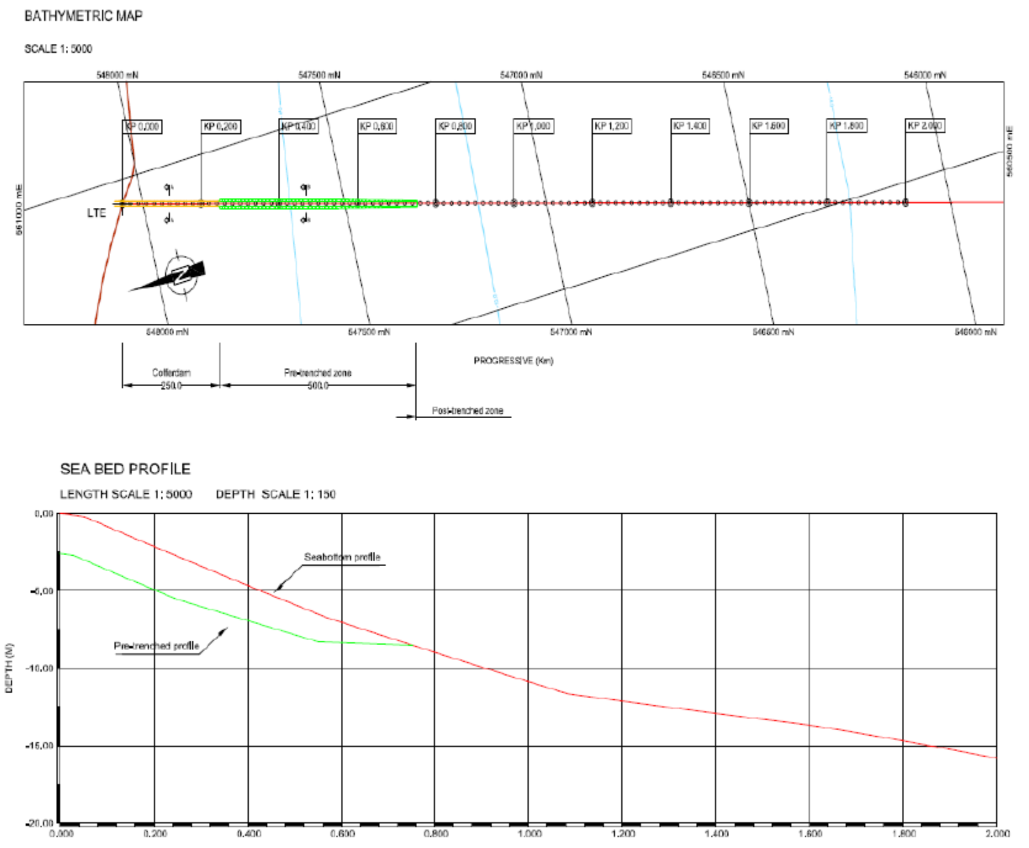


Source: eni, 2015

A typical shore crossing installation will be used: the subsea export pipeline approach to shore will be open trench type. In the first section of the shore, from the shoreline to approx. 0.250 KP, the pipeline will be pulled in a pre-excavated trench, protected by sheet piling to support the trench (cofferdam). In this section active backfilling for covering the pipeline with sediments is foreseen. Pipeline protection is referred to environmental loads (marine waves and currents) and it is guaranteed by sheet piling. In the second section (from approx. 0.250

to approx.0.750 KP) the pipeline will be pulled in a trench excavated on the natural sea bed to allow natural sedimentation for appropriate covering depth against pipeline instability in the surf zone. In the third section the pipeline will be simply laid on natural sea bed, and post trenching requirements will be evaluated. Figure 4.18 presents a schematic of the planned gas export pipeline landfall approach..

Figure 4.18 Preliminary Gas Export Pipeline Landfall Approach



Source: eni, 2014

The onshore section of the gas export pipeline (1500 m) will be laid underground (1 m as a minimum). More details about the onshore pipeline are provided in Section 4.6.5.

4.5.4 Onshore Receiving Facility (ORF)

After the NAG treatment in the FPSO (i.e. dew point control) gas is then sent to the Onshore Receiving Facility "ORF" (located at Sanzule).

The ORF will be located in Sanzule and will be designed to receive the treated gas coming from FPSO, via a 20" ID sealine (base case), mix it with the lean gas coming from GNGC LPG Plant and compress the gas mixture up to an allowable pressure of 100 bara (as operating pressure).

The ORF will have minimum facilities to receive treated gas from FPSO and from GNGC LPG Plant, including an inlet separator to disengage any unexpected liquids arriving with the normally dry gas (no slugs are expected at the Inlet Separator), a boosting gas compression station, a fiscal metering system and utility systems. Any slug expected during commissioning, start-up or maintenance will be recovered in a temporary Slug Catcher.

The onshore plant will be manned, accommodation camp and helipad and logistic infrastructures will be present.

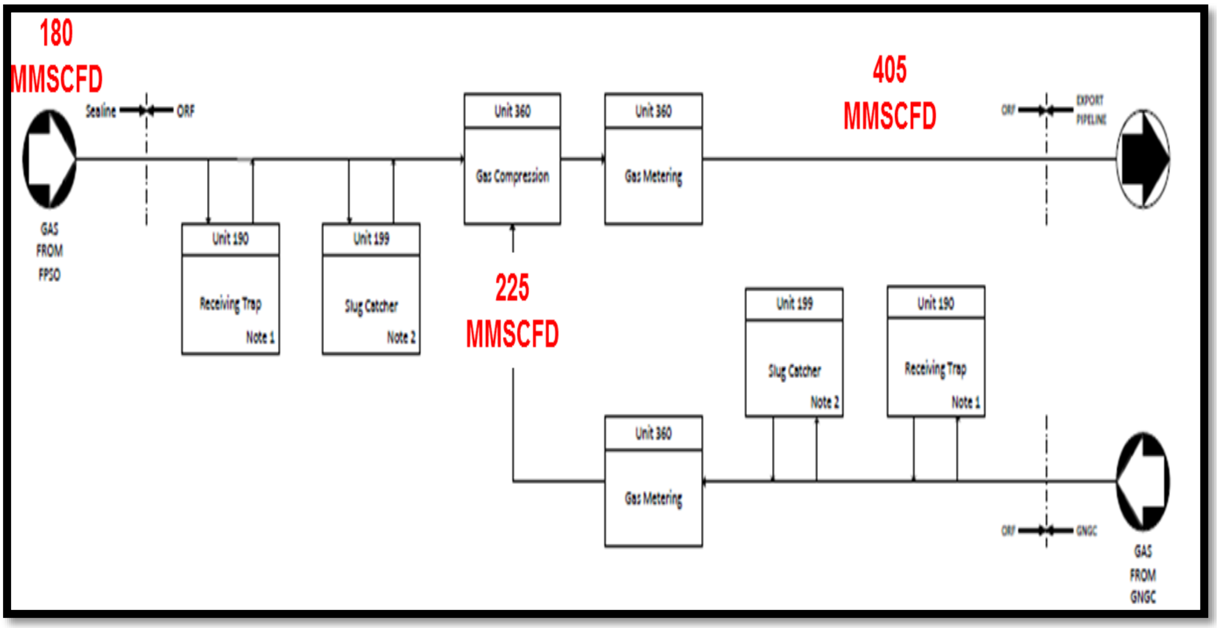
The ORF will be designed for two main operating cases; Base Case and Optional Case:

Base case: in which the gas will be received from the FPSO, via 20” ID sealine, then the gas compressed in two stages to be exported through an existing onshore pipeline (GNGC). Gas coming from OCTP and GNGC gas plant will be comingled and compressed up to 100 bara (as operating pressure). The comingled and compressed gas would be then tied-in into the 20” GNGC sales. The final sales gas pipeline form the ORF will have capacity of 405 MMCSFD

The base case flow rate normal operating conditions are summarized below:

- Gas from FPSO: 190 MMSCFD
- Gas from GNGC: 215 MMSCFD
- Export compression design: 405 MMSCFD

Figure 4.4.19 ORF Aggregate Compression Station



Optional Case: in which the gas will be received from the FPSO and GNGC as in the Firm Case however in this case, an additional 100 MMSCFD will be received from the same 20” ID sealine, while all other conditions remains the same as reported above in firm case. Then the gas from GNGC will be reduced in order to accommodate such increase coming from offshore. The ORF lines and the utilities will be designed as in the firm case to be capable of operating during this optional case but at this stage only space and tie-ins will be provided for the additional train(s) able to accommodate the extra capacity for the increased gas.

The expansion case flow rate normal operating conditions are summarized below:

- Gas from FPSO: 290 MMSCFD

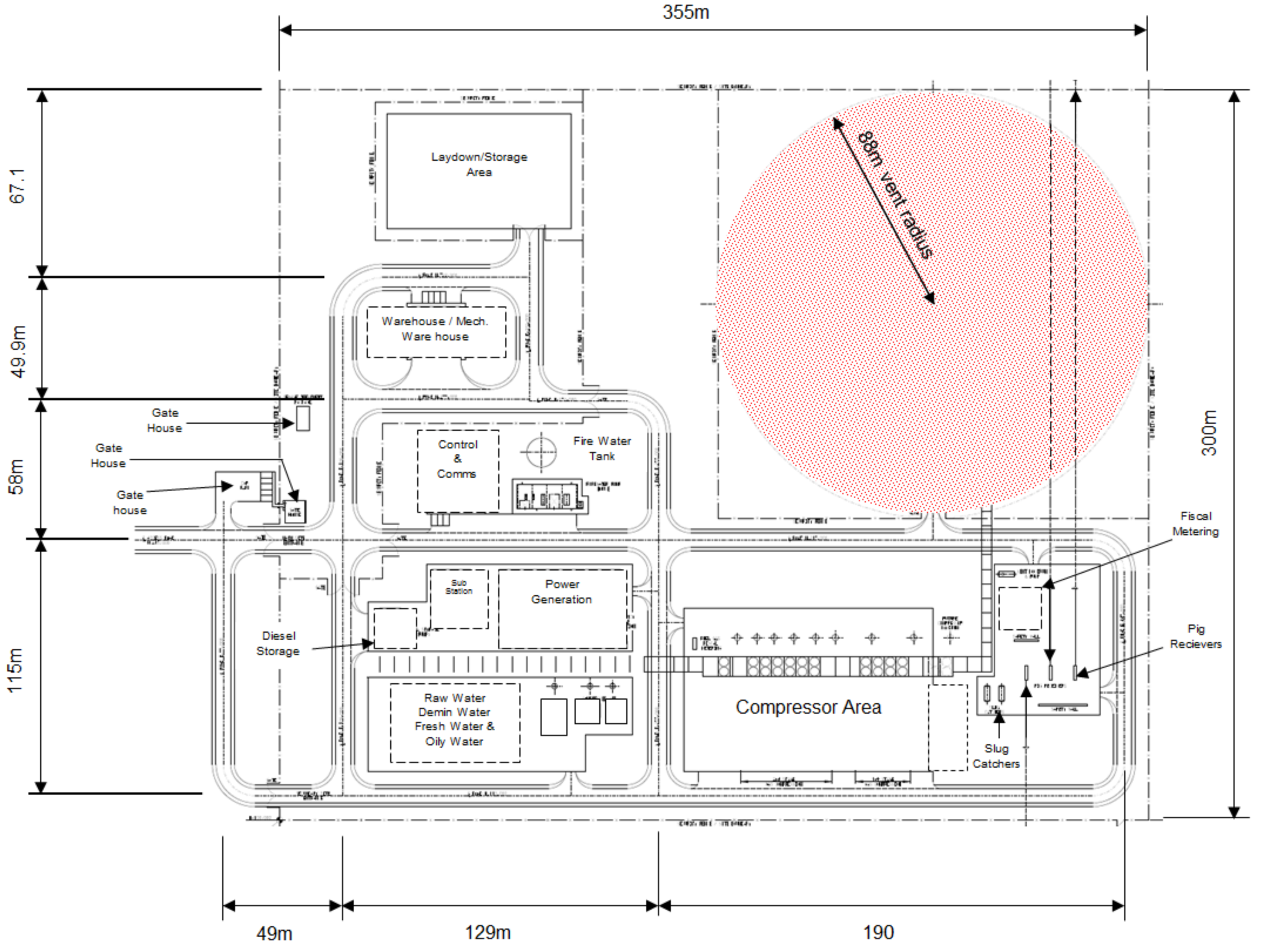
- Gas from GNGC: 115 MMSCFD
- Export compression design: 405 MMSCFD

Considering the 100 MMSCFD extra flowrate (from other potential operators), the booster compressor in Sanzule will be designed for a flow rate of 320 MMSCFD to accommodate the extra gas from the offshore.

The ORF will include the following facilities, as presented in Figure 4.20:

- Receiving Traps
- Slug Catcher
- Gas Compression and Metering;
- Vent and Blow Down System
- Fuel Gas System
- Diesel fuel System
- Compressed Air System
- Main Power Generation System
- Emergency Power Generation System
- Water System
- Drain System
- Nitrogen system
- Fire fighting System;

Figure 4.20 ORF Layout



Source: eni, 2014

Process Units

Slug Catcher: temporary facilities to accommodate slugs or debris during commissioning, start-up or maintenance. They will separate unexpected liquid arriving with dry gas. The gas arrival pressure at the ORF inlet is expected at about 25-30 bar.

Receiving trap system will provide facilities to receive the pig from the FPSO, performing the cleaning, dewatering and debris control in the export pipeline.

Gas Compression and metering unit: Gas compression unit is made up of two stages which compress the gas from the OCTP FPSO and from GNGC facility to tie-in into the GNGC pipeline at 100 bar with a maximum export flow rate of 405 MMSCFD, It is made up of two compression stages, the first compresses the gas of OCTP and the second compresses the gas from the outlet of stage 1 and the feed from GNGC.

The 1st stage compression comprises of 2 x 100% machines gas driven (6.9 MWth each), the 2nd stage compression comprises of 3 x 50% machines gas driven (9.3 MWth each).

A fiscal metering system is foreseen in ORF, to meter the gas coming from GNGC plant, the sales gas and the first stage compressed gas. It is foreseen also a fiscal meter in the fuel gas line.

Fiscal metering system will be designed and installed in accordance with Ghanaian, International (e.g. AGA, API MPMS, ISO, ASTM) and Company (The sampling is covered in eni doc. no. 27610.VAR.STA.PRG standards Fiscal Flow Measurement for Hydrocarbon Gas).

Utility Units

Vent and Blow Down System: The vent system provides for the safe disposal of hydrocarbon fluids from pressure safety devices and blowdown valves during process upsets, emergencies, blowdown, maintenance activities and shutdown conditions.

The vent headers will be maintained slightly above atmospheric pressure by a nitrogen purge (with fuel gas backup). The Vent Stack will be fitted with a Vent Snuffing System which will utilise a controlled pulse of nitrogen to extinguish any flame should the vent be ignited.

The Vent Stack will include a water seal to exclude oxygen from the headers. The Vent Stack will be continuously purged with nitrogen (with fuel gas backup). Venting will be only allowed for emergency and maintenance services, while continuous venting is prohibited.

Fuel Gas System: Fuel gas is required for:

- Fuel for the GT compressor drivers
- Fuel for the GT drivers of the main electrical generators
- Backup purge gas for the vent system

Fuel gas from either source is metered by the Fuel Gas Fiscal Metering Package

Diesel Fuel System: Diesel fuel will be delivered by road tanker, filtered and stored in the Diesel Tank. The diesel fuel will be circulated through a filter and coalescer to remove solids and free water. Diesel fuel is required by:

- Emergency Diesel Generator
- Firewater Pump

Treated diesel fuel is pumped to the two users as required to maintain the level of the respective day tanks.

Compressed Air System: Compressed air is required for plant instrumentation, nitrogen generation and auxiliary utility purposes, such as the operation of pneumatic tools. Compressed air will be supplied by two electrically driven Air Compressor Packages, one in operation and one on standby. The supply will be dried by duty/standby Air Dryer packages and stored in the instrument air receiver, which provides 15-30 minutes buffer capacity should the instrument air supply fail.

Main Power Generation System: During normal operation, electrical power will be generated by gas turbine driven generators (3 MWth). Principal loads include:

- Instrument Air Compressors
- Gas turbine starters and ancillaries

The Main Power Generation Package, comprising 3x50% generators, and has the capacity to produce ~3000 kW of electricity for use. Electricity is generated by the Main Power Generators which operate one duty, one assist and one standby. The Main Power Generators are driven by the Main Power Generation Gas Turbines using fuel gas as fuel.

The Power Generation unit will include abatement technologies as per the best available techniques to minimize NOx emissions.

Emergency Power Generation System: The Emergency Power Generation System provides electrical power for:

- Start-up
- Essential utilities when the Main Power Generation System is unavailable
- Shutdown, to ensure the safe shutdown of the terminal

Systems supplied from the Emergency Power Generator include:

- Potable Water Treatment and Distribution
- Borehole Pumps
- ORF Plant Lighting
- Firewater Jockey Pumps
- Instrument Air Compressors

The Emergency Power Generation Package will be capable of producing ~1200 kW, with automatic start-up following the failure of the Main Power Generation System.

Raw and Utility Water System: The main water supply to the ORF shall come from a borehole within the ORF. Downhole pumps shall supply the water. Assuming the water quality is sufficient, Fire water shall be chlorinated only.

Fresh and Demineralised Water System: Potable water will be extracted from groundwater. Assuming a ground water source of suitable quality and sustainable volume for extraction, the raw water will be chlorinated (using hypochlorite), filtered by multimedia filters and stored in the Potable Water Tank.

Potable water will be distributed by the Potable Water Pumps. UV disinfection will be used in distribution to ensure microbial quality. Demineralised water for gas turbine washing shall be produced from Potable Water by reverse osmosis.

Sanitary Disposal System: Two domestic sewage systems will be installed. One serving the accommodation area while the second one will serve the ORF area. Domestic sewage will be treated biologically by the Sewage Treatment Package. Treated water will be discharged to an underground infiltration system while sludge from sewage treatment will be collected by tanker for offsite disposal in a licensed Waste Management plant.

Nitrogen Generation System: The Nitrogen generation system will generate 97% Nitrogen from instrument air, the main principal users are:

- Purging of the vent system
- Gas Turbines and compressor seals
- Equipment purging during maintenance.

The Nitrogen Generation Package will comprise two trains operating one duty, one standby

Water/Foam Firefighting System: There will be two firefighting systems within the ORF, one positioned at the plant site and a second, smaller system, covering the accommodation camp.

For the Plant chlorinated water from the Borehole Pumps shall be stored in the Firewater Tank which serves both the Fire and Utility water systems. Jockey Pumps, (2 x 100%, duty/standby) will maintain the firewater ring main, one electric and one diesel driven pump.

The accommodation area will be served by a dedicated firewater tank and pumps. The tank will be filled from the potable water supply from the ORF.

Open Drains System: Given the very unlikely hydrocarbon liquid being present in process equipment, the major sources of hydrocarbon contamination of wash-down and rain water are:

- Oil from gear boxes and hydraulic systems
- Diesel fuel for the firewater pump and emergency generator

Paved areas will contain potential oils, oily water utilising a collection sump. Rain water will be diverted away from the equipment paved areas using a basic steel structure roofing to divert the rain water into roof drainage and routed away from the relevant area. This prevents the rain water contacting potential oily substances and elimination of separation and treatment. Drip pans shall be provided under potential leak source (e.g. vessel and pumps) to contain any spillage of flammable liquids. Diesel storage tank will be with a bund sizing of 110% of the capacity of the tank. Should a failure of the tank occur then the fuel would be contained and removed by gully sucker for disposal.

Closed Drains System: Liquid hydrocarbons are not expected within the process equipment except under exceptional conditions. Any liquid present will be collected in the 1st stage compressor KO drums. Any liquids found in the compressor knock out drums will be discharged to the Vent KO Drum.

Compressors will trip on a liquid high in the KO drum(s). High level alarms will be provided to allow operator to discharge the liquid to the vent KO drum which will be of sufficient size to allow collection of liquids and venting of gases generated as a consequence.

There will be a hard pipe routing from the compressor KO drums on the 1st stage compression in the unlikely event that possible liquid could reach the inlet to the ORF. The liquid level will be monitored / controlled so intermittent discharge of liquid is sent to the vent KO drum.

4.5.5 Accommodation Camp and Heliport

A temporary accommodation camp will be constructed to accommodate the peak personnel number during the onshore construction phase (approximately 400-600 workers, during an estimated period of 3 years). This accommodation camp will be dismantled at the end of construction and commissioning phases and the area will be restored to its previous conditions. This camp will include the following facilities: standard accommodation blocks, a limited number of offices, canteen and cooking facility, laundry area, first aid facility, roads and parking areas, recreational facilities and drainage system. This camp will be located in the onshore licence area, not far from the ORF, as shown in Figure 4.17. The construction of this camp will result in a temporary land take.

A permanent accommodation camp will serve to accommodate the peak personnel expected during the operations phase (approximately 45 people). It will have standard accommodation blocks, and will be equipped with canteen and kitchen area, laundry area, internal roads, recreational facilities, parking area, medical facility, sewage facilities and drainage network.

The camps will be designed in accordance with eni's standards, that are consistent with IFC/EBRD guidance note, in particular, the following site characteristics will be assessed in order to locate the permanent camp:

- existing previous uses of the area
- noise levels
- exposure to process gases
- air pollution
- risk of subsidence
- risk of flooding
- existing utilities located both above and below ground
- soil contamination or existence of mines (in case of former war areas)
- soil conditions including bearing capacities
- site overall conditions
- water table level
- legal restrictions
- adjacent structures.

Both temporary and permanent camps will be constructed in full compliance with the IFC/EBRD guidance note on Workers' accommodation: processes and standards.

Both, the temporary and permanent accommodation facilities, in accordance with the abovementioned standard will be constructed in a flat area, providing slopes to drain the rain water or allow the possible overflows gathering. It will be located far from the ORF plant restricted areas and it will have a rectangular shape area to allow an easy implementation of the different elements and infrastructures.

The access by road will be located, as much as possible, in barycentre point of the fenced area, in order to optimize the internal links of the transport infrastructures and to allow the presence of only one control gate.

The general layout will take into account the facilities locations, functional flows, capacities, etc. in order to evaluate the possible interferences, gaps, congestions, safety issues, etc.

The plot plan layout will be designed to avoid housing concentration. Large spaces will be provided to avoid congestion. The permanent accommodation camp will be equipped with a sewage treatment system to treat civil water form toilets, showers, lavatories, kitchen and laundry. An Imhoff tank will be installed. Treated water will be discharged through an underground infiltration network, while sewage sludge will be disposed as waste offsite. The same sewage collection and treatment system will be installed in the temporary accommodation camp in order to treat civil waters.

During operation and construction, the accommodation camp will be subject to curfew during night time and movements outside the accommodation camps or, if applicable, the facilities will be restricted. During the day, entrance and exit will be monitored for safety and security at the entrance gates of the compound.

The offshore construction personnel will be accommodated at the FPSO. Offshore personnel will be transferred directly to and from Takoradi and will not spend time onshore in the Sanzule area.

The FPSO will accommodate 136 people, and offshore living quarters will be as describe in Section 4.5.2.

The heliport will accommodate an aircraft 22 m long and with a maximum take-off weight of 9.2 tons. The permanent heliport will be mainly used for MEDEVAC purposes along all the project phases.

Specific locations of helipad and accommodation camps are still under investigation, and will take into consideration technical, environmental and social aspects.

For both construction and operation phase, at the ORF and FPSO catering services will be provided by an external provider.

4.5.6 Construction Yard

A temporary Construction Yard is foreseen near the ORF, in the onshore concession area, as shown in Figure 4.17 (ORF Temporary Construction Facility – TCF). The maximum expected area is about 100,000 m^2 and the construction yard will be dismantled at the end of the construction and commissioning phases and the area will be restored to its previous conditions. As described in the abovementioned Figure 4.17, this construction yard will be located outside the ORF footprint, resulting in an additional land take, that will be restored after construction activities' end.

4.6 CONSTRUCTION PHASE

The project will be constructed by qualified Contractors. The following sections provide details on the construction activities and construction methods.

4.6.1 Wells Drilling and Completion

The drilling and completion activities will be performed by the Maersk Voyager, as shown in Figure 4.21.The same rig will be used for all the oil and NAG wells located in OCTP block: an integrated drilling and completion schedule has been developed by the operator.

The rig will be capable of operating in water depths up to 3,300 m. It will be an advanced drilling ship, dynamic positioned (DP-3), Dual Activity/Dual BOP rig designed to minimize emissions and discharges to sea. The unit will be capable of performing all the planned drilling and completion operations required to develop the fields and deploying the Subsea Production Trees and other associated subsea equipment.

Two supply vessels will normally support drilling activities.

Figure 4.21 Maersk Voyager

Source: eni, 2015

The Maersk Voyager has the following storage capacities: Table 4.13:

Table 4.13 Drilling Rig Storage Capacities

Fuel (Diesel Oil or Heavy Fuel Oil)	6210 m^3
Drilling water	2410 m^3
Potable water	1425 m^3
Liquid mud (active & reserve)	2767 m^3
Waste liquid (mud & washing water)	2000 m^3
Brine	777 m^3
Oil base Mud	998 m^3
Crude Oil	452 m^3

Bulk bentonite/Barite	452 m^3
Bulk Cement	2300
Sack storage	7540 m3
Ballast water	6210 m^3

Source: eni, 2015

The Drilling and Completion Operations sequence for the development project of OCTP Block is foreseen as follows:

- Pre-drilling for all new wells and temporary suspension;
- Installation of Subsea Horizontal Production Trees (with "drill through" capability) by the rig on each well followed by completion phase on same well after Subsea tree installation;
- Re-entry of three exploration/appraisal wells operations will include installation of Subsea tree, re-entry and Completion.

The planned duration of each well (predrilling + completion phases) is in the range of 75 – 80 days. The total duration of drilling and completion activities for the first four wells of OCTP Phase 2 will last for about 25 months (including suspensions and operations on other wells of OCTP phase 1 as per project schedule (for detailed schedule see *Table 4.2*), while the fifth well will be drilled and completed in a later stage (2028).

NAG Wells Count

The OCTP NAG development scenario foresees the following number and type of wells:

Campanian Not Associated Gas (NAG) Development:

- 3 new producer wells to be drilled in the Sankofa area;
- 1 producer wells to be re-entered and completed (Sankofa 2A ST).

The Gye Nyame well will be re-entered and completed in 2028 (Drilling rig to be nominated at later stage).

Wells Design: Since all development wells will be drilled in the same reservoir (same pressure) the same well control policy will be applicable. Such policy is the standard eni policy for deep water development wells without any derogation/exemption. eni's well design documents have to strictly follow an approval process applicable to wells defined as "critical" (i.e. >500 m water depth and oil producers) according to eni's Management System. All drilling programs have to be approved by the relevant Head Quarters office (that will act as independent, expert third party in charge of verification/review) in due time.

The position of the wellheads has been established based on the following:

- well path optimization;
- reservoir constrains;
- seabed natural constrains;

- seabed planned production facilities and pipelines.

In order to reach the reservoir targets from planned well locations at seabed, most of the wells are deviated.

The well trajectories are two dimensional, and the targets are penetrated in tangent section. More details about Gas wells are summarized in Table 4.14.

Table 4.14 NAG wells characteristics

Field	Well			Casing Strings	Well TD		Max DLS (deg/30m)	Max Incl. (deg)	Tot. Displ. (m)
	Name	Type	Water Depth		VD (m)	MD (m)			
OCTP Gas Campanian (Gye Nyame not included)	SANK-D	Gas Producer	947	36" CP - 20" CSG - 13 3/8" CSG - **9 5/8" CSG**	2,683	3,015	3.00	42.29	927
	SANK-EC	Gas Producer	811	36" CP - 20" CSG - 13 3/8" CSG - **9 5/8" CSG**	2,719	3,014	3.00	37.67	923
	SANK-E-D	Gas Producer	948	36" CP - 20" CSG - 13 3/8" CSG - **9 5/8" CSG**	2,792	3,094	3.00	38.65	922
	SANK-2A ST	Gas Producer	864	36" CP – 20”x13 3/8" CSG - 9 5/8" CSG - **7" LNR**	2,743	2,900	2.52	42.00	508

Source: eni, 2015

The majority of the wells inclinations varies between 35 and 45 degrees through the reservoir intervals.

The 26” hole (riserless) will be drilled vertically, while the 17½” section will be the build-up section while the reservoir production sands will be drilled tangent, in 12¼” or 8½” hole section according to the specific well design.

The pre-drilling activities include the rig positioning at well location and jetting of the 36” conductor pipe.

The typical casing profile for a Campanian Gas producer (see Figure 4.22 include a 36” conductor pipe, a 20” surface casing, a 13 3/8” (13 5/8”) intermediate casing and 9 5/8” production casing.

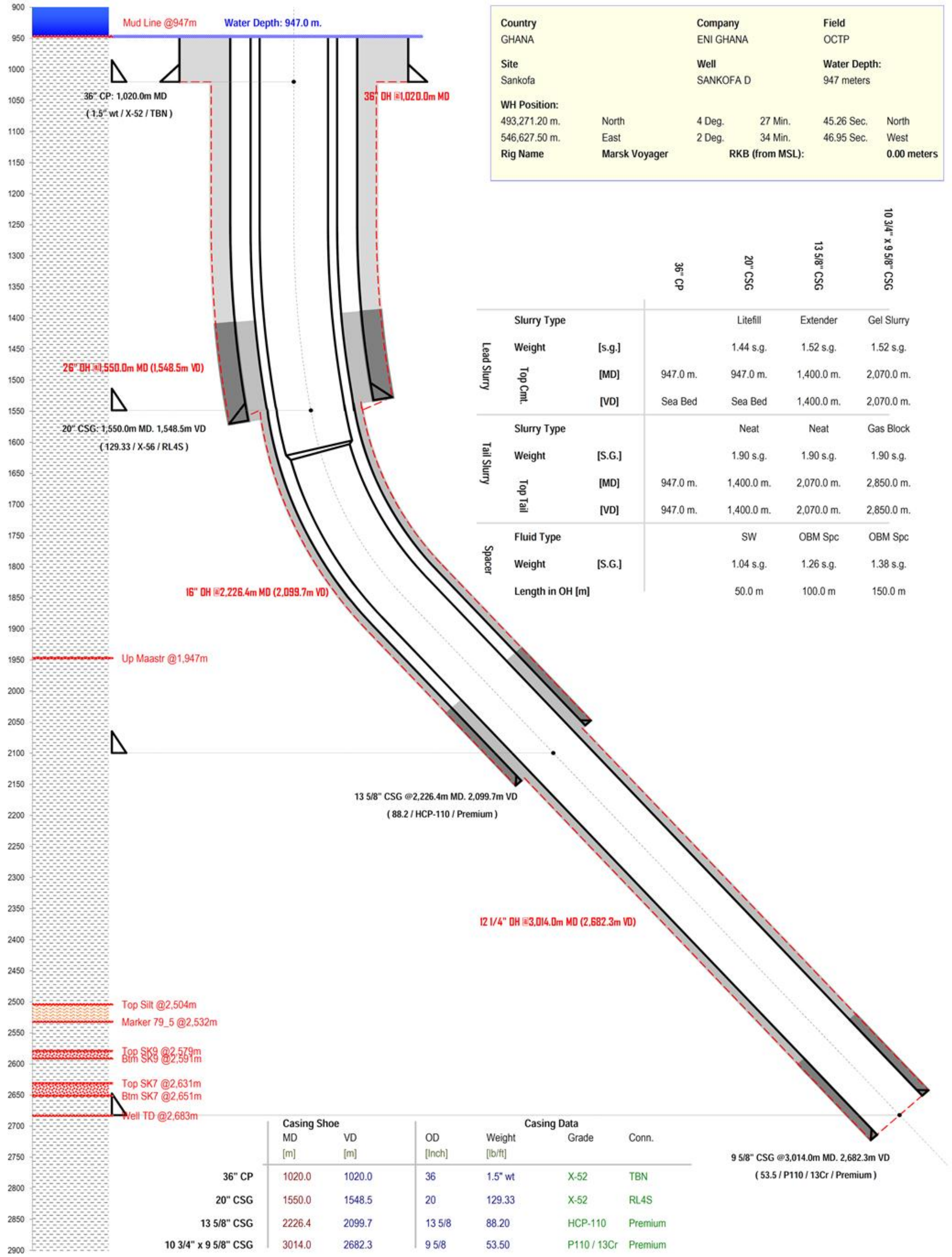
The 36” conductor pipe will be set (Jetting) vertical approximately to the depth of 70-90 m below sea bed in order to provide structural integrity at the mud line.

The 26” hole section will be drilled through the unconsolidated formation riser-less with return to seabed using seawater and high viscosity pills as required. The setting depth of the 20” casing string will guarantee enough fracture gradient to drill the next section with BOP and riser installed.

The 17½″ hole section will be drilled with Non-Aqueous Drilling Fluid (NADF) weighted with calcium carbonates, allowing a better management of possible circulation losses that can occur. The 13 3/8″ intermediate casing will guarantee enough fracture gradient to drill the next 12¼″ hole section (production sands). Subject to directional plan, this casing will cover build-up section of the well.

The 12¼″ hole section will be drilled with NADF weighted with calcium carbonates, allowing a better management of possible circulation losses. This section will be drilled tangentially (hold section). The 9 5/8″ production casing string will cover the reservoir section, with sufficient rate hole to allow the completion of the well (frac pack in cased hole).

Figure 4.22 Typical Casing Profile



Source: eni, 2015

Well Re-entry

As part of the OCTP Gas development, one well already drilled in exploration campaign (Sankofa 2A-ST) will be recovered as producer.

The re-entry and side-track from the existing wellbore will be performed in 8 ½" hole section and a 7" production Liner will be set to cover the production sands with sufficient rat-hole to allow the completion of the well (Frac Pack in 7" cased hole).

The 8½" hole section will be drilled with NADF weighted with calcium carbonates, allowing a better management of possible circulation losses that can occur.

In the OCTP reservoirs Temperature and Pressure ranges are in line with regional gradients. Based on measurements acquired in previously drilled exploration wells, the maximum formation pressure will be 4900 psia (equivalent to a formation pressure gradient of 1.15 $kg/cm^2/10$ m at 3000 m of vertical depth).

Maximum static bottom-hole Temperature at deepest targets is 90°C, extrapolated from available measures in previous exploration wells. During operations T will be much lower.

Drilling Mud and Mud Circuit

The drilling fluids are normally made up of a liquid (water or oil) set in a colloidal state and weighted down with specific products. The colloidal properties achieved with special clays (bentonite) and enhanced by particular additives that give the mud the required rheological properties, turning it into a gel able to keep the weighting additives and debris in suspension, even when circulation is cut off.

The purposes of the drilling fluids are:

- Remove debris from the bottom of the well and carry it up to the surface.
- Cool and lubricate the drilling bit.
- Contain the fluids present in the rock formations.
- Consolidate the walls of the borehole and reduce infiltration into the formation.

Selection and definition of the drilling fluids is based on experience gained in the field.

The surface riserless intervals will be drilled with sea water and High Viscosity (Hi-Vis) Sweeps. The sweeps will be circulated up to seabed to keep hole cleaning.

After BOP/ riser latched, Non Aqueous Drilling Fluid (NADF)) will be used to drill 17 ½", 12 1/4" and 8 ½" (when required) hole sections. The mud type will be Versaclean LTOBM while Base fluid will be Escaid 120. Selected mud type is included in Group III NADF.

A mud system with a high inhibitive capacity and low reaction levels with the formation is necessary for the riser section. Therefore a non-aqueous drilling fluid system will be used.

Drilling mud will be prepared in mix tanks by mixing mud materials, in particular clays (bentonite), weighting agents (barite, calcium carbonate) and other compounds

Table 4.15 presents a summary of the estimated mud types for each drilling section.

Table 4.15 Estimated Drilling Mud Type

Casing Size	Hole Size	Estimated Mud Type
(in)	(in)	(Type)
36″	(Jetting)	Sea water + HV pill
20″	26″	Sea water + HV pill
13⅝″	17½″	Non-Aqueous Drilling Fluid (NADF)
9⅝″	12¼″	NADF
7″ LNR (Re-entry well)	8½″	NADF

Source: eni, 2015

In a drilling system, the mud circuit is particularly complex since it must also include a system able to separate drilling debris and treat the mud.

The mud is fed into the drill pipes using high pressure pumps and it exits from the nozzles in the bit at the bottom of the well. It incorporates the drilling debris and then rises back up to the surface. Used mud will be treated in the Solids Treatment System composed of equipment such as a vibrating screens, a desilter, desander, centrifuges, etc., which separate the mud from the drill cuttings. Then mud will be reconditioned in dedicated tanks and then will be pumped back into the well.

The drilling rig will be equipped with a cutting and mud treatment system to properly process and handle the NADF and the cuttings in accordance with government and local regulations,. The treated cuttings will be disposed of at water depths equal or greater than 500 m. Cuttings will be discharged at each rig location and thus water depth will vary from well to well, ranging from 600 to 1100 m of water depth. Discharge outlets, under the drilling rig, will be located 50 m below sea level, and then natural sedimentation will allow cuttings deposition on the seabed.

An adequate reserve of mud will be kept ready in dedicated tanks to handle any sudden need that may arise due to leaks in circulation or absorption of the well.

Composition of the drilling mud will be controlled to meet specific density and viscosity characteristics, as these characteristics are involved in control and counterbalance the pressure exerted by fluids in the reservoir. The hydrostatic pressure exerted by the column of mud will be greater than the normal hydrostatic gradient and even abnormal pressures will be contained by adding substances that increase the density of the mud.

In order to prevent uncontrolled emissions of formation fluids from the wellbore, each well will have its own approved well control plan and will be drilled using a mud density able to overbalance the formation fluids and using a system of valves located upstream of well opening (well head and BOP) able to close the well. The standard procedure for drilling will be consistent with the global industry group recommendations post-Macondo (IOGP Deepwater wells, report No. 463 and report of the JOINT INDUSTRY SUBSEA WELL CONTROL AND CONTAINMENT TASK FORCE).

Well Completion

Subject to well profile, the reservoir will be penetrated with 12 ¼" (9 5/8" casing) or 8½" (7" liner or open hole) section.

According to the reservoir characteristics, all Campanian Gas Producer wells require application of Sand Control techniques (Cased Hole Frac Pack) that will be performed in 9 5/8" casing for new wells and in 7" liner for Sankofa 2A-ST.

On two wells (Sankofa-D and Sankofa-EC), a Dual Zone smart completion is planned to control independently the two production layers, while on the well Sankofa 2A-ST a stacked frac pack on two zones is planned with a standard completion (commingle).

All wells will be completed with a single production 5 ½" tubing.

Table 4.16 NAG wells completion characteristics

Field	Well			Production Csg / Open Hole	Lower Completion	Upper Completion	Tbg Size
	Name	Type	Deviation				
OCTP Gas Campanian	SANK-D	Gas Producer	Deviated	9 5/8" CSG	CHFP/GP	Dual Zone Smart	5.5
	SANK-EC	Gas Producer	Deviated	9 5/8" CSG	CHFP/GP	Dual Zone Smart	5.5
	SANK-E-D	Gas Producer	Deviated	9 5/8" CSG	CHFP/GP	Single	5.5
	SANK-2A ST	Gas Producer	Deviated	7" LNR	CHFP/GP	Dual Zone Single	5.5

Source: eni, 2015

A permanent downhole monitoring system will be installed in order to monitor pressure and temperature during flowing and shut in both for producers and injectors wells.

Stimulation treatments like acid injection activities are not planned.

Subsesa Tree

Subsea tree elements will be hooked and flanged onto the casings installed during the drilling phase. These elements will provide the well head with valves to control production:

- Tubing spool
- Christmas tree: It will consist of a series of gated cut-off valves having a hydraulic or pneumatic actuator, or manual valves located on a T or V cross.

Based on previous subsea developments, production trees will be 5" x 2" nominal bore, horizontal type, with a 345 bar (5000 psi) design pressure.

Design temperature rating for subsea production trees will be from 5,5°C (10°F) below the normal ambient seafloor temperature or the lowest normal temperature to 120°C (250°F). Choke, wing valve connector and seal assembly downstream of choke will have a preliminary low design temperature of -29°C.

The valves will be operable by electro-hydraulic control system or by remotely operated vehicle (ROV). All the valves to be remotely operated (including chokes and downhole valves) will be equipped with hydraulic actuator. Chokes will feature electronic position sensor.

Pollution Prevention Measures

All the systems on the drilling rig will be classified as controlled discharge to prevent any type of spill, drilling mud or bilge oil into the sea.

All drains will collect the liquids into the drain holding tanks. Operating on 3-way valves installed on drainage system, heavy rainfall could be diverted overboard. Collected liquids will be offloaded periodically to the supply vessel tanks and then carried to land for treatment and disposal. There will be no discharges of these liquids in the environment.

Civil wastewater (sewage, water from wash basins, showers, kitchen) will be treated with approved systems to achieve legal concentration limits, before being discharged into the sea, accordingly with MARPOL.

The machine room, pump zone and engine area will also be fitted with coaming and bilge to collect oily liquids. The fluids will be gathered and sent to an oil-water separation system. The water separated will be sent to the liquid waste collection tank while the oil will be stored in special drums to be transferred to land for disposal

Blow Out Preventer

The rig will be equipped with 15,000 psi Blow Out Preventer (BOP) in accordance with eni well control policy and international standards, as they are critical to the safety of crew, rig and environment.

The two fundamental types of BOPs are annular and ram:

- Annular BOPs will be installed on top of the BOP stack. They will have a suitably shaped rubber element that can close and seal the casing/drill string.
- Ram-type BOPs able to perform several functions, such as closing around a tubular, or cutting a tubular and ensuring hydraulic sealing.

BOPs will be assembled to form the BOP stack, generally including 1 or 2 annular BOPs and 3 or 4 ram BOPs. There will be a set of shear rams that ensure total closing of the borehole during emergency situations by shearing the drilling pipes.

The BOPs will be hydraulically operated from 2 remote panels.

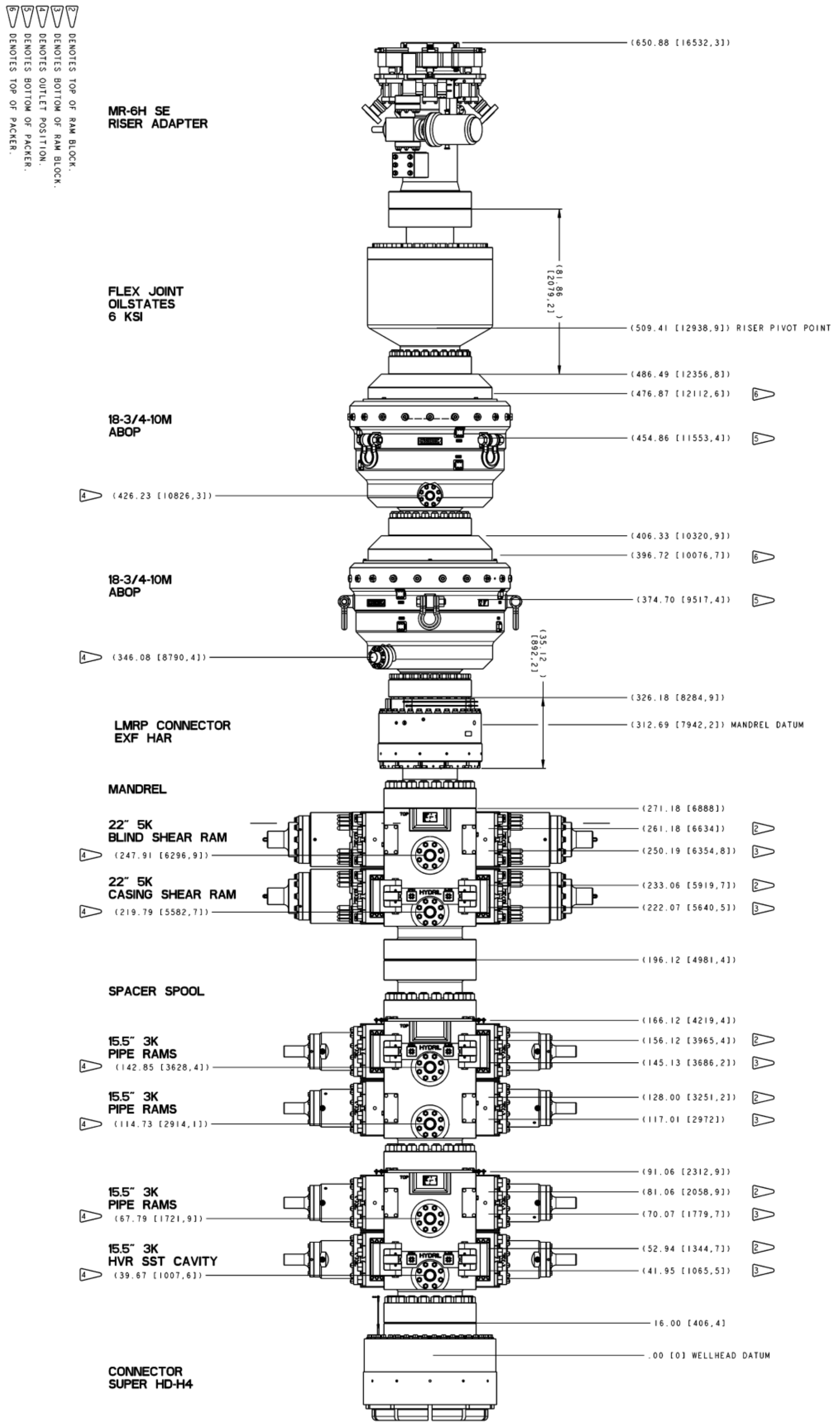
In below are shown the BOP stack configuration for the Maersk Voyager rig.

Table 4.17 BOP stack configuration for Maersk Voyager drilling rig

1.	**BOP STACK**				
				First BOP Stack	Second BOP Stack
1.1.	**Ram Type Preventer**				
a.	Quantity	No.	Five	Six	Six
b.	Make and Type	:	(+)	Hydril, Compact	Hydril, Compact
c.	Single /double/triple	:	(+)	Doubles x 3	Doubles x 3
d.	Size	in-psi	(+)	18¾" – 15,000 psi	18¾" – 15,000 psi
e.	Side outlet size	in-psi	(+)	$4^1/_{16}$" – 15,000 psi	$4^1/_{16}$" – 15,000 psi
f.	Ram lock type	:	(+)	MPL	MPL
g.	Complete with temperature sensor	Yes/No	(+)	Yes	Yes
h.	Complete with pressure sensor	Yes/No	(+)	Yes	Yes
1.2.	**Ram Preventer Configuration (From Top to Bottom)** A combination of 18¾" Ram Preventers (single, double or triple) should have as minimum the following configuration (top to bottom): Ram cavity No.1: Shear Blind Rams Ram cavity No.2: Casing Shear Rams Ram cavity No.3 Upper Pipe Rams Ram cavity No.4 Middle Pipe Rams Ram cavity No.5 Lower Pipe Rams				
				First BOP Stack	Second BOP Stack
a.	Pipe Ram type and Size: cavity No.1:	:	(+)	Blind Shear Rams	Blind Shear Rams
	O.D operating pistons	in	(+)	22"	22"
b.	Pipe Ram type and Size: cavity No.2:	:	(+)	Casing Shear Rams	Casing Shear Rams
	O.D operating pistons	in	(+)	22"	22"
c.	Pipe Ram type and Size: cavity No.3:	:	(+)	4½" x 7" VBR	4½" x 7" VBR
	O.D operating pistons	in	(+)	15.5"	15.5"
d.	Pipe Ram type and Size: cavity No.4:	:	(+)	3½" x 5⅞" VBR	3½" x 5⅞" VBR
	O.D operating pistons	in	(+)	15.5"	15.5"
e.	Pipe Ram type and Size: cavity No.5:	:	(+)	4½" x 7" VBR	4½" x 7" VBR
	O.D operating pistons	in	(+)	15.5"	15.5"
f.	Pipe Ram type and Size: cavity No. 6:		(+)	Subsea Test Cavity with 4½" x 7" VBR	Subsea Test Cavity with 4½" x 7" VBR
	O.D operating pistons	in	(+)	15.5"	15.5"

Source: eni, 2015

Figure 4.23 BOP stack configuration for Maersk Voyager drilling rig



Source: eni, 2015

Drilling Parameters Monitoring

Drilling parameters will be monitored by two independent systems of sensors. Sensors will operate in continuous mode, during all drilling operations as monitoring permits ready recognition of any operating anomaly. The first monitoring system will be integrated in the drilling rig monitoring system, while the second is a computerized unit manned by skilled personnel and installed on the drilling rig by service contractor. All drilling procedures will be strictly tested and audited against the IOGP recommendations.

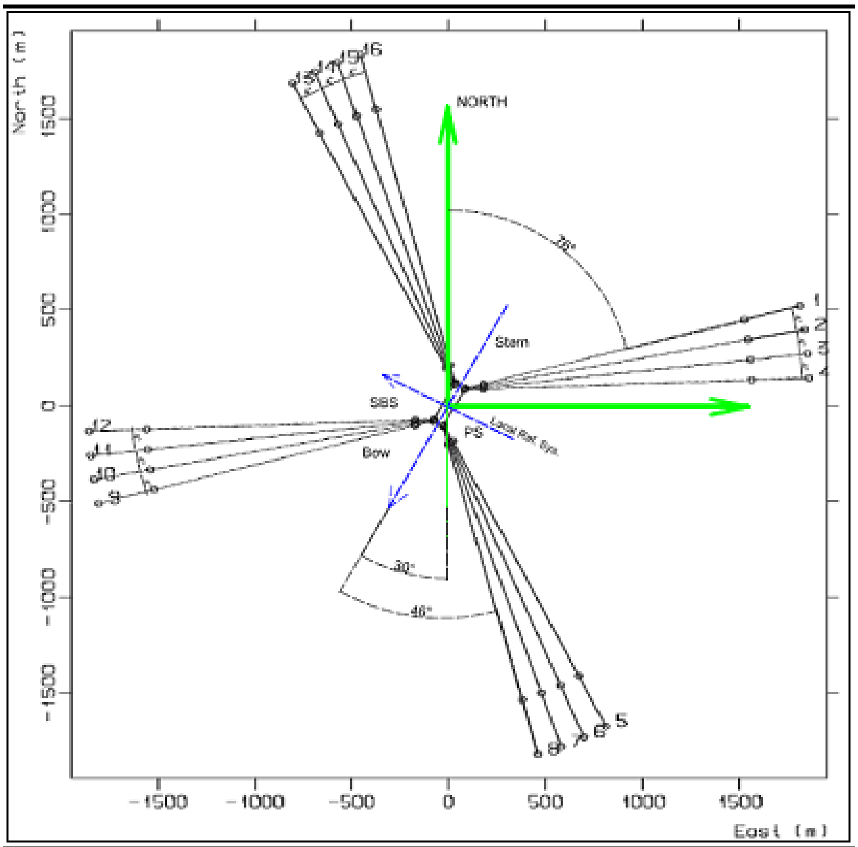
4.6.2 FPSO Installation

The FPSO will be installed as part of the Phase 1 Development. A brief description of FPSO installation activities is provided for here.

The FPSO unit will be constructed outside Ghana, in an onshore construction yard in Singapore and then towed to the selected installation site (8500 km). Only mooring and installation activities for the FPSO will be carried out in Ghana, in the OCTP Block area, offshore of the Western Ghanaian Coast.

The FPSO will be anchored to the seabed with a Spread Mooring System with 16 mooring chains, as shown in Figure 4.24. The mooring chain installation will be performed using a couple of large Anchor Handling Vessels (AHVs) or Anchor Handling Tug Supply (AHTSs) vessels and it will last approximately two to four weeks. The hook up of the FPSO will be carried out by a Dynamically Positioned (DP) Construction Vessel and three AHVs.

Figure 4.24 FPSO Mooring Pattern



Source: eni, 2014

All coordinates of FPSO anchors will be reported to the relevant authorities, so that shipping line users will be able to recognize the presence of the facility and avoid it for safety and security.

The FPSO will have a double balcony riser approach with a design capacity to accommodate the 30 risers needed for the two project phases.

The entire mooring process will last for 60 days.

4.6.3 Pipelaying - Offshore Section of the Gas Export Pipeline

The offshore section of the Gas Export pipeline consists of a 22” (OD) rigid pipeline about 63 km long. A pre-construction survey will be carried out using two survey vessels and a Remotely Operated Vehicle (ROV). Rigid pipeline will be built of pipe sections, using two different types of laying vessel that will navigate along the planned pipeline route.

The offshore export pipeline will be laid considering that in the nearshore (approximately 750 m) the pipeline will be buried under sea bed, with different trenching approaches; the total buried length will depend on final routing and soil conditions for pipeline stability. The pipeline will be laid on the sea floor, equipped with a ballast system to avoid sliding.

The following sections describe the foreseen pipelaying activities.

Pipeline Installation Nearshore and landfall

A nearshore pipelay barge will require support vessels and supply vessels to provide pipe and materials. In the section of the pipeline route where water depth is less than 10 m, the pipeline will be laid in open cut trenching in order to protect the pipeline and ensure its stability. In order to prevent the sediment transportation in the surf zone and therefore the accidental backfilling of the pre-trenched section during excavation and pipeline installation, a cofferdam will be temporary built in the very first section as listed below. Excavated material will be used to build a lateral causeway, to allow construction operation. The rest of the excavation will be performed as open trench.

The following trenches will be dug:

- from shoreline to approx. 0.250 KP: pre-excavated trench protected by cofferdams; by using tracked crane equipped with adequate vibro-hammer for sheet piling (cofferdam) and tracked excavator for trench preparation;
- from 0.250 to approx. 0.750 KP: pre-excavated trench on the natural sea bed by using a backhoe installed on an adequate vessel (or a plough operated by an adequate vessel, subject to sufficient water depth access); and
- from 0.750 to approx. 2.000 KP: post-excavated trench if required, the length of post-excavated trench will be minimized as much as possible and it will be defined on the basis of final routing, soil conditions and sealine stability requirements; the equipment used will be a backfill plough operated by an adequate mother vessel.

In order to minimize the impact from suspension of sediment, the above-described operations will be performed in the period of the year with the minimum current; also, in the post trenching activity, a suitable material can be used to cover the pipe.

Shallow Water Interventions

Due to the presence of very rough features on the sea bed in shallow water areas along the continental shelf, the pipeline will cross outcropping formations and thus intervention works will be necessary to maintain the pipeline stress levels inside the allowable limits.

Such works will be carried out mostly before the pipeline laying: those portions of the outcropping soil that could generate the pipeline overstress will be cut by appropriate machinery. The pipeline stress level will be maintained within the allowable levels by using a combination of pre-dredging by using standard dredging equipment (suction cutter dredging, back-hoe etc) and/or pipeline supports (grout bags etc.).

Pipeline Installation in Shallow and Deep Water

The pipe string will be laid on the natural sea bed in water in excess of 15 m. The laying vessel will move forward by reeling in anchor chain at the bow while easing out over the stern. Once all the anchor chain will be paid out, anchor handling tugs will reset the anchors. The delivery of pipes, supplies and materials will be ensured by specific supply vessels. eni consider the described laying procedure as standard and safe as it is carried out in accordance with best practice requirements for laying down activities.

Pipe joints will be aligned and welded in succession on the vessel barge launch line and progressively deposed on the sea floor. Welds will be protected against corrosion by resine coating.

For this project, two main ways to install subsea pipeline are foreseen, as showed in Figure 4.15:

- S-lay (preferred method);
- J-lay (only for deeper waters).

In the S-lay installation, the pipe will be assembled in a horizontal launch line, by welding together joints of steel pipe. As welding progresses, the pipeline will be gradually lowered to the seabed behind the pipelaying vessel. The name S-lay refers to the pipeline shape on its way to the seabed.

The J-lay pipeline installation was developed for laying pipe in deep waters as it puts less stress on the pipeline by installing the pipeline in an almost vertical position. The pipe joints will be welded to the pipeline almost vertically via a tall tower on the boat, and then lowered into the sea under tension. The laying method is defined J as the pipe only curves once assuming the shape of a J under the water.

The pipelaying operation will typically be carried out at a rate of 2 km of pipe laid per day, where trenching is not necessary.

Two different lay barges will be used: one shallow water lay barge that will start laying the pipe from the shore approach by mooring at 10 m of water depth and pulling the pipeline head to shore by using a barge anchor winch, or a winch installed on shore.

The barge will continue the standard S laying in the shallow water up to the border of the shelf break (about 100 m of water depth) then the pipeline will be abandoned on the sea bed.

The deep water barge, suitable for S-laying or J-laying, will recover the pipeline head and continue the laying up to the target area located near the SSIV manifold to be tied in. The tie in between pipeline PLET and the SSIV will be carried out by using a proper tie-in barge that will install the expansion loop /jumper. Special deep underwater connectors will be used to perform the connections.

The number of vessels to be used during the offshore pipeline installation is reported in the Table below.

Table 4.18 Vessels for Offshore Pipeline Installation

Operation	**Main vessel/machinery**	**Other vessels/machinery**
Shore approach preparation	1 Tracked crane for sheet piling	1 Tracked Excavator 1 Backhoe (optional) 1 Trailing Suction Hopper Dredger
Shore approach laying	S-lay Vessel	2 AHTs 1 Supply Vessel 1 Assisting Vessel 2 Cargo barge + 2 Tugs
Shallow water laying		
Deep water laying	J-lay Vessel	1 Supply Vessel 1 Assisting Vessel 2 Cargo barge + 2 Tugs + ROV
Intervention works for pre post trenching	1 ROV Vessel con Trenching Machines (ROV)	1 Supply Vessel
Free span reduction	1 Light Construction Vessel	1 Supply Vessel + ROV
SSIV / Plet Tie in barges	1 DP Construction Vessel	1 Supply Vessel + ROV

Source: eni, 2015

Pipeline will be overweighed with concrete, in order to be stabilized and protected from current, waves and sea traffic. Sacrificial anodes will be installed in order to provide protection against corrosion.

4.6.4 ORF Construction

<u>Heavy Equipment</u>

The onshore part of the Project will be a conventional civil engineering project and will not require unusual or unfamiliar heavy equipment or construction techniques. The major plant items needed are bulldozers, heavy excavators, spoil removal trucks, large heavy-lift cranes, standby generators, excavators, and rock breakers.

The activities will involve the following main phases:

- mobilisation;
- site clearance and preparation (infilling);
- plant construction; and
- commissioning.

The mobilisation phase will consist in the heavy equipment transportation through main existing transportation routes, while raw materials will be sourced locally, where possible.

The initial stage of the onshore construction will involve the clearance of vegetation and levelling of the site for the ORF and related infrastructures. Initial clearing activities will involve the clearing and stripping of existing vegetation and the provision of suitable access to the project site. Following the clearance of vegetation, the site will be graded and levelled. During this process, topsoil and cleared vegetation will be stripped and stockpiled separately from subsoil and managed as for waste management plan (disposed of or recycled, where practicable). As the ORF site has a high water table and is prone to flooding, the plant will be elevated approximately 3 m above surrounding area. The elevation will consist of 1 m of fill material topped with a stone mat layer to facilitate storm water drainage and then a further 2 m of fill material. A dedicated study will be performed to determine the amount of material needed for infilling, but this data are not yet available at this stage of the project. Anyway, if a new or existing (abandoned) quarry/borrow pit is used during project construction activities, a proper management and restoration plan will be prepared and reinstatement activities will be carried out at the end of the construction phase.

Site road network will be constructed at this stage to assist the movement of heavy items during the following construction phase. The access to the construction site will be restricted and duly indicated as forbidden passage to avoid potential accidents of the community inhabitants. Also a site lighting system will be installed.

Following site preparation, the construction of onshore facilities will start: this will include laying of concrete slabs, building construction, plant and storage areas construction and helipad installation. In addition the storm water and wastewater systems will be installed across the site. Wastewater treatment facilities will also be constructed.

The construction phase will require use of cranes, trucks, generators, earthworks vehicles, piling equipment, concrete mixers and dredging equipment.

Accommodation Camp and Heliport

A temporary accommodation camp will be constructed to lodge the peak personnel number during the onshore construction phase (approximately 400-600 workers, during an estimated period of 3 years). It will be equipped with standard accommodation blocks, offices, canteen and kitchen areas, laundry, recreational facilities, roads and parking areas, first aid facility and sewage system.

The offshore construction personnel will be accommodated at the FPSO.

A permanent accommodation camp of about 27000 m^2 is foreseen near the ORF to host ca. 45 persons involved in the operation of the onshore facilities. It will be composed of: standard accommodation blocks and 1 executive block. It will be equipped with canteen and kitchen area, laundry, internal roads, recreational facilities, parking area, medical facility, sewage facilities, drainage network, firefighting network, electrical system and technical area.

The clinic foreseen in the accommodation camp will be composed of a consultation room, a medical storage, an emergency room fully equipped and toilets.

The construction type of both the accommodation camps could either be prefabricated modules, based in the local material availability as shown in Figure 4.25 or in concrete masonry units (CMU bricks).

Figure 4.25 Example of Prefabricated Modules

Source: eni, 2014

A permanent heliport will be built and foreseen only to support medical emergencies throughout the project phases. The heliport is not foreseen to take part in the personnel movement activities to offshore locations, as these are to be handled from Takoradi Airport to either the Drilling Vessel or FPSO and back to Takoradi.

After construction activities, and during operations, the ORF, permanent accommodation camp and heliport will be permanently fenced due to security and safety issues, following eni HSE standards.

4.6.5 Construction of Onshore Pipeline

This section describes standard construction techniques for onshore pipeline, in particular for the following two pipeline sections:

- Gas export pipeline onshore section (from shore to ORF, about 1500 m);
- Onshore pipeline from ORF to the GNGC gas sales pipeline (about 800 m).

Layout and Configuration

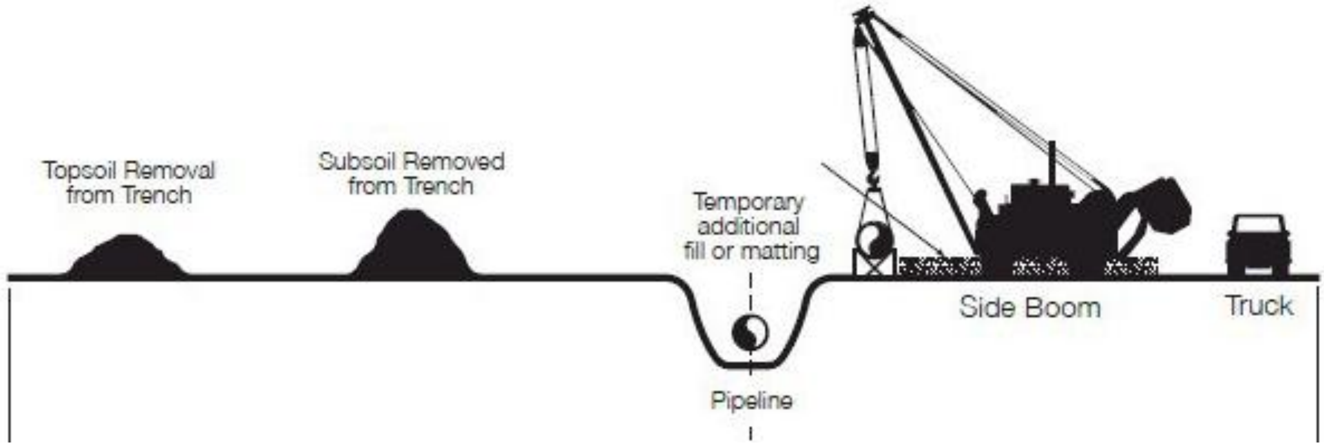
All onshore pipelines will be installed underground, and this implies the opening of a working strip along the right of way of the pipeline. During construction, the excavated trench will be clearly indicated and access and passage through the area will be restricted.

The overall width of the normal working strip will be 34 m. On one side of the pipeline topsoil trench excavated material will be stockpiled (approximately 9 m wide strip) and on the other side, a strip pipeline assembly and vehicles/machinery transit will take place (approximately 25 m wide strip).

A reduced working strip width can be applied where required for special environmental conditions.

A typical cross section of the construction working strip is shown in Figure 4.26.

Figure 4.26 Standard Working Strip (indicative only)



Source: ERM, 2015

Onshore pipeline construction will be a sequential process and will comprise a number of distinct operations carried out by different highly specialized crews.

Onshore pipeline construction activities foreseen for this project are described below.

- **Route survey**: The pipeline route will be surveyed and centreline and route boundaries of the construction corridor will be marked out. Environmental and archaeological specialists will be part of the survey team to clearly mark sensitive environmental and archaeological sites.
- **Preparation of the working strip**: Topographic and photographic records of the existing conditions will be prepared in order to document previous status. A record of buried and aboveground facilities will be recorded. The facilities will be disrupted or diverted only for the minimum width required for safe working. Topsoil, which supports plant life and contains seed stock, will be removed and stockpiled in the form of a continuous ridge along the edge of the working strip. Topsoil stockpile will be typically no higher than 2 m to avoid physical damage and compaction and any mixing with other trenched or construction materials. The working strip will be levelled, using suitable construction equipment (pickup trucks, loaders, dozers, shovel and backhoes, side booms, blades), to eliminate large stones, irregularities and other features.
- **Pipe stringing and bending**: The pipeline will be constructed from 12 to 18 long sections of steel pipe. Sections will be transported to the working place from the construction yard and positioned along the RoW using suitable side-booms and tracked vehicles. Pipe sections will be unloaded with a mounted pipelayer crane and placed end-to-end alongside the future trench. Where necessary, the pipe in place will be bended to match terrain contours or pipeline changes of direction. Usually an hydraulic bending machine is used.
- **Pipe welding** (Figure 4.27): Pipe steel sections will be welded together to form the pipeline using a motor-driven welding machine by a continuous arc welding process. The

pipe string will be placed on temporary supports along the edge of the future trench. Non-destructive tests will be performed for each weld.

Figure 4.27 Example of Pipe Welding

Source: ERM, 2014

- **Joint coating**: After the weld will be tested and approved, the exposed steel section will be covered with a protective coating, usually a heat-shrinkable polyethylene sleeve around the pipe. Moreover any coating fault or void will be repaired.
- **Trench digging** (Figure 4.28): The onshore pipeline will be laid in a trench around 2 m deep and 1.6-1.8 m wide at the base. It will be excavated with a suitable excavator or trenching machinery. The excavated soil will be piled adjacent to the topsoil pile, separated to prevent mixing. All rock will be removed from the trench prior to the lowering-in operation.

Figure 4.28 Example of Pipe Trench Excavation

Source: ERM, 2014

- **Pipe laying** (Figure 4.29): Welded string will be lowered into the trench by a team of side boom operators. Only stone-free material will be used for bedding the pipe sections and, in areas of rocky terrain, sand or sieved backfill material will be placed in the bottom of the trench and on both sides of the pipe for protection purposes.
- **Backfilling**: Backfill will be placed over the pipeline immediately after the pipe section has been lowered into the trench. Backfill material will be compacted in layers. Extreme care will be taken with the initial fill to avoid damage to the coating. After the initial layer of screened material is placed into the trench, the remaining soil and rock mixture will be replaced to complete the backfill. Trenching material not used for backfilling will be removed and disposed of.
- **Reinstatement**: Removed topsoil will be placed back on the working corridor. The original contours of the land will be restored as closely as possible. As part of the restoration process, all equipment, access roads and crossings will be removed. Land drainage infrastructure, access roads, other networks and facilities disturbed during construction will be reinstated to their former state. If required, the final step will be the establishment of access barriers to prevent trespassing on the ROW at appropriate points. All posts and markers will be located to minimise interference with agricultural activities.

Figure 4.29 Example of Pipe Lowering

Source: ERM, 2014

Swamp areas are located near the shore-ORF pipeline route. The pipeline route will be designed in order to remain away from wetland areas, but in case of swamp crossing, a safety construction approach will be chosen to prevent buoyancy, e.g. the pipeline will be weighted with concrete and wetland crossing will be specifically designed to mitigate impacts on the natural drainage.

Table 4.19 Equipment Expected in Use for Onshore Pipeline Construction

Working phase	Equipment	Number	Engine Power
Working strip preparation	Excavator	4	200-300 HP
	Backhoe loader	2	200-300 HP
Pipe stringing and bending	Crane 25 t (pipelayer)	2	200-300 HP
	Side boom	2	200-300 HP
	Pay-welder	2	200-300 HP
	Pipe bending machine	2	200-300 HP
Pipe welding	Pay-welder	2	200-300 HP
	welding machine	6	-
	Side-boom	2	200-300 HP
	Engine driver compressor	2	200-300 HP
Trench digging	Excavators	4	200-300 hp
	Trucks	4	200-300 hp
Pipe laying	Side-boom	8	200-300 hp
	Excavator	4	200-300 hp
	Backhoe loader	2	200-300 hp
Reinstatement	Excavator	4	200-300 hp
	Backhoe loader	2	200-300 hp

Source: ERM, 2014

4.6.6 Pre-Commissioning Phase

Pre-commissioning activities will consist of dewatering, drying and inerting the pipelines before they can be used for flowing the product. The pipelines will be cleaned and checked for free passage with cleaning pigs.

Pigging will be performed to clean up the pipeline and for gauging. Pigging device will consist of two or four sealing discs and a pair of guiding disc made of polyurethane.

Flooding, cleaning and gauging operations of gas export sealine will be done by means of the installation vessel or support vessel (equipped with pumps). Once the line has been cleaned and gauged, than the hydrotest can be performed from installation/support vessel or from ORF by means of pumps.

The purpose of hydrostatic testing is to confirm the integrity of the onshore and offshore pipelines. The pipelines will be flooded with seawater (additives will be added) by injection via a temporary pig launcher to allow leak test from the FPSO or from the ORF once the riser and jumper of subsea system have been connected to the gas export PLET. Dewatering after leak test will be performed from ORF to PLET/SSIV in order to allow offshore water discharge. In this case compressors will be required at ORF

All the chemicals used during this phase will be environmentally friendly and will be respondent to international standards and industrial best practice for oil and gas. Table 4.20 presents typical chemical content in wastewater from hydrotesting/leak test.

For the hydrotest of the pipeline to the ORF, about 13000 m^3 of seawater will be used and then discharged to the sea. (see Table 4.20). A procedure will be defined during detailed engineering (2016) and studies will be submitted to the competent authorities.

Table 4.20 Chemical Content in Wastewater from Hydrotesting

Chemicals	**Content in Wastewater [ppm]** [1]
Corrosion inhibitor	500
Oxygen scavenger	250
Biocide	100-200
Leak detection fluorescent pipe dye	100
Note	
[1] Concentrations according to Best industrial Practices in Oil and Gas	

Source: eni, 2014

Once the hydrotest has been performed (in accordance to the hydrotest procedure that will be developed), the system will be depressurised to ambient pressure and then the pipelines will be dewatered, dried and inerted with gas. Appropriate hydrotest water discharge protocols and procedures will be developed by eni to ensure that concentrations of additives remain below toxic levels for marine organisms.

4.7 OPERATION PHASE

During this Phase, the NAG production will take place. Gas extracted from the wells will be treated on the FPSO (hydrocarbon and water dew-pointed), sent to the ORF through the gas export pipeline, to be then received, fiscally metered, compressed and delivered to the GNGC gas sales line through a tie-in on the GNGC 20" gas sales line. The proposed Project has a lifespan of 20 years.

4.7.1 Offshore

Each NAG well will be directly tied-back with the FPSO through subsea flowlines and risers. On the FPSO, the condensates will be separated from the gas and blended with the oil for further treatment.

On the FPSO the hydrocarbons and water dew point of the NAG will be adjusted, and then the rich gas will be sent to the ORF.

A future gas booster compressor is foreseen on the FPSO to manage the expected pressure decline of the reservoir (expected on 2026).

During operation phase, not only NAG will be treated on the FPSO but also oil and associated gas coming from the oil reservoirs. Stabilized oil will be stored in dedicated FPSO tanks and periodically offloaded with a tanker. During offloading operations there will be at least two tugs to support the operation.

4.7.2 Onshore

NAG, when arriving at the ORF, will be sent to a temporary slug catcher) to manage any liquid slug from the sealine, during pigging activities or transient operations. At the end, sales gas will be measured using a fiscal metering unit and compressed to the required pressure. After these activities, the gas will be sent to the national system, through a tie-in on the GNGC pipeline located near the ORF.

An optional operating condition will include compression in the OCTP plant, then the mixed gas (OCTP + GNGC) would be sent to the Ghana National grid.

4.7.3 Maintenance

The operation and maintenance approach of the OCTP Phase 2 Project aims to achieve the following objectives:

- assure continuous exploitation operations;
- maximize ergonomics of installation;
- minimize project operational cost;
- assure assets integrity;
- reduce accident occurrence;
- minimize workers exposure to risks; and
- protect the environment.

Appropriate management control and engineering practices will be put in place in order to achieve and maintain the above listed objectives. They will comply with the requirements of eni, with international standards and legal obligations and with applicable national regulation.

The FPSO and the ORF will be permanently manned.

The staff on board of the FPSO will operate in turning shifts and will be accommodated in a living quarter that will include living room, recreation room, first aid facilities and helideck for emergencies. The staff of the ORF will be lodged in an accommodation camp located at the ORF Concession area at Sanzule, as shown in Figure 4.17.

Ordinary maintenance of project facilities will be performed during normal operation. The maintenance will be performed on site, the machines will be equipped with dedicated systems including the remote condition monitoring and sparing philosophy, aimed to ensure the requested plant availability. Moreover, the design will allow easy access to the main equipment for major maintenance.

4.7.4 Takoradi base and Takoradi Port

9 km north-west from Takoradi Port, eni has realised a new logistic base, designed to host and manage all needed items during different phases of the oil and gas development project. The base has the following characteristics:

- open storage area / pipe yard /driveways: 17,000 m^2;
- warehouse: 4,000 m^2;
- office area: 300 m^2;
- personnel facilities (kitchen, shower room): 250 m^2;
- option for additional open yard: 10,000 m^2.

The figures below presents the layout and a photo of the Takoradi logistic base.

Figure 4.30 Takoradi Logistic Base Layout

Source: eni, 2015

Figure 4.31 Takoradi Logistic Base

Source: eni, 2015

The logistic base operational from September 2014: the pipeyard is being used for storing tubulars, while a warehouse is being finalised to keep the materials requiring to be protected from the weather action.

For the OCTP project storage needs the optional 10,000 m^2 area will be used together with the storage area already in use. The commercial port of Takoradi is well connected to its hinterland, and annually handles over 600 vessels.

Berthing facilities include four multipurpose berths with drafts between 9.0 m to 10.0 m and dedicated berths for manganese 157 m; bauxite 170 m; fuelling and Oil Company (Tullow) 120 m. There are also buoys with a maximum draft of 11.0 m. The Port's vessel repairs facilities are under a plan for modernization and expansion.

In order to minimize congestion problems during construction and operation of OCTP project, eni will put in place with Port Authority an agreement to to provide the project with a dedicated berth and a dedicated area at quay side.

4.8 Decommissioning and Abandonment Phase

The proposed Project has a lifespan of 20 years. After that period, the project facilities will be decommissioned and abandoned in accordance with Ghana laws and regulations and international guidelines for abandonment of oil and gas facilities. A detailed programme of abandonment and decommissioning will be prepared.

As a minimum, the reservoirs will be sealed off and all equipment and debris will be removed to avoid interferences with human activities and environment restoration.

Wells, production facilities, umbilicals, flowlines, risers and infrastructures will be cleaned up, decommissioned dismantled and removed or abandoned in accordance to regulatory requirements. Sites will be left in a safe and environmentally acceptable condition.

The decommissioning activities will be performed with equipment similar to that foreseen for the construction activities, and will be completed in two years. Waste will be properly treated in compliance with national regulatory requirements.

4.8.1 Onshore Facilities

The onshore facilities, including onshore export gas pipeline to ORF, ORF and related facilities, will be decommissioned as follows:

- All underground pipelines will be flushed to remove fluids and sludge, plugged and then left in place (when possible).
- All aboveground pipelines, piping and equipment will be flushed to remove fluids and sludge then totally removed.
- All areas will be cleaned and all removed materials will be properly disposed.
- All areas will be restored to their initial status (before starting transportation and installation activities).
- All paved areas and foundations will be totally demolished, removed and relevant debris properly disposed.

- Roads, power plant and other infrastructures built for the project can be kept in place and handled to local authorities/communities.

Impacts arising from the ORF site decommissioning are significantly less than those produced during construction since the decommissioning activities will be carried out on paved surfaces. Therefore, the contribution of dust re-suspension due to vehicles transit on unpaved roads during the decommissioning phase will be negligible and the main dust emissions will be produced by handled material. Impacts on local air quality produced by dust emissions from handled material during the decommissioning phase are expected to be significantly lower than the impacts assessed for the dust emissions during the construction phase.

4.8.2 Offshore Facilities

FPSO, subsea facilities, export gas sealine and wells will be decommissioned as follows:

- All subsea wells will be properly plugged and abandoned. All permeable zones will be plugged individually to avoid any cross flow. Cement plugs will have top and bottom at least 50 meters above and below each permeable layer. An additional cement plug, at least 150 m long, will be placed with top about 50 m below the sea bed). X-mas trees and well heads will be abandoned on sea floor.
- Subsea FLETs will be flushed and then abandoned on sea bottom.
- Risers, umbilicals and flowlines will be disconnected from the FPSO, flushed, cleaned and filled with seawater before being plugged and abandoned on seabed.
- Flowlines, risers and umbilicals static sections will be flushed and left in place. Lines will be flushed and cleaned, filled with seawater, plugged and abandoned on the seabed properly secured.
- All subsea facilities will be flushed to FPSO topside.
- Waste water produced during clean-up operations is treated on FPSO facilities in order to reach the requested hydrocarbon residual and re-injected in a designated injection well.
- Mooring lines will be disconnected from FPSO and abandoned on the seabed.
- FPSO process equipment, piping and storage tanks will be cleaned out, flushed and drained. The FPSO will be towed from site for re-use, refurbishment, decommissioning or dismantling. It will be towed to from Ghana to Singapore (8500 km).
- The gas export pipeline will be flushed to ORF and abandoned on seabed. Wastewater produced during clean-up operations will be temporarily stored at the ORF and transported to the nearest wastewater treatment plant for adequate disposal.

4.9 USE OF RESOURCES AND ENVIRONMENTAL INTERFERENCES

The following section describes the interactions of the Project with the environment in terms of use of resources and environmental interference.

4.9.1 Land Use

<u>Construction Phase</u>

During the onshore construction phase, land will be needed for:

- construction of access roads and site access;
- construction sites for ORF, onshore section of the gas export pipeline, tie-in to the national grid including storage, accommodation, warehouse and parking; and
- temporary infrastructure (e.g. pipeline and construction yard, administration buildings, temporary accommodation camp).

Construction areas will not be fenced, by no trepassing warnings will be placed along working areas boundaries.

After construction, the temporary sites, pipeline right of ways, and land surroundings the sites will be restored to their original condition.

During operations, the only facilities that will be fenced (for safety and security reasons) are the accommodation camp, the ORF and helipad (showed in Figure 4.17). Table 4.19 summarises the land required for construction activities, as foreseen at this stage. In particular during construction phase 100,000 m^2 will be temporarily occupied by the construction yard and 30,000 m^2 will be occupied by the temporary accommodation camp (see Figure 4.17). These two infrastructures will be located in the concession area near the ORF area, resulting in a temporary land take. No additional temporary land take is foreseen outside the concession area. At the end of construction activities the two areas will be restored to their previous conditions.

Table 4.21 Land Use during Construction Phase

Component	**Temporary Land Use**
Onshore section of gas export pipeline (from landfall to ORF)	Working strip: max width 34 m length 1500 m Area: 51000 m^2
ORF and temporary associated facilities (e.g. construction yard)	190000 m^2
Connection to the Ghanaian national grid	Working strip: max width 34 m length 800 m Area: 27200 m^2
Temporary accommodation camp and related facilities	30000 m^2

Source: ERM based on eni data, 2014

<u>Operations Phase</u>

Land will be acquired (under a long term lease agreement) for permanent structures (i.e. ORF, Helipad and Accommodation Camp) and to allow for operations, maintenance and emergency access throughout the 20-year operational life of the project. Permanent facilities will be fenced for safety and security reasons and the remaining of the area will be accessible for the community commuting activities.

A safety zone of 50 m (25 m on each side) will be established over right of way for the onshore pipelines. The pipeline path will be clearly indicated and construction will be forbidden in this path. Free passage and movement of people will be granted. Other Community activities (e.g. agriculture, grazing, etc.) to be allowed in the acquired area, once construction activities have been completed, will be evaluated and risk assessed to determine pro's and con's (no other commitment can be done at this point in time).

Table 4.22 summarises the land required by the operation activities.

Table 4.22 Land Use during Operation Phase

Component	Permanent Land Take	Permanent Constraints
Onshore section of gas export pipeline (from landfall to ORF)	NA	Width 50 m (no construction activities allowed) Length 1500 m Area 75000 m^2
ORF	90000 m^2	
Connection to the Ghanaian national grid	NA	Width 50 m (no construction activities allowed Length 800 m Area 40000 m^2
Accommodation camp	27000 m^2	
Helipad	10000 m^2	

Source: ERM based on eni data, 2014

4.9.2 Materials

Construction Phase

Offshore

During the construction activities, various types of materials needed for the project execution will be used, such as steel, concrete, coating for the pipeline, or drilling mud. For well drilling and completion approximately 300 tons of chemical substances, 120 tons of bentonite and 300 tons of barite will be used.

Onshore

During the construction activities, various types of materials needed for the project execution will be used, such as steel, concrete and coating for the pipeline. Preliminarily, the minimum quantity of infilling material for the ORF can be estimated in about 440,000 m^3. As part of the site preparation and early works, the area hosting the permanent facilities will be levelled. A dedicated study will be carried out to determine, if necessary and the amount of extra material needed for infilling. Any quarry or borrow pit used for material supply will be restored at the end of construction activities. The source of infilling and construction materials will be procured through an adequate provider, that is in eni's vendor list and thus assessed by eni on a list of issues, including HSE, social and permitting aspects.

Operations Phase

Offshore

During the operations phase, only few chemicals will be used in the FPSO (such as MEG, corrosion inhibitor and methanol). Table 4.24 shows chemicals used during operation to be injected in the subsea system. The exhausted MEG will be regenerated in a dedicated unit in the FPSO, and then recycled to the process. A total amount of 169 m^3/d of MEG will be used during normal operation activities. On the FPSO it is foreseen a storage capacity for MEG of 584 m^3.

The following table provide a preliminary list of chemicals that it is expected to be used during drilling, completion, and FPSO operation. It is based on previous drilling activities carried out in Ghana and it is foreseen that the same chemicals will be used for OCTP Phase 2 drilling and completion activities. Chemicals classification is based on the following:

- PLONOR are substances that Pose Little Or No Risk to the Environment when used or discharged offshore (OSPAR Commission)
- OCNS HQ and colour bands for substances classification are:

Minimum HQ value	Maximum HQ value	Colour banding	
>0	<1	Gold	Lowest hazard
≥1	<30	Silver	
≥30	<100	White	
≥100	<300	Blue	
≥300	<1000	Orange	
≥1000		Purple	Highest hazard

- Non-CHARM: products not applicable to the CHARM model (i.e. inorganic substances, hydraulic fluids or chemicals used only in pipelines) are assigned an OCNS grouping, A - E. Group A includes products considered to have the greatest potential environmental hazard and Group E the least.

Table 4.23 lists chemical that it is expected to be used during well drilling and cementing.

Table 4.23 Chemicals used for drilling and well cementing

Chemicals used for drilling mud				
No	**Chemical Product Name**	**Classification**	**Physical State Liquid**	**OCNS Classification**
1	Barite	Weighting agent	Powder	E (PLONOR)
2	Escaid 120	Base Oil	Liquid	C
3	Bentonite	Viscosifier-Filtrate reduced	Powder	PLONOR
4	$CaCl_2$ 94 %	Common Chemical-Salt	Powder	PLONOR
5	Caustic Soda	Alkalinity Control	Powder	E
6	Citric Acid	Common Chemical-pH control	Powder	PLONOR
7	Defoam-X-EH	Defoamer	Liquid	N.A.
8	Duo-Vis	Viscosifier	Powder	Gold
9	Ecotrol RD	Filtrate Reduced	Powder	E
10	Guar Gum 3500 cps	Viscosifier	Powder	E (PLONOR)
11	KCl B.B.	Common Chemical-Salt	Powder	PLONOR
12	Kwik-Seal - F/M/C	Lost Circulation Material	Powder	E
13	Lime	Alkalinity Control	Powder	PLONOR
14	Mica - F/M/C	Lost Circulation Material	Powder	PLONOR
15	M-I Seal - F/M/C	Lost Circulation Material	Powder	N.A.
16	M-I-X II - F/M/C	Lost Circulation Material	Powder	N.A.
17	Nut Shell - M	Lost Circulation Material	Powder	E (PLONOR)
18	Oil Mud Wash	Surfactant	Liquid	N.A.
19	Onemul	Emulsifier	Liquid	C
20	Polypac R	Viscosifier	Powder	E
21	Safe-Carb 10/20/40/250	Weighting agent-LCM	Powder	E
22	Safe-Cide	Biocide	Liquid	Gold
23	Soda Ash	Alkalinity Control	Powder	E
24	Versa HRP	Viscosifier	Liquid	N.A.
25	Versacoat HF	Emulsifier	Liquid	N.A.
26	Versamod	Viscosifier (classified in CEFAS as Water Based Drilling Fluid)	Liquid	C
27	Versathin HF	Thinner (classified in CEFAS as OPF additive)	Liquid	C
28	Versawet	Emulsifier-Wetting agent	Liquid	E
29	VG Plus	Viscosifier-Filtrate reduced	Powder	E

Chemicals used for cementing for wells				
No	**Chemical Product Name**	**Classification**	**Physical State**	
1	D047	Antifoam Agent	Liquid	N.A.
2	D075	Silicate Additve - Extender	Liquid	N.A.
3	D080A	Liquid Dispersant	Liquid	N.A.
4	D081	Liquid Retarder	Liquid	N.A.
5	D110	Liquid Retarder	Liquid	Gold
6	D124C	Microsphere - Lightweight cement Extenders	Solid	N.A.
7	D145A	Low-temperature Liquid Dispersant	Liquid	Gold
8	D153	Anti-settling Agent	Solid	N.A.
9	D162	Liquid Anti-settling Agent	Liquid	N.A.
10	D168	UNIFLAC* - Fluid loss additive	Liquid	Gold
11	D175A	Antifoam Agent	Liquid	Gold
12	D182	MUDPUSH* II Spacer	Solid	Gold
13	D185	Low temperature Dispersant	Liquid	N.A.
14	D186	Low temperature cement set enhancer	Liquid	Gold
15	D193	Fluid loss Control Additive	Liquid	Gold
16	D206 Antifoam	Antifoam Agent	Liquid	Gold
17	D209	Lightweight cement Additve - Extender	Solid	N.A.
18	D500	GASBLOK* Low Temperature	Liquid	Gold
19	D600G	GASBLOK* Gas migration Additive	Liquid	Gold
20	D907	Cement Class G	Solid	N.A.
21	F103	Surfactant	Liquid	N.A.
22	U066	Mutual Solvent	Liquid	N.A.
Note: After conclusion of tender process, alternative types of chemicals will be evaluated with contractor, in particular if they fall in C category of OCNS classification in order to evaluate availability and feasibility of using a more environmentally friendly chemical.				

Source: eni, 2015

During operation, in subsea system of NAG wells only MEG, methanol and corrosion inhibitor will be used. In particular MEG will be injected on a continuous basis with an expected daily rate of approx. 169 m^3/d. Also the corrosion inhibitor will be injected continuously, while methanol will be used only for well remediation. The following Table 4.24 lists chemicals used in the subsea system during operation and injection characteristics.

Table 4.24 Chemicals used during operation (for NAG production)

NAG production	MEG	Corrosion Inhibitor	Methanol
OCNS Classification	E	N.A.	PLONOR
Injection Regime	Continuous	Continuous	Only during well remediation
Subsea Injection Point	Xmas Tree	Downhole	Xmas Tree
Density [kg/m³] @4°C	1120	1000	822
Viscosity [cP] @4°C	50	50	0.745
Commercial name (or equivalent)	-	Norust 491	-
Dosage (ppm) (Reference phase)	1000000	max (100 ppm / 20 l/MMSm3)	600000
	Water	Water / Gas	Water
Dilution	4.25/5	1/5	Pure

Source: eni, 2015

For oil treatment, on the FPSO will be used the chemicals listed below, together with lubricants for machineries and equipment and fuel types, in

As antifouling/biocide Bactron K31 will be used in the cooling water. The concentrations will range from 2 to 5 ppm. This chemical is not classified under OSPAR, but all the Bactron family of products and specially the K series are the least toxic of the OCNS classification levels (Gold).

Table 4.25.

As antifouling/biocide Bactron K31 will be used in the cooling water. The concentrations will range from 2 to 5 ppm. This chemical is not classified under OSPAR, but all the Bactron family of products and specially the K series are the least toxic of the OCNS classification levels (Gold).

Table 4.25 Chemicals used on FPSO for oil production, fuels and lubricants

FPSO process: oil treatment	Asphaltene inibitor
	Scale inhibitor
	Corrosion inhibitor (gas phase)
	Corrosion inhibitor (liquid phase)
	Foam inhibitor
	Polielectrolyte
	TEG
	DEG
	Oxygen scavenger (for seawater used for cooling)
	Disemulsifier
	MDEA
	Reverse emulsion breaker
Lubricants for Machineries and Equipments	Mobil DTE 16M (and/or Similar)
	Mobil DTE 846 (and/or Similar)
	Mobil Delvac 1 (and/or Similar)
	GRADE VG 32 (and/or Similar)
	S4 WE220 (and/or Similar)
	Tellus 68 Lube Oil (and/or Similar)
	Shell Gadus S2V 100 3 Grease (and/or Similar)
	Mobil XHP 222 (and/or Similar)
	Mineral Oil or Every Oil in Acc to SAE30 (and/or Similar)
	Multigrade Oil 15W40 (and/or Similar)
	Mobil DTE Heavy (and/or Similar)
Fuels	HFO (heavy fuel Oil)
	MFO (marine fuel Oil)

Onshore

In the ORF only a limited quantity of materials and chemicals will be used, mainly for maintenance of equipment and for plant running.

For ORF compression the following lubricants will be used for machineries and equipment: Tellus 68 Lube Oil and Mobil DTE 846.

4.9.3 Fuels

Construction Phase

Offshore

Vessels, heavy equipment and motor engine driven equipment will mostly be fuelled by diesel and marine fuel oils.

For the vessels, fuel will be pumped into the ships' tanks via fuel tanker and all precautions will be taken to eliminate spills. A boom will be deployed at the stern and bow of the vessel when refuelling is taking place; additionally there will be sufficient mops, pads and absorbents available during the fuelling process, whereby in the unlikely event of any spill occurring it will be dealt with immediately.

For the drilling rig a mean daily consumption of 35 to 40 m^3 of diesel is estimated, while the two/three 5000/6000 hp supply vessels fuel consumption is estimated as below 0.1 kg of diesel.

Onshore

During the construction activities, various types of construction equipment will be used. They will mostly be fuelled by diesel supplied by tank trucks. Refuelling operations will be carried out with all precautions to avoid spills. Any incidental spill will be immediately collected using booms, pads and absorbent mops depending the case and absorbent material properly stored and sent for treatment at dedicated facilities.

<u>Operation Phase</u>

Offshore

During the operation phase, fuel gas will be used (produced by the FPSO process itself), mainly for turbines, compressors and power generation. Marine diesel fuels will be used by ships' engines.

Onshore

In the ORF main power generation will be powered by fuel gas turbines, while emergency power generation will be fuelled by diesel. Based on 190MMSCFD inlet gas plus gas coming from GNGC to have the aggregate compression of 405MMSCFD, are foreseen 3 gas turbine with around 25-30MW of power consumed depending on operating scenario. Two drivers power both the first and second stages and the third driver powers an individual compressor for stage two.

4.9.4 Energy

<u>Construction Phase</u>

All the electric supply needed for the construction activities both onshore and offshore will be provided by electric power generation units located on the work sites. They will be fuelled with diesel.

<u>Operation Phase</u>

Offshore

All the electric supply needed for the FPSO operation will be provided by gas turbines and generators located on the FPSO itself and fuelled with fuel gas at a rate of 24 MMSCFD. A diesel generator will be also present to supply energy in case of emergency.

Onshore

All the electric power supply required for the ORF operation will be provided by a main electric power generation unit, consisting of gas turbines and gas power generators. The emergency power supply will be diesel fuelled. Therefore, connection to local existing electrical power line is not needed.

4.9.5 Water Consumption

Construction Phase

The foreseen water consumption is related primarily to the watering of the construction sites to reduce dust emissions during earthmoving activities, and for human consumption. The current water supply alternatives are groundwater (in this case, groundwater wells will be installed in the ORF area) as best case for the construction phase and as alternative water will be purchased from a provider. In the commissioning phase, water consumption is related to the hydrotesting activities: seawater will be used for the onshore pipelines, as well as for the offshore gas export pipeline and for the SURF system.

The following Table 4.26 shows the estimated water consumption foreseen during the construction activities.

Table 4.26 Water Consumption Estimated during the Construction and Operation Phase

Typology	Quantity	Comments
Offshore		
Seawater	13000-15000 m^3	For hydrotesting (construction phase only)
Water for consumption	Approximately 20-30 m^3/day during construction and 7-10 m^3/day during operation	100 l/person per day (both during construction and operation)
Industrial water	60-90 m^3/day	Various uses including drilling mud
Onshore		
Water for consumption	Approximately 60-70 m^3/day during construction and 7-10 m^3/day during operation	100 l/person per day (both during construction and operation)
Industrial water	20 m^3/day	Working strip humidification (construction phase only)
Seawater	500-600 m^3	For hydrotesting (construction phase only)

Source: eni, 2014

Operations Phase

During the operations phase, the freshwater consumption will be related to the FPSO and ORF activities. This consumption is expected to be low and related to human consumption and for maintenance. As stated above, the two alternatives are either the use of groundwater as best case or as alternative the use of sea water, after treatment in a desalinization plant.

On the FPSO, seawater will be used for cooling water and firefighting. The estimated amount is 110,000 m^3/month.

4.9.6 Transportation and Traffic

Construction Phase

Offshore

The Project will create an increase of vessel traffic on local routes connecting with the mainland, and in particular from Takoradi Port:

- traffic increase related to the pipelaying activities;
- traffic increase related to pipelaying barge supply and drilling rig support (diesel, material, pipe, crew on site, etc.); and
- traffic increase due to construction waste handling and waste water transportation.

The Project will increase onshore traffic, via road, and offshore to the support port.

Drilling material will arrive from abroad, transferred to the Takoradi logistic base and, when needed, sent offshore, through two Platforms supply Vessels (on average 4 trips/week).

Personnel will be transported to the drilling rig from onshore using one helicopter, on average 2/4 trips per day.

Onshore

There will be considerable transportation of personnel, heavy equipment and materials along the pipeline routes and the related working strip. Traffic will then mainly travel up and down the construction area along the right of way.

An average number of 50 vehicle movements per day are estimated through the construction area during the pipeline construction activities, with a peak of 60 movements per day during the excavation and pipeline laying activities, due to the transfer of excavated soil to be disposed and of sand used to protect the pipeline. Helicopters will only be used for medical emergencies.

During the construction activities discontinuous movements are foreseen through the public roads, involving mainly transport of materials, sand, excavated soil, waste and water to and from the construction site. Transportation on public road will be mainly from Takoradi. It is estimated an average number of 50 vehicle movements per day for transportation of construction material, construction equipment and construction personnel. Various types of vehicles are foreseen such as: 30 ton trucks, mini buses, water trucks, pick-ups, light vehicles, etc.

Operations Phase

Offshore

The marine traffic foreseen during the operational phase will be due mainly to supply the FPSO and for crew shift changes by air. Further marine traffic (average of 3 trips per week: types of vessels AHTS - Anchor Handling Tag Supply) will be generated during the maintenance and surveillance phase of the flowlines and offshore export pipeline.

Onshore

During operation, the traffic is essentially related to the movement of workers, by bus or cars, for the ORF operation and planned maintenance and inspection of the onshore pipelines. ORF personnel will be based in the nearby permanent accommodation camp connected to the ORF by an internal 600 m new road. It is estimated the use of two busses for the ORF personnel for crew shift purposes.

The offshore personnel will be transported by helicopter from and to Takoradi, and the helicopter will also be used for emergency purposes. The helicopter will remain in the Takoradi military airport being able to reach all points on/offshore in relatively short time.

4.9.7 Air Emissions

Construction Phase

Offshore

During the offshore construction activities, the airborne emission will be pollutants from the exhausts of heavy equipment and vessels. Pollutants will be produced by equipment and vessels from combustion engines, and released in the exhausted gas. The main pollutants produced will be NO_X, CO, PM_{10} and SO_X.

During well production tests, gas from the tested wells will be flared. The estimated flow rate of gas burnt in the flare will be 11.25 MMSCF. Testing lasts approximately 4.5 days.

Estimated emissions to air during construction phase are listed in Table 4.27 below. The table includes emissions during pipeline laying, well drilling and completion, subsea system installation and FPSO installation. These emissions are assessed in the EIS for the Phase 1 Development and are summarised here.

Table 4.27 Emissions to Air During Offshore Construction

Emission source		Unit	Emission
Offshore			
Exhaust gas total flow rate		m^3/h	130.000
Discharge temperature		°C	450
Unburnt hydrocarbons	flow	g/h	800
	concentration	mg/Nm^3	16
Carbon dioxide	flow	g/h	44.000
	concentration	mg/Nm^3	880
Nitrogen oxides	flow	g/h	80.000
	concentration	mg/Nm^3	1.600
Sulphur dioxide	flow	g/h	13.000
	concentration	mg/Nm^3	260
Particulate Matter	flow	g/h	3.000
	concentration	mg/Nm^3	60
Data estimated on the sum of all power generation units for a total power of 16,700 HP.			

Source: eni, 2014

For operation and construction the IFC GHG estimation tool will be used to estimate GHG emissions. Detailed results are provided in Annex G, and in particular in sections G.4.2, G.5.4, G.10.5.2 and G.10.6.3. Moreover the IFC Carbon Emission Estimator Tool was compiled and it is available upon request.

Onshore

During the onshore construction activities, the air emissions will be pollutants from the exhausts of heavy equipment and soil dust particles from movement of soil.

Soil dust will be produced during the excavation and backfilling activities, and during the earthworks related to the onshore pipeline and ORF construction activities. Other sources of dust emission will be the traffic movements of trucks, minivans and heavy equipment on the pipeline right of way. Main pollutants produced by engines will be NO_X, CO, dust and SO_X.

Operations Phase

Offshore

Offshore air emission sources are related to the FPSO operation, mainly gas turbines for power generation and gas compression, and the flares. Flares are only used for limited periods during commissioning phase and during operations in emergency cases. The Project has adopted a "zero flaring" design philosophy.

Table 4.28 presents the main emission source characteristics foreseen at this project stage.

Table 4.28 FPSO Main Emission Sources

Equipment	Stack diameter	Mass Flow rate	Exhaust temperature	O_2 content	NO_X	SO_X	PM
	m	Kg/h	°C	%	mg/Nm³	mg/Nm³	mg/Nm³
3 x Gas Turbine LM2500+G4 (34 MW each)	Not defined yet	321804	550	15%	360 ppmvd if gas fuelled; 510 ppmvd if liquid fuelled	2 ppmvd if gas fuelled; 290 ppmvd if liquid fuelled	
2x 45t/hr boilers	DN1200	50081-50971	283-289	2-3	<460 (liquid fuel) <320 (gas)	<910 (liquid fuel) N/A (gas)	<50 (liquid fuel) N/A (gas)
Main Engine (only for navigation to site)	Not defined yet						
2 x Gas Turbines lm 2500 for NAG Booster compressor (from 2026 to 2036, 25 MW each))	Not defined yet						

Equipment	Stack diameter	Mass Flow rate	Exhaust temperature	O_2 content	NO_X	SO_X	PM
	m	Kg/h	°C	%	mg/Nm^3	mg/Nm^3	mg/Nm^3
3 x (2.4 MW) Essential diesel generator (only in case of black out)	450	19140	370	NA	1548	Fuel depending	33
1 x (1 MW) Emergency diesel generator (only in emergency)	200	5186	414	NA	2966	Fuel depending	23
Gas turbines can be fuelled with fuel gas or liquid fuel. The following expected emissions are estimated for the two fuel types. **FUEL GAS Expected Emission:** Estimated NO_X emission is not to exceed 360 ppmvd @15%O_2. Estimated CO emission is 15 ppmvd @15%O_2. **LIQUID FUEL <u>Expected Emission:</u>** Estimated NO_X emission is not to exceed 510 ppmvd @15%O_2. Estimated CO emission is 15 ppmvd @15%O_2.							

Source: eni, 2015

Other secondary sources of emissions are emergency diesel generator (discontinuous) and MEG heaters.

When more detailed design and emission data are available, eni will produce a detailed dispersion modelling for main emission sources. GHG emission estimation will be also performed.

Onshore

The ORF will be the end point of the export gas pipeline. Gas entering the ORF will be measured, compressed and delivered into the existing national network. The gas will not be stored in the ORF.

The ORF air emission sources will be related to the ORF operation, mainly gas turbines, diesel power generation units and gas compression.

A further discontinuous air emission source in the ORF will be the vent: it will be used only during commissioning, start-up, shut down and emergency conditions for the pipeline and plant depressurisation.

At this stage of the project no emission estimates are available for the ORF.In any case compliance with WHO Ambient Air Quality Standards and/or Ghanaian Standards at nearest receptors will be assured and a dispersion model of the ORF emissions will be developed

4.9.8 Noise Emissions

Construction Phase

Offshore

During the offshore construction phase noise emission will be produced by the rig during wells drilling and completion activities, and by the support vessels. Estimated noise levels based on previous drilling activities with Saipem 10000 or equivalent rig in the different rig areas are:

- engine zone: 105.5 Leq dB(A);
- derrick floor where rotary table and winch are located: 93.6 Leq dB(A);
- pump zone: 85.6 Leq dB(A); and
- cementing unit: 104.2 Leq dB(A).

The noise expected to be produced is of low frequency, and the noisiest side of the rig is the side where the engines are located.

During drilling activities, underwater noise will be generated. Noise emissions of primary concern are generated by the drill rig and support and supply vessels. Quantification is provided in Chapter 10.

Onshore

The noise emissions generated from the pipeline right of way and the ORF site and yard during the construction activities by heavy equipment are listed in Table 4.29. The reported pressure noise levels at 1 meter from the source are typical for the equipment. Helicopters will only be used in emergency situations, so associated noise has not been included in this table. Additional details on noise levels at community receptors are discussed in Chapter 10 and more in detail in Annex G.

Table 4.29 Typical Noise Power Level for Construction Equipment

Type of Equipment	Power Noise Level
Excavator	70 - 84 dBA
Backhoe loader	70 - 84 dBA
Crane	70 - 84 dBA
Pipelayer	70 dBA
Side-boom	84 - 99 dBA
Pipe bending machine	60 dBA
Engine generator	70 - 84 dBA
Pay-welder	70 - 84 dBA

Source: eni, 2014

During commissioning phase, noise sources are compressors and pumps for the hydrotesting.

Operations Phase

Offshore

The FPSO operation will generate noise from the processing equipment.

Relative to working conditions, the noise upper threshold value for occupational exposure is 85 dBA assuming a maximum working day of 8 hour/day and a maximum working week of 40 hours/week (OSHA Standard Occupational Noise Exposure, 1910.95). Areas exceeding noise levels will be identified and marked and suitable ear protection will be provided to workers in those areas.

The estimated noise produced by the FPSO and supply vessels is normally kept under 90 dB within the operational boundaries of the FPSO. Noise issues are discussed in Impact Assessment Chapter

Onshore

Considering the ORF characteristics, the continuous noise emission sources will be the gas turbines, diesel power generators and the compressors. At this stage of the project no specific item data are available, but the design will be developed assuring that all the equipment is in compliance with the applicable limits and, where necessary, noise attenuation packages are used to meet WBG guidelines at the nearest residential receptors. eni will develop the design of the ORF in compliance with eni standard noise and vibration management and a specific noise study will be developed to verify the compliance with the mentioned standard. This study will include a detailed modelling of noise sources.

The main discontinuous noise sources present in the ORF will include operation valves, filters and air coolers. All the equipment will be in compliance with the applicable limits and, where necessary, noise attenuation packages will be used.

4.9.9 Waste Handling and Disposal

For the Project, only waste management companies approved by Ghanaian authorities will be used for transportation, recycling and disposal of produced wastes. A Waste Management Plan is in place at eni Ghana as described in the next paragraphs.

No NORM presence is foreseen in OCTP reservoir and thus no NORM contaminated waste will need treatment and disposal.

<u>Construction Phase</u>

Offshore

Wastes produced from drilling activity are seawater-based used mud, Non-aqueous drilling fluid mud, cuttings and domestic liquid and solid wastes.

The amount of waste generated by the drilling rig is estimated in 3.5 to 4.5 tons/day of which about about 2.5 tons/day is hazardous waste and the remaining of nonhazardous waste.

Treatment of drilling wastes (used mud and cuttings) will depend on the drilling phase:

- When seawater-based drilling mud is used, the drilling is made without riser (riserless), so the cuttings and water based drilling muds produced are mixed with seawater and flow to the seabed.

When Non-Aqueous Drilling Fluid (NADF) is used, the drilling is made with the riser so that cuttings will be flowing out together with drilling mud through the flowline and separated from the mud. Cuttings contaminated by NADF will be appropriately treated on the drilling rig, as described in Section 4.6.1. The treated cuttings will be disposed of at water depths equal or greater than 500 m. Discharge outlets, under the drilling rig, will be located 50 m below sea level, and then natural sedimentation will allow cuttings deposition on the seabed (ranging from 600 to 1100 m of water depth). Discharge will be in compliance with Ghanaian limits. In section 3.8 is included a list of discharge limits related to offshore drilling activity.

Water based muds will be discharged at sea, while NADF muds will be recovered on the drilling rig. NADF cuttings will be discharged at sea only after proper treatment in compliance with Ghana standards and discharge limits. Table 4.30 summarizes the expected volumes of drilling cuttings produced.

Table 4.30 Estimated Quantities of Cuttings Produced for a Single Well

Drilling phase	Mud type	Cuttings (m^3)
Riserless phase	Seawater based	400
Riser phase	Non-Aqueous Drilling fluids	400

Source: eni, 2014

Other waste produced during the construction activities (e.g., battery, oily dust cloth, used lubricants, medical waste) will be collected on the drilling vessel and brought onshore for appropriate treatment and disposal.

Onshore

All waste materials will be collected, stored and transported separately in appropriate and approved containers.

The overall objective is to minimize the impacts of waste generated during the construction phase through the following:

- minimize the amount of waste that is generated;
- maximize the amount of waste that is recovered for recycling, including segregation of recyclable wastes at source;
- minimize the amount of waste that is disposed in landfills;
- ensure that hazardous wastes (eg, used oils, lead-acid batteries) are securely stored and transferred to appropriate facilities in the construction site;
- avoid dust impacts from handling of construction wastes;
- ensure wastes are properly contained, labelled and disposed of in accordance with local regulations; and
- dispose of waste in accordance with the waste management plan.

The construction waste management strategy will incorporate the following good site practices which will reduce the risk of impacts arising from waste. The construction waste management plan will cover the following key aspects:

- inventory and schedule of likely wastes;
- assessment of local waste management facilities;

- waste minimization principles;
- maximize reuse and recycling;
- waste segregation (liquid and solid/reusable and recyclable);
- waste collection, storage and transfer;
- specific disposal procedures for all waste steams identified, including waste transfer notes if moved to an offsite licensed facility;
- auditing and reporting procedures; and
- closure process, which will include appropriate monitoring and recording.

For pipeline construction, most of the excavated soil will be used to backfill the trenches. Excess soil will likely be spread out and contoured along the route.

Wastewater and solid waste from the work and construction sites will also be generated and disposed of accordingly with local and international standards.

Operations Phase

Offshore

During FPSO operations, small quantities of waste will be produced mainly due to equipment maintenance and operation. Wastes will be collected, unloaded and transported onshore to suitable facilities to be disposed in line with the local regulations and best practice. Some waste will be produced by living facilities located on the FPSO: it will be disposed of accordingly with regulatory framework in place (as described in section 3.8) and in line with the management plan.

Solid waste will be collected every 15 days and the following amounts are foreseen (refer to Table 4.31).

Table 4.31 Estimated Quantities of Produced Waste

Waste	**Quantities (Kg/15 days)**	**Waste**	**Quantities (Kg/15 days)**
Not segregated waste	2,160	Plastic bottles	180
Plastic	60	Used sulphur filters	120
Cans	100	Oily rags	100
Carton, wood and paper	80	Empty buckets of paint	100
Glass	100	Used media filters	50

Source: eni, 2015

Food waste will be shredded and dumped at sea through a sieve with an aperture of 25 mm as specified by Ghanaian and MARPOL regulations. No discharge of any kind of garbage (including food wastes and cooking oil) will take place within 500 m of the FPSO, as stated in Section 3.8.

Onshore

During operation, small quantities of waste will be produced from the ORF from equipment maintenance and operation. Domestic waste will also be generated. Both waste types will be handled accordingly to local regulations and best practice.

Waste Management Plan

eni Ghana has in place a Waste Management Plan as part of the HSE Integrated management System. The OCTP project waste management system will be based on the same general principles and disposal guidelines.

In particular the OCTP waste management plan will cover the collection, storage, treatment, transport, disposal, discharge, reporting and data management of all the waste to be generated during offshore and onshore operations, including drilling, infrastructures and facilities construction, operations and maintenance. The OCTP waste management plan will include site-specific procedures detailing how waste is to be managed, treated and disposed of, identifying the waste types and streams and defining waste handling contractors and final disposal sites.

The OCTP waste management plan will be based on the following general principles:

- All waste will be managed to ensure protection of the natural environment and the health and safety of personnel and the community;
- Waste minimization is a key point of the waste management process and it is achieved by applying the following hierarchy:
  - Reduce waste quantity,
  - Re-use materials where possible,
  - Recycle where feasible,
  - Recover as much as possible,
  - Responsible disposal

Both hazardous and non-hazardous waste will be identified, risk assessed and classified. After that a proper waste handling technique will be selected.

At each project facility (drilling rig, FPSO, ORF) a dedicated waste storage area will be selected and equipped with waste containers and different waste types will be segregated in order to prevent accidental spillages, fires, soil contamination, loss of integrity and possibility of contact with people and animals. Storage containers will be selected on the basis of waste characteristics and clearly labelled. Containers for offshore waste will be in compliance with ISO 1496 or EN 1279.

All waste producers (Operator, Contractors and sub-contractors) will maintain a waste register and prepare an inspection and reporting plan. The waste register will include the following information:

- Source of waste (e.g. rig, vessel, FPSO, ORF, accommodation camp, etc),
- Waste description (e.g.: oily rags, drilling mud, chemicals),
- Classification of waste streams (i.e. hazardous or non-hazardous),

- Quantity (weight (kg) or volume (L or m^3)),
- Waste Transfer Note numbers,
- Dates of transfer.

Main non-hazardous waste will be transported, stored and disposed of as reported in the following Table 4.32, while in Table 4.33 are listed main hazardous waste types and handling methods.

Table 4.32 Non-hazardous waste handling

Waste Type	Transport	Sea Transport	Onshore	Final treatment/Destination
Wood (pallet, packaging, furniture, beam, crate)	Open skip / empty return container	Open skip with net/ empty return container with net	Open skip / empty return container	Reuse where feasible Otherwise Municipal landfill (Sofokrom Landfill, approved by EPA)
Food (Organic waste, food,)	Closed drums	Closed drums	Closed drums	Municipal Landfill (Zeal/Zoil's Integrated Oilfield Waste Management Facility)
General waste (Domestic waste, paper, tins, cardboard, glass, plastic, textiles)	Open skip	Open skip with net	Open skip	Municipal landfill (Sofokrom Landfill, approved by EPA) Or Zeal/Zoil's Integrated Oilfield Waste Management Facility Or Cyclus Elmina Plastic Recycling ltd.
Metal (steel, gratings, iron beams, casings, scraps, steel containers)	Open skip	Open skip with net	Open skip	Recycle in Ghana: after cleaning (if needed), Ferro Fabrics in Tema (EPA approved)
Empty barrels	Closed container or half height	Closed container or half height	Closed container or half height	Recycle: Cleaning at Zeal/Zoil's Integrated Oilfield Waste Management Facility And then Ferro Fabrics in Tema (EPA approved) or other EPA approved plastic recyclers

Source: eni, 2015

Table 4.33 Hazardous waste handling

Waste Type	Offshore container	Sea/road transport method	Onshore storage	Final treatment/Destination
Batteries	Barrel	Return container	Barrel	Waste handling contractor Zeal/Zoil's Integrated Oilfield Waste Management Facility
Waste electrical and Electronic Equipment	Open skip	Open skip with net	Open skip	Zeal/Zoil's Integrated Oilfield Waste Management Facility
Paint and thinner and other flammable liquids	Barrel/Clip top drums	Return container	Barrel	Waste handling contractor Zeal/Zoil's Integrated Oilfield Waste Management Facility
Spray can/aerosol	Barrel	Return container	Barrel	Waste handling contractor Zeal/Zoil's Integrated Oilfield Waste Management Facility
Fluorescent tube/light bulb	Original packing/open plastic drums	Return container	Barrel	Waste handling contractor Mercury recovery at Zeal/Zoil's Integrated Oilfield Waste Management Facility and glass disposal at Sofokrom Municipal Landfill
Chemical (pure)	Barrel/tote tank/original packaging	Closed container or tote tank	Closed container or tote tank	Waste handling contractor Incineration at Zeal/Zoil's Integrated Oilfield Waste Management Facility
Chemical (mixture)	Barrel/tote tank/original packaging	Closed container or tote tank	Closed container or tote tank	Waste handling contractor Incineration at Zeal/Zoil's Integrated Oilfield Waste Management Facility
Oily solid waste (rags, filter, gloves)	Clip top drum or lidded skip	Clip top drum or lidded skip	Clip top drum or lidded skip	Waste handling contractor Zeal/Zoil's Integrated Oilfield Waste Management Facility
Used oils/Waste Oil	Mobile tank/barrel or ships hold	Mobile tank/barrel or ships hold	Mobile tank/barrel or ships hold	Recycling contractor Zeal/Zoil's Integrated Oilfield Waste Management Facility
Oily waste water	Mobile tank/barrel or ships hold	Mobile tank/barrel or ships hold	Mobile tank/barrel or ships hold	Recycling contractor Zeal/Zoil's Integrated Oilfield Waste Management Facility
Medical waste	Bio-hazard bag and box	Bio-hazard bag and box	Bio-hazard bag and box	Incineration at Takoradi Hospital Or Incineration at Zeal/Zoil's Integrated Oilfield Waste Management Facility
Medicines	NA	Sealed bag	NA	Medical disposal at Takoradi Hospital Or Incineration at Zeal/Zoil's Integrated Oilfield Waste Management Facility

Source: eni, 2015

Available disposal options in the OCTP area are:

- Incineration: for non-hazardous and hazardous wastes will be used the incineration site in Takoradi. The eni's approved contractors are Zeal & Zoil.
- Landfilling: Takoradi landfill will be used for non-hazardous wastes. The eni's approved contractor are Zeal & Zoil.
- Scrap Metal Recycling: using an in-Country existing recycling contractor.
- Waste Oil Treatment and Recycling: through a recycling contractor in the bitumen producing industry or other Ghanaian industries.
- Burning Basket: it will be used only for non-hazardous kitchen, canteen and cabin waste on the drilling rig, the FPSO, the pipe laying barges and the support vessels. It will be used only in compliance with MARPOL Annex V.
- Discharge at sea: for riserless drilling cuttings, where water based mud is used and for cuttings contaminated by non-aqueous drilling fluid after proper treatment on board of rig.

eni will only use contractors that are certified and authorized by authorities to perform waste transportation, handling and management of wastes. Furthermore, at its own discretion, eni will carry out audits to ascertain disposal sites are being operated to acceptable standards and all necessary permits are maintained.

4.9.10 Waste Water

<u>Construction Phase</u>

Offshore

The drilling rig, the pipelaying vessel and other support vessels will adhere to MARPOL regulations and will be equipped with waste water treatment units for the treatment of civil wastewater.

The seawater used during the precommissioning activities related with the offshore pipeline hydrotesting will be discharged to the sea. Only environmentally friendly inhibitors will be used and their discharge concentrations will be in line with local and international standards as stated in Table 4.20.

A discharge protocol will be developed to ensure compliance with set standards, it will be available during completion of detail design (2016).

Onshore

No waste water discharge to the environment is foreseen from the onshore activities during construction phase. Liquids are only associated with the equipment and therefore a liquid processing/ treatment infrastructure is not foreseen. Any hydrocarbon liquid will be drained into a suitable receptacle and removed for disposal off site. All liquid waste will be treated as waste, properly stored and disposed off-site, in particular it will be treated and disposed at Zeal's and/or Zoil's Waste Management Facilities. Sanitary water will be treated in sewage treatment plant as described in Section 4.5.4.

Operation Phase.

Offshore

The waste water effluents from the FPSO operation are reported in Table 4.34 together with the estimated quantities. The estimated quantities and types include waste water produced in the FPSO for both Phase 1 and Phase.

Table 4.34 Waste Water Effluent from FPSO

Discharge Sources	Location	Substance	Emissions Flowrate
Cooling Water	FPSO Topside	Hot Water treated with biocides and antifouling	1700 m^3/h with a maximum discharge temperature of 31 °C. Typical biocides/antifouling concentration is 2-5 ppm.
Produced Water	FPSO Topside	Produced Water	Depends on reservoir water cut. The treatment system has a design capacity of 45000 bblsd.
Domestic Water	FPSO Topside	Domestic water	6 m^3/day
Service Water	FPSO Hull	Seawater	TBD
Ballast Water	FPSO Ballast System	Seawater	TBD
Bilge water	FPSO Topside	Oily and accidentally oily water	10-15 m^3/month

Source: eni, 2014

All waste water streams will be discharged to the sea after treatment on the FPSO, except produced water which will be reinjected in reinjection wells.

Domestic wastewater, discharged from w.c., washbasins, showers and kitchen, will be treated in a purification system before being discharged to the sea in accordance with MARPOL regulations. A biological-type purification system will be used. Cooling water will be discharged to the sea.

Oily and accidentally oily waters (bilge water) will be collected and treated in a separator. Recovered oil will be filtered and collected in a tank for onshore disposal. The treated water will be sent to liquid waste collection tank and then discharged to the sea.

Onshore

The waste water effluents from the ORF operation will be mainly civil water and storm water, as in the ORF process only the gas stream is present and thus no liquids will be generated and no chemicals will be added into the gas stream. Liquids will be associated mainly with equipment. Main industrial sources of wastewater will be accidental contamination with diesel (for emergency power generation) and lube oil (from turbines and compressors) and turbine blade washing. To avoid accidental contamination of storm water with diesel a containment basin will be installed around the diesel tank, together with a shelter to avoid rain water ingress in the basin.

Gas turbines and compressors will be protected by paved areas and shelters as well, to avoid rainwater contamination with lube oil and engine oil. A sump will be installed to drain water.

Any residual oil or lubricant will be removed and disposed of. During maintenance activities, oil will be drained in suitable receptacles and the sent to disposal.

Gas turbine washing will be performed with demineralised water and biodegradable chemicals. Wastewater will be collected in a dedicated pit that can be emptied by a gully sucker.

The wastewater effluents will be removed and disposed of in appropriate treatment plants (owned by Zeal or Zoil local waste management companies).

No wastewater treatment plant is foreseen in the ORF, except for treatment of civil waters produced at the plant. In Section 4.5.4 more details are given.

4.10 EMPLOYMENT AND LABOUR

4.10.1 Construction Phase

During construction the workforce demand has been estimated at Table 4.35. Most of the workforce will be provided by construction contractors and only few eni representatives/supervisors will be present.

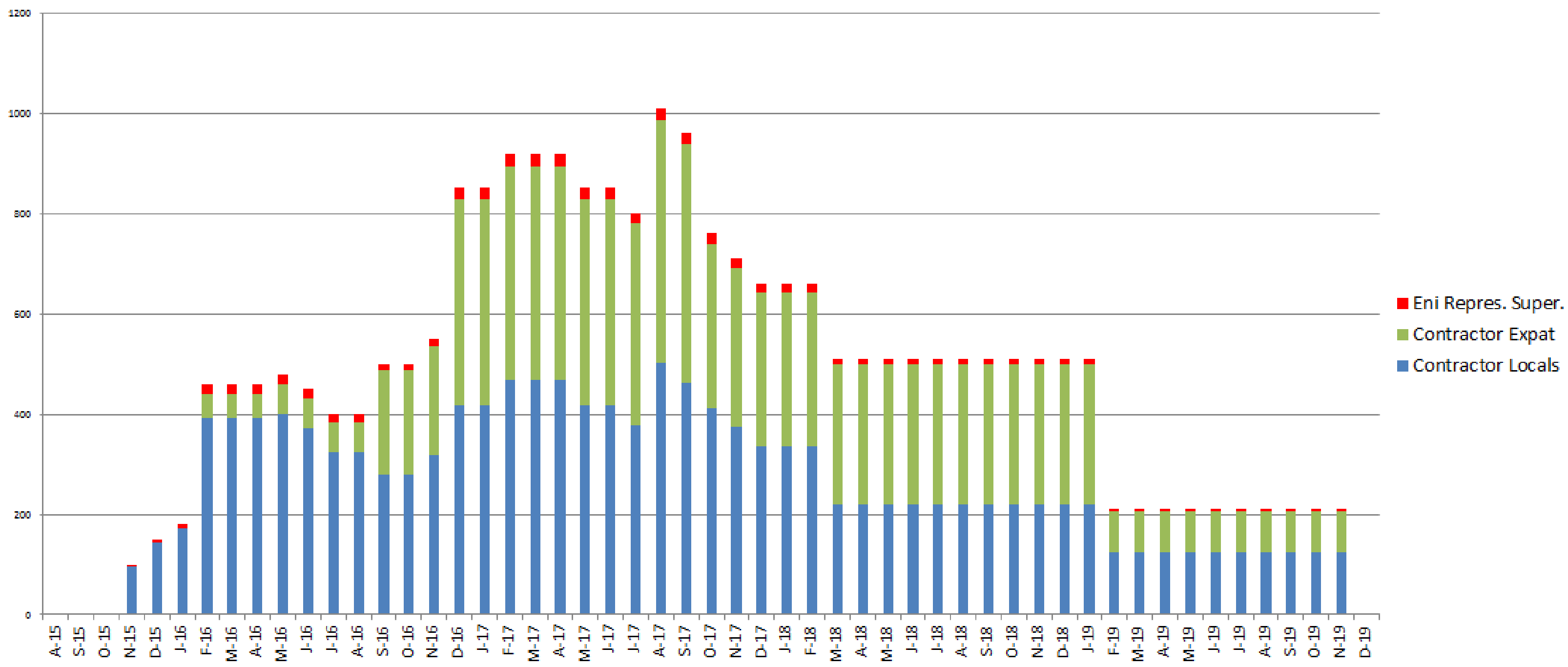
Table 4.35 Estimated Personnel Requirements for Construction Phase

Activity	Project activities dates and duration	Total workforce	Contractor Locals	Contractor Expatriates	eni's representatives/supervisors
Drilling (oil and gas wells) and Completion	End 2016 - Beginning 2019	300	98	196	6
Offshore Installation Campaign	Aug 2017 – Nov 2019	210	123	83	4
Gas Export Sealine	Sept 2016 – Sept 2017	200	50	150	-
ORF & related infrastructures – Early Works	Nov 2015 – Aug 2016	210	200	-	10
ORF & related infrastructures – Construction	Feb 2016 – Feb 2018	418	320	80	18

Source: eni, 2014

Figure 4.32 shows the monthly workforce demand estimated during the entire construction period.

Figure 4.32 Workforce Demand for the Construction Period (November 2015 - November 2019)



Source: eni, 2015

Workforce related to onshore construction activities will be lodged in the temporary accommodation camp located near to the ORF (see section 4.7.4 for details). Offshore workforce will be lodged on the FPSO.

During construction activities expatriates provenience will be global. Priority will be given to local workers for all types of work.

During construction, labour workforce is expected to be as follows:

- Skilled: 60%,
- Semi-skilled: 20%, and
- Non-skilled: 20%.

4.10.2 Operations Phase

During operations permanent employees on the FPSO will be about 65 people (8 locals, 49 expatriates and 8 eni expats). Employees will be housed on the FPSO.

For the ORF, 45 people will be employed (80% locals, 20% expatriates). They will be lodged in the permanent accommodation camp.

During operations, mostly expatriates will have Italian nationality. Depending on professional profile and required skills, local people will be recruited; in particular preference will be given to people of the OCTP project area. If some profiles cannot be recruited in the project region, they will be recruited in other Ghana regions. Priority will be given to local-local for all types of work. At this stage of the project, it is not possible to estimate how many people will be recruited locally and how many in other regions in Ghana as details about required profiles for the workforce are not defined yet.

During operations, labour workforce is expected to be as follows:

- Skilled 70%,
- Semi-skilled: 30%-20%, and
- Non-skilled 0%-10%.

4.11 HEALTH, SAFETY AND SECURITY

The OCTP Project Phase 2 will be developed and will operate in compliance with safety requirements included in all applicable conventions and codes that cover maritime activities and Ghanaian legislation and regulations that cover onshore operations.

The following Table 4.36 summarizes main applicable legislation, conventions and codes.

Table 4.36 Safety related conventions and regulations

Conventions concerning safety at sea (IMO)	Ghanaian legislation concerning safety onshore
International Convention for Safety of Life at Sea (SOLAS) 1974 and associated Protocols and Amendments	Labour Act (Act No. 651 of 2003)
International Convention on Load Lines (LL) 1966	Explosives Regulations (LI 666 of 1970)
Convention on the International Regulations for the Prevention of Collisions at Sea (COLREG) 1972	Road Traffic Act (Act No. 683 of 2004)
International Standards of Training, Certification and Watch-keeping Convention (STCW) 1978 and 1995 Amendments International Convention for Safe Containers (CSC) 1972	Radiation Protection Instrument (LI 1559 of 1993)
International Convention on Maritime Search and Rescue (SAR) 1979	
Convention on the International Maritime Satellite Organisation (INMARSAT) 1976	

Source: ERM, 2015

Moreover the project will be in accordance with eni HSE standards and project documentation (Project HSE Plan, Project HSE Philosophy). As eni Ghana is the operating Company, only eni's HSE Integrated Management System is relevant for the OCTP project and thus only that IMS is describe in the following sections.

4.11.1 Project Design

The installations design will satisfy HSE criteria defined in the HSE Philosophies. HSE approach to design has the following main objectives:

- avoid/Eliminate the risk when possible
- minimise the potential of hazardous occurrences;
- minimise the risk and consequences of an accidental event;
- ensure a safe working environment for personnel;
- ensure adequate means of escape in case of emergency;
- provide sufficient safety devices and redundancy to detect, isolate and minimise uncontrolled releases of flammable and potentially toxic fluids;
- provide appropriate fire protection systems to rapidly bring under control and extinguish any reasonably foreseeable fire which could develop during normal operations; and
- minimise the potential for pollution of the environment.

The above listed objectives will be reached applying the following hierarchy of control principles to reduce risks to the ALARP area (As Low As Reasonably Practicable).

- elimination: remove the hazardous substance, machine or task from the work place;
- substitution: replace the hazardous substance, machine or task with a safer one.

- design: modify tools or equipment or put safeguards;
- management: develop and implement safe procedures for hazardous activities.
- personal Protective Equipment (PPE): personal equipment such as safety glasses, footwear and hearing protection.

Orientation and Layout

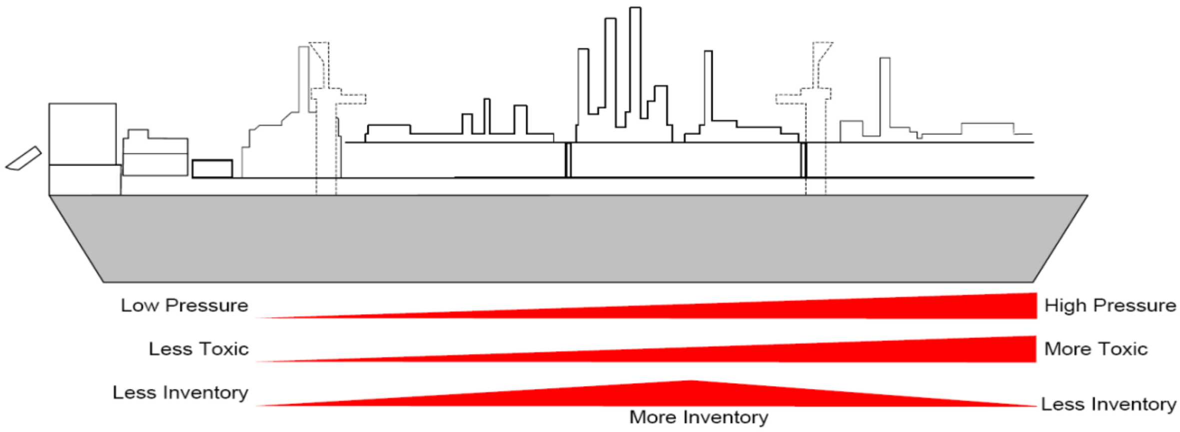
The driving criteria for onshore plant (ORF) orientation and layout shall be:

- unrestricted areas to be located upwind/crosswind restricted areas;
- open flames to be located upwind/crosswind restricted areas;
- areas containing ignition sources (e.g. heaters, furnaces, turbines, etc.) to be segregated from those containing flammable fluids;
- hydrocarbon inventories to be minimised by optimising routing of piping;
- passive fire/explosion protections (e.g. fire walls, blast walls, etc) to be considered where distances/orientation cannot be optimised and to prevent escalation; dead ends for hydrocarbon accumulation to be avoided;
- utilities to be used as a "buffer" between restricted and unrestricted areas; thermal radiation loads following a fire shall not exceed 3 kW/m^2 at the boundaries of onshore plant;
- flares, incinerators, atmospheric vents and exhausts location and height to ensure acceptable pollutant (e.g. SO_X, H_2S, NO_X, etc.) concentrations are not exceeded in working and unrestricted areas of the plant as well as outside it.

The additional driving criteria for FPSO layout shall be:

- approaching sectors for helicopter, supply vessel, jack-up, etc. to be free of obstacles/live equipment;
- approach, landing and take-off sectors for helicopters to experience minimum obstruction or thermal induced turbulence;
- orientation and layout to be such that no more than 5 kW/m^2 radiation from flare(s) in emergency situation is experienced over open areas and 7 kW/m^2 over areas where sheltered escape is allowed;
- segregation ensured between accommodation and the topsides process modules;
- arrangement of topsides modules location with respect to more / less hydrocarbon inventory (see Figure 4.33);
- arrangement of topsides modules location with respect to presence of systems with high / low pressure (see Figure 4.33);
- arrangement of topsides modules location with respect to more / less toxic inventory (Figure 4.33).

Figure 4.33 FPSO Topside Allocation



General Process safety features

The adoption of intrinsic safety principles will be maximized during design of project installations.

The process control system and the emergency system will be operated on functionally independent basis (e.g. process control system different from shut down system in each individual element).

The "fail safe" principle will be applied, i.e. components will move to or stay in the predetermined safest configuration upon loss of signal or power (e.g. BDV - fail open, ESDV – fail closed).

The principle of "double block and bleed" will be adopted in case of toxic fluids and flammable gases or when operators could be exposed to hazards due to high pressure/temperature.

A Supervisory Control And Data Acquisition (SCADA) system will be installed on the FPSO and an Integrated Controlled Safety System (ICSS) will be installed ORF, in order to monitor and control plant processes.

Emergency Evacuation and Escape routes

In designing escape routes the following HSE minimum requirements will be considered:

- Escape routes will be adequately lit and readily identifiable by personnel in an emergency, including indication of the direction to muster area and/or temporary refuge.
- Each escape route from plant areas as well as muster areas will be designed to ensure safe escape of all persons expected in those areas equipped with all assigned PPE and/or rescue equipment.

Temporary refuges will be designed in order to protect persons inside against accident scenarios which exceed the Design Case Scenario until the evacuation process is completed.

The evacuation system will be designed following the minimum requirements listed below:

- At least two alternative evacuation systems (e.g. helicopter and survival crafts) from any installation will be provided.

- The survival craft system (e.g. life boats) will be designed to accommodate 200% of the maximum Personnel on board at any time in at least 2 units.
- The survival crafts will be located in areas which minimise their exposure to accident effects and protected from foreseeable accident loads.
- The survival crafts will be located in areas or equipped with systems which allow rapid abandonment of the installation location in foreseeable weather conditions.
- The evacuation systems will be supplied by their own uninterruptible power source fit for use in explosive atmosphere.
- The helicopter deck, where present, will be installed in compliance with relevant International and National Regulation Authorities Requirements and will be equipped with a dedicated helicopter fire-fighting system.

Rescue Systems will be designed taking into account that:

- For any installation, both offshore and onshore, a rescue system will be available at any time.
- Where a temporary refuge is present the rescue system will be able to approach the refuge and rescue people inside ensuring the same level of protection of the refuge itself.

Fire and Gas Protection Systems

In each offshore and onshore installation, the fire and gas detection system will be monitored from the central control room and will be designed to provide early detection of any hazards, initiate appropriate interventions such as emergency shutdowns, blow-down and firefighting and to facilitate the safe evacuation of personnel.

The active fire protection system and equipment will be designed to control fires and prevent escalation, to protect escape and evacuation routes, rapidly dilute gas concentration of an evaporating vapour cloud and limit damages for equipment and structures. The firefighting system will include the following:

- firewater system;
- foam system;
- gaseous fire extinguishing system;
- water mist system; and
- portable fire extinguishers.

Other safety design features

In pressurised systems, any isolatable section will be designed for a pressure rating which is the highest among all operating and shut down conditions. A pressure protection system will be provided to prevent the build-up of pressure greater than the rating and valve failures will be taken into account.

If internal vacuum conditions can occur in any section of the plant, it will be designed to withstand the vacuum conditions or measures will be implemented to prevent vacuum.

The design of the venting/flaring system will include a knock out system when liquids are foreseen and it will be sized for the maximum amount of liquid that can be relieved during an emergency situation. The flare/vent system will be protected against flame back. All emergency systems will be protected from the effects of the credible major accident scenarios (fire, explosion, etc.) to ensure that they remain operational for the duration they are required.

The ***Emergency Shutdown Systems (ESD)*** will provide hierarchical shutdown levels. It will segregate the plant into discrete isolatable sections that can be depressurized. The ESD system will be totally independent from the Distributed Control Systems and it will allow for both automatic and manual initiation.

In particular for the FPSO an automatic Emergency Shut-Down System (ESD) will be provided, including a vessel shutdown system, a topside shutdown system and a offloading shutdown system. A specific ESD procedure will be available during oil offloading activities to ensure ESD interlink and simultaneous isolation both on the FPSO and the Export Tanker facilities.

The ORF ESD system will be independent from the FPSO ESD system, but it will continuously monitor the offshore FPSO ESD system, repeating alarms from the FPSO system in the ORF Central Control Room, however these alarms are for information and no actions will be taken at the ORF based on such signals. Similarly, ESD alarms from the ORF will be made available to the FPSO.

The Emergency Shutdown (ESD) System will be organized in hierarchical shutdown levels. Hierarchy of shutdown levels activation will guarantee facility protection against the worst accidental event.

The Emergency Shutdown (ESD) System and associated Blowdown system will provide isolation of the hydrocarbon inventory and equipment and evacuation of gaseous inventory from those sections under controlled conditions to the flare system.

The shutdown systems will be designed to prevent escalation, provide mitigation measures to protect personnel, the environment and assets against foreseeable potentially accidental events.

ESD valves will be provided for all import and export risers and they will be located at the end of the riser above the maximum splash zone, as close to the sea as possible, and in a way that they will be protected against credible accidental dropped objects.

ESD valves can only be by-passed if by-pass is equipped with an ESD valve with the same integrity level.

The ESD valves will be compliant to the following requirements.

- Designed for the possible incident scenarios in the area of operations.
- If jet fires are credible, the ESD valves will be fire safe for 15 minutes, (according to API RP 607).
- Shut down valves will be fail-safe, (fail-close).

No interconnections (small diameters and primary instruments included) will involve sections which are not isolatable (e.g. sea-side of the ESD at the beginning of the riser).

The ESD/PSD/LSD and F&G PLC controlling unit (namely ESD/ F&G unit) will be independent from the Process control unit. The systems will achieve a high level of reliability. The ESD/F&G controlling unit shall be certified for SIL3 rating as minimum.

The ESD valves reset will be locally and manually operated and only permitted once the shutdown cause has been locally checked and removed

Facilities for depressurization of gas injection flowlines and riser system will be provided on the FPSO.

Every intervention of detection and/or shut down will be signaled at the FPSO control room.

After the maintenance and test operations, protection will be reactivated as soon as possible.

It will be possible to bypass the automatic shutdown control and maintain integrity level, to allow maintenance so as reliability test operations can be done.

A failure of the normal feeding system will cause automatic switching, without black-out, over a reserve power supply; wrong feeding operations will be signalled by acoustic and visual alarms.

The ESD system will be protected against electromagnetic interference.

Equipment and cables shall be adequately protected and cable pathways shall be realized in order to limit their involvement in possible accidental situations.

Manual activation points of the ESD system will be clearly identified and protected against spurious activation.

In the event of confirmed fire and gas detection, critical process conditions or manual initiation, the shutdown system will trip the production facilities, the inlet manifolds and process utility equipment and take the necessary executive actions to place the plant into a safe condition, with the aim to avoid escalation of the event.

The shutdown system will initiate pre-programmed actions automatically, on detection of abnormal process conditions and hazardous conditions, or by manual activation.

For the ORF, the Emergency Shutdown (ESD) system will function to isolate inventory entering or exiting plant equipment and facilities, remove heat input to heaters and stop all associated rotating equipment.

The ESD system at the ORF will operate on four hierarchical levels: a shutdown at one level will cascade to initiate shutdowns at the next level below. The four levels are as follows:

- Level 1: ORF Shutdown and Depressurization
- Level 2: ORF Shutdown
- Level 3: Process Section Shutdown

- Level 4: Individual Equipment Shutdown

All ESD trips will have a manual reset function in the Central Control Room (CCR). Automatic resets will not be used.

Instrument and Plant Air, Nitrogen and the fire-fighting system will not shutdown on activation of ESD levels 1, 2 or 3.

In the ORF, the Emergency Blowdown (Depressurization) Systems (EDP) will generate for each plant section a depressurization in compliance with API RP 521, while in offshore plants (FPSO) each section will be depressurized in compliance with DNV TN B 306 – "Relief, Depressurising, Flare and Cold Vent Systems".

No intelligent pigging is foreseen for the gas export pipeline.

FPSO Design

The FPSO design will satisfy requirements set out in the above mentioned IMO Conventions and by a ship classification society. The ship classification society will evaluate the FPSO against the structural and mechanical standards and will independently review FPSO construction activities and perform regular surveys for maintaining classification status.

Also other vessels involved in the project will be classified and regularly inspected by an established certification body.

The FPSO will have adequate structural strength and it will be designed for the site most harsh environmental operating conditions at the OCTP Block in Ghana, without the need to access dry docking facilities for the 20 years of the project expected life.

Safety procedures and equipment on the FPSO

On the FPSO will be provided the following safety equipment and systems: Personal Protective Equipment: Personnel protective equipment will be provided to safeguard personnel from any danger during construction, operation and maintenance of the facilities. Each person working or visiting the FPSO will be equipped at least with safety helmets, shoes, gloves and goggles. First aid kits and stretchers will be provided on board.

- Safety showers and emergency eyewashes will be provided adjacent to all equipment containing methanol, chemical injection packages and battery room as minimum. These units will be connected to potable water supplies, and designed to ensure the water is at a safe temperature for use, also avoiding the direct exposure to sun radiation.
- Proper protection will be provided for all piping whose external temperature exceeds 65°C and which could come into contact with people performing normal duties. The protection may be thermal insulation, guards made of suitable material and/or warning signs.
- Lifesaving Equipment will consist of the following items: Life Jackets, Life Buoys, Helideck Emergency Set, Rope ladders, Inflatable life rafts, Lifeboat, Fire fighting equipment. A rescue boat will be provided; lifejacket, lifebuoy and rescue boat will be in compliance with SOLAS and LSA regulation.
- One or more windsocks will be provided and located on a suitable position in order to be clearly visible both to helicopter / supply vessel approaching to FPSO unit.

- Personnel lifesaving equipment for evacuation purposes will account for at least 200% of the maximum expected number of persons on board.

4.11.2 Flight and Transport Safety (for offshore personnel)

Personnel transfer will occur typically by helicopter. Offshore personnel will depart from Takoradi. Specific safety procedures for helicopter and vessel transport of personnel will be implemented.

Facilities for mooring boats during the transfer of personnel will consider adverse sea conditions to protect vessels and FPSO from heavy impacts.

If personnel are transferred from the vessel to the FPSO by crane, only cranes, cables, and baskets certified for personnel transfer will be used.

Only passengers who have completed the offshore survival training course will be allowed offshore to work unless in possession of a dispensation. All helicopter passengers will receive a briefing before departure which will include safety information and actions to be taken in case of emergency. Safety equipment will be provided.

4.11.3 Onshore activities safety

The onshore activities, as stated above, will follow all the relevant and applicable Ghanaian laws and international practices for similar operations. In particular vehicle safety and material storage and handling are considered.

Vehicle safety

All OCTP project vehicles and drivers will comply with the Ghanaian law, in particular the Road Traffic Act, 2004 (Act 683) and eni procedures will be put in place in order to cover the following points:

- all vehicles will be in good condition with regular maintenance and safety checks;
- heavy vehicles will have a pre-shift check by the operators;
- drivers will not be allowed to drive under the influence of alcohol or drugs; defensive driving training will be provided and a zero tolerance be implemented (e.g. excess speed, driving under influence and other crass events will be dealt with disciplinary policy and prone to immediate dismissal of the contractor/staff.
- load weights and dimensions on heavy vehicles will comply with national;
- only predetermined routes will be followed and
- requirements and local conditions. Vehicles with loads are checked prior to leaving the site.

Materials storage and handling

Materials will be stored and handled in a safe manner, following Ghanaian laws and regulations:

- radiation protection instrument 1993 (LI 1559) for the use of radioactive devices (for the pipeline non-destructive testing during construction);

- Labour Act (Act No. 651 of 2003) requires the safety and absence of risks to health in connection with use, handling, storage and transport of articles and substances.

Moreover eni will design the chemical substances and hazardous waste areas in order to maintain segregated incompatible goods and substances during storage and transport. An appropriate labelling system will be put in place and will allow to quickly recognize the type of substance in emergency situations. Material Safety Data Sheets will be distributed to all involved personnel and will be available on site. Standard handling and storage procedures will be put in place.

Safety shower/eye wash stations will be located near hazardous substance handling areas in order to be readily available in all areas where exposure is likely. Appropriate Personnel Protection Equipment (PPE) will also be used by all personnel.

4.11.4 Emergency Response

For the OCTP project the emergency management strategy for the project will:

- identify the resources needed for an adequate Emergency Response; and
- describes the Emergency Preparedness principles and the overall strategy.

Emergency Response Plans will be based on the Emergency Response Strategy and will cover the following:

- location, facility, operation and organizational specific Emergency Response Plans for 1st, 2nd and 3rd Levels of Emergency;
- evacuation, escape and rescue requirements for each facility;
- oil spill requirements and measures for each operation in line with oil spill response requirements.

First Level of Emergency is defined as an event that can be dealt with by on-site/location personnel and resources:

- the incident does not have any effect outside the site, and external agencies are unlikely to be involved;
- there is unlikely danger to life, environment, or to Company assets or reputation;
- the incident will be managed through the Site Emergency Response Plan and Procedures.

Second Level of Emergency is reached when the event may be dealt with locally but requires involvement of wider eni Ghana support and external agencies/contractor resources:

- the incident may be 'on-site', have some effect outside the site or be 'off-site', and external emergency services will be involved;
- there is likely danger to life, environment, or to eni Ghana assets or eni reputation;

- the incident will be managed through Site Emergency Response Plan/Procedures and the HO Emergency Response Plan and Emergency Support Procedures may be activated in part, e.g. for Media Response.

Third Level of Emergency involves a major incident, on or off-site, which requires the involvement of wide-ranging eni e&p division organization and other international resources and external agencies:

- the incident will have technical, media, public affairs and personnel implications which require immediate assistance from eni e&p division;

- there will be at least one, or a combination of the following:

    - death and/or serious injury,

    - potential for significant pollution or environmental damage,

    - substantial damage to property,

    - major media attention,

    - broader implications on reputation, legal or financial liabilities, licence to operate,

    - the eni e&p HQ Emergency Response Plan and Emergency Support Procedures will be activated.

Crisis are considered an escalation of a third level of emergency or an event which resolution extends in time and that has the potential to cause serious repercussions on the integrity of the company, both nationally and internationally, as well as to compromise the image and reputation of eni in international markets.

The Crisis is declared by eni and eni e&p top management that prepare appropriate structures (eni Crisis Committee) for managing ad-hoc the situation by identifying appropriate resources within the senior management and business/technical functions.

Emergency Response Plans will have the purpose of addressing potential emergencies, designating roles and responsibilities of personnel and identifying the requirement to interface with Government and external parties.

The workforce will be trained about Emergency Response plans through regular drills and training exercises. In addition, Sanzule Community will be involved and duly informed on the project's activities through outreach campaigns.

Equipment, facilities and trained personnel for crisis management and emergency response will be identified in order to be readily available. An assessment of emergency equipment needs will take place on a regular basis. An helicopter for MEDEVAC will always be available Takoradi airport, able to reach both onshore and offshore locations in case of need and depending on the severity of the case, the IP can either be evacuated to Takoradi medical facilities or straight to Accra.

Support vessel will be supporting drilling activities and be located within the vicinity (inside the exclusion zone) of the Drilling Vessel..

Blow out studies have been carried out to provide an assessment of different scenarios and potential impacts of a blow-out event during drilling or work-over operations.

An Oil Spill Contingency Plan will be developed in order to manage potential spills and mitigate consequences, as detailed below in section 4.12.1.

The response strategy will be based on the following criteria:

- Monitor and Evaluate (including aerial surveillance);
- Assisted Natural Dispersion;
- Containment and Recovery;
- Chemical Dispersants;
- Shoreline Protection and Clean-up.

4.11.5 Security measures

During onshore construction fencing is not foreseen, but access to certain areas will be restricted.

During operation the ORF, the permanent accommodation camp and the helipad will be fenced and a CCTV system will be installed for security reasons. The access to the ORF, the accommodation camp and heli-pad will occur through entrance gates monitored by security personnel. Onshore security will be assured by a private company with unarmed personnel. As part of recruitment process and vendor management policies, background checks will be carried out to ensure that security providers as well as any other worker or contractors are not implicated in past abuses.

Principle of proportionality and practices consistent with the UN Code of Conduct for Law Enforcement Officials will be applied.

Around FPSO a buffer zone of 500 m will be established for safety and security reasons. eni will provide a dedicated patrol vessel to monitor and patrol offshore buffer zones (personnel will be unarmed). Ghana Navy, if required, will support eni's patrol vessel to assure the buffer zones to be respected. In that case eni will seek to ensure personnel act in a manner consistent with its policies and will encourage the authorities to disclose security arrangements for the project. Additional Ghana Navy representatives can be deployed in the the eni's patrol vessel for extra support (in this case, they will be unarmed).

A security management plan together with a specific patrolling procedure will be developed for both onshore and offshore installations.

4.12 Health, Safety and Environmental Integrated Management System

eni Ghana, through its HSE IMS (Integrated Management System), is committed to guarantee the Sustainable Exploration & Production of Oil & Gas in Ghana by applying its best standards, in order to protect the health and safety of its employees, contractors, visitors, and the general public, while preventing pollution and minimizing any adverse effects on the environment and the host community, in respect with their traditional values and historic heritage.. The Health Safety and Environmental Integrated Management System (HSE IMS), describes how eni Ghana manages HSE and social issues commensurate with the company's potential risk exposure and in line with the Company's Sustainability's engagement and values. As eni Ghana is the operator of the OCTP Block, the eni Ghana HSE IMS is the only integrated management system applicable for the Block, therefore this section describes only the eni Ghana HSE-IMS.

Under this IMS, the Company will promote the highest standards for the protection of health, safety, the preservation of the environment and the respect of the local communities.

The eni Ghana IMS is based on the following principles:

- to comply with all the appropriate legal requirements of the Republic of Ghana and international standards;
- to be fully compliant with all eni Ghana and eni s.p.a policies and standards;
- to prevent illness and injury and promote both health & safety of the Company staff, Contractors and Subcontractors and other persons involved in the Company business activities;
- to minimise/avoid workplace incidents and continuously improve the Company's HSE performances;
- to prevent pollution and minimise any negative impacts on the environment;
- to take into account the social impact of the Company's business activities
- to be fully prepared to respond to any HSE emergency event;
- to manage any foreseeable HSE hazard and effect through a structured process and demonstrate that all major risks are minimised to a level that is tolerable and As Low As Reasonably Practicable (ALARP);
- to promote a culture in which all employees of the Company share this commitment;
- to manage Health, Safety, Environment and Sustainable Development issues.

In order to guarantee the practical application of the general principles listed above, the Company will:

- identify, evaluate and manage risks for both human health and environment;
- establish accountability & responsibility for Health, Safety, Environment and Sustainable Development within the organization;
- ensure that its contractors and their HSE Management Systems are compliant with eni's IMS;
- provide HSE awareness training to all personnel and encourage the active involvement of employees in the management of HSE aspects;
- include HSE performances in the appraisal of all staff;
- maintain certified Health, Safety and Environmental Management Systems;

- ensure social aspects are incorporated in all issues including mechanisms to ensure compliance of contractors, training of personnel, performance in appraisal of staff, community grievance mechanisms, stakeholder engagement, local content/local hiring/local procurement, community liaison mechanisms;
- take into account the expectations of local community stakeholders in the Environmental Impact Assessments of all new activities;
- require and fully support its staff to intervene and stop an unsafe activity;
- measure, appraise and report on HSE and Sustainable Development performances and implementation of the HSE Management System;
- ensure adequate feedback of information in order to facilitate continuous improvement;
- establish and maintain effective Emergency Response Plans (ERP's), together with local Authorities.

The HSE IMS will be reviewed at least every 12 months or more often if necessary. It is subject to constant internal audits (technical audits carried out by headquarters with the aim of identifying any potential gaps and indicating necessary actions to fill them up). Additionally, being the company ISO 14001 and OHSAS 18001 certified, it is subject to audits from a third party for compliance to the abovementioned standards. Audits are carried out annually as surveillance audit and every three years for re-certification purposes.

The HSE IMS applies to all activities performed by or on behalf of eni Ghana, including those undertaken in Ghana and contractors work locations overseas. Contractors, and in particular major contractors, will have their own management systems which shall be compatible with eni Ghana HSE Policy, daughter policies and principles of the HSE IMS. The HSE IMS is also an enduring and live system applicable to the full lifecycle of eni Ghana activities from exploration, through development and production including decommissioning.

The HSE IMS documentation includes a set of Guidelines, Protocols, Standards, Procedures, Work Instructions, Programmes and Plans designed to ensure that the Company's operations and activities are performed in accordance with the requirements defined by the Laws of the Republic of Ghana, standards to which the Company voluntarily subscribes, and the expectations of the Company's JV Partners and Stakeholders. It is structured in line with IOGP Guidelines for the Development and Application of HSE Management Systems. It also is compliant with ISO 14001 and OSHAS 18001 regulations.

The system concentrates on those activities with the potential to have the greatest impact on people and the environment and provides a process for continual improvement in the Company's HSE performance.

The eni Ghana HSE IMS applies to all Company's business processes and thus also to those related to OCTP Phase 2 project.

The HSE Integrated Management System will include the following documents (see Table 4.37).

Table 4.37 HSE Integrated Management System for eni Ghana: Documents List

Guidelines	• HSE Guidelines • Sustainability Guidelines

Protocols	• Driving Protocol • Drugs and Alcohol Protocol
Manual	• HSE IMS Manual
Plans	• HSE Plan • Emergency Response Plan • H2S Safety Plan • Waste Management Plan • Drilling Oil Spill Contingency Plan – Keta Block • HSE 4-year Plan • Medical Emergency Response Plan • Development Drilling and Production Operations Oil Spill Contingency Plan – OCTP Block (Draft)
Standards	• Standard on Contract HSE Requirements • Standard on In Vehicle Monitoring System • Standard on Emergency Response Strategy
Procedures	• HSE Documentation Management • HSE Legal Requirements • HSE Training • Non conformities • Incident and Investigation Reporting Procedure • Identification of Significant Environmental Aspects • Risk Management • HSE Monitoring and Reporting • HSE Communication • Audit • Management Review • HSE Objectives and Plans • Meet and Greet • Contractor HSE Management • Emergency Medevac • Emergency Evacuation – Accra Offices • Management of Change • Emergency Evacuation – Takoradi base
Work Instructions	• Ropes Maintenance • Lifting and Hoisting • HSE Meetings • HSE Induction • PPE • Management HSE Leadership Visits • Fitness to Work • Offshore Boarding and Documental Control • Offshore Periodical Operational Control • Periodical Maintenance
Programs	• Audit Program 2013-2015 • Training Program 2014-2015
Registers	• Risk Register • Legal Register • Environmental Analysis Register
Reports	• Environmental Analysis • HSE-IMS Audit Report • Management Review 2012 • Specific Audit and Investigation Reports • Survey Report of Sanzule Area

Source: eni Ghana, 2015

4.12.1 Oil Spill Contingency Plan (OSCP)

eni Ghana, as mentioned above in Table 4.37, has in place a HSE-IMS that includes an Oil Spill Contingency Plan for the OCTP Block (Development Drilling and Production Operations Oil Spill Contingency Plan – OCTP Block). This document is based on response for oil spills from all oil spill sources identified for each accidental scenario in the mentioned OCTP block and related facilities. Likelihood and consequences of all oil spill scenarios are semi-quantitatively assessed and likely consequences and impact scenarios are considered in the oil spill risk assessment. Impacts are evaluated using oil spill modelling and consequences on the basis of environmental social and economic sensitivities mapped in the impacted areas.

A tiered response approach is foreseen and for each scenario a suitable response technique is selected.

The scope of the Oil Spill Contingency Plan (OSCP) will be to cover development drilling and production operations in the OCTP Block in Ghana. Il will cover the following operations:

- *Development Drilling operations*: Oil spills arising from the development drilling of subsea wells, including blow out events;
- *Production operations*: Oil spills arising from production operations relating to the FPSO unit, subsea wells, subsea network of flexible flowlines and risers, processed crude oil stored in the FPSO cargo tanks, shuttle tankers periodically moored to the FPSO, stored crude oil pumped to the shuttle tanker via an offloading hose, gas sealine 63 km long to the Onshore Receiving Facilities (ORF).
- *Field Support*: Oil spills arising from activities involving the field support vessels.

The Plan contains organisational responsibilities, actions, reporting requirements and resources available to ensure the effective and timely management of an accidental oil spill; and supplies the Emergency Response Team (ERT) with a high level strategic document that covers the main procedures and information required during an oil spill response.

Mitigation measures will be put in place in order to ensure that identified risks are acceptable and reduced to an ALARP level. eni will implement the following mitigation measures to reduce the oil spill occurrence, minimize potential impacts and related consequences:

1. <u>Process Safety Management and Training</u>: personnel will be trained to ensure the prevention of unintentional releases of chemicals, oil or other potentially dangerous materials during activities at any of the facilities.
2. <u>Design Safety</u>: design and engineering of the facilities will be of the highest quality and standards.
3. <u>Asset Integrity Assurance</u>: routine operator inspections, maintenance inspections and internal and external audits will be carried out to ensure identification, reduction and eventually elimination of potential oil spill scenarios.
4. <u>Process Isolation</u>: Emergency Shut Down (ESD) valves will be installed at every well head, at the FPSO and ORF. The ESD system is an integral part of the Combined Safety System (CSS) and executive actions and provides full alarm and fault status indication as well as valve isolation.

5. Incorporation of Industry Lessons: process incidents studied by O&G industry and lessons learned will be reviewed and used as a basis to ensure that the outcoming recommendations will be considered and implemented during the operation.
6. Emergency Preparedness: An emergency preparedness system is in place. It consists of the procedures, training requirements, equipment and agreements for assistance with contractors and other oil companies.

Main Oil Spill Response Resources are:

In field, will be available resources needed for Tier 1 spills:

- Harbour Containment and Recovery System: 100 m permanent buoyancy boom, Komara 12k skimmer system and temporary storage tank (1,500 gallons).
- Offshore Dispersant Capability: 2 x dispersant spray sets, Boat Spray 50, 8 x 1,000 L in dispersant and sorbant booms and pads.

- For Tier 2 and Tier 3 additional resources are available in Accra and other African cities. In particular the West And Central Africa (WACAF) Aerial Surveillance and Dispersant Service will provide an aerial observation package and dispersant spraying equipment. For Tier 3, as eni is member of Oil Spill Response Limited (OSRL) and thus can mobilise OSRL and require its intervention.

More detailed information about oil spill response for OSCP Block are presented in Annex F, that include the OSCP prepared by eni Ghana for this project. In this Annex is reported the second draft of the OCTP OSCP that integrate IFC comments.

4.13 ANALYSIS OF ALTERNATIVES

The preferred Project design is described in this Chapter and is the basis for the EIS. This Section describes alternatives that evaluated during design to maximize and ensure environmental and social sustainability of the Project. The alternatives evaluated include:

- no project alternative;
- location alternatives; and
- layout design and/ or technology alternatives.

4.13.1 No Project Alternative

The No Project alternative implies maintaining the status quo thus only the oil reservoirs will be exploited along Phase 1, while the NAG reservoirs will be left in place thus not bringing the additional benefits to the economy. The offshore part of the Block where the Phase 1 Development is located will remain unavailable for fishing. The near shore and onshore areas will be left unmodified and available for the current land use. There would be no additional noise and effluent emissions into the environment.

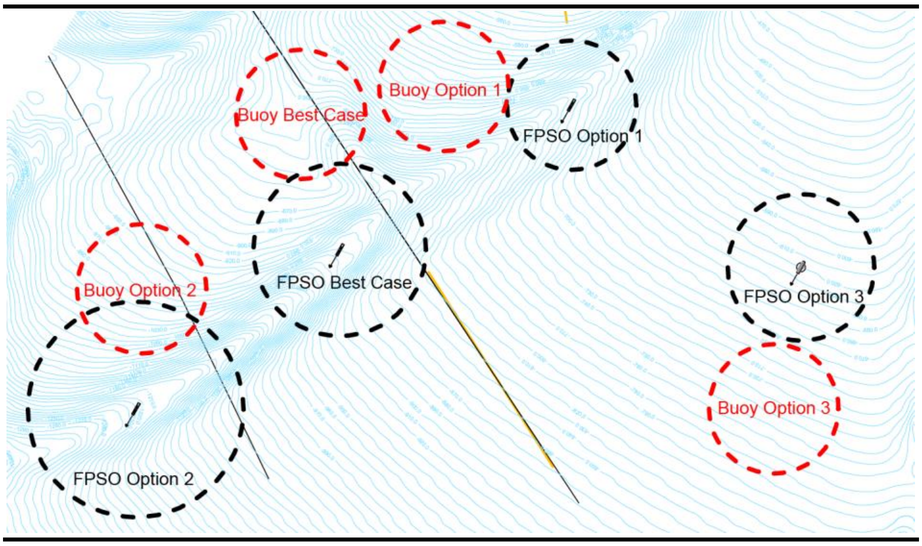
4.13.2 Location Alternatives

A site selection process was carried out prior to selecting the preferred Project site both for onshore and offshore facilities.

For the offshore part of the project, due to the reservoirs target area and related water depths; the natural solution to develop the field is through a Floating Production Storage and Offloading (FPSO) facility. The FPSO location was evaluated and four positions were selected as shown in Figure 4.34. The FPSO positions evaluated are:

- Over the canyon with an approx. water depth of 600 m (Option Best Case);
- On the east side of the canyon between Sankofa field and Gye Nyame field with an approx. water depth of 600 m (Option 1);
- Over the canyon with an approx. water depth of 800 m (Option 2);
- In Sankofa field area with an approx. water depth of 1000m (Option 3).

Figure 4.34 FPSO Location Options



Source: eni, 2014

The preferred option is the best case option as it will allow minimization of flowlines and umbilicals lengths, and thus, as a consequence risks and costs minimization.

For FPSO mooring configuration both Turret and Spread mooring were considered, taking into account local seabed and weather conditions. The spread mooring option will be used in the OCTP project in order to allow the possibility to anchor the FPSO outside the canyon (even if her location is exactly on the canyon) and assure a high level of flexibility to the plant configuration.

For flowlines from NAG well to FPSO construction rigid and flexible flowlines options were evaluated. Consequently subsea layout solutions entailing both rigid and flexible options were considered. , flexible flowlines were selected as preferred solution, in order to minimize sea bed disturbance and the need of excavation works. In particular the selection of the routes of the 8" and 10" deep water flowlines has been performed based on the available bathymetric data and geohazard studies. Flowlines lengths are listed in Table 4.8). The criteria for the route selection are:

- Minimization of the overall route length;
- Minimization of the risks related to evidences of geohazards (Faults, canyons, channels and scours, steep slopes and slope instabilities, pockmarks, gas hydrates, mud volcanoes and fluid/gas expulsion features, turbidity currents and hydrodynamic effects, rock outcrops, rough seafloor and liquefaction, anomalous soil conditions and other issues, man-made features from fishing activity); evidences found have been described in Chapter 6.
- Avoiding the evidences of seabed features and bottom irregularities and keep the bottom profile along the route as smooth as possible;
- Adequate clearance from debris and other obstacles;
- Horizontal radii at turn points along the routes compared with regard to the lateral curves stability;

- Avoiding crossing over lines of the same field.

The Umbilical routes have been considered preliminarily spaced 50m from flowline routes.

For the subsea gas export pipeline, a corridor of 2 km along the most direct route to shore was investigated. The final route was selected to minimize interferences with subsea irregularities and disturbed sea morphology.

The ORF location was selected on the basis of environmental, social, technical and logistic evaluations. The investigated area for the onshore plant runs along Ghanaian Western Coast from town of Takoradi to the Ivory Coast Border for 4-5 km inland. A desk-based study was performed and then site surveys were performed. The study was performed in a very early stage of the project when a CPF was foreseen instead of an ORF. Therefore the study was performed for a more impacting plant (Central Processing Facility treating also condensates, instead of Onshore Receiving Facility receiving and compressing only gas). The study wasn't repeated for the ORF, as it is less impacting than the CPF.

The following aspects were considered to perform preliminary location evaluation:

- Technical and Logistic Aspects:
    - Topography/Elevation/Morphology;
    - Geology;
    - Tectonics and Earthquakes;
    - Hydrology of streams and rivers;
    - Hydrology of lakes, lagoon and swamp areas;
    - Hydrogeology;
    - Bathymetry;
    - Meteorological-marine conditions;
    - Geohazards and extreme climatic events;
    - Transport Infrastructures;
    - Distance from OCTP Block located 60 km from Ghanaian Coast;
- Environmental, Social and Health Aspects:
    - Climate;
    - Soil;
    - Morphodynamics;
    - Biodiversity and Ecosystems;
    - Protected Areas and critical habitats;
    - Socio-cultural Conditions, including resettlement;
    - Land Law;
    - Health Conditions.

Based on the abovementioned aspects, seven suitable areas were identified and analysed using a Strengths-Weaknesses-Opportunities-Threats (SWOT) analysis. Then aerial and site surveys were carried out by an interdisciplinary team and collected data were integrated in the site location assessment. Each site out of seven was evaluated and ranked for Technical, Logistics, Environmental and Social Aspects. The following Table 4.38 shows the ranking of the seven sites.

Table 4.38 Evaluation of Onshore Plant Location

Area	Area description	Rank position	Criticalities	Advantages
Macroarea 1	25 km from Ivory Coast's Border, near town of Awiane	***4***	• Earthworks needed for land levelling • Far from Takoradi • Pipeline from OCTP Block should cross an existing pipeline • Close to border (Ivory Coast is a politically unstable Country) and far (82km) from OCTP Block • Presence of scattered villages and households • Potential presence of valuable/important vegetation/ecosystems • Potentially flooded area • Groundwater table is potentially near the surface • Medium resettlement impact (about 750 households) • Presence of cultural sites • Presence of tourism infrastructures and potential development • Predominance of family owned land • Livelihood highly depends on fishing and subsistence farming • Poor sanitation conditions	• Flat area • Regular bathymetry with shallow waters near shore • No river estuaries • 1 km from nearest town • Few communities downwind (50 households) • Predominance of extensive plantation cover • Absence of Ecosystem priority areas • No communities affected by groundwater pollution
Macroarea 2	43 km from Ivory Coast border, near town of Bonyere	***6***	• Earthworks needed for land levelling • Near to a lagoon system • Far from Takoradi and near to the Ivory Coast border • Pipeline from OCTP Block should cross an	• Flat area • Regular bathymetry with shallow waters • No river estuaries • Predominance of extensive plantation

Area	Area description	Rank position	Criticalities	Advantages
			existing pipeline • Far (69km) from OCTP Block • Close to Bonyere (an isolated rural settlement) • Potential presence of valuable/important vegetation/ecosystems • Potentially flooded area • Groundwater table is potentially near the surface • Some communities located downwind (150 households) • Livelihood highly depends on fishing and subsistence farming • Presence of tourism infrastructures and potential development • Poor sanitation conditions	cover • Absence of Ecosystem priority areas • No communities affected by groundwater pollution • Low presence of cultural sites • Low resettlement level (250 households)
Macroarea 3	60 km from Ivory Coast's border, between Atuabo, Beku and Elkwe	*7*	• Bordered by a significant Lagoon system (Amansuri lagoon) • Presence of swampy areas • Far from Takoradi • Pipeline from OCTP Block should cross an existing pipeline • Close to many small villages • Far (59km) from OCTP Block • Presence of scattered villages and household • Potential presence of valuable/important vegetation/ecosystems near the lagoon and along the coast • Potentially flooded area • Potential presence of subsea canyons • Groundwater table is potentially near the surface • Predominance of	• Flat area • Regular bathymetry with shallow waters • No river estuaries • Distance from Atuabo is 1.5 km • Few communities downwind (87 households)

Area	Area description	Rank position	Criticalities	Advantages
			wetlands and forest areas with an high naturality index • Presence of Ecosystem Priority areas (Important Bird Areas/Key Biodiversity Area) • Presence of a foreseen Ramsar area (Amansuri lagoon) • Many communities affected by groundwater pollution • Water table is classified as highly vulnerable • Medium resettlement level (662 household) • Presence of cultural sites • Livelihood highly depends on fishing and subsistence farming	
Macroarea 4	77 km from Ivory Coast's border, near town of Sanzule	***1***	• Earthworks needed for land levelling • Close to Amansuri river • Far from Takoradi • The area is between two villages and scattered villages and households are present • Potential presence of valuable/important vegetation/ecosystems along the coast • Potential interesting points for tourism (beaches, cultural/historical heritage) • Potential presence of subsea canyons • Groundwater table is potentially near the surface • Many communities downwind (838 households) • Presence of Ecosystem Priority areas (Important Bird Areas/Key Biodiversity	• Flat area • No major earthworks needed • Regular bathymetry with shallow waters • Near to OCTP Block (53 km) • Good road conditions • Presence of plantations and forests (re-vegetation of abandoned plantations) coverage giving a medium naturality index • Few communities affected by groundwater pollution • Low presence of cultural sites • Presence of abandoned cultivated areas, thus medium

Area	Area description	Rank position	Criticalities	Advantages
			Area) • Presence of a foreseen Ramsar area (Amansuri lagoon) • Presence of a Refugee camp on macroarea border • Livelihood highly depends on fishing	risk of livelihood disruption
Macroarea 5	90 km from Ivory Coast's border, near Essiama, Kikam and Asanta	***5***	• Presence of swampy areas • Far from Takoradi • Very close to towns of Essiama and Kikam • Presence of scattered villages and household • Potential presence of valuable/important vegetation/ecosystems along the coast • Potential interesting points for tourism (beaches, cultural/historical heritage) • Potential presence of subsea canyons • Many communities downwind (503 household) • Presence of forests with an high naturality index • Presence of Ecosystem Priority areas (Important Bird Areas/Key Biodiversity Area) • Presence of a foreseen Ramsar area (Amansuri lagoon) • Many communities affected by groundwater pollution • Very high resettlement level (2181 households) • Presence of many cultural sites • Land ownership disputes	• Flat area • No major earthworks needed • Near to OCTP Block (51 km) • Good road conditions • Medium risk of livelihood disruption due to predominance of forest areas
Macroarea 6	110 km from Ivory Coast's border, near Axim and	***3***	• Earthworks needed for land levelling • Complex hydrology network	• Absence of soft soils • Far from significant river and no

Area	Area description	Rank position	Criticalities	Advantages
	Egyembra		• The area is not flat • Presence of scattered villages and households • Potential presence of valuable/important vegetation/ecosystems along the coast • Potential interesting points for tourism (beaches, cultural/historical heritage) • Potential presence of subsea canyons • Presence of hard rocks • Presence of greenstone with possible asbestos presence • Some communities downwind (312 households) • Presence of forests with an high naturality index • Many communities affected by groundwater pollution • Presence of many cultural sites • Poor access route • Presence of tourism infrastructure and potential development • Land ownership disputes • Livelihood highly depends on fishing	estuaries • No swampy areas • Near to OCTP Block (47 km) • Near to town of Axim (2 km) • No presence of ecosystem priority area • Low groundwater vulnerability • Medium resettlement level (395 household) • Low risk of livelihood disruption due to predominance of forest areas
Macroarea 7	135 km from Ivory Coast's border, near town of Atwiwa and Dixcove	***2***	• Earthworks needed for land levelling • Close to river estuary (Swini) • Potentially flooded area • Poor access route • Far from OCTP Block (57 km) • Potential presence of valuable/important vegetation/ecosystems along the coast • Potential interesting points for tourism (beaches, cultural/historical heritage)	• Flat area • No major earthworks needed • Near to Takoradi (40 km) • Not close to populated areas • No presence of Ecosystem Priority areas • Few communities potentially affected by groundwater pollution

Area	Area description	Rank position	Criticalities	Advantages
			• Presence of greenstone with possible asbestos presence • Near to a natural reserve. Expansion foreseen towards this area • Some communities downwind (424 households) • Presence of forests and wetlands with an high naturality index • High groundwater vulnerability • Presence of tourism infrastructures and potential development • Land ownership disputes • Livelihood highly depends on fishing	• Very low resettlement level (137 households) • Low presence of cultural sites • Low risk of livelihood disruption for the presence of forests and wetlands

Source: eni, 2014

On the basis of the explained extensive evaluation a site near Sanzule was selected for the ORF construction and gas export pipeline land approach.

The selection of site 4 was done taking into account 2 components, i.e. ESH sensitivities and technical feasibility. The selected solution is the best to minimize the impacts taking into account technical, environmental, safety and social aspects.

Technical feasibility included e.g. land topography, shore approach conditions (depending on bathimetry and subsea topography, waves, etc), hydrology, existing infrastructures, distance from the FPSO etc.; selection of site 4 is the result of the overall analysis.

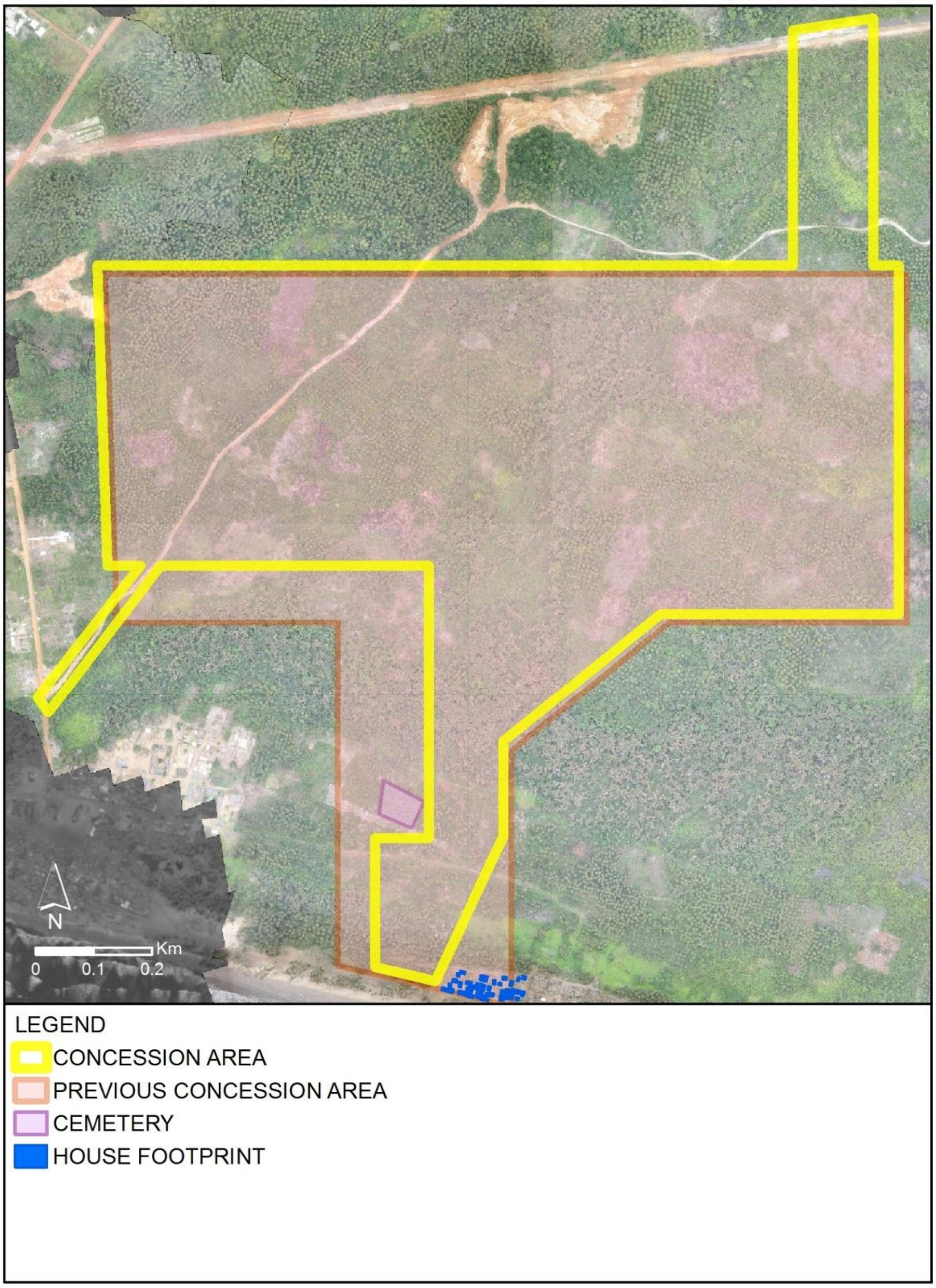
It must be noted that:

1. The macroarea 4 is much larger than the final project area, which was selected to minimize the listed sensitivities (e.g. resettlement of 971 household is a removed criticality)
2. Many issues related to difficult technical aspects, even if not explicitly stated, are reflected onto damages to ecosystem's physical component and consequently damages to biological components (e.g. damage of coastal integrity, need for blasting in hard grounds, need for a longer sealine related to distance from offshore facilities) and with social consequences.

In this area two main options for the shore landing and onshore pipeline to the ORF were evaluated. The preferred option minimize village resettlement and interferences with cultural sites, as shown in Figure 4.17 in purple.

Moreover, after the location evaluation described above, the footprint of the concession was modified on the basis of detailed site surveys. In particular, the concession footprint was refined in consultation with the local community and some areas were excluded from the concession in order to avoid impacts on inhabited areas located to the East of the onshore section of the gas pipeline corridor (see houses footprints in blue) and the cultural heritage area (see cemetery footprint in pink) located to the West of the onshore pipeline section, as shown in Figure 4.35.

Figure 4.35 Onshore concession footprint reduction from 2014 to 2015



Source: eni, 2015

4.13.3 Layout and Technology Alternatives

Two compression station operation conditions were selected in order to assure maximum flexibility to the compression station:

- the so-called "firm" case foresees compression of OCTP NAG gas received from the OCTP FPSO plus 215 MMSCFD of lean gas from the GNGC Atuabo gas plant. The total handling capacity for the aggregate compression station is 405 MMSCFD that will be compressed and sent to the GNGC gas sales line;
- the so-called "optional" case foresees aggregate compression of OCTP gas from the FPSO, an extra 100MMSCFD from the export sea-line through an inlet T and GNGC gas from GNGC Atuabo plant. Considering the ORF location in Sanzule and the sales gas pressure at tie in point 100bara, the export pipeline capacity is 405 MMSCFD. GNGC Atuabo gas plant will reduce its flowrate.
- The optional case foresees aggregate compression of OCTP gas from the FPSO, an extra 100MMSCFD from the export sea-line through an inlet T (and GNGC gas from GNGC Atuabo plant. Considering the ORF location in Sanzule and the sales gas pressure at tie in point 100bara, the export pipeline capacity is 405 MMSCFD. GNGC Atuabo gas plant will reduce its flowrate.

4.14 PROJECT AREA OF INFLUENCE

For environmental, social and health resources and receptors, a specific direct Area of Influence (AoI) has been defined in order to allow for a comprehensive description of the areas which may be directly or indirectly affected by Project. For the assessment of cumulative impacts, a larger area of influence has been considered for each component, in order to include the cumulative impacts potentially generated by the following Projects that could reasonably be expected to be developed in the area:

- eni Ghana Oil Development (Phase 1, under evaluation);
- TEN Development (proposed, ESHIA under evaluation);
- GNGC Gas Plant at Atuabo and Pipeline (Phase 2 under construction); and
- Lornho Oil Service Port at Atuabo (proposed, ESHIA under evaluation).

The direct AoI is summarised in Table 4.39, Source: ERM, 2015

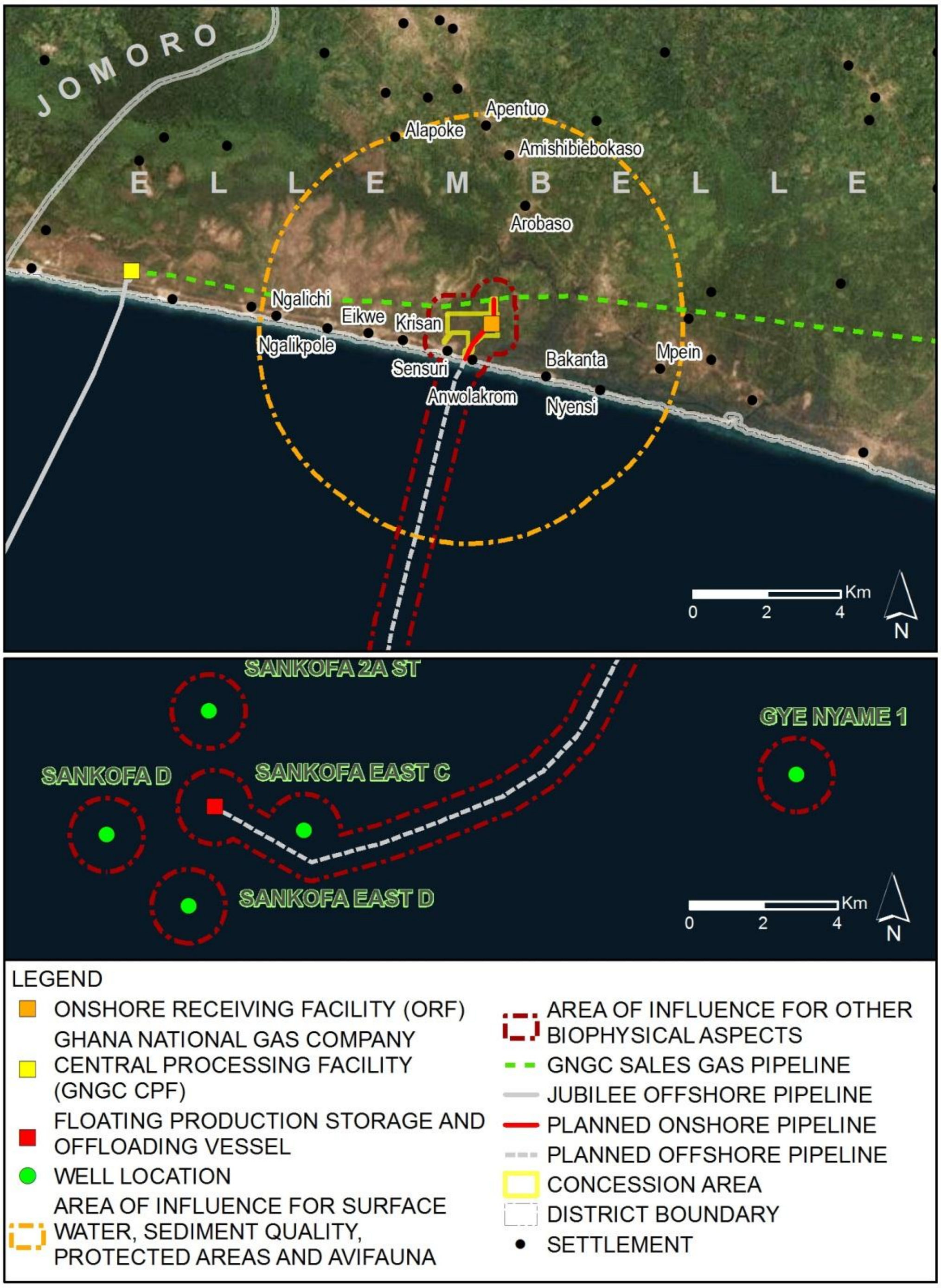
Figure 4.36 and Figure 4.37.

Table 4.39 Environmental, Socio-economic and Health Area of Influence

Environmental Area of Influence	
Five offshore wells	• direct footprint • 1 km radius regarding water quality (increased turbidity, spills) around well locations and vessel de/mobilisation routes accidental events and diesel spills - coastal zone area length
FPSO	• direct footprint and 1 km radius.
Offshore pipeline	• direct footprint and 300 m buffer from the centerline (due to increased turbidity from pipeline laying).
Onshore pipeline	• direct footprint for soils. 200 m noise, dust, biodiversity (clearance, and pipeline ROW maintenance) • max 200-300 m groundwater impacts on shallow aquifer due to spills and upset conditions • 5 km for surface water/ sediment quality, surface water flows and wet season implications, protected areas and avifauna
Onshore Receiving Facility site	• direct footprint; • 200-300 m (500 m max) for noise (compressors during operation), dust, air emissions • 2 km for habitat/ transformation (i.e. boundary of the Amansuri river and the sea) • max 2 km for shallow water groundwater (ie boundary of the Amansuri river and the sea) • 5 km for surface water, protected areas and avifauna
Socioeconomic, Cultural and Health Area of Influence	
Direct Area of Influence (DAOI)	3 km buffer zone around ORF. Potentially impacted communities within the DAOI include the villages of Sanzule (including Anwolakrom, immigrant fishing community that belongs to Sanzule), Bakanta, Krisan, Eikwe, and Atuabo. The latter is outside the 3 km buffer around the ORF but is the largest community in the area and is considered directly affected by the Project. The neighboring communities of Ngalikpole, Ngalichi, Anochi, Asemda-Suazo and Beku were initially considered as part of the DAOI when the project concept involved an optional pipeline from ORF to GNGC CPF in Atuabo. Information on these communities is provided in Annex C.
Extended Area of Influence (EAOI)	Selection of key localities, communities and stakeholder groups (e.g. District Assemblies and Chief Fishermen) in the six wider affected coastal Districts. Stakeholders in the extended area of influence were selected based on consideration of the following factors: • Size of population; • Coastal location; • Reliance on fisheries livelihoods and main source of income; • Level of vulnerability and access to infrastructure and services, employment/ income-generating opportunities, number of female-headed households); • Health status and access to health services; • Presence of district traditional leadership; • Known stance towards current oil and gas operators (assessed from key issues and responses to previous studies in the area; and • Engaged as part of the EIS for Phase 1 of the Project.

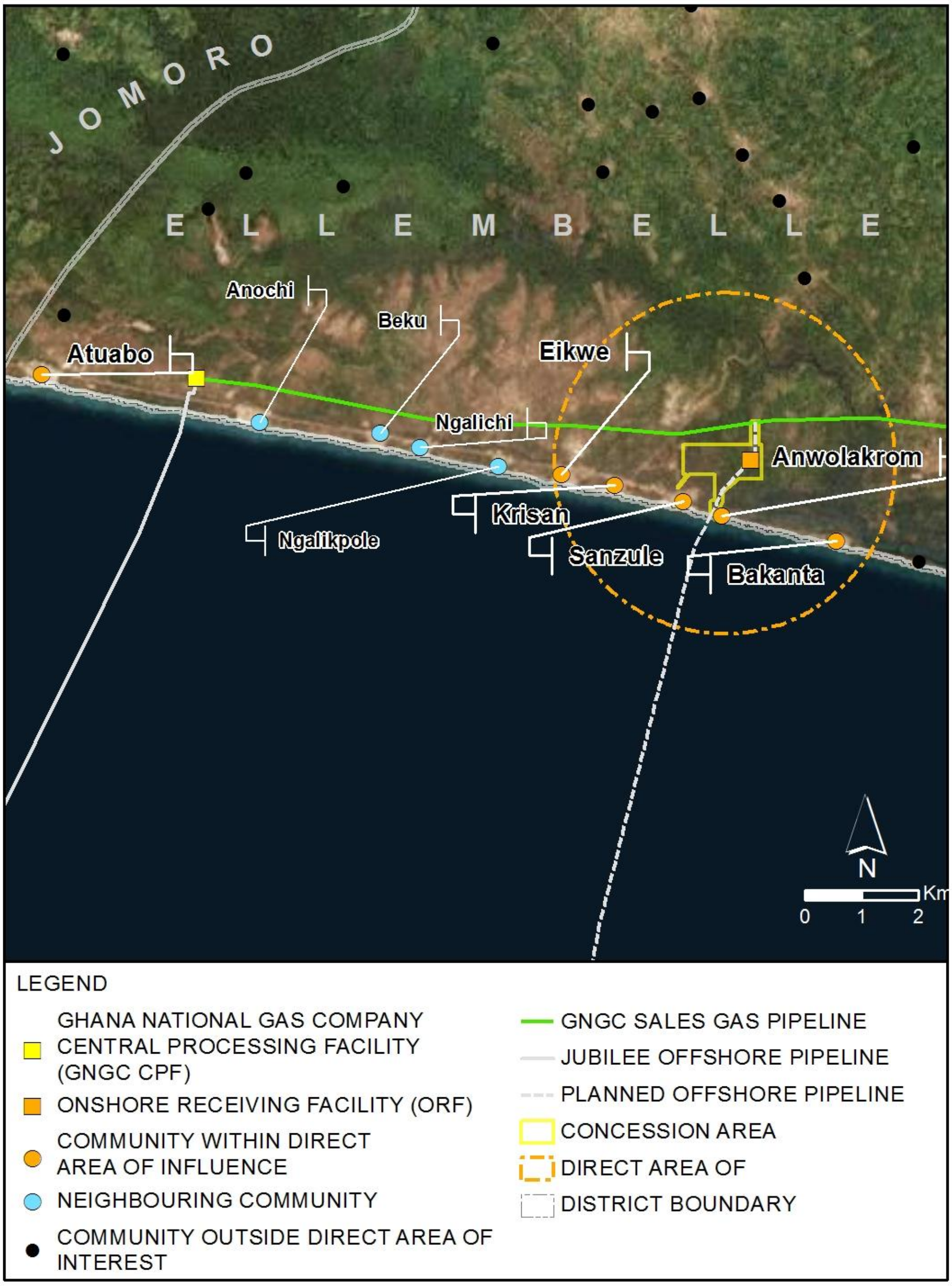
Source: ERM, 2015

Figure 4.36 Environmental Area of Influence



Source: ERM, 2015

Figure 4.37 Socio-Economic, Cultural and Health Direct Area of Influence



Source: ERM, 2015

ESHIA for GHANA OCTP BLOCK Phase 2

ABSTRACT

Chapter 5 provides a summary of the stakeholder engagement disclosure activities undertaken during the EIS process.

July 2015	06	Final version	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

Summary of Revisions

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5 STAKEHOLDER ENGAGEMENT

This Chapter provides a summary of the stakeholder engagement disclosure activities undertaken during the EIS process. This includes a description of stakeholder mapping, consultation undertaken during the EIS, and development of a grievance mechanism. An overview of the key issues raised by stakeholders is also provided.

It also provides an outline of stakeholder engagement activities that the Project will undertake following submission of the EIS into Project construction and operations. These activities will be detailed in a Stakeholder Engagement Plan (SEP) that will be prepared as part of Project implementation.

5.1 OBJECTIVES

Stakeholder engagement is a key component of sustainable development and the EIS process. It involves those stakeholders interested in, or affected by a proposed development working to actively identify opportunities, risks and issues of concern. Stakeholder engagement assists in accounting for locally relevant conditions rather than imposing potentially insensitive processes and designs onto an existing social, health and biophysical environment.

The primary objectives of stakeholder engagement are as follows:

- ensure that adequate and timely information is provided to stakeholders;
- provide sufficient opportunity to stakeholders to voice their opinions and concerns, and to ensure that these concerns influence Project decisions; and
- establish a relationship and form of communication between the proponent, eni Ghana, and affected communities for the lifetime of the Project.

Stakeholder engagement is a requirement of the Ghana EIA regulations. It is also a requirement of international lenders as it is recognised that failure to engage stakeholders can create significant risks to a project development.

5.2 STAKEHOLDER IDENTIFICATION

The objective of stakeholder identification is to establish which organisations and individuals may be directly or indirectly affected (positively and negatively) by, or have an interest in, the Project. Stakeholder identification is an on-going process, involving regular review and the updating of the stakeholder register as the Project proceeds. The sections that follow provide an overview of stakeholder groups that were identified, as well as an indication of their interest in the Project.

As part of EIS scoping, a stakeholder mapping exercise was undertaken to identify key stakeholder groups and organisations. This mapping exercise drew on knowledge of the Project area and from prior experience of EISs in Ghana particularly in the Western Region. It also incorporated the experience of eni Ghana and eni Foundation stakeholder engagement activities, primarily related to commercial matters and community health investment.

Stakeholders were identified on the basis that they would have an interest in the Project and would also have knowledge through which to provide insight into possible issues and concerns related to the Project. Further stakeholder groups were identified through consultation.

A full list of the stakeholders consulted during the EIS, including the stakeholder register, is provided in Annex A and its appendices.

During this process stakeholders were grouped in order to develop appropriate tools and methodologies, and to maximise the value of engagement activities.

Stakeholders were divided into two main categories: primary stakeholders and secondary stakeholders (Table 5.1).

Table 5.1 Primary and Secondary Stakeholder Groups

Primary Stakeholders	Secondary Stakeholders
Directly affected communities and residents, landowners and land users (with special consideration of the various disaggregated groupings within these categories, including vulnerable groups)	Non-governmental organisations (NGOs) active at a national and local level, as well as those having international representation in the country
Regulatory authorities, councillors and traditional authorities covering national, regional, district and stool levels with authority in the directly affected Project area. Ghana National Petroleum Corporation (GNPC) and Ghana Maritime Authority.	Other groups including media, environmental associations, business groups
Ministry representatives in political positions	Relevant sector specific agencies operating nationally or locally

5.2.1 Primary Stakeholders

This category of stakeholders includes those directly affected by Project activities, as well as the regulatory authorities and other ministries of government authorities with direct authority over aspects of the Project activities. Primary stakeholders are critical stakeholders to the project.

<u>Directly Affected People</u>

Within this range of stakeholders, affected communities were identified to be the communities located in the Direct Area of Influence of the Project. This includes the following communities of the Ellembelle District: Sanzule, Krisan, Eikwe Bakanta, Atuabo and Asemda-Suazo. At the time the stakeholder engagement was performed, the project concept included the construction of an optional pipeline from the ORF to the GNGC CPF in Atuabo. Therefore, Ngalikpole, Ngalichi, Beku and Anochi were also considered to be within the Direct Area of Influence of the Project. The construction of this pipeline is no longer an option at the time of writing this report.

While none of the physical infrastructure of the communities will be directly affected by the Project, farming, plantation and fishing areas are within the Project's footprint. The directly affected stakeholder groups that were engaged included:

- local residents;
- traders;
- fishers;
- farmers and plantation owners;
- agricultural producers (particularly palm oil, coconut oil and palm wine);
- youth;
- women;
- refugees;
- religious groups;
- elderly; and
- traditional healers.

The Paramount Chief (Awulae) of the Stool sits in Atuabo and is the custodian of the land. As a result, the Chief was identified to be directly affected on many levels, in addition to his traditional council and elders and to the Community District Assembly based in Atuabo. The traditional leadership in the ten settlements within the Study Area were also identified to be directly affected stakeholders.

The disaggregated stakeholder groups in this category were identified through map work, scoping meetings, and during socio-economic and fisheries surveys. Emphasis was placed on identifying potentially vulnerable groups within this category.

Government Authorities

Relevant regulatory and ministerial authorities were identified as those departments and divisions representing the Ghanaian Project decision-makers with direct involvement in the planning and permitting for the Project. Authorities are also key role-players in the implementation of aspects of the management plans during Project implementation.

Regulatory authorities were identified from existing databases, liaison with government officials, prior project experience and consultation, government databases and telephone directories.

The affected National, Western Region and Ellembelle District regulatory authorities that were engaged through the EIS process included:

- Ghana EPA;
- Ministry of Petroleum;
- Western Regional EPA;
- Western Region Coordinating council (WRCC);
- Western Regional Office of the Minister; and
- Ellembelle District Assembly.

Ministry Representatives

Ministerial representatives were also engaged directly during Scoping Phase by the developer in order to update them regarding the progress and to ensure on-going and regular interactions. . These included the following:

- Ministry of Environment, Science, Technology and Innovation, represented through the Environmental Protection Agency;
- Ministry of Petroleum, represented through the Ghana Petroleum Commission and the National Petroleum Corporation (GNPC);
- Ministry of Transport, represented through the Ghana Maritime Authority (GMA), the Ghana Ports and Harbours Authority (GPHA) and the Ghana Civil Aviation Authority (GCAA);
- Ministry of Food and Agriculture represented through the Fisheries Commission.
- Ministry of Lands and Natural Resources, through the Wildlife Division of Forestry Commission;
- Ministry of Tourism, through the Ghana Tourism Authority;
- Ministry of Roads and Highways;
- Ministry of Defence; and
- Ministry of Water Resources, Works and Housing.

5.2.2 Secondary Stakeholders

This group of stakeholders was identified to comprise of interest groups who have a personal, business or civil interest in this Project. These groups include NGOs and CBOs from Accra, and other major towns in the nearby area, as well as locally relevant schools, clinics and businesses. A small number of Ghana-based international organisations involved in sustainable development, environmental issues, health, media, academia and research organisations and other such potentially interested groups were also identified.

These stakeholders were identified from existing databases, internet resources and local telephone directories. Further identification took place during informal contact between eni Ghana and individuals or organisations. Additional stakeholders were identified during the baseline data collection process where special interest groups that may have been overlooked were recognised as clear stakeholders in the Project's development.

These secondary stakeholders included:

- Conservation Foundation (NGO);
- Ricerca e Cooperazione (NGO);
- Friends of the Nation (NGO);
- Western Region Coordinating Council (WRCC);
- Marine Police;
- Enterprise Development Center (Jubilee & Ministry of Energy);

- Museums and Monument Board;
- District Assembly of: Jomoro, Ellembelle, Shama, Nzema East;
- Sekondi Takoradi Metropolitan Assembly;
- Western Region Regional Health Director;
- Ellembelle District Health Director;
- Group of fishermen of Shama and Essiama; and
- Chief fishermen of Upper Dixcove, Upper Axim, Half Assini and Sekondi.

5.2.3 Vulnerable Groups

Vulnerability to project related impacts is based on an individual or groups ability to adapt to socioeconomic or bio-physical change. Vulnerable individuals and groups are potentially more susceptible to negative impacts or have a limited ability to take advantage of positive impacts.

Vulnerability is a pre-existing status that is independent of the project and may be reflected by an existing low level of access to key socio-economic or environmental resources or a low status in certain socio-economic indicators. Vulnerable groups may also have difficulty participating in the stakeholder engagement process and thus may not be able to fully express their concerns regarding the Project.

This section identifies individuals and groups in the study area that are differentially more vulnerable than the general population, whether this is due to a specific characteristic, or as a result of a broader range of factors. The understanding of vulnerabilities provided here is drawn from the Assessment of Impacts (Chapter 10 and, for details, Annex G), which identified individuals or specific groups and, where necessary, developed additional targeted mitigation measures.

Within every assessment there are some population groups that are automatically considered vulnerable due to their positioning within society and/or inherent characteristics that make them less able to cope with change. There may also be other groups that are vulnerable due to the specific socioeconomic context. The main population groups that have been identified as potentially vulnerable in the context of the OCTP Project and the rationale for their identification are presented in this Chapter below.

Generic Vulnerability

Women: Due to the nature of gender relations, women are often reliant on male members of the family for financial and domestic support. Local livelihoods are based on farming and fishing, and there are certain tasks that women cannot perform. This is either due to cultural taboos (fishing) or a lack of physical strength (forests clearing, house building/maintenance). As such they are reliant on male relatives to support their livelihoods, with female-headed households being particular vulnerable. Women are also vulnerable in the context of decision-making within the community. Although the project area is matrilineal, the majority of family heads are male, as is the chief, meaning women are less represented and have less influence over group decisions.

Children: In order to access assets/resources children are often reliant on older members of the households or community. When a child is not adequately represented by an adult, from a low income family or an ethnic minority,(s)he may be vulnerable to exploitation within the community or work place.

Youth: Youth may be vulnerable in terms of access to assets, education or employment opportunities. Participation by the youth in community decisions is also dependent on whether village elders allow them access.

Elderly: Elderly members of the community may have a minimal income and are more likely to have reduced physical or mental capacity to cope with changes to their environment.

Low-income households: Low-income households have fewer resources on which to rely and are less likely to have savings and/or access to credit, which make them vulnerable to shocks and change.

Physical/mental health and disability: Those who lack physical mobility or who have mental health issues may be vulnerable to changes and unable to participate in decision making. This also includes addicts such as those reliant on drugs or alcohol.

Socioeconomic study area Vulnerability:

Households with no legal right to land: Individuals or groups without legal land title or rights to land are vulnerable to land use change through eviction and loss of livelihood without compensation. Within the project context this includes migrants and some residents without female links to the village meaning they are excluded from the matrilineal land inheritance.

Migrants: Migrants are vulnerable due to their lack of access to land (as above), but also because they lack representation in community decision-making, which is usually undertaken by heads of clans and the village chief.

Refugees: There is a refugee camp not far from the village. Residents of the camp come to Sanzule to fish and find occasional work. This group is vulnerable within the socioeconomic study area due to their high levels of poverty, lack of stable income or access to the support networks found within the village. This group will not be directly affected by project activities, but they are less able to access any project impacts and may be impacted by secondary impacts from increased traffic and noise or sexual exploitation from worker influx.

Focus group meetings were held with various groups in order to understand who is vulnerable within the project context. Group meetings were held with women and fishermen, with key informant interviews conducted with the manager of Krisan refugee camp. Informal engagement activities were also conducted with residents to understand their issues and concerns and in general the socio-economic conditions affecting refugees in the DAoI. Although no separate focus group was held with sharecroppers during the scoping and baseline engagement, land users have been specifically engaged as part of the Resettlement Action Plan development by Delin and will be further surveyed and consulted with during the supplementary baseline survey planned by ERM in April 2015 to inform the preparation of a detailed Livelihood Restoration Plan.

The findings from these engagement activities were used to develop a vulnerability framework. The vulnerability framework, which draws from policies and methodologies used by development and rights-based organisations, is based on a set of indicators encompassing access to livelihoods, resources and socioeconomic status. The impact assessment team used this framework as a guide to identify and characterise potentially vulnerable groups based on their understanding of the socioeconomic context and consultation feedback.

Potential vulnerable groups identified as part of the EIS include women, the elderly, children, sharecroppers, fishermen_and landless labourers. Vulnerability of these groups is based on reduced opportunities to participate in local decision-making, as well as their economic vulnerability, particularly with regard to land access, employment and dependence on other community members.

- **Women**, including female-headed households: Specific areas of vulnerability related to reliance on male relatives in order to maintain livelihoods. Additional vulnerability identified in varying levels of participation in decision making at the settlement level.
- **Elderly**, The elderly have specific vulnerabilities relating to income levels and limited ability to change or increase access to additional finances.
- **Children**, Vulnerable children may be present throughout the study area where they are not adequately cared for and protected by an adult and are potentially participating in work that is hazardous or prevents them from continuing education. Levels of vulnerability vary greatly, and are likely to be linked to additional factors such as overall household and clan income.
- **Refugees**: The refugees living in the Krisan refugee camp are vulnerable to a number of specific project impacts. Firstly they are less able to access positive project impacts, such as employment, due to barriers including a lack of documents (ID cards, proof of qualifications etc) and lack of knowledge of local languages/English. Refugees are also more vulnerable to negative impact such as sexual exploitation during worker-influx.
- **Fishermen**: Fishing is the main economic activity for 70% of Sanzule households; however, the area designated for the project site is an important source of food and additional income for fishing households. Fishermen reported that due to the seasonal nature of fishing and unpredictability of income, farming is crucial to maintaining household livelihoods. Fishermen and their households will be more vulnerable to shocks from the loss of this land and have increased pressure on incomes resulting from the need to buy products they once grew themselves.
- **Sharecroppers**: Sharecropping is a common practice within the social study area and there are two types of sharecroppers: those who sharecrop on family land and who therefore have some rights over access; and those that use land that does not belong to their family and over which they have not rights. All sharecroppers will receive compensation for their lost crops, but only those using family land will be eligible for the wider benefits made to the clan in the form of compensation for the loss of land. Those using non-family land are seen as more vulnerable as they will lose access to their livelihood activity and are not guaranteed access to alternative sites.
- **Landless labourers**: Labourers are usually those that do not have access to land, either as they are migrants or not eligible for family land under the matrilineal system. Landless farm labourers are seen as particularly vulnerable due to their lack of access to compensation for loss of land, in addition to their loss of livelihoods. The level of vulnerability at an individual level will depend on the ability to find alternative sources of income.
- **Low-income households** are vulnerable. In the study area these are likely to be households reliant on their land for a small income or subsistence farming. Reliance on land makes these households particularly sensitive to land use losses or change. Low income households have fewer resources to cope with change, they are less likely to have savings and access to credit and more likely to have lower education levels. In addition, within this group, there are individuals that are additionally vulnerable including children, youth and the elderly.

5.3 Stakeholder Engagement in the EIS

This Section provides an overview of the stakeholder engagement. The stakeholder engagement and disclosure process is in four stages, each having different objectives for engagement:

- Scoping consultation, including notifications and consultations with key informants and community representatives;
- Engagement during EIS baseline surveys;
- EIS disclosure; and
- Project implementation.

The key elements of each stage of the stakeholder engagement process are outlined in the sections that follow.

5.3.1 Recording Stakeholder Engagement

Minutes were recorded during all formal stakeholder meetings. The issues raised during meetings were captured and tabulated. Additional issues raised through written correspondence received were also captured and tabulated.

Records of stakeholder engagement activities (stakeholder database, minutes, lists of attendees, copies of comments received and issues trail) are presented in Annex A.

Stakeholder engagement materials are included in the Appendices of Annex A, SEP and will be kept on file in order for the Project team to refer to them for consideration during Project implementation, to identify trends in grievances, and to design corrective actions as required.

5.3.2 Stage 1: Scoping

Background Information Document (BID)

A Background Information Document (BID) was developed to provide an overview of the proposed Project, potential environmental, social and health issues and a description of the EIS process and timeline. BIDs were used during Scoping to provide basic information to stakeholders. A response sheet was included with the BID and gave interested parties an opportunity to register for the Project and to raise their concerns, issues or suggestions.

Notifications

The stakeholder mapping exercise identified stakeholders that would be best engaged through face-to-face meetings. A copy of the BID and a covering letter requesting a meeting were hand-delivered to these stakeholders. Meetings were confirmed through subsequent telephone and email communication.

Consultations with Key Informants and Community Representatives

Scoping engagement was carried out in December 2014 to identify the potentially significant environmental, social and health issues relating to the implementation and operation of the Project. These issues were used to define the EIS approach, to inform the design of the environmental and socio-economic baseline studies, and to ensure that there is sufficient information to address all potential impacts and issues in the EIS process.

During scoping, a total of 30 meetings were held with 30 national and regional stakeholder groups or organisations. Stakeholders included national, regional, district and local authorities, Non-Governmental Organisations (NGOs), international organisations and fisher association. A list of the scoping consultation meetings undertaken is provided in Table 5.2.

A further 10 scoping consultations with directly affected communities were conducted in the form of Village Meetings. Due to the parallel scheduling of the scoping and baseline study activities these meetings took place just prior to the commencement of Focus Groups and Key Informant Meetings for the purposes of baseline data gathering. Since they were conducted by the baseline EIS team these meetings are listed in both Table 5.2 and again in Table 5.3.

Table 5.2 Summary of scoping consultation meetings (December 2014)

No.	Organisation'/Group	Date	Location	Attendees
1-10	Directly Affected Communities (Village scoping consultation meeting see Table 5.3)	02-Dec-14 to 05-Dec-14	Asemde- Suazo, Krisan, Bakanta, Eikwe, Sanzule, Atuabo, Ngalekpole, Ngalichi, Anochi, Beku	N/K* (1)
11	EPA	02-Dec-14	Accra	3
12	Ministry of Energy & Petroleum	02-Dec-14	Accra	2
13	Wildlife Division of Forestry Commission	02-Dec-14	Accra	3
1	Fisheries Commission	02-Dec-14	Accra	7
15	Petroleum Commission	03-Dec-14	Accra	4
16	Ricerca e Cooperazione	04-Dec-14	Accra	1
17	Ghana National Petroleum Corporation (GNPC)	04-Dec-14	Tema	8
18	Ghana Ports & Harbour Authority	04-Dec-14	Tema	3
19	Friends of the Nation	05-Dec-14	Takoradi	2
20	Conservation Foundation	05-Dec-14	Takoradi	1
21	EPA: Western Region	08-Dec-14	Takoradi	5
22	Ghana Ports & Harbour Authority: Western Region	08-Dec-14 and 17-Dec-14	Takoradi	4
23	Marine Police	08-Dec-14	Takoradi	5
24	Fisheries Commission	08-Dec-14	Takoradi	3
25	Western Region Coordinating council (WRCC)	08-Dec-14	Takoradi	6
26	Enterprise Development Center (Jubilee & Ministry of Petroleum)	08-Dec-14	Takoradi	3
27	Ghana Tourism Authority	09-Dec-14	Takoradi	3

(1) These meetings were held in public locations (e.g. Chief's Palace) in each village and although majority of attendees noted their names in the circulated registers, many additional attendees also arrived and left during the proceedings or listened at the edges of the group and did not formally register their presence. It was therefore not possible to accurately capture total attendance in each case.

No.	Organisation'/Group	Date	Location	Attendees
28	Museums and Monument Board	09-Dec-14	Cape Coast	5
29	Jomoro District Assembly	03-Dec-14	Half Assini	9
30	Ellembelle District Assembly	03-Dec-14	Nkroful	10
31	Sekondi Takoradi Metropolitan Assembly	08-Dec-14	Takoradi	3
32	Shama District Assembly	09-Dec-14	Shama	3
33	Nzema East District Assembly	08-Dec-14	Axim	8
34	Western Region Regional Health Director	02-Dec-14	Sekondi	3
35	Ellembelle District Health Director	02-Dec-14	Nkroful	4
36	Fisherman of Shama	05-Dec-14	Shama	24
37	Fisherman of Essiama	09-Dec-14	Essiama	15
38	Chief Fisherman of Upper Dixcove	08-Dec-14	Dixcove	2
39	Chief Fisherman of Upper Axim	08-Dec-14	Axim	6
40	Chief Fisherman of Half Assini	03-Dec-14	Half Assini	4
41	Chief Fisherman of Sekondi	09-Dec-14	Sekondi	2

Each of the face-to-face meetings followed a general format as follows:

- introduction by the meeting facilitator;
- introduction to eni Ghana and the EIS team;
- description of the proposed NAG development and the Project's components; and
- discussion of the key issues and any information that may be relevant to the Project.

The consultation team also included translators who spoke Fante and Nzema so that the key elements of the Project and the main issues arising could be discussed with non-English-speaking stakeholders.

The stakeholders that participated in each consultation meeting were recorded in an attendance register. Notes of the consultation meetings, attendance registers and written comments received are provided in Annex A.

<u>Distribution of Scoping Report</u>

In line with the EPA's requirements, the Scoping Report was submitted to the EPA in December 2014. Following EPA's review of the Scoping Report, it is expected that copies will also be delivered to key stakeholder groups.

5.3.3 Stage 2: Detailed Baseline Surveys

<u>Socio-Economic and Health Baseline Field Research</u>

Socio-economic and Health baseline field research fieldwork (undertaken in December 2014) included meetings with traditional authorities and town elders, Focus Group Discussions (FGDs) with identified special interest groups in the towns, and Key Informant Interviews (KII) with individuals who had information of particular relevance to the Project (e.g. education and health). A schedule of these meetings is outlined in Table 5.3.

Table 5.3 Summary of Engagements with Affected Communities

02/12/2014	**Team 1**	**Team 2**	**Team 3**
Community	Sanzule, Bakanta, Krisan and Eikwe	Ngalekpole, Ngalichi Beku, and Anochi	Atuabo and Asemda-Suazo
Engagement	Introductory meeting with village Chiefs	Introductory meeting with village Chiefs	Introductory meeting with village Chiefs

03/12/2014	**Team 1**	**Team 2**	**Team 3**	**Team 4**
Community	Asemdesauzo	Krisan	Bakanta	Eikwe
Engagement	Village scoping consultation meeting, FGD with women, and FGD with men (Scoping Meetings)	Village scoping consultation meeting, FGD with women, and FGD with men Education KII- Headmaster at Ngalichi and Supervisor of the schools at district level and Assemblyman Chief)	Village scoping consultation meeting, FGD with women, and FGD with men Education KII- Teachers at Bakanta Kindergarten and Bakanta primary school	Village scoping consultation meeting, FGD with women, and FGD with men Education KII: Educators of the Catholic Primary School, Eikwe Health KII's- Hospital Administrator, Health Information Officer, Sub-District Public Health Nurse and HR Manager at Eikwe Hospital

04/12/2014	**Team 1**	**Team 2**	**Team 3**	**Team 4**
Community	Sanzule	Atuabo	Ngalekpole	Ngalichi
Engagement	Village scoping consultation meeting, FGD with women, and FGD with men KII Education: Teachers from Sanzule/Krisan Primary School Vice head at Sanzule vocational school KII Health: Health Workers at the Sanzule CHPS Compound (Dr Eric Odei (SRC))	KII's Education- Head Teacher Atuabo Methodist Junior High School and Assistant Head Teacher Atuabo Methodist Primary School KII Health: Health workers at the Atuabo CHPS Compound (Dr Eric Odei (SRC))	Village scoping consultation meeting, FGD with women, and FGD with men KII Education: Kindergarten Teachers at Ngalekpole	Village scoping consultation meeting, FGD with women, and FGD with men Education KII: Head Teacher Ngalichi/ Beku JHS and Head Teacher at Ngalichi/ Beku Primary School

05/12/2014	**Team 1**	**Team 2**	**Team 3**
Community	Anochi	Beku	(ORF Site visit)
Engagement	Village scoping consultation meeting, FGD with women, and FGD with men	Village scoping consultation meeting, FGD with women, and FGD with men KII Education: Headmaster and the Asemda-Suazo Primary School	KII Krisan Refugee Camp Manager

08/12/2014	**Team 1**	**Team 2**	**Team 3**
Community	Atuabo	Eikwe	(Scoping Meetings)

Engagement	Village scoping consultation meeting, FGD with women, and FGD with men, and meeting with Paramount Chief	KII Health: District Health Administration(Ghana Heath Service Outstanding Scoping Meetings in EAoI see Table 5.2	(Outstanding Scoping Meetings in EAoI see Table 5.2)

Each engagement was facilitated in English, Fante and Nzema as appropriate, and structured using all or some of the following methodologies:

- an introduction to the Project using the BID along with photographic representations of similar projects;
- walkabouts by the social/health specialists accompanied by members of a stakeholder group to locations of significance to the group.

These methods provided mechanisms where no one group member would dominate an engagement activity, but rather facilitated broad participation with an emphasis on ensuring that vulnerable groups such as women and fishermen were heard and recorded. Information derived from the activities has been used in the EIS to highlight community strengths and vulnerabilities, and to identify potential Project impacts.

Significantly, this type of active engagement contributes to the development of relationships based on trust between stakeholders and the Project that can act as a bridge for future phases of the Project.

Figure 5.1 provides photographs illustrating the different methodologies used for engagement.

Figure 5.1 Meeting with Wildlife Division in Accra (left), and Fishermen of Essiama (right)

5.3.4 Stage 3: EIS Disclosure

Following the compilation and submission of this EIS to the EPA for their consideration, the EIS will be subject to public comment through disclosure. At this stage, consultation will take place through an EPA-led disclosure process, and the availability of EIS will be published in mass media and announced in local media of the Western Region of Ghana.

In addition, a Reconnaissance Survey [(1)] will be carried out throughout six coastal districts, the Western Regional House of Chiefs and engagement of Civil Society Organizations (CSOs), Media and other Governmental Institutions. During the Reconnaissance Survey, all engaged stakeholders will be informed of the public hearing venues and where they can access the copies of the EIS. The EIS will be made available in public places such as District Assembly offices, Regional EPA offices, and Public Libraries. National regulations stipulate that 12 copies of the EIS must be submitted to EPA, but eni has agreed to submit 20 copies to maximize its distribution of the EIS.

Public hearings have initially taken place in Takoradi-Sekondi on 8th, 9th, and 10th April. Public hearings were be divided in three venues, by type of stakeholders:

- Civil Societies (CSOs, represented by the Relevant Ministries, Agencies and Department Heads), Media and the General Public;
- Six (6) Coastal Districts, represented by Municipal Chief Executives, District Chief Executives, Presiding Members of the six coastal Districts an Assembly Members; and
- The Western Regional House of Chiefs (Traditional Leadership).

During these initial public hearings, copies of the non-technical summaries were made available for the general public, facilitating the general access to the project.

In addition, a dedicated workshop was held at the Community of Sanzule on 31st March, where the project was presented to the Community and better interaction could be achieved. Copies of the presentation were made available to facilitate visual access to the information.

5.3.5 Stage 4: Project Execution

An output of the EIS process is the development of ESHMPs for Project construction and operations. This SEP is one component of the ESHMPs and will be further refined prior to the next phase of the Project, once more detailed information on implementation structures, roles, responsibilities and resources is available. Information on the contents and implementation of the ESHMP will be presented through a number of briefing sessions and on-going meetings with local communities. These will take place at different levels within the Western Region, Ellembelle District and in affected communities.

In addition, the grievance mechanism (Annex A) will be implemented to be effective throughout the Project lifecycle.

5.3.6 Stage 5: On-going Engagement

eni Ghana, through its corporate and communications team, is continuing engagement with stakeholders on a regular and ad hoc basis. Meetings between the Paramount Chief and eni Ghana regarding access to land for the Project's development are on-going.

In the same way, eni Ghana continues to meet with interest groups in affected communities, NGOs and regulatory authorities. These interactions, together with the outcomes of Scoping

(1) The reconnaissance survey will be carried out by EPA and is focused on informing all the relevant stakeholders of the public hearings venues.

and baseline data activities, are influencing the design of the Project on a day-to-day basis. This will continue until the submission of the EIS at which point the design will be finalised in order for environmental permitting, on a set Project design, to take place.

5.3.7 On-going Engagement during Construction and Operation Phases

This section references outlining key objectives and activities planned for ongoing Stakeholder Engagement by eni Ghana during the construction and operation phases:

Construction Phase

Ongoing Stakeholder Engagement during the construction phase has the following key objectives:

Key Objectives of Engagement

- Identify all stakeholders likely to be affected by construction activities and keep aware/abreast of any changes to stakeholder base e.g. through in-migration;
- Keep stakeholders regularly informed of construction activities and schedule, and progress in implementing environmental and social management programme;
- Maintain visibility and site presence of Community Liaison staff and keep open communication lines with stakeholders and their key representatives;
- Anticipate, receive and quickly respond to grievances; and
- Identify responsible contractors, and carefully manage and oversee contractors interactions with stakeholders.

Activities

In order to meet these objectives a number of key activities will be undertaken. The precise resourcing arrangements and schedule for these activities will be refined and finalised in consultation with stakeholders following the disclosure of the EIS:

Regular update of the stakeholder register and stakeholder risk analysis

In order to ensure all stakeholders affected by construction are identified and engaged the CLO will be responsible for ensuring the stakeholder register is regularly updated and risks associated with stakeholders are assessed and re-evaluated as necessary based on information revealed through interactions, engagement and grievance management. Any new stakeholders that may have arrived in the Project area or developed an interest or interest in the Project should be monitored, analysed and strategies developed for engaging them. The FLO and GO respectively will be responsible for feeding back information on new stakeholders or changing stakeholder issues/risks which arise through their stakeholder interactions, to the CLO as part of this process.

Regularly engage and inform stakeholders of construction activities and schedule

The CLO (supported by the FLO) will be responsible for designing and implementing regular proactive and structured, engagement with stakeholders through appropriate methods or forums. This engagement will be focused on informing and updating community members about the Project construction activities and schedule including anticipated delays or changes, in that given month, and on the potential impacts that can be expected to occur along with the measures planned to mitigate these.

These engagements may include:

- Face to face information dissemination meetings with local leadership and other key authorities;
- Community/group meetings or information sharing on topics of community concern such as community health and community safety awareness sessions;
- FGD's for special interest groups with particular concerns such as fishing groups and land users; and
- Targeted and appropriately designed activities will be conducted to engage vulnerable groups and individuals.

Where appropriate for special interest groups/vulnerable groups eni may need to facilitate and provide support in the establishment of a committee or representative forum through which to engage and share new information e.g. for those affected by economic displacement who will be receiving compensation. This should be done in coordination with the team responsible for the Land Acquisition process.

All engagements will be documented both in writing and photographically, with minutes taken in standardised format and attendance recorded. Minutes should be shared with and approved by participants.

Any issues and or grievances raised during engagements will be logged in the stakeholder issues register. Grievances raised in these engagements will be dealt with according to the steps described in Section 8 below.

Establish a site presence

In order to ensure the Community Liaison Team is visible and accessible to the affected stakeholder base, the Project will consider establishing a permanent site based Community Liaison Office at Sanzule to ensure easy access for the community during the construction phase to be staffed by a CLO. At least one of the two CLOs planned to be recruited by the Project will be a Sanzule resident. This will be publicised to the communities as a location where information is available to them about the Project construction activities and schedule and where their issues/grievances will be registered and if possible responded to.

If a physical office cannot be permanently or regularly staffed, then a schedule of visits at a regular pre agreed time/ location by CLO/FLOs/GOs at Sanzule will be made available to stakeholders.

It is recommended that the frequency of these engagements is at least weekly at the commencement of construction activities. The need for this engagement will be monitored and if required this frequency will be maintained into the operational phase of the Project. Based on this review this engagement may be reduced over time to less frequent (every other week or monthly) after the schedule of activities is well established and had been communicated.

Information Dissemination

Information dissemination tools will be used to support the above activities for example: distribution of printed material e.g. an accessible Project update document such as a newsletter will be considered as a medium for communicating changes to stakeholders concerning Project design, progress on meeting social and environmental management commitments, details of upcoming construction activities and or changes to schedule. The Project will also provide information to stakeholders through other media (newspaper, radio, etc.)

Receive, track and respond to grievances

Unresolved stakeholder grievances can quickly escalate, often leading to unforeseen work stoppages and delay. It will therefore be key during the construction phase to respond quickly and effectively to grievances raised, and work closely through regularly engaging with stakeholders to try and anticipate where stakeholder issues or concerns may arise before they do. The GO and FLO will be responsible for supporting the CLO in identifying, logging and responding to all grievances and resolving locally those that can be managed in the immediate term, or reporting and escalating more complex issues to eni management as appropriate.

The planned process for tracking and responding to stakeholder grievances is described in more detail in Section 8.

Oversee Contractor Stakeholder Engagement

Unmanaged or poorly documented contractor-stakeholder interaction or engagement can also present risks to the Project. It may result in inconsistent or contradictory messages or conflicting commitments from the contractor/Project representatives to stakeholders which can give rise to unmet expectations.

The CLO will liaise with and oversee the construction Contractor to ensure that any interaction taking place between contractor workforce and stakeholders is consistent with the standards, core principles and procedures for undertaking, recording and documenting stakeholder engagements, as is outlined in this SEP.

Operation Phase

Ongoing Stakeholder Engagement during the operation phase has the following key objectives:

<u>Key Objectives</u>:

- Achieve a smooth transition from construction to operations including the integration of social and environmental commitments into the operational management system;
- Maintain visibility (albeit a reduced presence) and continuity of stakeholder relationships;
- Continue with regular engagement and disclosure to stakeholders as required;
- Continue to review and update stakeholder information; and
- Continue to receive, track and respond to grievances.

Activities

The operation phase will consist of a continuation of many of the same Stakeholder Engagement activities that have been undertaken during construction, but at a reduced frequency. These are described below:

Continue Regular Engagements

Regular direct engagement will continue between the community liaison function and key project stakeholders, and will be aimed primarily at maintaining continuity of relationships, monitoring the effects of project impacts on stakeholders and particularly on vulnerable groups, and demonstrating long term organisational commitment to delivering on social and environmental mitigations or to resolving outstanding issues and grievances.

As at Construction Phase, the Community Investment Team (including CLOs (supported by the FLO) will be responsible for designing and implementing this engagement with stakeholders through appropriate methods or forums. This engagement will be focused on continuing to inform and update community members about the Project operation activities and schedule including anticipated delays or changes, in that given month, and on the potential impacts that can be expected to occur along with the measures planned to mitigate these.

These engagements may include:

- Face to face information dissemination meetings with local leadership and other key authorities;
- Community/group meetings or information sharing on topics of community concern such as community health and community safety awareness sessions;
- FGD's for special interest groups with particular concerns such as fishing groups and land users; and
- Targeted and appropriately designed activities will be conducted to engage vulnerable groups and individuals.

Regular scheduled engagement through an appropriate forum for special interest groups/vulnerable groups will continue (final schedule to be developed during the preparation of the detailed Annual implementation plan).

Information Dissemination

Information dissemination tools and media will continue be used to support engagement activities as detailed in the Construction Phase activities.

Design engagements to manage stakeholder expectations around the transition to operations

Operations phase engagement activities will be designed to clearly communicate anticipated changes brought by the transition from construction to operations and to manage community expectations around the associated impacts eg a reduction in employment and other economic opportunities, and an expected high turnover in Project staff.

Ensure continuity of community liaison staff or sufficient handover period

The loss of familiar project staff can impact on established stakeholder relationships and cause a loss of institutional knowledge and often a breakdown in trust. If possible, Community Liaison Officers/other staff employed during the construction phase will be retained and or an adequate handover period secured in order for any new personnel to be introduced and to establish relationships before taking over key liaison roles.

Regular update of the stakeholder register and stakeholder risk analysis

In order to ensure all stakeholders affected by operations are identified and engaged the CLO will be responsible for ensuring the stakeholder register is regularly updated and risks associated with stakeholders are assessed and re-evaluated as necessary based on information revealed through interactions, engagement and grievance management. Any new stakeholders that may have arrived in the Project area or developed an interest or interest in the Project should be monitored, analysed and strategies developed for engaging them. Specific changes in the Project design and economics, affecting Project demands and plans (e.g. levels of production, change of suppliers, improvements in operations, modifications of plans and procedures, etc.) will be monitored, and the stakeholder mapping adapted as necessary, as these can result in new stakeholders arising or lead to a change and stakeholder interest in and concerns about the Project. The FLO and GO respectively will be responsible for feeding back information on new stakeholders or changing stakeholder issues/risks which arise through their stakeholder interactions, to the CLO as part of this process.

Continue documenting engagements and logging and responding to grievances

Engagements will continue to be recorded and documented in minutes, and all stakeholder issues and grievances logged and managed according to the given procedures.

Evaluate stakeholder perceptions towards continuous improvement

Finally, it may be helpful during operations as part of project monitoring activities, to assess and evaluate stakeholder perceptions towards the Project and how these may have changed during the course of the construction period. This information can help inform approaches to engagement and provide insights to facilitate continued relationship building with stakeholders through the operations phase of the Project.

<u>Next Steps towards Implementation</u>

An Annual or more detailed operation/implementation plan and a schedule detailing ongoing Stakeholder Engagement activities during both the construction and operation phases of the Project, and throughout its lifecycle through to decommissioning will be developed, following disclosure and submission of the final EIS report to EPA.

The plan will include detail on planned engagement activities and how they will be carried out and operationalised including:

- Frequency and location of engagements;
- Methods for summoning stakeholders for meetings and engagements;

- How meetings and meeting materials will be developed; and
- What methods and media will be used to disclose information (e.g. newspaper, local radio, pamphlets) including tools to ensure accessibility of information to non-literate or vulnerable groups.

The plan will contain additional detail on the type of information to be disclosed, how issues, comments and concerns of stakeholder will be incorporated into the Project and how feedback will be provided to stakeholders on issues and concerns.

Finally, a section on monitoring and evaluation including performance indicators will be included.

This SEP and the stakeholder register, along with the issues register will be updated at this point and iteratively at key milestones during the construction and operations phases.

Therefore, the next formal stakeholder engagement activities will occur under the auspices of the EPA when it holds public hearings before finalising a permitting decision on the Project.

5.4 Resources, Role and Responsibilities

Resources, roles and responsibilities for implementation of the SEP and of ongoing stakeholder engagement as part of the Project are not yet fully defined, but are likely to include:

5.4.1 Community Liaison Officer

eni already has Community Liaison Officers (CLO) in place who is responsible for continued community engagement, facilitation of meetings, distribution of information to stakeholders and eliciting comments, translation of material into the local languages and record keeping. The CLO is a Ghanaian citizen who is fluent in the local languages and familiar with the local customs.

The CLO is and will continue to be responsible for::

- Interfacing with National, Regional and District Authorities, Traditional Authorities and Project Affected Villages;
- Responding to low priority grievances and initiating and coordinating responses from the appropriate managers to mid and high priority grievances;
- Reporting to the HSE Manager on a weekly or monthly basis regarding engagement activities and community issues and concerns including the management of grievances;
- Being present in and accessible to the communities and overseeing the Grievance Mechanism function; and
- Directing communication with stakeholders around the resolution of stakeholder issues and grievances.

5.4.2 Community Investment Coordinator

eni foresees and has planned hiring a "Community Investment Coordinator" to manage a team of at least three people (including the current CLO and one additional and one Community Investment Advisor).

- Coordinating local programs including local employment (recruiting), training, community investment;
- Organising of participatory monitoring programme with affected communities;
- Analysis of issues and grievances to propose actions to reduce potential conflicts;
- Organizing information sessions; and
- Delivering regular reports to Communities and stakeholders containing information regarding project activities and project environmental and social performance.

5.4.3 Grievance Officer

Should the need arise; the eni will appoint a Grievance Officer (GO) to assist the CLO. The Grievance Officer will be responsible for:

- Collection, logging and prioritising grievances;
- Coordinating and tracking timely responses;
- Monitoring corrective actions;
- Communicating with stakeholders around the resolution of grievances;
- Interfacing directly with the community at regular intervals in appropriate forums;
- Being based on site and available to the community at well publicized times and at accessible locations; and
- Reporting to the CLO on a weekly basis.

The CLOs and GOs should receive appropriate training in stakeholder engagement, facilitation, presentation skills and conflict management.

The Grievance Officer reports to the CLO, who, in turn reports to the Project Environmental Manager. While most of the stakeholder engagement activities are undertaken by a small number of junior staff within the organisation, it is important that there is senior level buy-in and oversight of the process. Without the support and buy-in of senior staff, the process will have limited success.

5.4.4 Fisheries Liaison Officer

Should the issues arising during the EIS process indicate a need the eni cold consider appointing a Fisheries Liaison Officer (FLO) to support the CLO and GO during the construction and operation phase. The FLO will be responsible for:

- Interfacing directly with Fishers/Fishmongers in Project Affected Villages and the DAoI and EAoI at regular intervals in appropriate forums;

- Reporting to the HSE Manager on a weekly or monthly basis regarding engagement activities and issues and concerns raised by Fishers/Fishmongers including the specific Fishing related grievances;
- Being present in and accessible to the fishers on site in both the onshore and if appropriate the offshore environment;
- Directing communication with fishers around the resolution of their specific issues and grievances;
- Responding to low priority fishers/fishmongers' grievances and initiating and coordinating responses from the CLO and appropriate managers to mid and high priority grievances.
- Reporting to the CLO on a weekly basis.

5.4.5 Land Acquisition/RAP Liaison Officer

Should the issues arising during the EIS process indicate a need the eni could consider appointing a Land Acquisition/RAP Liaison Officer (RLO) to support the CLO and GO during the construction and operation phases. The RLO will be responsible for:

- Interfacing with Traditional Authorities and Project Affected Villages undergoing resettlement;
    - The management of RAP specific Grievances including:
    - Collection, logging and prioritising of RAP specific grievances;
    - Coordinating and tracking timely responses;
    - Monitoring corrective actions;
    - Responding to low priority RAP related grievances and initiating and coordinating responses from the appropriate managers to mid and high priority grievances; and
    - Communicating with stakeholders around the resolution of grievances;
- Being present at site and accessible to the RAP affected communities and overseeing and providing support where required (e.g. with RAP related consultation activities) to the RAP implementation team;
- Reporting to the CLO on a weekly basis /or Reporting to the HSE Manager on a weekly or monthly basis regarding RAP engagement activities and community issues and concerns specific to the RAP process including the management of RAP related grievances.

5.5 STAKEHOLDER ISSUES

This Section provides an overview of the key issues raised by stakeholders during the Scoping phase. A summary of these comments raised during the Scoping consultations is provided in Table 5.4.

All comments received have been recorded and are presented in in the full issues trail in the SEP (Annex A). A summary of the issues raised have been included in Table 5.4, and these issues have been considered as part of this EIS, and where appropriate suggestions have been incorporated in the Project design, and in the development of mitigation measures, as indicated in the table.

Feedback on key issues will be provided to stakeholders through the disclosure of the EIS and through ongoing stakeholder engagement as outlined in the SEP.

Table 5.4 Summary of Issues

Issue Group	Summary of issues	Addressed in EIS
Accidents	Several stakeholders mentioned concerns over accidental damage to gas pipeline and possible gas leakage.	Chapter 10 and Annex G – Impact Assessment, Section G.7.9
Employment and Local Content	Several stakeholders emphasized the need for local content and youth employment.	Chapter10 and Annex G – Impact Assessment, Section G.7.1
Security	Several stakeholders mentioned that the offshore gas pipeline should be buried to prevent any damage from ships dropping anchors. They also added that the offshore pipeline route needs to be clearly marked and updated in the (admiral chart) navigational chart so the sea farers (including fishers) will avoid the ROW. Stakeholders highlighted that policing of the offshore pipeline ROW and FPSO exclusion zones from encroachment from other uses could cause conflict.	Chapter 4 Chapter 10 and Annex G – Impact Assessment, Section G.7.7
Livelihoods and compensation	Stakeholders indicated that the proposed Project area is currently used for fishing, farming and grazing and expressed concern regarding the loss of livelihoods and the stressed the need for compensation of any lost livelihood.	Chapter 10 and Annex G – Impact Assessment, Section G.7.2
Cultural heritage	Stakeholders expressed concern over the affection to the cemeteries and potential archaeological resources currently located within the Project area. Stakeholders identified those cultural resources in the area need to be preserved and buffer areas should be implemented.	Chapter 10 and Annex G – Impact Assessment, Section G.7.4
In-migration	Stakeholders expressed concern that there would be in-migration of people (especially job-seekers) into the area resulting in impacts to the socio-economic structure, traditional values, demographics and cultural heritage.	Chapter 10 and Annex G – Impact Assessment, Section G.7.3 and G.9.7
Tourism impacts	Some stakeholders expressed concern regarding the conflicting proposed industrial land use and activities with the plans for the development of the Western Region coastline as an area for sustainable tourism. They also expressed concern over the project activities and their potential effect on the tourism potential of the area.	Chapter 10 and Annex G – Impact Assessment, Section G.7.1
Sensitive biodiversity	The impacts on marine fauna (fish, marine mammals) and onshore wildlife were raised as important aspects for consideration, and that biodiversity offsets should be implemented if appropriate. Concerns were also raised regarding the Project's impacts on the annual algae bloom.	Chapter 10 and Annex G – Impact Assessment, sections G.4 and G.5
Fisheries Impact Assessment	Several stakeholders mentioned the need for the EIS Team to undertake a separate Fisheries Impact Assessment.	Chapter 10 and Annex G – Impact Assessment, sections G.6
Pollution and waste management	Stakeholders highlighted the importance of marine and onshore pollution control and ensuring responsible waste management.	Chapter 12, section 12.4 and Annex F

Issue Group	**Summary of issues**	**Addressed in EIS**
Fishing	Apart from the livelihoods aspects (above), stakeholders indicated their concerns regarding disturbance to fishing activities including access to fishing areas (exclusion zones) and potential catch reduction. Stakeholders expressed concerns related to increased exclusion zones as a result of additional FPSOs in the area.	Chapter 10 and Annex G – Impact Assessment, Section G.7.2 and G.9.7
Air emissions	Stakeholders were concerned about the potential air emissions from the onshore receiving facilities and from vessels, including potential for gas leaks and the resultant impacts on human health and marine fauna.	Chapter 10 and Annex G – Impact Assessment, Section G.4.1
EIS process and stakeholder engagement	A number of stakeholders highlighted the requirements for thorough stakeholder consultation process as part of the EIS. Some also mentioned that the planned timing for the EIS process could impact the quality of the process. The stakeholders highlighted that engagement is needed in collaboration with local, district and regional authorities. Stakeholders indicated that there should be thorough engagement with the local fishers regarding security measures and restrictions, as well as social investment needs.	Chapter 5 and Annex A - SEP
Alignment with regional planning, industrial growth and other developments	Stakeholders indicated that the planning and design for the Project should be integrated with other local and regional planning processes. Planning for the Project was encouraged to include and anticipate future or other developments in the area.	Chapters 2, 5 and Annex A - SEP
Operational safety	Stakeholders suggested that the location of the helipad should consider the proximity to any waste disposal sites due to the operational interactions of the helicopters with avian fauna which are attracted to the disposal site.	Chapter 4
Community Health and Safety	Stakeholders indicated that there should be clear warning signs along the onshore pipeline right of way.	Chapter 10 and Annex G – Impact Assessment, section G.7.7
Cumulative impacts	Stakeholders highlighted that cumulative impacts need to be thoroughly assessed in the EIS.	Chapter 10 and Annex G – Impact Assessment, section G.10

5.6 GRIEVANCE MECHANISM

Grievances are complaints or comments concerning the way in which a Project is being implemented. A grievance mechanism provides a formal and on-going avenue for stakeholders to engage with the company, whilst the monitoring of grievances provides signals of any escalating conflicts or disputes.

Identifying and responding to grievances supports the development of positive relationships between the Project proponent and the communities, and other stakeholders. An effective grievance management process should include the components described in Box 5.1 below.

A Grievance Mechanism has been developed developed and is structured according to recommended good practice and draft eni guidance,, (see also Annex A).The process for managing grievances is implemented through the HSE & Community Investment Department, based in Accra and Community Liaison Officers (CLO), based on site. The HSE & CI structure is responsible for co-ordinating grievances as they come into the Project and will follow the Grievance Procedure in ensuring resolution., At this stage,

The CLO is the the first point of contact for people wishing to submit grievances and is responsible for ensuring adherence to the grievance procedure. A Grievance Officer will be recruited to support the CLO in managing and tracking grievances during construction and operation phases. See Step 1 of detailed steps below.

Box 5.1 Key Components of an Effective Grievance Mechanism

Simple and Culturally appropriate Process: It should be convenient to submit complaints. There should be several, appropriate channels through which community stakeholders can submit complaints free of charge, and without retribution to the party that originated the issue or concern..
Simple Internal Procedure: A simple and consistent procedure is required to record grievances, identify those responsible for addressing them and ensure that they are resolved.
Staff Arrangements: Roles and responsibilities in the grievance management process need to be defined and agreed.
Training: The launch or modification of the grievance management process should include internal induction and/or training for operational staff and a Community Liaison Officer.
A Set Timeframe: The grievance process should set a timeframe within which complainants can expect acknowledgement of receipt of grievance and a response and/or resolution of grievance.
Sign Off: Actions planned to resolve grievances considered to be of significant concern by the Grievance Officer should be signed-off by a member of the senior management, suitably qualified to assess the effectiveness of the response.
System of Response: A clear system of response is required to identify who should respond to the complainant and how. Response to the party originating the grievance should be provided in a timely and transparent manner.
Appeal process: An appeal process with the involvement of third parties should be in place in case the complaint is not resolved to satisfaction of the party originating the grievance.
Disclosure: The grievance mechanism should be clearly and widely disclosed to affected communities.
Access to Legal Remedies: The mechanism should not impede access to judicial or administrative systems.
Monitoring Effectiveness: Mechanisms should be set in place for monitoring the effectiveness with which complaints are being recorded and resolved.

Source: ERM, 2014

The Project Grievance Mechanism comprises the following key steps, which are outlined in further detail below:

- Step 1: Establishing and Publicising the Grievance Management Mechanism;
- Step 2: Receive and Track Grievances;
- Step 3: Assess and assign responsibility for resolution;
- Step 4: Investigate Grievances;
- Step 5: Respond and Resolve and Close Out; and
- Step 6: Monitor Report, and Evaluate the Grievance Mechanism

5.6.1 Step 1: Establishing and Publicizing Grievance Mechanism

The grievance mechanism needs to be available and accessible to all affected communities and therefore once established will need to be publicized and communicated within Project Affected Communities.

Consultation on the workings of the procedure will take place with communities and stakeholders at District, Municipal and Metropolitan Assemblies across the DAoI and with institutions in selected locations in the EAoI.

A range of different approaches will be used for this communication as deemed appropriate, including face to face meetings and group (e.g. village) meetings. In addition, information materials such as a brochure or flyer, describing the process will be produced and distributed by hand and via posting in publicly accessible locations in the Project DAoI and EAoI.

The contact details of the Project Community Liaison Officer (CLO) and Grievance Officer (GO) will be provided clearly on this notice as the key points of contact for receiving grievances.

5.6.2 Step 2: Receive and Track Grievances

Grievances can be submitted in writing, telephonically or presented verbally to the Project CLO or Grievance Officer.

Logging Grievances

All grievances shall be logged using a Grievance Form. eni will log, document and track all grievances within a Grievance register to be managed and updated by the Grievance Officer with oversight from the Project CLO.

The database shall be monitored regularly for recurring grievances so that appropriate standardised mitigation can be developed.

The following information shall be recorded for each grievance:

- Grievance case number;
- Complainant's name and contact details(1)
- Date of complaint;
- Details of complaint;
- History of other complaints / queries / questions (if known);
- Resolutions discussed and agreed with the party(ies) in question;
- Actions implemented (including dates) and;
- Outcome of the actions implemented.

For complaints in person, typically the responsible eni staff (CLO or GO) shall either complete himself of help the complainant with the completion of a feedback form.

For complaints by phone, eni's staff shall register the complaint themselves using the feedback format.

(1) Name and contact details are necessary for interaction around the resolution of the grievance. Anonymous submissions will be permitted, but the party submitting should understand that direct response will not be possible.

Acknowledging Receipt of a Grievance

eni shall formally acknowledge receipt of any grievance as soon as possible, and within a standardised time period.

An initial response should be provided not more than (5) five days from the date it was submitted and shall inform the complainant about the timeframe in which a response can be expected. A full response should then be provided no later than a month from receipt and acknowledgment of the grievance.

The acknowledgement must be sent in written form although it can be anticipated by phone depending upon the complainant.

The process of acknowledgement shall include responding to the complainant, using appropriate communication channels, about the following issues:

- explaining next steps;
- providing a target date for resolution of the issue or, if necessary, the full response to the feedback;

Ideally, acknowledgment of a grievance to the complainant should include the name of the person assigned to resolve the issue.

5.6.3 Step 3: Assess and Assign Responsibility for Resolution

eni will assess each type of grievance for an understanding of the types of response required and in order to assign responsibility of the appropriate individual to manage the response.

The following risk levels indicated in Table 5.5 may be considered and assigned to classify the type of response required.

Table 5.5 Grievance/Issue Risk Level

Issue Risk Level	Description
Level 1	Positive feedback requiring acknowledgement and thanks to the remittent and or feedback that is not related to eni Upstream Area and needs to be directed elsewhere.
Level 2	A question or request for information.
Level 3	A grievance that is not a breach of law or of an eni policy and is not related to • death or serious illness or • a recurrent question /request for information
Level 4	A repeated or widespread grievance or • a grievance that is a breach of law or eni policies or • a direct accusation of breach of human rights or • a grievance related to death or serious illness.

In some cases, an issue may require specialised support to be addressed; e.g. from the Health, Safety and Environment, Procurement or Operations Departments and will be escalated accordingly.

Please note all grievances assessed as level 3 or 4 require the involvement of Senior Management of the eni company involved.

5.6.4 Step 4: Investigate Grievances

eni will investigate fully all grievances submitted, and where necessary will involve other departments, contractors and senior management in the process in order to fully understand the circumstances that led to the grievance being raised. eni's companies or projects may decide to invest in this type of assistance as deemed necessary for grievances of a significant risk level (Level 3 and 4).

This investigation should be performed in a timely manner to avoid delaying the resolution of a grievance. eni will aim to resolve any grievances within 30 days from the date that of receipt. This timeframe can be extended to 60 days for more complex grievances (eg level 4 grievances), if required

The following steps shall be performed as part of an investigation to avoid delaying resolution of a grievance:

- Obtain as much information as possible from the person who received the complaint, as well as from the complainant to gain a first-hand understanding of the grievance. When this grievance information is gathered and or in any interaction between eni and a community, including site visits, a CLO, GO or FLO will be present;
- Undertake a site visit, if required, to clarify the parties and issues involved. Gather the views of other stakeholders including eni employees, if necessary and identify initial options for settlement that parties have considered.
- Determine whether the grievance is eligible for consideration and valid.
- Eligible grievances include all those that are directly or indirectly related to eni' Project and that fall within the scope of the Grievance Mechanism as outlined above.

- Ineligible complaints may include those that are clearly not related to the eni Project or its contractors' activities, whose issues fall outside the scope of the Grievance Mechanism procedure or where other eni or community procedures would be more appropriate to address the grievance.
- If the grievance is deemed ineligible it can be rejected however a full explanation as to the reasons for this must be given to the complainant and recorded in the Grievance Database.
- If the grievance is eligible, its risk level should be determined using the significance criteria in Table 5.5. This will help to determine whether the grievance can be resolved immediately or requires further investigation and whether senior management will need to be informed of the grievance.
- If the grievance concerns physical damage, (e.g. fishing boat, crop, house, community asset) a photograph should be taken of the damage and its exact location recorded the as accurately as possible.
- Inform the complainant of the expected timeframe for resolution of the grievance.
- Enter the findings of the investigation in the Grievance Database.

5.6.5 Step 5: Respond, Resolve and Close Out

A response should be provided to the complainant in all cases, by the CLO, and if necessary the local eni's management. This may only consist in a simple clarification of a technical issue. Responses can be either oral or written, depending on whether the grievance was received orally or in writing.

<u>Ineligible Claims</u>

If a claim is rejected as ineligible (not considered to be related to eni's or its contractor's activities) or without basis the and the response is that the grievance does not require action by the company to resolve it, it should still be documented and included in company systems for grievance tracking for further reference. The message that the Project does not intend to provide a response, should be handled sensitively to the complainant.

<u>Eligible Claims</u>

Preliminary Response

In the case of all eligible complaints, eni will provide an initial response within a stipulated period of time and propose the next steps and actions for resolution. The CLO/GO will then communicate the results of the assessment and the status of their claim to the complainant.

Final Response

This response should provide clear information on the proposed final corrective action and detail any related commitments made by both parties. It should obtain the written agreement of the complainant.

If the complainant is not happy with the proposal they should be free to seek resolution through a formal external dispute resolution mechanism.

Should the grievance be of level 3 or 4 (see table 7.1), the response or update may need to be provided directly by eni local senior management in order to demonstrate responsiveness and commitment by eni to resolving stakeholder grievances.

Close out

A complaint is closed out when no further action can be or needs to be taken.

When closing out, it is important to ensure full proof of close out based on fully documented evidence of the resolution process including:

- Written internal record internally, with the date and time it took place, and sign off by responsible staff sign off;
- Photographs if relevant documenting the resolution; and
- Written confirmation of the complainants' agreement with the resolution (a template close-out agreement or similar may be used).

The final close out status of the complaint e.g. open (under investigation), resolved (resolution has been agreed), unresolved (not possible to reach an agreed resolution and case has gone to external dispute resolution), abandoned (complaints where the complainant is not contactable after a certain period and complaint becomes null and void), must be recorded in the Grievance Register.

Appeal Process

The grievance process will include an appeal process with the involvement of third parties to mediate in cases where no agreement is reached to the satisfaction of the affected person. If deemed necessary this may include forming a grievance committee with participation of local representatives and involving a third party in the process of grievance resolution.

The mechanism will not impede access to judicial or administrative systems.

5.6.6 Step 6: Monitor, Report and Evaluate

eni management will monitor grievances routinely as part of the broader management of the Project. This entails good record keeping of complaints raised throughout the life of the construction and operation of the Project. On receipt of grievances, electronic notification to management must be distributed. Grievance records must be made available to management at all times.

Monthly internal reports will be compiled by the Grievance Manager and distributed to the management team.

As part of the grievance monitoring, eni will implement a process to analyse grievances. This will ensure wider actions are taken where required to solve root problems causing grievances rather than just individual grievances. eni will also develop performance indicators to evaluate the grievance management process.

ESHIA – Phase 2 OCTP Ghana

ABSTRACT

Chapter 6 provides an overview of the current environmental conditions at the national, regional, district, and local level.

July 2015	06	Final version	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
DATE	*REVISION*	*REVISION DESCRIPTION*	*PREPARED*	*CHECKED*	*APPROVED*

SUMMARY OF REVISIONS

July 2015	05	Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
April 2015	04	Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
March 2015	03	Interim Draft Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
27-02-2015	02	Issued for submission to Authorities	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
23-02-2015	01	Issued for comments	ERM	eni SEQS/SAL	G. Nicotra
26-01-2015	00	-	Cristina O.	Henry C.	Daniele S.
DATE	*REVISION*	*REVISION DESCRIPTION*	*PREPARED*	*CHECKED*	*APPROVED*

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6 ENVIRONMENTAL BASELINE

6.1 INTRODUCTION

This Chapter describes the current biophysical environment of the Project Area of Influence (AoI). The description covers both the terrestrial and marine environments which may be directly or indirectly affected by the proposed Project and activities.

6.2 DATA SOURCES

6.2.1 Secondary Data

The baseline description draws on a number of publically-available secondary sources including:

- Published scientific studies;
- Published academic texts and reference books;
- Reports covering sensitive or protected species and habitats (eg, UNEP and IUCN publications);
- Publicly available geospatial data (topographic data, aerial photographs, satellite imagary);
- Publicly available data on air quality conditions and meteorology;
- Publicly available data on geology, soils, and hydrology;
- Information on protected areas from the Ghanain government;
- Information from international organisation including Food and Agriculture Organization (FAO), International Union for Conservation of Nature (IUCN), Fishbase, and Birdlife International; and
- Publicly available environmental reports in particular environmental assessment reports for other projects near the Project.

A detailed list of references is provided in *Section 14.*

6.2.2 Primary Data

The baseline description also draws on primary data collected during a series of field surveys covering the onshore and offshore Project areas.

Surveys of the onshore areas were conducted specifically for this ESHIA in both the wet and dry season order to cover the natural seasonal variability. The first survey was conducted in March and April 2014 covering the dry season period. The second season covering the wet season was conducted in October 2014 (covering the ORF and beach locations) and December 2014 (covering the optional onshore pipeline route).

The surveys covered the following elements of the biophysical environment:

- air quality;
- background noise levels and receptors;
- soils;
- sediment quality in freshwater courses;
- surface water and groundwater quality;
- terrestrial biodiversity (ie, flora and fauna) and ecosystems;

Surveys of the offshore areas were conducted as part of the ESHIA for the Phase 1 development. The data collected during the surveys is contained in two reports:

- Environmental Survey Report – Offshore Geophysical and Geotechnical Site Survey – OCTP Development Project Phase 1 (wells and intrafield flowlines area) FUGRO - April 2013):and
- Environmental Survey Report – Offshore Geophysical and Geotechnical Site Survey – OCTP Development Project Phases 2&4 (offshore pipeline area) – FUGRO (February and March 2013).

The offshore surveys focused on:

- Marine water quality;
- Planktonic and zooplanktonic;
- Fish and fisheries;
- Marine sediment quality; and
- Benthic macro fauna.

Details of the survey methodology related to each onshore and offshore environmental survey are presented in the relevant sections.

6.3 ATMOSPHERE

This Section describes the climate, air quality and acoustic conditions in the Project area. A general overview of the current Greenhouse Gas (GHG) emissions at country level is also reported in Section 6.3.4.

Most of the data reported in this Section 6.3.1 to 6.3.3 was collected during field surveys conducted in March 2014 and October 2014 at three onshore locations.

Additional meteorological data were collected during a meteocean survey, performed from February to April 2014, at one onshore location, in correspondence of a meteorological station, and at one offshore location, in correspondence of a wave buoy.

All monitoring locations are reported in Table 6.1 and mapped in Figure 6.1. The related reference documents are listed in Chapter 14.

During the surveys of March 2014 and October 2014, locations were monitored for the following parameters:

- Air quality indicators including CO2, NO2 , SO2, , VOCs, TSP, PM10;
- Ambient noise levels; and
- Meteorological conditions including air temperature, relative humidity, and wind speed and direction.

Data collected from February to April 2014, instead, were related only to meteorological conditions, including air temperature, relative humidity, wind speed and direction, solar radiation.

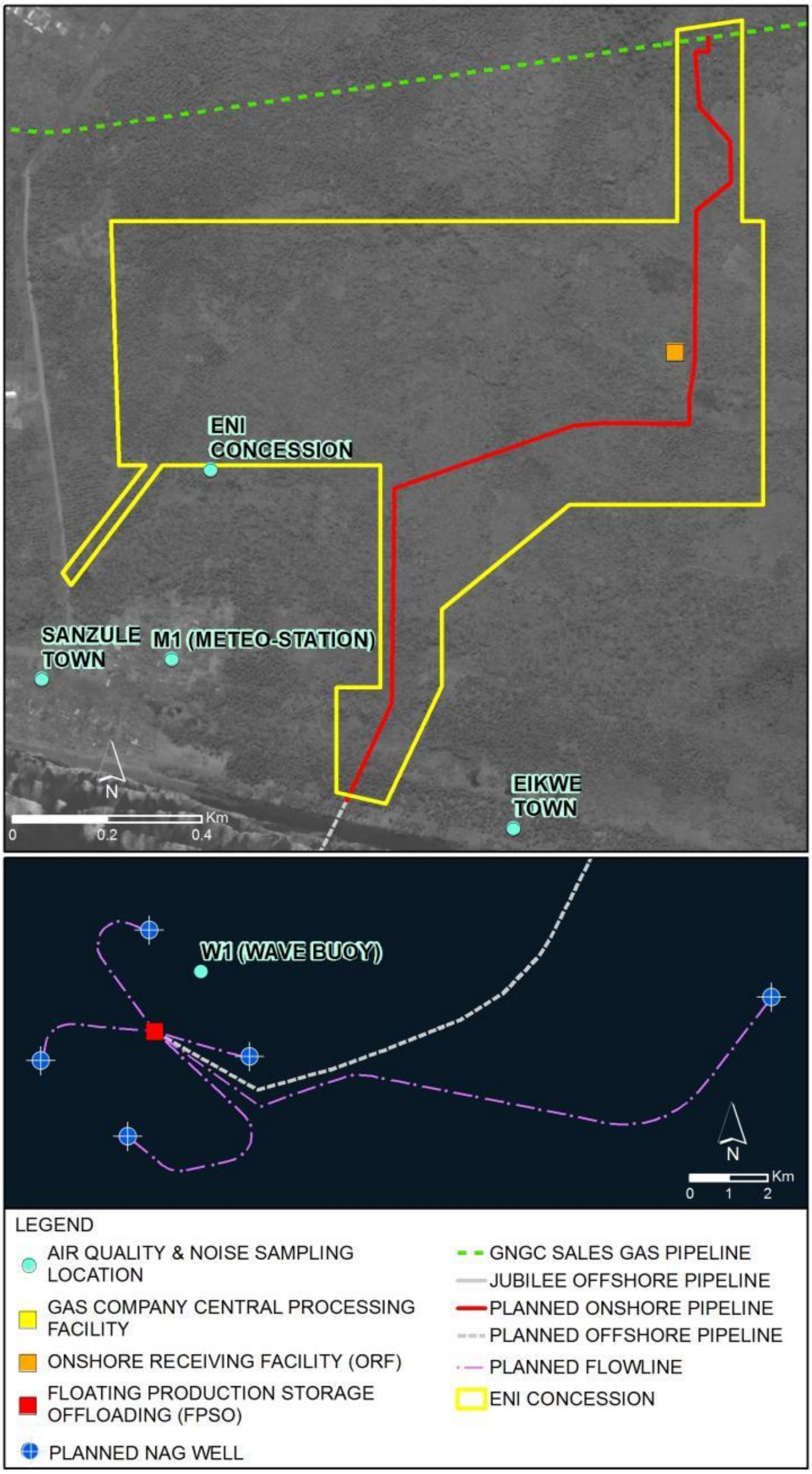
Further details are included in Annex B (Section B.1).

Table 6.1 Monitoring Locations

Location	Type	Coordinate (latitude)	Coordinate (longitude)
Sanzule community	Onshore	N 04° 57' 38.1"	W 002° 27' 16.9"
Eikwe community	Onshore	N 04° 57' 27.8"	W 002° 26' 44.5"
Eni onshore concession/ acquisition area	Onshore	N 04° 57' 52.5"	W 002° 27' 05.3"
Meteorological station (M1)	Onshore	N 04° 57' 39.48"	W 002° 27' 7.98"
Wave buoy (W1)	Offshore	N 04° 28' 59.4"	W 002° 32' 34.8"

Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report (ESL Consulting, 2014) (REF. 1, REF. 2, REF. 6).

Figure 6.1 Monitoring site locations



Source: ERM, 2015

6.3.1 Climate and Meteorology

This Section describes the climate and seasonal distribution of the meteorological parameters of the Project area. The information is drawn from secondary data as well as data collected during field surveys. Secondary data were used for the characterisation of rainfall (REF. 4).

Table 6.2 summarises the average climate and meteorological conditions of the Project area during the wet and dry season for the onshore locations monitored in March 2014 and October 2014.

Table 6.3 summarises the average meteorological conditions recorded from February 2014 and April 2014 both onshore and offshore.

Table 6.2 Meteorological parameters recorded during the dry and wet seasons

Location	Average Meteorological Parameter					
	Dry Season			Wet Season		
	Temperature [°C]	Humidity [%]	Wind speed [m/s] and direction	Temperature [°C]	Humidity [%]	Wind speed [m/s] and direction
Sanzule community	31.97	74.09	0.86 Northeast	35.37	61.81	0.87 Northeast
Eikwe community	30.84	82.49	1.07 Northeast	32.06	79.95	1.34 Northeast
Eni onshore concession/ acquisition area	32.03	76.7	0.58 Northeast Southeast	31.82	69.95	0.56 Northeast

Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report (ESL Consulting, 2014) (REF. 1, REF. 2).

Table 6.3 Meteorological parameters recorded from February to April 2014

Location	Average Meteorological Parameter				
	Temperature [°C]	Humidity [%]	Wind speed [m/s] and direction of maximum [°True]	Air Pressure [mbar]	Solar Radiation [W/m²]
M1 (onshore)	27.5	81.9	2.1 86°	1009.9	128.4
W1 (offshore)	28	82.9	3.9 73°	1010.6	(not recorded)

Source: eni Ghana Offshore Cape Three Points Survey Final Report (FUGRO, 2014) (REF. 6).

The regional climate of southwest Ghana is driven by the Inter Tropical Convergence Zone (ITCZ), resulting during the boreal (northern hemisphere) winter in a climate dominated by dry and continental air from the Sahara. On the contrary, humid and warm maritime air from the Atlantic Ocean is prevalent during the boreal summer. This alternation leads to the existence of two well-marked seasons: a dry season, between December and April; and a wet season, between May and July and September and November.

The main climate characteristics of the Project area are the following:

- With the exception of the readings at the eni concession area, which recorded 24-hour average less than the monitoring value for similar study during the dry season, the wet season temperatures were numerically higher than the dry season values.
- During the dry season, relative humidity tends to increase overnight reaching 90%, whilst regular fluctuating pattern was observed across all the locations in the wet season.
- Wind directions in all the onshore monitored locations were predominantly from the northeast, during both dry and wet season with average speeds between 0.5 and 2 m/s. The highest mean wind speed was recorded on the coast (monitoring location M1).
- The average annual rainfall is about 730 mm, with two peaks of precipitation occurring in May through June and October through November.
- The meteorological parameters monitored in the offshore location (W1) showed a mean temperature of 28°C and a mean wind speed of 3.9 m/s, higher compared to the speed recorded onshore.

6.3.2 Air Quality

There are no major industrial activities in the Project area and thus no significant sources of air pollutant emissions. The majority of emissions to air arise from the smoke of cooking fires; exhaust of generators used for power supply; and vegetation burning to clear land for farming. During the survey conducted in December 2014 on-going road construction along the length of the pipeline ROW was creating dust along the immediate stretch.

Two air quality measurements were taken at each sampling point: one 24-hours monitoring measurement as part of the field survey held in March 2014 (dry season) and one 24-hours measurement in October 2014 (wet season). A summary of the results relative to limits provided by Ghana EPA and the guideline values contained in the World Bank EHS Guidelines (World Bank Group, 2007) are presented in Table 6.4 and Table 6.5. Measurements of ambient air were carried out using the highly flexible AEROQUAL air quality monitor (AQM 60). The AQM instrument is based on analytic Gas Sensitive Semiconductor (GSS) technology. The GSS is a combination of smart measurement techniques and mixed metal oxide semiconductor sensors that exhibit an electrical resistance change in the presence of a target gas. The air pollutants measured were nitrogen dioxide (NO_2), carbon dioxide (CO_2), sulfur dioxide (SO_2), volatile organic compounds (VOCs) and particulate matter (TSP and PM_{10}). The ambient concentrations were recorded for every minute during 24-hours at each location, from which hourly concentrations were calculated and daily mean concentration determined.

Table 6.4 Ambient Air Quality (March 2014 dry season survey)

Parameter	24 h Average Concentration			Ghana EPA (24hour time weighted average)	World Bank Group EHS Guidelines (2007)
	Eni concession	Sanzule community	Eikwe community		
NO_2 (µg/m^3)	1.90	1.88	1.38	150	40 (annual) 200 (1-hour)
SO_2 (µg/m^3)	**130.34** (b)	**78.65** (b)	**218.69** (a) (b)	150	20 (24-hour) 500 (10-minute)
TSP (µg/m^3)	19.04	28.76	25.72	150	NG
PM_{10} (µg/m^3)	14.56	20.32	21.28	70	20 (annual) 50 (24-hour)
VOC (ppm)	0.07	0.06	0.05	NG	NG
CO_2 (µg/m^3) [1]	523651.25	505007.68	496228.87	NG	NG

Notes:

NG=No Guideline
Values highlighted in **bold** exceeded the (a) Ghana EPA guideline or (b) the IFC guideline.
The comparison with IFC/WHO can be done only for SO_2 and PM_{10} for which a 24-hour limit has been set by IFC/WHO.

[1] CO_2 is not considered an air pollutant, and no concentration limit or emission limit for CO_2 is defined by international standards. Anyway, as greenhouse gas, it was included in the monitoring activity.

Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Dry season (ESL Consulting, 2014) (REF. 1).

Table 6.5 Ambient air quality results (October 2014 wet season survey)

Parameter	24hour Average Concentration			Ghana EPA (24hour time weighted average)	World Bank Group EHS Guidelines (2007)
	eni Concession	Sanzule community	Eikwe community		
NO_2 (µg/m^3)	0.10	0.05	0.08	150	40 (annual) 200 (1-hour)
SO_2 (µg/m^3)	19.74	**65.93** (b)	**30.49** (b)	150	20 (24-hour) 500 (10-minute)
TSP (µg/m^3)	28.77	81.38	133.35	150	NG
PM_{10} (µg/m^3)	18.42	**52.53** (b)	**84.52** (a) (b)	70	20 (annual) 50 (24-hour)
VOC (ppm)	0.07	0.02	0.04	NG	NG
CO_2 (µg/m^3) [1]	542621.7	598222.89	585411.4	NG	NG

Notes:

NG=No Guideline
Values highlighted in **bold** exceeded the (a) Ghana EPA guideline or (b) the IFC standard.
The comparison with IFC/WHO can be done only for SO_2 and PM_{10} for which a 24-hour limit has been set by IFC.

[1] CO_2 is not considered an air pollutant, and no concentration limit or emission limit for CO_2 is defined by international standards. Anyway, as greenhouse gas, it was included in the monitoring activity.

Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Wet season (ESL Consulting, 2014) (REF. 2).

During the dry season all parameters analysed except SO2 at all three locations were within the Ghana EPA limits. The SO2 levels at the three locations are understood to be elevated as a result of fish smoking process or waste burning. Compared with the WBG air quality guidelines (2007), the SO2 values at all the stations are above the recommended guideline.

During the wet season the measured levels of NO2 and TSP within Ghana EPA limits and IFC guidelines values. The IFC guidelines values (2012), instead, were exceeded at Sanzule and Eikwe for SO2 and at Sanzule and Eikwe for PM10. High monitored levels of SO2 could be a result of the fish smoking process or waste burning. The elevated PM10 concentration are suspected to be a consequence of road construction works which were underway during the survey work.

6.3.3 Light, Noise and Vibration

Light and vibration levels in the Project area are currently low due to the general lack of industrial activities in the area. Current levels of noise are associated to domestic activities and natural sounds such as the ocean, waves, wind, and insect noise. Noise levels were measured at the same locations as the air quality sampling points and were found to be higher along the pipeline ROW due to on-going road construction activities (December 2014). No wet season noise monitoring was undertaken along the pipeline ROW.

Average noise levels were recorded during 24 hours at each sampling point (ie, included both daytime and nighttime periods). Noise levels were measured using the ACO Pacific sound level meter used for a real-time sound level measurement. The sound meter was calibrated with ACO Pacific Acoustic Calibrator (94dB@1kHz) prior to data collection at each sampling location. The results are summarised in Table 6.6. The sampling locations – the same for air quality monitoring- are reported in Figure 6.1.

Table 6.6 Ambient Noise Levels

Location	Measured Sound Pressure Level [dBA]					
	Dry Season			Wet Season		
	Average (Leq)	Day Time	Night Time	Average (Leq)	Day Time	Night Time
Sanzule Community	55.19	55.07	55.19	63.70	65.90	64.53
Eikwe Community	59.86	60.48	59.49	61.31	62.02	60.80
eni Concession	53.33	52.31	54.37	58.39	57.21	59.21

Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report (ESL Consulting, 2014) (REF. 1, REF. 2).

Relatively high noise levels for a rural environment were monitored at all locations throughout the day, without significant variations between day time and night time. The results indicate that the average background noise level at Sanzule and Eikwe exceeded the EPA permissible day-time noise level of 55 dB(A) and night time level of 48 dB(A) for residential area, and the IFC limits of 55 dB(A) for day-time and 45 dB(A) for night time. Monitored levels at the eni Concession are below the EPA limit and IFC guidelines for industrial area (70 dB(A)).

The main contribution to the noise levels at Eikwe and Sanzule are reported to come from fishing activities (beach seine), which together with vehicle movements, occasional music and sea waves breaking at the beach were the main noise sources observed in the vicinity of the settlements.

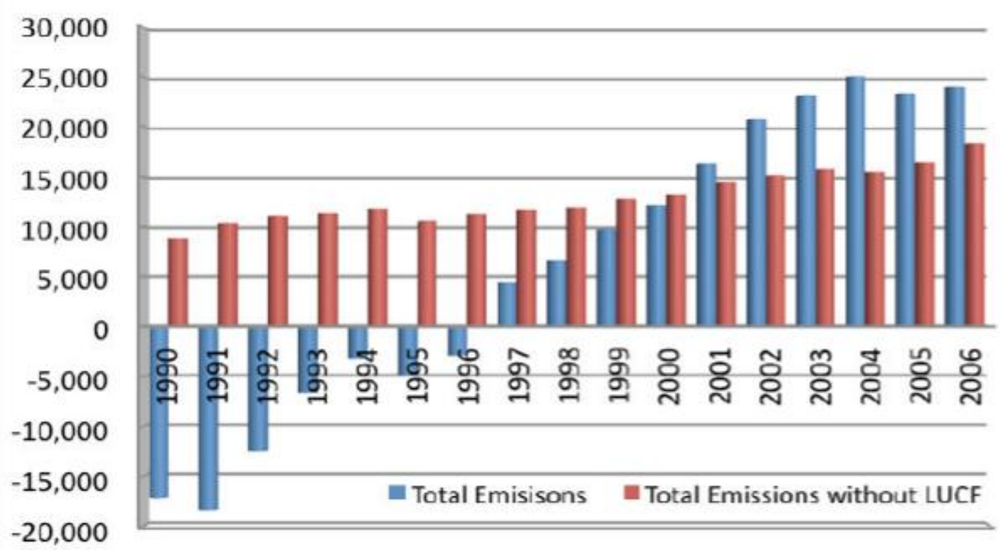
6.3.4 Ghana's National GHG Emissions

The latest available detailed inventory of Ghana's national GHG emissions is for the years 1990 - 2006. This inventory was published in 2011 by the Environmental Protection Agency and Ministry of Environment, Science and Technology (MEST) of Ghana as part of Ghana's Second National Communication to the UN Framework Convention on Climate Change (UNFCCC).

The Greenhouse Gas Inventory prepared by Ghana reports emissions by sources and removal by sinks for five major sectors, namely: energy, industrial processes, agriculture, land use change and forestry (LUCF), waste. The major gases covered include carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O) and perfluorocarbons.

In 2000, the total net greenhouse gas emissions (including LUCF emissions) in Ghana were estimated at 12.2 MtCO2e. This is 173% above the 1990 level of 16.8 MtCO2e, and 96% lower than 2008 level of 23.9 MtCO2e. The total net greenhouse gas emissions increased by 242.4% from 1990 to 2006. If emissions from LUCF are excluded in 200, the total GHG emission was estimated at 13.3 MtCO2e, which is about 49.4% above the 1990 level, and 38% lower than 2008 level. Without LUCF emissions, the total emissions increased by 107% from 1990 to 2006 (Figure 6.2).

Figure 6.2 Trend of total GHG emissions with/without LUCF (GgCO2e)



Source: Ghana's Second National Communication to the UNFCCC (2011).

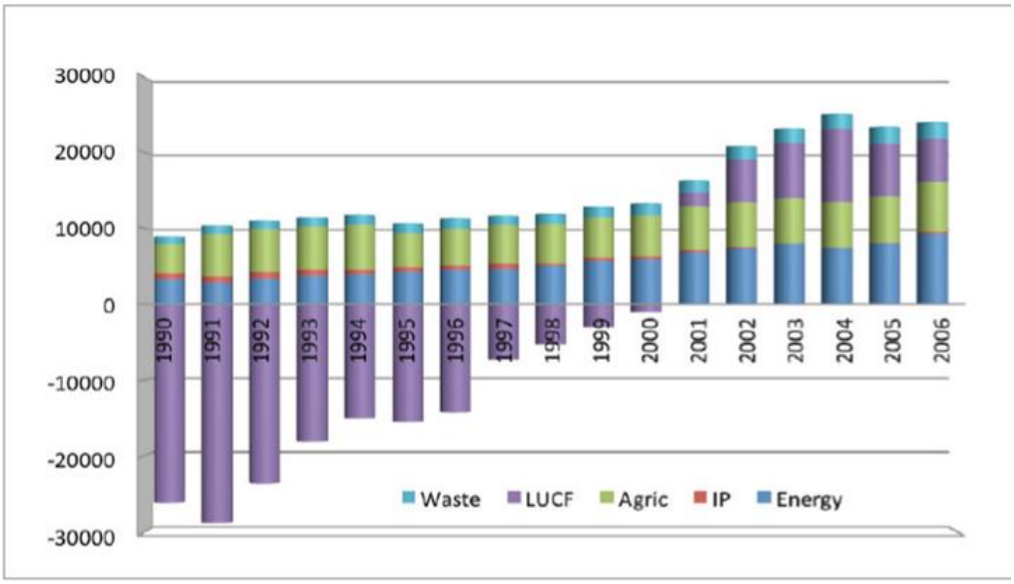
Ghana's emission represents about 0.05% of the total global emissions and is ranked 108 in the world, which represents a total per capita emission of nearly 1 tCO2e per person as of 2006. Though Ghana's emissions is lower than other major developing economies, the trends clearly indicated a strong growing potential in the near to medium term horizon as the economy continues to grow and expand development to new frontiers, dominated by agriculture, forestry and oil and gas industries.

As shown in Figure 6.3 the largest contribution to the total national emissions was the energy sector, accounting for 41%. Energy sector emissions increased by 32% above 1990 levels and declined marginally by 2% to 39% of the total emissions by 2006. Emissions from transport and residential categories were the largest emission sources within the energy sector. The general increase in emissions from the sector could be attributed to the increasing fuel consumption in the growing proportions of power generated from thermal sources, increasing fuel consumption and poor fuel efficiency in the road-transport category as well as rising biomass use in the residential sub-category.

The second largest contributor to total national emission was from the agricultural sector, amounting to approximately 38%. The general increasing trends of agricultural emissions of about 44.2% between 1990 and 2006 reflect increasing trends in livestock numbers and emissions from fertilizer application. Within the sector, emissions from agricultural soils, enteric fermentation and rice cultivation have had significant impacts on the general emission.

Emissions from the waste sector constituted an average of 10% between 2000 and 2006, which is approximately 8% higher than the 1990 levels is the third largest contributor to the national emissions. The main sources of emission from this sector are from disposal of solid waste on land (particularly, waste dump site) and wastewater handling. The sector emissions were driven by the increasing per capita solid waste generation among population especially in the urban areas of Ghana. Disposal of solid waste to land with relatively deeper depth and to sanitary landfill sites is increasingly becoming common practices in urban waste management. This provides suitable conditions for the production of methane, which is not managed in any way in Ghana.

Figure 6.3 Trend of total GHG emissions by sector (GgCO2e)



Source: Ghana's Second National Communication to the UNFCCC (2011).

In terms of reported greenhouse gas emissions, carbon dioxide was estimated at -23.9MtCO2e in 1990 to 2.6MtCO2e and 10.5MtCO2e in 2000 and 2006 respectively, including LUCF. Between 1990 and 1999, CO_2 emissions contributed to net removal by sink but experienced a steady inter-annual reduction at an average rate of 24% until 1999. Beyond 1999, net CO2 emissions increased up to 12.4MtCO2e in 2004 and decreased marginally to 10.5MtCO2e in 2006. This decease could be largely attributable to the net positive effect of the national afforestation programmes through the enhancement of forest biomass stocks. It similarly experienced steady increase between 1990 and 2006 but saw a slight reduction in 2004.

6.4 Onshore Geophysical and Chemical Component

6.4.1 Freshwater Resources

The Section describes freshwater resources in the Project area in terms of hydrogeology characteristics and water quality. Sampling and analysis of surface water sources was undertaken during the field surveys conducted in March and October 2014, at the locations reported in *Table 6.7* and *Figure 6.4*.

Table 6.7 Surface Water and Groundwater Monitoring Locations

Location	GPS Coordinates (latitude and longitude)	Parameters
Surface Water Sampling Locations (and sample ID)		
Amansuri Upstream (SW-AMA-UPP)	N 04° 59' 05.6" W 002° 26' 26.8"	• pH • Salinity • Temperature • Dissolved Oxygen (DO) • Biological Oxygen Demand (BOD5) • Turbidity • Conductivity • Total Dissolved Solids (TDS) • Chemical Oxygen Demand (COD) • Total Suspended Solids (TSS) • Silicate, Orthophosphate • Nitrate (Nitrogen) • Heavy metals (Pb, Hg, Cd, Cr, As, Zn, Cu, Mn and Fe) • Microbiology (total & faecal coliforms) • Zooplankton • Phytoplankton • Chlorophyll a • Oil and Grease • Total Petroleum Hydrocarbons (TPH)
Amansuri Mid 1 (SW-AMA-MID 1)	N 04° 57' 16.2" W 002° 25' 29.7"	
Amansuri Mid 2 (SW-AMA-MID 2)	N 04° 56' 49.1" W 002° 22' 32.1"	
Amansuri Downstream (SW-AMA-LOW)	N 04° 56' 36.4" W 002° 22' 58.2"	
Amansuri Pipeline (SW-AMA-PiP)	N 04° 58' 28.6" W 002°25'38.0"	
Groundwater Sampling Locations (1) (and sample ID)		
GW 1 (DOL 1)	N 04° 57' 54.8" W 002° 27' 17.9"	• pH • Salinity • Temperature • Dissolved Oxygen (DO) • Biological Oxygen Demand(BOD5) • Turbidity • Conductivity • Total Dissolved Solids (TDS) • Chemical Oxygen Demand (COD) • Total Suspended Solids (TSS) • Silicate • Orthophosphate • Nitrate (Nitrogen) • Heavy metals (Pb, Hg, Cd, Cr, As, Zn, Cu, Mn and Fe) • Microbiology (total & faecal coliforms) • Oil and Grease and Total Petroleum Hydrocarbons (TPH).
GW 2 (ENI 1)	N 04° 57' 38.6" W 002° 27' 07.8"	
GW 3 (AYI 1)	N 04°57'28.2" W 002°26'49.2"	
Bakanta (GW-BKT)	N 04°57'14.8" W 002°25'43.0"	
Eikwe (GW-EIK)	N 04°57'57.1" W 002°28'16.1"	
Baku (GW-BAKU)	N 04°58'16.2" W 002°30'09.8"	
Anochi (GW-ANOR)	N 04°58'40.1" W 002°31'13.9"	

(1) Please note that all groundwater samples were taken at mid-depth of each borehole to obtain a homogeneous sample representation of the area.

Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Water Quality Technical Report – Wet season (ESL Consulting, 2014).

See *Figure 6.4* for all sampling points for the dry and wet seasons.

Figure 6.4 Surface and groundwater sampling points

Source: ERM, 2015

Surface Water

Regional Hydrology

The Western Region of Ghana is characterised by the presence of many brackish and freshwater lagoons and wetlands in the low lying coastal areas due to the high level of annual rainfall (Aggrey-Fynn et al. 2011; Yankson 1999). These areas are particularly important as they serve as ecotones (ie, transition areas) between freshwater, marine and terrestrial environments, and as a result exhibit high species diversity and heterogeneous habitat types (Aggrey-Fynn et al, 2011 and Basset et al, 2006). These areas are typically surrounded by mangrove forests in coastal areas. An increasing number of these lagoon and wetland systems are becoming degraded due to the influence of anthropogenic activities (Aggrey-Fynn et al, 2011, Karikari et al 2006).

The largest rivers in the west of the country are the Ankobra, Bia and Pra Rivers, with the Tano River forming part of the Ghana's western border. In the Project AoI, the main watercourse is the Amansuri River which flows eastward from about 1.4 km northeast of the Project site until it enters the sea approximately 7 km east of the eni concession area.

Lagoons and Wetlands

There are a total of six designated Ramsar sites in Ghana (World Bank, 2006). These are all located in the Volta and Central Regions and far from the Project area. The largest lagoons in the region are the Domini Lagoon near Half Assini and the Amansuri Lagoon near Esiama, the latter being located about 4 km northwest of the western end of the optional onshore pipeline in Atuabo and within the Project AoI. The system of Tano, Aby and Ehy Lagoons on the southwestern border with Ivory Coast is located 36 km west of the Project AoI and is not discussed.

The Amansuri Lake, together with the low lying lands that surround it constitute the Amansuri wetland system, located to the north and northwest of the eni concessionand across the optional onshore pipeline ROW between the eni concession and the GNGC Gas Plant at Atuabo. The Amansuri wetland system is the largest freshwater marsh in the Western Region (approximately 8,000 ha), with a catchment of approximately 1,010 km^2 (Ramsar, 2012). The wetland area feeds into the Amansuri Lake (approximately 2.5 x 1 km in size) and finally (via the Amansuri River) into the Amansuri coastal lagoon (further to the east, at 7 km from Project site, close to the mouth of the river) (FAO, 2012). The Amansuri wetland system which receives water from several streams including the Adenimumio, Evini, Bosoke, Eivla and Myejini, drains to the east behind an elevated coastal area, which obstructs drainage seawards, and as indicated above is one of the reasons that allow the area to be seasonally flooded (Ramsar, 2012). Seasonally flooding occurs up to a depth of approximately 1 m in several zones within the Project AoI (Ramsar, 2012) particularly in areas along the optional pipeline ROW.

Both ephemeral and permanent ponds occur in the Project AoI within the general wetland area. These ponds host various freshwater fish species and are associated with fishing activities. The low lying grasslands associated with this wetland system are seasonally flooded during the wet season. These seasonally inundated areas lie within the AoI, and intersect the optional onshore pipeline ROW at some locations.

The Amansuri wetland system has been proposed as a wetland site(1) under the Convention on Wetlands of International Importance (known as the Ramsar convention). It has not been formally designated.

Surface Water Quality

Following is a summary of the results of the analysis of surface water samples taken during the field surveys.

Temperature, pH and Salinity

During the wet season an average of 27.0°C was recorded for the surface water samples taken. During the dry season the water sample temperatures were recorded at an average of 29.7 °C, ranging from 27.7 to 31.0°C. These temperatures are representative of a healthy tropical aquatic environment. Water temperature is influenced by ambient temperature, dissolved and suspended solids, turbidity and colour, the time of the day and the season. The average water temperature during the wet season was slightly lower than during the dry season, corresponding to the difference in air temperatures.

The pH measured during the wet season was almost neutral with an average of 6.85, ranging from 6.56 to 7.2. During the dry season the pH was slightly more acidic with an average of 6.63, ranging from 6.52 to 6.80. The recorded values were within the Ghana Water (GW) standard and suggesting a good quality aquatic environment as pH standard values indicated by EPA are between 6.5 and 9. pH values fall within the WHO standard of 6.5-8.5.

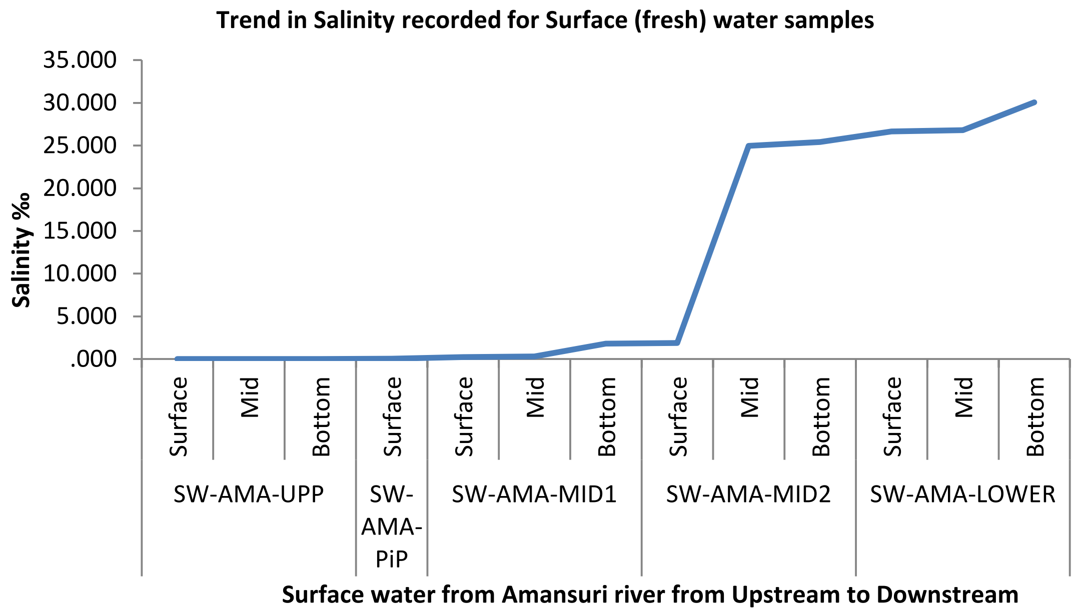
The salinity measured during the wet season showed a trend of gradual increase in the concentration of salts in the water from the Amansuri upstream (SW-AMA-UPP in the figure below) to the downstream (SW-AMA-LOWER in the figure below) with values ranging from 0.01 to 30.06‰. The salinity values recorded for the surface water downstream were high, and similar to that recorded for the marine water due to the estuarine environment where saline water from the ocean mixes with the freshwater from the river. During the dry season the salinity also gradually increased from the Amansuri upstream to the downstream with values ranging from 1.6 ‰ to 15.1 ‰. This increase can be graphically seen in *Figure 6.5*.

Electrical Conductivity

The average electrical conductivity during the wet season was 17,2 µS/cm for the Amanzuri River, ranging from 33 to 48,9 µS/cm. The elevated conductivity levels of nearshore seawater samples reflect the high levels of solutes (salt) associated with the sea water and estuarine waters as seen in the high salinity values downstream. During the dry season, the average electrical conductivity of the Amansuri River ranged from 3,7 to 27,0 µS/cm. Conductivity values obtained were in general lower for the wet season survey than on the dry season, with the exception of the eastuarine area which again had a very high level of salt concentration during the wet season.

(1) Named after the Ramsar Convention on Wetlands held in Ramsar, India in 1971

Figure 6.5 Salinity Trend (Wet Season)



Turbidity, Suspended & Dissolved Solids

Turbidity levels are influenced by suspended and colloidal materials including soil particles (clay, silt, and sand), algae, plankton, microbes, and other substances and are directly proportional to suspended and dissolved solids in water bodies. Turbidity measures the light scattering properties of water samples relative to a standard and may interfere with light penetration. High concentrations of TDS may affect taste adversely and deteriorate plumbing and appliances and there are WHO health-based limited for drinking water. The WHO and EPA have identified that TDS concentrations below 1000 mg/l are normally acceptable to consumers (WHO, 1996).

The average turbidity for wet season samples was 29.62 NTU and was higher than that of dry season (3.28 NTU) indicating the presence of organic particles from surface run-off from flooding and rains into water courses.

Total suspended solids (TSS) during the wet season ranged from 3 to 37 mg/L with an average of 18.20 mg/L for surface water samples, all below the EPA standard of 50 mg/l. During the dry season TSS were higher (possibly due to higher dust levels), and ranged from 1 to 79 mg/L with an average of 37.67 mg/l. The only sampling point exceeding the standard value was the Amansuri Midstream 2.

The total dissolved solids (TDS) recorded for surface water samples during the wet season ranged from 22.0 to 30,170 mg/l. During the dry season TDS levels were found to be lower at the points sampled, ranging from 2,197.0 to 16,230.0 mg/Land with a mean of 11,874.1 mg/L. Given that the quality guidance for TDS levels fixed by EPA and WHO is 1,000 mg/l, all the stations in the dry season, and the Midstream 2 and Downstream stations in the wet season presented poor water quality values in terms of dissolved solids.

Dissolved Oxygen, Biological Oxygen Demand and Chemical Oxygen Demand

Dissolved oxygen (DO) indicates the amount of oxygen available in water for aquatic organisms to use for respiration. Aerobic microbes need oxygen for multiplication and other cellular activities. In relatively stable conditions, comparison of dissolved oxygen values can be used as the basis for determining the flow rate of the water bodies under consideration. It has been established that fast flowing water bodies have high dissolved oxygen values. The amount of oxygen dissolved in water is influenced by temperature.

The average DO obtained from the wet season assessment was 5.52 mg/l with a range of 1.88 – 8.46 mg/l while the dry season average was lower at 2.73 mg/L with a range of 0.23 – 5.38 mg/L.

Biochemical Oxygen Demand (BOD) is the amount of oxygen required by bacteria while stabilizing decomposable organic matter under aerobic conditions and higher BOD levels indicate a degree of pollution of natural water bodies, domestic and industrial wastes. The average BOD_5 levels recorded during the wet season were 193.4 mg/l, ranging from 64 to 354 mg/L. During the dry season sampling, the average BOD_5 levels recorded an average BOD of 85.1 mg/l ranging from 78 to 95 mg/l. The recorded average indicates high levels of organic pollution and poor water quality on both season, as reflected by the fact that these values are higher than EPA's permissible limit (50 mg/l) for industrial discharge into natural water bodies.

The wet season average Chemical Oxygen Demand (COD) levels recorded for surface water samples was less than the detection limit of 5 mg/L. The dry season sampling showed an average COD level of 3881.3 mg/l ranging from 425 to 6,400 mg/l, indicating highly polluted waters on the dry season. This COD/BOD ratio is considered to be unusual and although a sampling or analytical error cannot be excluded or as a result of very high rainfall recorded in the project area during the wet season which might have led to very high dilution.

Nutrients (Phosphate, Nitrate and Silicates)

Phosphate occurs naturally in water, especially groundwater as a result of geological weathering. It also occurs from the agricultural use of mineral fertilizer and manure. Elevated concentrations of phosphate promote the growth of plants and algae leading to eutrophication (Pedersen, 1997). Studies have shown that natural waters have a phosphorus concentration of about 0.02 mg/l.

The average concentration of phosphate investigated during the wet season assessment was 0.92 mg/l, ranging from 0.06 to 4.0 mg/l which was higher than that of the dry season (0.22 mg/l). This could possibly be caused by surface run-off containing phosphate from fertilizer and soap from human activities in the area.

Nitrogen in the form of nitrate is an important nutrient for plant growth. However, in drinking water sources such as groundwater (boreholes and wells), nitrate is considered as a contaminant due to its harmful biological effects. High concentrations of nitrate in drinking water cause methemoglobinemia (the formation of methemoglobin; a form of hemoglobin that cannot release oxygen for body tissues), cited risk factor in developing gastric and intestinal cancers. A limit of 10 mg/litre is usually imposed on drinking water in order to prevent this disorder. The average nitrate concentration during the wet season for the surface water samples was 1.81 mg/l and ranged 1.2 to 2.5 mg/l, which was higher than the WHO guideline value of 0.2 mg/l for short-term. During the dry season water samples recorded an average of 9.60 mg/L and ranged from 5.6 to 13.7 mg/l. This is an indication of run-off from agricultural soils and other agro-chemicals as well as organic matter contaminating the water.

Silicates are those compounds which have a silicon-oxygen anion chemically combined with such metals as aluminum, calcium, magnesium, iron, potassium, sodium and others to form silicate salts. Water moving over and through natural deposits will dissolve a small amount of various silicate minerals, making silicates a common contaminant of most waters. Natural physical and chemical weathering processes also produce many extremely small particles or colloids of silicate minerals. Silicate causes algae to grow exponentially for a longer period of time and biomass increase can be directly related to an increase of silicate concentrations. Increased production in "trophic levels" of the food chain leads to increased primary production which can result in an increased zooplankton biomass (grazing on the algae) and increased fish biomass (feeding on zooplankton). The average concentration of silicates in the Amansuri surface water samples in the wet season were 16.3 mg/L and ranged 12.9 to 21.9 mg/l. During the dry season the average concentration of silicates in the Amansuri surface water samples was 1.4 mg/L and ranged 0.54 to 2.8 mg/l.

Heavy Metals

Heavy metals measured during the field surveys included cadmium (Cd), lead (Pb), copper (Cu), mercury (Hg), chromium (Cr), arsenic (As), zinc (Zn), manganese (Mn) and iron (Fe).

Human uptake of most trace metals occurs mainly through food and drinking water. Cd has significant effects on humans when it accumulates in the kidneys by interfering with filtering mechanisms. Lead is a toxic metal and can cause behavioral problems as well as learning disability. Although it occurs naturally, the WHO Guideline Limit for lead in drinking water is 10 µg/l and the USEPA fixes it at zero (0) indicating that there is no safe level of exposure to lead. Copper (WHO drinking water guideline limit of 2.0 µg /l,) is also found in natural deposits but exposure to excess copper in drinking water may result in liver and kidney damage.

Mercury (WHO drinking water guideline limit of 0.001 mg/l) is a liquid metal found in natural deposits such as ores. Mercury is used in dry cells and fluorescent light. Accumulation of mercury in the human body can lead to kidney damage. Water containing iron and manganese readily becomes turbid on exposure to oxygen making it unacceptable from an aesthetic point of view owing to the oxidation of iron to Fe (III) and manganese to Mn (IV). Iron and manganese in water interfere with laundering activities, impart objectionable stains to plumbing fixtures and support the growth of iron bacteria.

Arsenic (USEPA drinking water limit of 0.01 mg/L) is a semi-metal. It enters drinking water supplies from natural deposits in the earth or from agricultural and industrial sources and is commonly associated with mining activities.

The other metallic trace elements under consideration were chromium (Cr) and zinc (Zn). These metals naturally exist in oxides or ores. Chromium is essential for the functioning of some biological systems while Zn is useful in industrial metals. The analytical results indicate that the levels of Zn and Cr were below detection limits for surface water.

The concentrations of Cu, Cd, Cr and As in surface (fresh) water samples during the wet season were all below detection limit and within the WHO guideline value. The concentrations of Zn, Mn and Pb were within the WHO guideline limit of 3 mg/L, 0.40 mg/L and 0.001 mg/L respectively. The concentration of Hg ranged from <0.001 to 0.006 mg/L, thus the concentration of samples from Amansuri midpoint 2 (SW-AMA-MID2) with a value of 0.003 mg/L and Amansuri dowmstream (SW-AMA-LOW) with a value of 0.006 mg/L were above the WHO guideline limit. The source of Hg pollution remains unknown. Again the concentrations of Fe in all the surface water samples were well above the WHO guideline limit of 0.30 mg/L ranging from 1.52 to 2.86 mg/L.

During the dry season the average cadmium level was 0.32 ppb and ranged from 0.05 to 0.65 ppb. Pb levels had an average of 0.879 ppb ranging of 0.3282 to 1.7362 ppb all below the WHO acceptable limit of 10 ppb. The average copper level of 5.74 ppb for surface water samples was below the USEPA limit of 1.3 ppm and WHO level of 2 ppm. An average mercury level of 0.0042 ppb was recorded ranging from 0.0043 to 0.0085 ppb which is above the WHO acceptable level of 0.001 µg/L or 0.001 ppb. The concentration of iron in surface water had average of 0.37 mg/L which was higher than the Ghana and WHO Water Standard of 0.3 mg/L. On the contrary, the recorded averages for manganese were below the Ghana Water Standard limit of 0.04 mg/L. The average concentration of As in the dry season surface water samples was 23.13 µg/L with values ranging between 0 to 75 µg/L.

Table 6.8 Heavy Metal Concentration (surface water)

Sampling Location	Season	Cd	Pb	Cu	Hg	As	Fe	Zn	Cr	Mn
		µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	mg/l	mg/l
Amansuri Upstream	Dry	0.0536	0.9760	12.917	0.002	5	1.07	nd [1]	nd	0.54
	Wet	nd	nd	nd	nd	nd	1.72	0.042	nd	0.134
Amansuri Midstream 1	Dry	0.2442	1.7362	4.487	0.0085	0	0.214	nd	nd	0.005
	Wet	nd	0.012	nd	0.001	nd	1.79	.017	nd	0.02
Amansuri Midstream 2	Dry	0.65	0.3282	2.153	0.0004	12.5	0.127	0.02	nd	0.016
	Wet	nd	0.015	nd	0.003	nd	2.86	0.015	nd	0.019
Amansuri Downstream	Dry	0.342	0.47725	3.4206	0.002	75	0.076	nd	nd	0.013
	Wet	nd	nd	nd	0.006	nd	2.38	0.011	nd	nd
Amansuri Pipeline	Wet	nd	nd	nd	nd	nd	1.52	0.082	nd	nd
WHO Guideline		100	10	2 mg/l	0.001	-	0,3	3	-	0.4

A Water Management Plan will be developed together with a Water Risk Assessment in order to evaluate the quality of the water sources to be used and, in case of any criticalities in terms of heavy metals concentrations (e.g., high levels of Pb that may prove limiting for human supply), evaluate the best water supply option. In any case, water sources to be used will be pre-agreed with the local authorities.

(1) nd = not detected (i.e. below detection limits).

Total Petroleum Hydrocarbons (TPH) and Oil and Grease

There were no significant concentrations of TPH nor oil and grease detected in the samples analyses. All samples were below the detection limit (> 2ppm) in both the dry and wet seasons.

Microbiology

Sources of total and faecal coliform in surface water within the area of influence might include agricultural runoff, effluent from septic systems or sewage discharges and infiltration of domestic or wild animal fecal matter. Drinking water contaminated with these organisms can cause stomach and intestinal illness including diarrhea and nausea, and even lead to death. These effects may be more severe and possibly life threatening for babies, children, the elderly or people with immune deficiencies or other illnesses within the community. As a result, coliform bacteria are considered "indicator organisms"; their presence warns of the potential presence of disease causing organisms and the need to take a precautionary action.

Generally, there was a widespread load of total coliforms and faecal coliforms in water samples as well as E.coli and total heterotrophic bacteria. In terms of total and faecal coliforms, none of the water samples conformed to the WHO Guidelines and Ghana Standards GS 175-1 (2013) of zero (0) total and faecal coliform counts per 100 ml. This is probably due to the lack of water treatment facilities for the nearby communities. None of the surface water samples during the wet and dry seaon met the WHO Guideline for all the microbial parameters measured. *Table 6.9* shows the measured microbial levels for the wet season and

Table 6.10 the dry season.

Table 6.9 Bacteria Levels in the Wet Season (surface water)

Sample identification	Total coliform (TC) cfu/100ml	Faecal Coliform (FC) (cfu/100ml)	*E. coli* (cfu/ 100ml)	Total heterotrophic bacteria (cfu/ml)
SW-AMA-UPP	930	80	26	1404
SW-AMA-MD I	837	279	40	156
SW-AMA-MID2	1020	279	186	676
SW-AMA-LOW	1302	651	372	1092
SW-AMA-Pip	2790	225	125	780
Ghana Standards GS 175-1	**0**	**0**	**0**	**500**
WHO Guidelines	**0**	**0**	**0**	**-**

Table 6.10 Bacteria Levels in the Det Season (surface water)

SID	Total Coliform (cfu/100ml)	Faecal Coliform (cfu/100ml)
AMA UPSTREAM	2790	465
AMA MIDSTREAM 1	837	66

AMA MIDSTREAM 2	1209	2
AMA DOWNSTREAM	186	3
Ghana Standard	**0**	**0**
WHO Guideline	**0**	**0**

A Water Management Plan will be developed together with a Water Risk Assessment in order to evaluate the quality of the water sources to be used and, in case of any criticalities in terms of microbiology presence (e.g., high levels of Coliform and Faecal Coliform that may prove limiting for human supply), evaluate the best water supply option or a disinfection process prior to use. In any case, water sources to be used will be pre-agreed with the local authorities.

Chlorophyll a

Chlorophyll is the photosynthetic pigment that causes the green color in algae and plants. The concentration of chlorophyll present in water is directly related to the amount of phytoplankton living in the water. Chlorophyll is vital for photosynthesis, which allows plants to obtain energy from light. The average concentration of chlorophyll a in the surface water (Amansuri Rver) was 1.75 μg/l ranging from 1.22 to 1.90 μg/L which was lower than that recorded during the dry season assessment (average concentration of 44.56 μg/l). Lower levels of chlorophyll a suggest better water quality in terms of organic pollution and eutrophication.

Plankton

Zooplankton are useful bio-indicators of the physical and chemical conditions of aquatic environments. They can be abundant in freshwater and can be used as indicators of changes in water quality.

Fresh water plankton analysis showed a relatively small number of taxa with small numbers of individual zooplankton species (*Table 6.11*). Zooplankton species were obtained from three sampling points along the Amansuri River. These levels indicate a poor ecological health, possibly due to a recent pollution event. Due to the central role played by zooplankton in the trophic link between primary producers and higher trophic levels, they form an important part of the aquatic food web. Their low numbers in this waterbody may indicate the low productivity of the environment.

Table 6.11 Zooplankton Distribution in the Amansuri River

Plankton Species	SW1	MID 1	MID 2
Calanoids	2	4	0
Cyclopoids	4	6	0
Crustacea	2	0	0
Crustacean larvae	2	0	0
Cladocerans	6	0	2
Ostracod	2	0	0
Copepod nauplii	2	0	2

Phytoplankton diversity in the Amansuri river (SW1, MID1 and MID 2) was very low with a total species count of just four. This comprised two species of green algae and two species of diatoms (Table 6.12). *Nitzchia*, a diatom recorded at the station SW2 is a potential toxic species, known to produce a neurotoxin and this stream should be further monitored.

Table 6.12 Phytoplankton Distribution in the Amansuri River

Sample No: SW1	
Species	**No. of Individuals**
Ulothrix	10
Sample No: SW2	
Species	**No. of Individuals**
Nitzchia	14
Sample No: MID2	
Species	**Number of Individuals**
Scenedesmus	2
Ulothrix	1

Groundwater

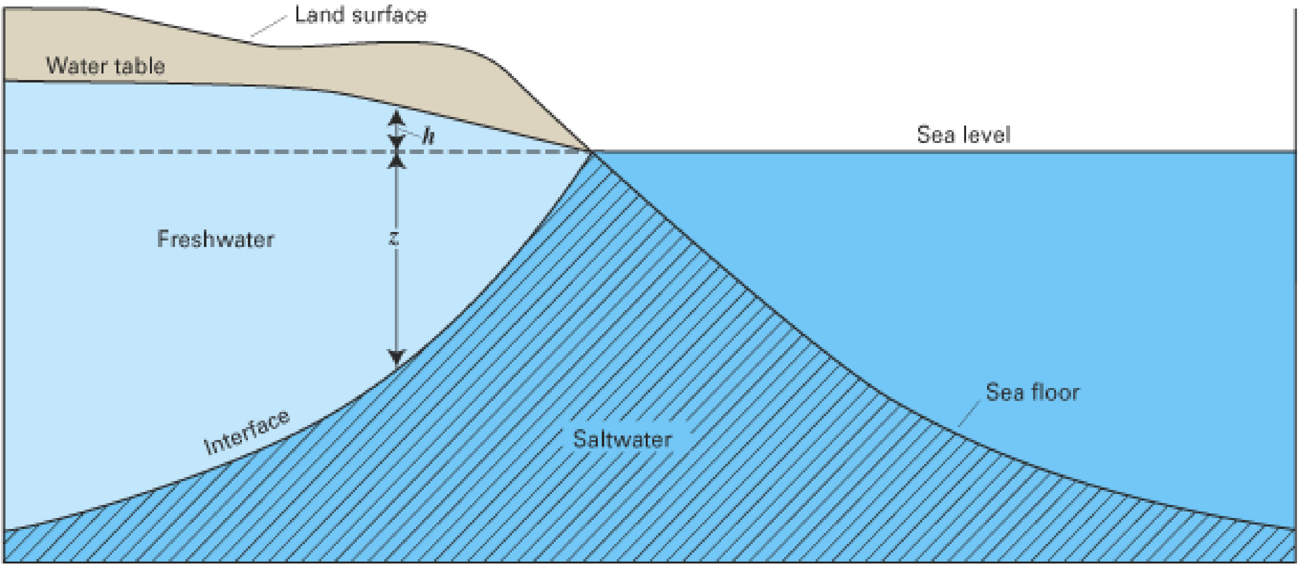
Regional Hydrogeology

Two main hydrogeological provinces are found within Ghana, namely the Basement Complex (consisting of Precambrian crystalline igneous and metamorphic rocks and covering 54% of Ghana) and Voltain Formation (a Paleozoic consolidated sedimentary formation and covering 45% of Ghana).

The remaining 1% percent of Ghana is covered by Cenozoic and Mesozoic sediments. The Project is situated in this region. There are three main aquifers, namely a shallow unconfined freshwater aquifer, a saltwater aquifer in the sandy layer and a deep freshwater aquifer.

Diagrammatically the upper two aquifers occur as depicted in *Figure 6.6*. The shallow aquifer is a sandy unconfined aquifer and occurs in the recent sands close to the coast. It is between 2 m and 4 m deep and contains fresh meteoric (ie, rain) water. The intermediate aquifer is either semi-confined or confined and occurs mainly in the Red Continental deposits of sandy clay and gravels. The depth of this aquifer varies from 6 m to 120 m, and it contains mostly saline water. The third aquifer is a deep limestone aquifer, which varies in depth between 120 m and 300 m. The groundwater in this aquifer occurs under artesian condition and is fresh.

Figure 6.6 Diagram Showing the Two Upper Aquifers along the Coast



Source: USGS, 2003

Recharge to the upper freshwater aquifer systems is mainly by direct infiltration of precipitation through fracture and fault zones and also through the sandy portions of the weathered zone. Some amount of recharge also occurs through seepage from ephemeral stream channels during the rainy seasons. The infiltration of saltwater occurs from the sea and there is an interface of the fresh water and saltwater at some depth, deeper away from the coast line but still generally shallow across the coastal strip.

Groundwater Quality

Following is a summary of the results of groundwater sampling and analysis conducted during the field surveys. Groundwater samples were taken from existing shallow wells which draw water from the sandy unconfined aquifer at depths estimated between 2 m and 4 m below ground level.

By comparing borehole position and distance to sea it can be deduced that water levels increase near the coast, from around 5 m bgl to about 2-3 m below ground level. Even more importantly, the groundwater table seems to be representing a confined water layer possibly recharged by upslope areas since after drilling the water levels steadily increased by at least 1-2 m.

A special case was borehole BH11E, near the coastline, probably on the dune sands belonging to the Fredericksburg and Krisin series, where water level found at 2.5 m depth rose to ground level after drilling. This show that in this area water recharge is able to provide a positive net water pressure that could represent the main source of seasonal flooding during the wet season.

Temperature, pH and Salinity

During the wet season the ambient air temperature recorded for groundwater ranged from 33.58 to 35.56 °C while water temperature ranged from 26.94 to 29.83 °C with averages of 34.71 and 28.065 °C respectively. During the dry season the average water temperature for groundwater was slightly higher at 29.73°C, ranging from 29.12 to 30.68°C.

The average pH of groundwater sources (boreholes and wells) sampled during the wet season was 6.77 indicating its neutrality, suitable for drinking and other domestic uses. The average pH ranged from 5.19 (GW 2A) to 8.21 (GW-3A – AYI1). The recorded values were within the Ghana Water (GW) standard (with the exception of ENI1 samples in both seasons), and just outside of the WHO guidelines for drinking water (6.5-8.5).

Salinity in the wet season samples revealed that the concentration of salts in the water was very low and ranged between 0.02 to 0.34 % with an average salinity of 0.13 %. During the dry season the salinity was also very low with concentrations of salts in the water ranging between 0.01 to 0.89 ppt with an average salinity of 0.31 ppt.

Electrical Conductivity

The United States Pharmacopeia (USP) states that the maximum permissible conductivity of drinking water at a pH of approximately 7, should be below 5.8 µS/cm (micro siemens per centimetre) (Drinking Water Standards, 2003). The average wet season electrical conductivity for groundwater samples recorded was 290 µS/cm ranging from 50 to 728 µS/cm, which is above these recommended values. The average electrical conductivity of groundwater sampled in the dry season from the Sanzule community was 673.33 µS/cm ranging from 32 to 1,924 µS/cm. Comparing the average conductivity obtained for the various water samples during the dry season to the wet season, it follows a usual trend of low values for the wet season assessment.

Turbidity, Suspended & Dissolved Solids

The average turbidity for the groundwater samples during the wet season assessment was 2.55 NTU. The average turbidity for groundwater obtained during the wet season assessment was higher than that of the dry season (0.95 NTU) indicating the intrusion of organic particles into the water sources.

Total suspended solids ranged from 0.00 to 51.75 mg/L with an average of 5.99 mg/L for the groundwater samples in the wet season and ranged from 1 to 33 mg/L with an average of 19.67mg/L for the dry season samples.

In terms of dissolved solids, an average of 180 mg/L was recorded for the groundwater samples analyzed with a range from 30 to 452 mg/L in the wet season and a mean of 335.11mg/L was recorded for the Sanzule groundwater samples with a range from 49.6 to 2,035.0 mg/L during the dry season, which is above the WHO and EPA recommended level of 1000 mg/l for drinking water normally acceptable to consumers (WHO, 1996).

Dissolved Oxygen, Biological Oxygen Demand and Chemical Oxygen Demand

The average DO of groundwater samples obtained from the wet season assessment was 4.59 mg/L ranging from 3.12 to 6.07mg/L. The average concentration of DO in all the water samples were higher than that recorded for the dry season assessment with an average DO of 3.95 mg/L.

The average wet season BOD_5 levels recorded for groundwater samples was 71.90mg/L, ranging from 22 to 129.2mg/L which is higher than the EPA's permissible limit (50 mg/L) for industrial discharge into natural water bodies and is an indication of organic matter contamination. The average BOD_5 levels recorded during the dry season was 85.87mg/L ranging from 75.2 to 94.6 mg/L which also exceeds the permissable limits.

Nutrients (Phosphate, Nitrate and Silicates)

The average concentration of phosphate in groundwater samples investigated during the wet season assessment was 0.14 mg/L ranging from 0.03 to 0.70 mg/L and an average of 0.297mg/L ranging from 0.18 to 0.49 mg/L during the dry season. Studies have shown that natural waters have a phosphorus concentration of about 0.02 parts per million (ppm). These measured levels thus show some level of impact on the groundwater in the area due to human activities in the area.

The average nitrate concentration for the groundwater samples in the wet season was 9.1 mg/L ranging from 3.5 to 17.0 mg/L. The average nitrate concentration for the Sanzule groundwater samples during the dry season was 20.63 mg/L, ranging from 7.4 to 45.0 mg/L.

Heavy Metals

The same set of heavy metals assessed for the surface water was again assessed for the groundwater samples. The metals include cadmium (Cd), lead (Pb), copper (Cu), mercury (Hg), chromium (Cr), arsenic (As), zinc (Zn), manganese (Mn) and iron (Fe).

For groundwater samples the concentrations of heavy metals were generally low with the concentrations of As, Cr, Cd and Cu all below detection limit and below the WHO guideline limits during both the wet and dry season sampling.

The concentrations of Pb recorded for GW1(A), GW2(A), GW3(A) and GW-BAKU(A) in the wet season had values above the WHO guideline of 0.010 mg/L (or 10 µg/l). The dry season sampling, on the other hand, revealed Pb levels below the guideline value with an average level of 0.552 µg/l, ranging from 0.067 to 0.978 µg/l.

The concentrations of iron (Fe) found in the groundwater sampled in the wet season were all within the WHO guideline value of 0.3 mg/l with the exception of GW-EIK (groundwater from Eikwe community) which had a high value (5.2 and 1.72mg/L). A dry season range of 0<0.01 to 0.05mg/L was recorded for Sanzule groundwater samples. Although the concentration of Fe in the DOL 1 sample (water from borehole at Charlotte Dolphyne School) was below detection limit, the overall average for iron was higher than the Ghana Water Standard of 0.3 mg/L, which is consistent with the high levels found naturally in the soils and sediments.

The concentration of manganese (Mn) found in the groundwater samples ranged from <0.005 to 0.115 mg/L during the wet season and from 0.016 – 0.022 mg/L (mean of 0.019 mg/L) fore the dry season, both of which are within the WHO guideline value of 0.40 mg/L.

The concentration of Zn ranged from <0.005 to 0.093 mg/L well below the WHO guideline value of 3.00 mg/L. In contrast, the concentration of mercury (Hg) in the wet season ranged from <0.001 to 0.008 mg/L with levels in GW1, GW2 and GW3 all in Sanzule community having Hg levels higher than the WHO guideline of 0.001 mg/L. Mercury levels in Baku and Eikwe were also higher than the WHO guideline limit see Figure 6.8.

Figure 6.7 Average concentration of Pb found in groundwater sources wet season

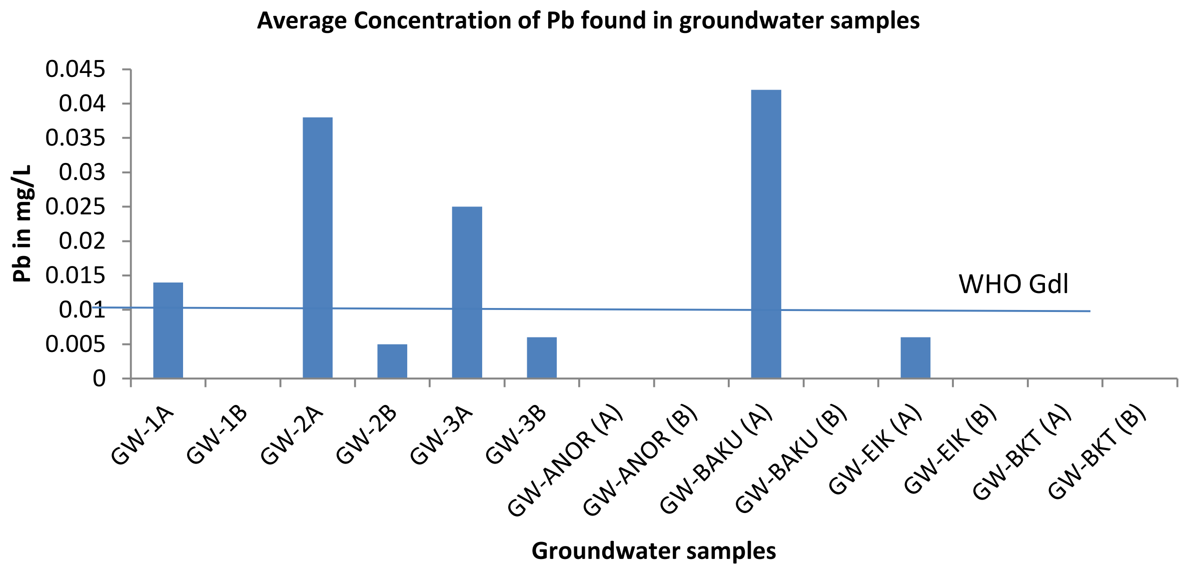
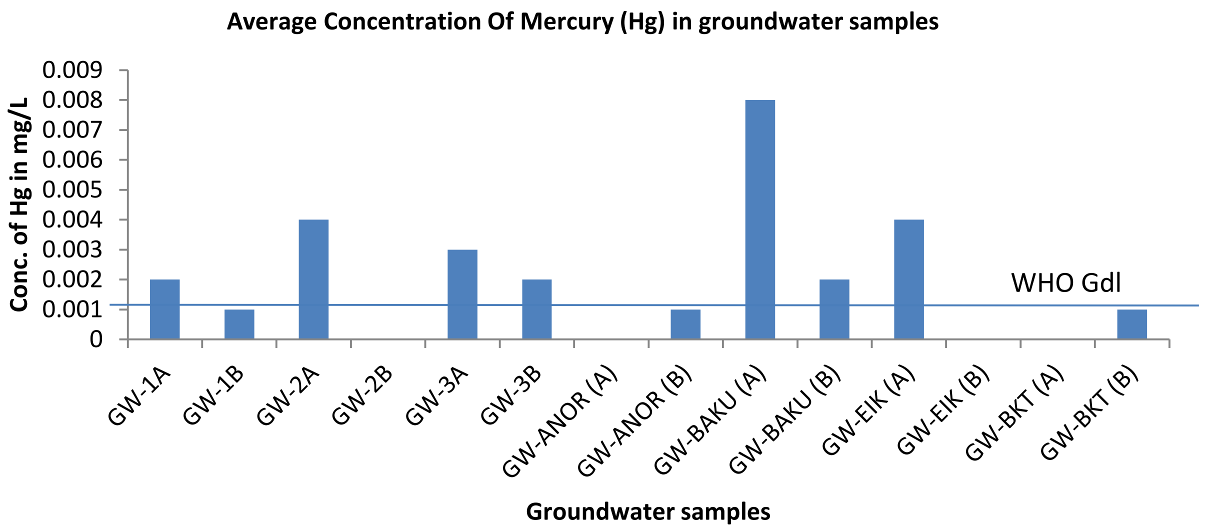


Figure 6.8 Average Concentration of Hg found in groundwater sources



The geotechnical and geophysical survey performedby Fugro reports values of 0,04 mg/l of lead in groundwater. The survey results suggest that high lead and mercury concentrations could have been originated from localised waste burning, mining activities to the north, or from the weathered and eroded Birimian geology., . The metals present in groundwater could have leached directly from the rock or the soil above.

Total Petroleum Hydrocarbons (TPH) and Oil & Grease

There was no significant concentrations of TPH nor oil and grease in either the dry or wet season. All groundwater samples recorded concentrations below detection limit of 2 ppm.

Microbiology

In terms of total and faecal coliforms, none of the water samples conformed to the WHO Guidelines and Ghana Standards GS 175-1 (2013) of zero (0) total and faecal coliform counts per 100 ml. In the wet season there was zero (0) cfu/100 ml of e.coli in GW (2) (same location as ENI1), groundwater from the borehole situated near the ENI Met station in Sanzule community. Groundwater soures from Anorkyi (GW-ANOR 1&2), Baku (GW-BAKU 1&2), Sanzule (GW1 &2) were all within the total heterotrophic bacteria Ghana Standards GS 175-1 of 500cfu/1ml. None of the other water samples met the WHO Guideline for all the microbial parameters measured. See *Table 6.13*.

During the dry season sampling (only three wells were sampled – Table 6.14) the results indicate a widespread load of coliforms in water samples with the exception of groundwater samples from DOL 1 (well from Charlotte Dolphyne School) which conformed with the WHO Guidelines and Ghana Standards GS 175-1 (2013) of zero (0) total and faecal coliform counts per 100 ml. However, none of the other water samples meet the WHO Guideline for all the microbial parameters measured. Water from the well in Sanzule (ENI 1), also the main drinking source for the Sanzule community, was found to contain low levels of total coliform (3) and zero (0) faecal coliform count per 100ml.

Sources of total and faecal coliform in groundwater within the project area might include agricultural runoff, effluent from septic systems or sewage discharges and infiltration of domestic or wild animal fecal matter. Poor well maintenance and construction of shallower wells could also increase the risk of bacteria and other harmful organisms getting into a well water supply. he presence of faecal coliform in groundwater bodies may indicates that the water may contain other harmful or disease causing organisms, including bacteria, viruses, or parasites. Drinking water contaminated with these organisms can cause stomach and intestinal illness including diarrhea and nausea, and even lead to death. These effects may be more severe and possibly life threatening for babies, children, the elderly or people with immune deficiencies or other illnesses within the community.

Table 6.13 Bacterial Levels in the Wet Season (groundwater)

Sample identification	Total coliform (TC) cfu/100ml	Faecal Coliform (FC) (cfu/100ml)	*E. coli* (cfu/ 100ml)	Total heterotrophic bacteria (cfu/ml)
GW-ANOR 1	651	465	372	208
GW-ANOR 2	644	444	366	250
GW-BKT1	1488	1023	558	780
GW-BKT 2	1488	1020	556	780
GW-2(A) (ENI1 site)	12	3	0	780
GW-2(B) (ENI1 site)	10	2	0	400
GW-1(A) (DOL1 site)	95	6	2	416
GW-1(B) (DOL1 site)	90	4	2	416
GW-BAKU1	460	24	17	364
GW-BAKU2	465	20	15	360
GW-EIK1	1860	837	186	1456
GW-EIK2	1873	840	190	1404

GW-3(A) (AYI1 site)	930	558	269	728
GW-3(B) (AYI1 site)	939	549	273	624
Ghana Standards GS 175-1	**0**	**0**	**0**	**500**
WHO Guidelines	**0**	**0**	**0**	**-**

Table 6.14 Bacteria Levels in the Dry Season (groundwater)

SID	Total Coliform (cfu/100ml)	Faecal Coliform (cfu/100ml)
DOL 1	0	0
ENI 1	3	0
AYI 1	1023	2
WHO Guidelines	**0**	**0**
Ghana Standard	**0**	**0**

6.4.2 Geology, Topography and Soils

Geology

In terms of geology, the Project is located in the southernmost part of the Ashanti volcanic belt. This coastal region of Ghana comprises primarily of hard granites, granodiorites, metamorphosed larva and pyroclastic rock. These formations would have been created during the Cretaceous period 135 million years ago. In some cases these coastal formations are covered by Ordovician, Silurian and Devonian sandstone and shale (HPI, 2009).The area has a comparatively prominent morphology, defined by northeast-southwest trending ranges of hill mostly underlain by volcanic rocks. The geology of southwestern Ghana is dominated by greenstone belts composed of mafic volcanic rocks and intervening basins typically consisting of fine-grained deep marine sediments metamorphosed at green schist facies. The sedimentary rocks of the Tano Basin, which includes the project area, are grouped together as "Apollonian System" of the lower Cretaceous, Mesozoic rocks. These rocks overlie a pre-Cambrian basement of metamorphic rocks known as the Birimian System. The Birimian rocks are schists, phyllites and greywackes.

The rocks of the project area comprises of limestone, marl, mudstone with intercalated sandy beds and may be divided as follows from older to younger in ascending succession:

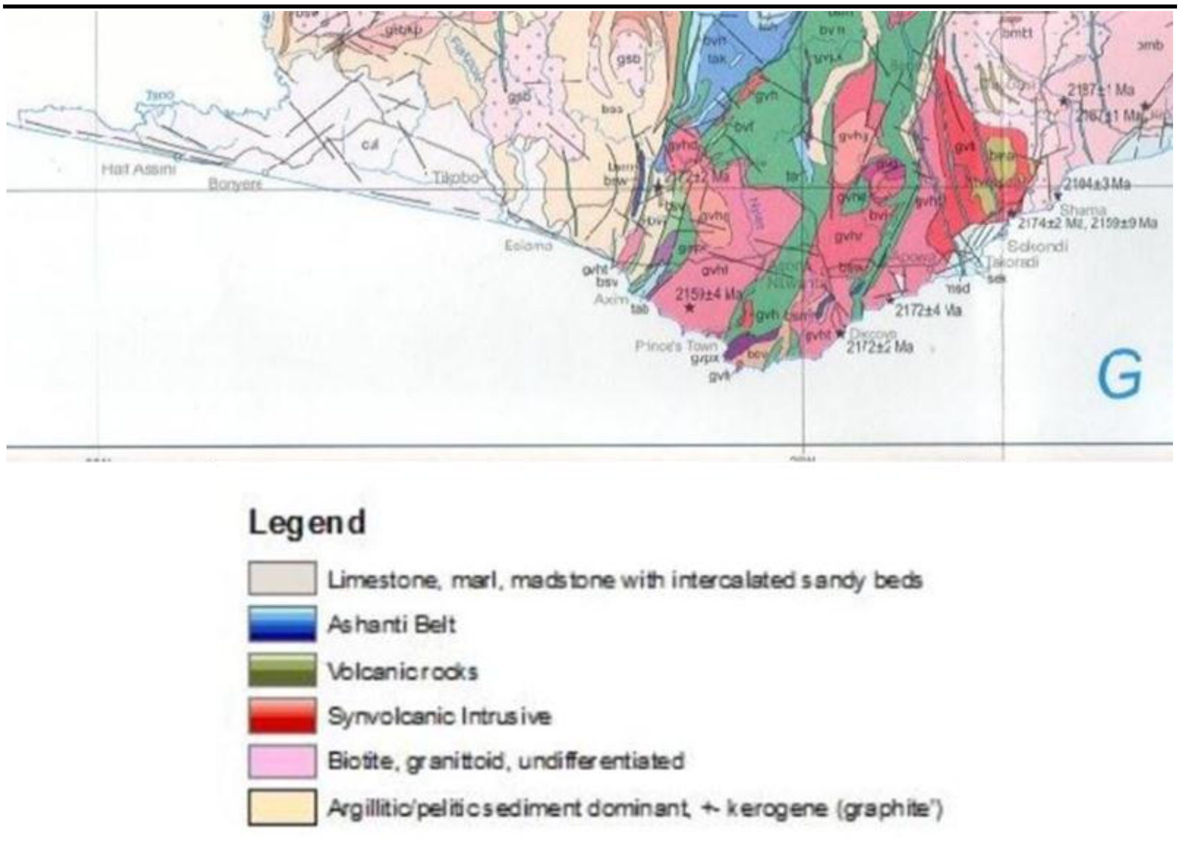
- Unit I: Beach deposits of loose sand with occasional layers of clays and shaly clays.
- Unit II: Nauli-type limestones with interbedded black-shaly clays.
- Unit III: Sandstones with minor shales.
- Unit IV: Conglomerates consisting of beds of pebbles and cobbles of igneous and metamorphic rocks firmly cemented with calcareous cement.
- Unit V: Sandstones with minor shales.
- Unit VI: Black carbonaceous shales. The unit is entirely composed of thin bedded black, carbonaceous shales which are separated from each other by much thinner layers of grey silt. The black shales are very rich in carbonaceous matter.

Higher ground in the region, which is considered to represent a deeply dissected peneplain, reaches elevations of 70-120 m above sea level and rises distinctly above the adjoining lower ground, which is frequently underlain by intrusive rocks and does not exceed 50 m in elevation. The terrain covered by basin sediments and Cretaceous rocks is very flat and swampy in most parts.

In terms of seismic activity, southern Ghana may experience significant earthquakes, though is not considered as a highly active area (HPI, 2009). The crustal evolution of coastal Ghana was characterised by the development of a series of spatially restricted shallow, mostly marine coastal basins roughly along a line running close to the present-day Ghanaian coastline during the Phanerozoic eon about 540 million years ago. The Phanerozoic constitutes the age of multicellular animal life on Earth. During this time micro- and multicellular organisms left a detailed fossil record, and built up complex and diverse ecosystems. The oil recently discovered is in the Phanerozoic coastal basins offshore.

Extensional coastal basin formation began as early as the Ordovician (Sekondian Group) and was followed by formation of basins represented by the Devonian (Accraian Group), the Upper Jurassic (Amisian Group) and the Upper Lower Cretaceous (Apollonian Group). Sedimentation in coastal basins continued as evidenced by Tertiary and Quaternary clastic sediments widespread in the Keta and Tano basins (*Figure 6.9*).

Figure 6.9 Geological map of southwestern Ghana



Source: Ghana Geological Survey Department, 2009

Topography

The onshore Project area is a flat area of low altitude (0-10 m) with very few headlands or rocky outcrops. The ground elevation increases from the sea for several meters within the beach up to around 4 m high when it decreases again below 2m high resulting on the generation of flat and low-lying area that occupies the central section of the ORF site. The higher grounds are located at the north-western most corner of the ORF site with 8.9 m elevation, while the site generally varies between 3.9 and 4.6 m.

In the general area, the coastal low lying areas extend inland for several kilometers. As a result little rock removal and little land levelling are expected for the development of the onshore Project facilities but there will need to be sandfilling of the site to elevate the area for the facilities.

Soils
Soil samples were analysed as part of the field survey. Samples were taken diagonally, in a northwest and southeast direction at three locations in the dry season and four locations in the wet season in and around the ORF site (Figure 6.10). An additional four samples were taken along the optional onshore pipeline RoW.

Soil Profiles

The soil samples collected at points ENI1, ENI2, ENI3 and ENI4 in the wet season survey were also analyzed to characterise the soil profile. The samples were described and classified following the World Reference Base (WRB) Classification System (FAO, 2006). Soils sampled from each horizon were analyzed at the Soil Research Institute, Accra Centre's Laboratory.

The results showed that soils at ENI1 (northwest corner of the proposed ORF site) are well drained and have largely been influenced by the cultivation of coconuts and oil palms. The classification according to FAO (2006) is Haplic-Xanthic Ferralsol.

At ENI2 sampling site the soil, like at ENI1 reflects the influence of the cultivation of coconuts and oil palms are, though in this case it is poorly drained. The classification according to FAO (2006) is Haplic-Gleyiic Fluvisol, which are considered to have developed on alluvial deposits.

Soil at ENI 3 location present also characteristics that evidence the influence of the cultivations in the area. They have been classified as Areni-Haplic Regosol (FAO, 2006), a well drained soil.

The soil in the vicinity of the cemetery (ENI4) correspond to Areni-Xanthic Ferralsol (FAO, 2006), which are moderately well drained. As in the other samples the soils at this location reflect the influence of the coconuts and oil palm cultivations.

Figure 6.10 Soil sampling locations (wet and dry season)

Figure 6.11 Soil Profiles at ENI2 and ENI4 Locations

Source: ESL, 2014

<u>Grain Size</u>

The wet and dry season results show consistent distribution of grain-sizes (sand, silt and clay) throughout the project area (

Table 6.15). The soil texture was predominantly sandy across all the sites and is therefore well drained. The grain size distribution in all the soil samples follow a similar sequence of sand> clay>silt. The silt and clay fractions were marginal in most of the samples. None of the soil samples had a fine grained size fraction (silt and clay) greater than 12%. The dominance of sand fractions within the project area reflect the generally low trace metal concentrations.

The distribution of grain-sizes throughout the pipeline RoW depicted a similar pattern to the results from the wet and dry seasons. The sediment texture was mainly sandy across all the sites and is well drained. The grain size distribution in all the sediment and soil samples follow a similar sequence of sand> clay>silt. The silt and clay fractions were marginal in most of the samples and none of the soil samples had a fine grained size fraction (silt and clay) greater than 16%.

Table 6.15 Soils Grain Size Distribution

Sample ID	Sand %	Silt %	Clay %
Dry Season			
ENI 1	87	8	5
ENI 2	95	5	0
ENI 3	95	5	0
Wet Season 2014			
ENI 1	85.01	12.5	2.49
ENI 2	93.91	6.09	0
ENI 3	95.26	4.74	0
ENI 4	96.36	3.64	0
Wet Season 2015 (pipeline RoW)			
Sanzule-S1 (0-15 cm)	83.56	14.44	2
Sanzule-S1(15-30 cm)	82.28	15.22	2.5
Eikwe-S1 (0-15 cm)	91.72	8.28	0
Eikwe-S1 (15-30 cm)	96.42	2.55	1
Eikwe-S2 (0-15 cm)	95.69	4.31	0
Eikwe-S2 (15-30 cm)	95.27	3.73	1
Eikwe-S3 (0-15 cm)	97.34	2.666	0
Eikwe-S3 (15-30 cm)	97.34	2.66	0

Heavy Metals

Heavy metals were assessed for all sample and results show a general variation in levels of trace metals concentrations in the soil samples. Average metals levels decreased in the following sequence Ni>Zn>Fe>Cr>Cu>Pb>Hg>Cd>As. According to the sequence, the levels of nickel, zinc, chromium and iron in the soil were relatively high. Considering the absence of known anthropogenic sources of metal pollution in the area, it is considered likely that elevated values may reflect local geological conditions.

The results of the analysis of soil samples for heavy metals is summarised in Table 6.16.

Table 6.16 Heavy Metals in Soils

Location	Cd	Pb	Cu	Hg	As	Nickel	Fe	Zn	Cr
	mg/kg	mg/kg	mg/kg	µg/kg	µg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Dry Season									
ENI 1	0.026	0.059	0.344	0.5	12	65.81	8.333	0.833	0.8
ENI 2	0.036	0.059	0.2	1.04	1.4	37.49	8.312	0.833	1.2
ENI 3	0.036	0.187	0.8	0.229	11.5	44.98	8.312	<0.001	0.9
Wet Season 2014									
ENI 1	0.0001	0.0616	0.3349	0.0055	0.029	96.95	0.50	1.40	1.22
ENI 2	0.0300	0.0690	0.0836	0.0026	0.006	97.99	9.40	0.99	1.35
ENI 3	0.0188	0.1075	0.0081	0.0035	0.000	95.76	9.48	13.97	6.31
ENI 4	0.0039	0.1660	0.0010	0.1126	0.007	86.00	0.50	260.00	4.52
Wet Season 2015 (pipeline RoW)									
Sanzule-S1 (0-15 cm)	<0.001	<0.001	374	4.97	1600	3.61	40	192	540
Sanzule-S1(15-30 cm)	<0.001	<0.001	278	3.75	1600	2.27	30	232	640
Eikwe-S1 (0-15 cm)	<0.001	<0.001	356	4.23	<0.001	2.49	20	192	800
Eikwe-S1 (15-30 cm)	<0.001	<0.001	270	3.65	<0.001	2.89	<0.001	220	440
Eikwe-S2 (0-15 cm)	<0.001	<0.001	260	4.35	<0.001	3.49	<0.001	176	720
Eikwe-S2 (15-30 cm)	<0.001	<0.001	288	3.67	<0.001	2.96	10	160	420
Eikwe-S3 (0-15 cm)	<0.001	<0.001	388	3.85	<0.001	2.75	10	236	720
Eikwe-S3 (15-30 cm)	<0.001	<0.001	384	1.05	<0.001	2.17	<0.001	268	460

- **Nickel.** Both dry season (mean concentration was 30.155 mg/kg with a minimum of 4.17 mg/kg and a maximum of 65.81 mg/kg) and wet season (94.18 ± 5.53 mg/kg) results show that nickel was the most abundant of all the metals analyzed throughout the study area. The highest and lowest nickel values recorded for the soil samples were observed for the samples obtained from the Midpoint and Near Cemetery respectively. Samples along the pipeline RoW in comparison had quite low levels of nickel with soil samples from Sanzule recording, relatively, the highest mean Ni concentration value of 2.94 ± 0.95 mg/kg. Nickel concentrations in all the samples were found to be below the recommended limit of 100 mg/kg by the EPA/ROC (1989).

- **Zinc.** Wet season zinc (Zn) levels for the soil samples were 69.09 ± 127.42 mg/kg. Zinc levels along the RoW were high with concentrations ranging from 160.0 to 268.0 mg/kg. In general, Zn concentrations decreased with increasing sampling depth. All the samples analysed in this study had zinc levels higher than the EPA/ROC (1989) permitted critical level of 80 mg/kg in dry soils.

- **Iron.** With regard to iron (Fe) concentrations, it was observed that the soil samples had a wet season mean of 4.97 ± 5.16 mg/kg which is consistent with the dry season results. The results of the wet season study also show that the the maximum and minimum iron values were recorded for samples obtained from the South East and North West locations respectively. The RoW soil samples from Sanzule had relatively the highest Fe concentrations, ranging between 30 and 40 mg/kg with a mean value of 35 mg/kg. The maximum iron level recorded for the Eikwe samples was observed at Eikwe-S1 with 50% of the soil samples from Eikwe having iron levels below detection limit (<0.001 mg/kg).

- **Copper.** Copper (Cu) and its compounds are naturally occuring. The wet season results show that soil copper levels within the project area vary from 0.001 to 0.33 mg/kg, with maximum and minimum copper concentrations recorded from the northwest of the site (0.33 mg/kg) and Near Cemetery (0.01 mg/kg) respectively. A mean copper concentration value of 0.11 ± 0.16 mg/kg was reported for the soil samples. The RoW soil copper levels ranged from 260.0 to 388.0 mg/kg with mean values of 326.0 ± 67.88 mg/kg and 324.33 ± 58.36 mg/kg reported for samples from Sanzule and Eikwe respectively. For the soil samples from Eikwe, those obtained from Eikwe-S3 and Eikwe-S2 sampling locations recorded relatively the highest and lowest copper levels respectively. Mean copper concentration observed for the Eikwe sediments was 270.5 ± 9.14 mg/kg. Copper levels in all the samples analysed in this study were above the suggested critical level of 100 mg/kg by the EPA/ROC (1989).

- **Lead.** The wet season soil samples recorded a mean value of 0.10 (± 0.05 respectively) mg/kg of lead (Pb), similar to the one from the dry season. The maximum values in both sampling seasons were recorded at ENI3 site, located south east of the proposed Project site and at ENI4 (only wet season) close to a existing cemetery. The minimum lead values were recorded for the sample at the North West corner of the site. Pb levels along the ROW were below laboratory detection limit of 0.001mg/l, suggesting that lead levels were either very low or non-existent in the area.

- **Cadmium**. Cadmium (Cd) concentrations throughout the project area were relatively low with concentrations less than 0.05 mg/kg, likely to be indicative of local geology. This was found to be in line with the previous study results conducted during the dry season in April 2014. Mean cadmium levels for the soil samples were 0.01 ± 0.01 mg/kg. Cd levels along the ROW were below laboratory detection limit of 0.001mg/l, suggesting that cadmium levels were either very low or non-existent in the area. Cadmium in soils is derived from natural and anthropogenic sources. Low levels of human exposure over a prolonged period result in high blood pressure, sterility among males, kidney damage and flu-like disorders (Sawyer et al., 2003). Higher concentrations in the human body are reported to cause a disease known as "Itai-Itai", characterised by brittle bones and intense pain. The use of cadmium-containing fertilizers and sewage sludge is most often quoted as the primary reason for the elevated cadmium content of soils.

- **Arsenic.** Arsenic has been implicated for a number of human disorders including skin pigmentation, hardening and cancers, bladder, lung and kidney disorders, peripheral vascular diseases, ischemic heart diseases, liver damage and diabetes mellitus (Sawyer et al., 2003). Levels of As from samples from Eikwe also recorded levels which were below the detection limit of 0.001ug/kg. However the soil samples from Sanzule recorded As concentrations of 1600 µg/kg. Arsenic is mainly released into ground and surface water systems, as well as geological environment from mine wastes, including mine tailings, waste rock and slag due to their solubility and mobility. Although not verified, it is possible that these levels are as a result of gold mining activities upstream from the sampling sites, which could be the reason for the higher than expected levels of arsenic in the soils at Sanzule. Twogold mines are located in the Tarkwa area, 50 km to the northeast of the Project site; another mine located in proximity of Bomoakpole is approximately 13.5 km far from the Project site and 8.5 km north of the Amansuri River. The differences between Sanzule and Eikwe reading may be as a result of Sanzule's location downstream from Eikwe and closer to any stream and surface-flow from the Tarkwa area.

Figure 6.12 Soil and Surface Water Sediment Sampling Locations

- **Mercury.** Similar to the dry season study results, mercury (Hg) concentrations in the wet season were low in the project area. The maximum mercury values recorded for the study area were observed from the Near Cemetery which was consistent with the dry season study, recording a mean value of 0.03 ± 0.05 µg/kg. Mercury levels in soil samples along the RoW from Sanzule and Eikwe, however, ranged between 3.75 - 4.97 µg/kg and 1.05 - 4.35 µg/kg respectively indicataing higher levels. Maximum Hg concentration values reported for soil samples from Eikwe were recorded at Eikwe S2 at depth 0 - 15 cm.

- **Chromium.** Wet season chromium (Cr) levels in the soil samples ranged from 1.22 to 6.31 mg/kg with a mean value of 3.35 ± 2.49 mg/kg. Dry season chromium levels ranged from 0.8 to 1.2 mg/kg. Soil samples from the North West recorded relatively the lowest chromium concentration value for the study area. Along the RoW chromium was the most abundant of all the metals analysed. Chromium concentrations for the Eikwe soils ranged from 420.0 to 800.0 mg/kg with a mean value of 593.33 ± 170.96 mg/kg fromn Eikwe and 590.0 ± 70.71 mg/kg from Sanzule. Chromium levels recorded for all the samples analysed in this study extremely exceeded the EPA/ROC (1989) suggested critical chromium level of 16 mg/kg in dry soils. These levels are considered to have its origin on anthropogenic activity, due to previous works (heavy trucks, earth moving machines, etc.) carried out in the area, though its origin remains unclear.

<u>Oil and Grease and Total Petroleum Hydrocarbons (TPH)</u>

TPH's include hexane, jet fuels, mineral oils, benzene, toluene, xylenes and naphthalene as well as other petroleum products and gasoline components. Humans are exposed to TPH through breathing air at gasoline stations, using chemicals at home or work, using certain pesticides, and drinking water contaminated with TPH. Exposure to some chemicals that comprise TPH can cause cancers and other non-cancer related diseases.

Oil & grease and TPH levels in all the soil samples taken during the wet season were below detection limit (<0.02 ppm) (

Table 6.17), suggesting an uncontaminated site. The previous study in the dry season reported oil and grease values ranging from 0 - 21 ppm. Concentrations of oil and grease and TPH in the RoW soil samples were low, ranging <2 to 7 mg/kg with mean value of 7mg/kg. About a third of the soil samples had oil and grease levels below the detection limit. Apart from those samples below detection limit, all the soil sampling locations recorded the same oil and grease concentration value of 7 mg/kg.

None of the soil samples from the RoW sampling locations detected TPH except for one sample from Eikwe-S3 which recorded a TPH level of 7 mg/kg. The non-detection of TPH in the soil samples is consistent with the wet season study results of October 2014 conducted for other sampling locations within the eni onshore concession. TPH values varied from 18 – 28 ppm during the previous study in the dry season.

Table 6.17 Oil and Grease, TPH, and TOC in Soils

Sample ID	Oil & Grease	TPH	Total Organic Carbon
	mg/kg	mg/kg	%
Dry Season			
ENI 1	0	0	0.17
ENI 2	7	18	2.16
ENI 3	21	21	1.44
Wet Season 2014			
	ppm	ppm	%
ENI 1	<2	<2	0.52
ENI 2	<2	<2	0.71
ENI 3	<2	<2	1.12
ENI 4	<2	<2	2.02
Wet Season 2015 (pipeline RoW)			
Sanzule-S1 (0-15 cm)	<2	<2	0.82
Sanzule-S1(15-30 cm)	7	<2	0.6
Eikwe-S1 (0-15 cm)	7	<2	2.78
Eikwe-S1 (15-30 cm)	7	<2	0.49
Eikwe-S2 (0-15 cm)	<2	<2	1.05
Eikwe-S2 (15-30 cm)	7	<2	0.32
Eikwe-S3 (0-15 cm)	<2	<2	0.86

Total Organic Carbons

Total organic carbon (TOC) is the carbon stored in soil organic matter. It serves as the main source of energy and nutrients for soil microorganisms influencing many soil characteristic including colour, nutrient holding capacity and stability, which in turn influence water relations, aeration and workability.

TOC levels recorded for the soil samples ranged from 0.52 – 2.02% during the wet season and.0.17 – 2.16 % during the dry season which is consistsent with a largely undisturbed enviroment.

TOC levels recorded for the RoW sampling locations was found to decrease with increasing depth. TOC levels for the soil samples showed that the highest and lowest TOC levels were observed at Eikwe-S1 and Eikwe-S3 respectively. Eikwe-S1 (0.96%) recorded relatively the highest mean TOC level followed by Sanzule-S1 (0.71%).

Polycyclic Aromatic Hydrocarbons

Polycyclic Aromatic Hydrocarbons (PAHs) are a class of persistent organic pollutants containing two or more fused benzene rings. Soils samples were analysed for 14 PAHs: naphthalene, acenaphtylene, acenaphthene, fluorene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(a)pyrene, indeno(123-cd)pyrene, dibenz(a,h)anthracene and benzo(g,h,i) perylene.

The results obtained from the dry and wet season surveys revealed PAHs concentrations below detection limit (<0.001 mg/kg) throughout the study area suggesting essentially an uncontaminated site. The apparent absence of PAHS in the study area is reflective of the rural nature of the area with no major industrial sites.

Similar to the study results of April 2014 and October 2014, the results of the 2015 wet season RoW sampling indicate PAH concentrations below detection limit (<0.001 mg/kg) throughout the study area indicating essentially an uncontaminated site.

6.4.3 Surface Water Sediments

Sediment samples were taken from the bed of the Amansuri river at four (4) locations from downstream towards upstream and were analysed for a number of chemical and physical parameters.

Heavy Metals

Heavy metals concentrations of each sediment sampling site are summarized in

Table 6.18. The results show a general variation in levels of trace metals concentrations in the sediment. Average metals levels decreased in the following sequence Ni>Zn>Cr>Fe>Cu>Pb>As>Cd>Hg for the Amansuri sediments. According to the sequence, the levels of nickel, zinc, chromium and iron in the sediments were relatively high, possibly reflecting the natural rock composition in the area.

Table 6.18 Heavy Metals in Surface Water Sediments

Sample ID	Pb	Hg	Cd	Cu	Ni	Zn	Fe	Cr	As
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/kg
Wet Season									
Ama Upstream	0.2239	0.0056	0.0139	0.3018	85.69	17.04	9.25	5.43	0.026
Ama Midstream 1	0.0537	0.0053	0.0150	0.3664	126.45	2.37	0.49	2.74	0.011
Ama Midstream 2	0.0568	0.0046	0.0441	0.2345	224.44	4.19	6.48	3.01	0.235
Ama Downstream	0.0647	0.0049	0.0114	0.0152	48.52	4.75	4.46	9.92	0.077
Dry Season									
Ama Upstream	0.087	0.008	0.021	0.91	6.66	3.67	7.497	1.3	500
Ama Midstream 1	0.09	0.043	0.0495	0.815	21.66	0.666	7.983	0.8	0
Ama Midstream 2	0.08	0.015	0.019	0.49	59.14	2.499	14.99	0.9	500
Ama Downstream	0.096	0.003	0.045	1.5	46.65	1.332	8.33	1	5000

- **Nickel.** Similar to the results for the dry season, nickel (Ni) was the most abundant of the metals analyzed throughout the study area in the wet season. The maximum (224.44 mg/kg) and minimum (48.52 mg/kg) nickel values observed throughout the project area were recorded for Amansuri midstream 2 and Amansuri-Low sediments respectively with a mean nickel concentration recorded for the Amansuri sediments of 121.27 ± 75.78 mg/kg. The nickel levels were, however, significantly lower in the sediment during the dry season surveys with a minimum of 6.66 mg/kg upstream and maximum of 59.14 mg'kg in the midstream area.

- **Zinc**. The highest zinc (Zn) level recorded for the Amansuri sediments in the wet season was observed for the samples from the Amansuri upstream (17.04 mg/kg) and the lowest was observed for the Amansuri Midstream 1 (2.37 mg/kg) with a mean zinc value recorded for the Amansuri sediments of 17.04 ± 6.71 mg/kg. The dry season showed relatively lower zinc levels with a maximum of 3.67 mg/kg at Amansuri Upstream and a minimum of 0.666 mg/kg at Midstream 1.

- **Iron**. The wet season mean iron (Fe) concentrations in the Amansuri sediments were 5.17 ± 3.69 mg/kg. This is consistent with the previous study results conducted in the dry season in April 2014 where the mean iron value was 8.20 mg/kg and ranged from <0.001 to 14.99 mg/kg. The results of the wet season study also show that samples from the Amansuri Upstream and Midstream 1 had highest and lowest iron concentration values respectively.

- **Copper**. Copper (Cu) and its compounds are naturally occurring and are mainly found in rocks. The results show that mean Cu concentration reported for the Amansuri sediments

(0.23 ± 0.15 mg/kg) was relatively high and was consistent with the previous dry season results. Thus, reflecting the importance of sediments as sinks/reservoir for a variety of pollutants such as heavy metals. The maximum and minimum copper concentration values recorded for the Amansuri sediments were observed for the Amansuri Midstream 1 and Amansuri Low respectively.

- **Lead**. The highest lead (Pb) concentrations recorded within the project area were observed for the Amansuri upstream (0.22 mg/kg). Lead concentrations recorded within the project area in the dry season study ranged from 0.017mg/kg to 0.187mg/kg with mean of 0.088 mg/kg with the highest concentrations Downstream.

- **Arsenic**. Arsenic (As) levels for the Amansuri sediments sampled in the wet season ranged from 0.01 – 0.24 μg /kg with a mean of 0.09 ± 0.10 mg/kg). The Amansuri Midstream 2 recorded the highest arsenic level in the project area, which is consitent with the levels recorded within the surface water samples. The dry season study results reported arsenic levels ranging from 0 to 5 mg/kg and are considered high. These high levels could be caused by mining activities in the region.

- **Cadmium**. Cadmium (Cd) concentrations throughout the project area were relatively low with concentrations less than 0.05 mg/kg, likely to be indicative of local geology. This was found to be in line with the results conducted during the dry season study. Mean Cd levels for the Amansuri sediments were 0.02 ± 0.02 mg/kg. The maximum cadmium value of 0.044 mg/kg observed for the project area was recorded at the Amansuri Midstream 2. The previous study in the dry season recorded relatively high cadmium levels at the Amansuri midstream section at Bakanta.

- **Mercury**. Similar to the results from the dry season study, mercury (Hg) concentrations were generally low in the project area. Mercury concentrations recorded in the wet season for the Amansuri sediments ranged from 0.005 – 0.006 mg/kg with the Amansuri Upstream and Amansuri downstream recording the maximum and minimum values for the Amansuri sediments respectively. In the dry season Amansuri Midstream 1 recorded the highest levels of mercury (0.043 mg/kg) with the Amansuri Downstream having the lowest levels of mercury (0.003 mg/kg).

- **Chromium**. During the wet season sampling the Amansuri downstream sediment sample recorded the highest chromium (Cr) concentration (9.92 mg/kg) with the Amansuri Midstream 1 having the lowest levels of chromium (2.74 mg/kg) showing an average value of 5.28 ± 3.32 mg/kg for the whole samples. During the dry season sampling the Amansuri Upstream had the highest concentration of chromium (1.3 mg/kg) and the Amansuri Midstream 1 had the lowest concentrations (0.8 mg/kg).Chromium is a naturally occurring element found in rocks, animals, plants, soil, and in volcanic dust and gases.

Oil and Grease, Total Petroleum hydrocarbons (TPH), and Total Organic carbon (TOC)

Oil & grease and TPH levels in all the sediment samples were below detection limit (<0.02 ppm) on both survey seasons, suggesting an uncontaminated site. The only exception was the sample taken at Midstream 1 site at the Amansuri River in the dry season with 7 ppm of oil & grease.

TOC levels reported for the Amansuri sediments ranged from 0.24 -4.2% in the wet season and 0.13 – 1.55% in the dry season. The Amansuri Midstream 1 (4.2%) recorded the highest TOC level in the project area (*Table 6.19*).

Table 6.19 ***Oil and Grease, TPH, and TOC in Surface Water Sediments***

Sample ID	**Oil & Grease**	**TPH**	**Total Organic Carbon**
	ppm	**ppm**	**%**
Wet Season			
Ama Upstream	<2	<2	3.2
Ama Midstream 1	<2	<2	4.2
Ama Midstream 2	<2	<2	0.54
Ama Downstream	<2	<2	0.24
Dry season			
Ama Upstream	0	0	1.41
Ama Midstream 1	7	0	1.55
Ama Midstream 2	0	0	0.64
Ama Downstream	0	0	0.13

Polycyclic Aromatic Hydrocarbons

The results of the analysis of PAH concentration in sediments in both seasons were below detection limit (<0.001 mg/kg) throughout the study area indicating essentially an uncontaminated site. The apparent absence of PAHS in the study area is reflective of the rural nature of the area with no major industrial sites in the vicinity or upstream.

Grain Size

The dry and wet season sampling results (Table 6.20) were consistent with the largest proportion of the sediment consisting of sand, thus resulting in a well drained site. The grain size distribution in all the sediment samples followed a similar sequence of sand>silt > clay. The silt and clay fractions were marginal in most of the samples, except for the Amansuri Midstream 2 sediments which recorded a silt fraction of 39.51%, none of the sediment and soil samples had a fine grained size fraction (silt and clay) greater than 15%. The Amansuri Upstream, Midstream 1 sediments and the Amansuri downstream sediments had a relatively high sand fraction greater than 95%. The dominance of sand fractions within the project area reflects the general low trace metal concentrations.

Table 6.20 Surface Water Sediment Grain Size Distribution

Sample ID	Sand %	Silt %	Clay %
Wet Season			
Ama Upstream	95.88	14.12	0
Ama Midstream 1	98.41	1.59	0
Ama Midstream 2	52.99	39.51	7.5
Ama Downstream	97.02	2.98	0
Dry Season			
Ama Upstream	93	5	2
Ama Midstream 1	93	5	2
Ama Midstream 2	86	13	0
Ama Downstream	94	5	1

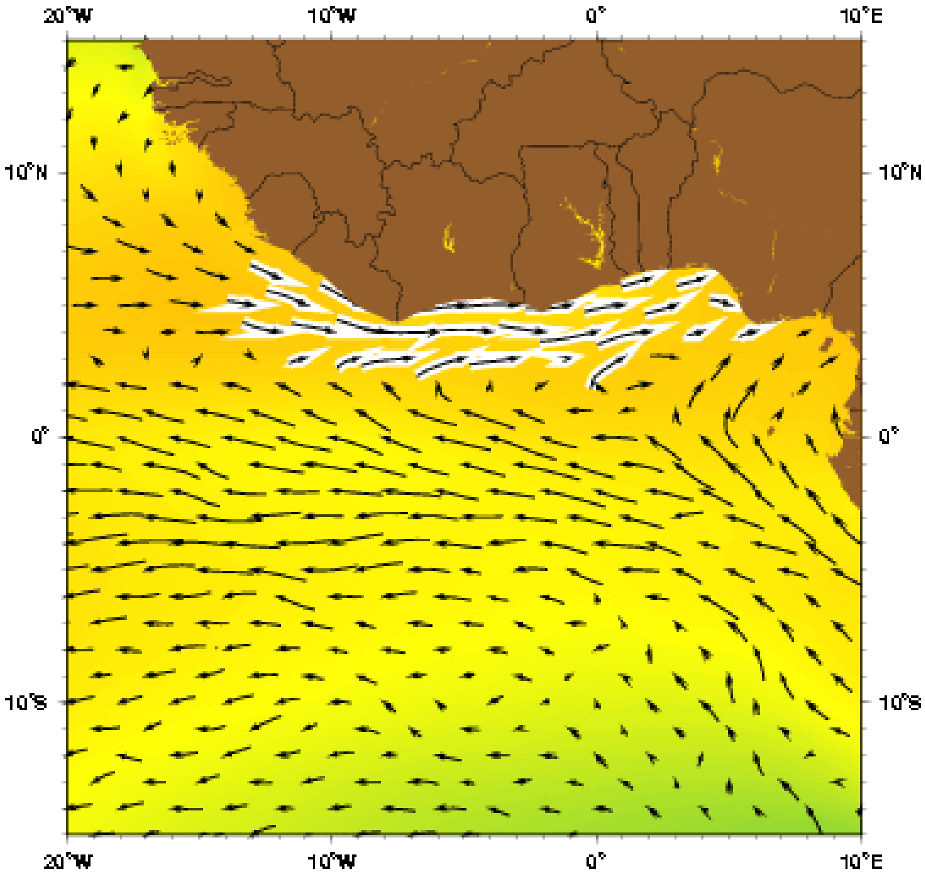
6.4.4 Oceans Seas and Coasts

The coastal and marine environment of West Africa has been classified into three Large Marine Ecosystems (LMEs) based on oceanographic conditions. According to the definition provided by Binet and Marchal (1993), the Project AoI lies within the Gulf of Guinea LME which occurs between the Bijagos Islands (Guinea-Bissau, ~11º N) and Cape Lopez (Gabon, ~1º S).

Currents

Water circulation in offshore Ghana is dominated by an eastward superficial flow known as the Guinea Current that runs parallel to the coast from Senegal to Nigeria. This current is the result of the oceanic gyral currents of the North and South Atlantic Oceans (Fontaine et al., 1999; Merle and Arnault, 1985). The interaction of the gyral current creates a counter-current flowing eastward known as the North Equatorial Counter Current (NECC). This feeds the Guinea Current off the Liberian coast (Hardman-Mountford, 2000). The current is shallow with an average depth of 15m near the coast and 25m offshore (Binet and Marchal 1993).

Figure 6.13 The Guinea current as represented by the Mariano Global Surface Velocity Analysis (MGSVA)



Note: Guinea current corresponds to the arrows highlighted in white. Increased length of arrows indicates higher current velocities.

Source: http://oceancurrents.rsmas.miami.edu/

The location of the Guinea Current remains fairly constant throughout the year, though its strength varies as it is generally reinforced by the monsoon winds. As a result the current reaches its maximum strength between May and July with peaks of 2 knots (1m/s).

Generally on coastal areas the current is attenuated and slightly modified on its direction by local coastal currents, winds and topography, resulting on a less persistent current nearer to shore. Near the coast the currents are predominantly wind-driven and present at a reduced size (a layer of approximately 10-40 m in diameter).

A small westward flowing counter current lies beneath the Guinea Current. Below 40 m depth this westward flow reaches velocities between 0.5 m/s to 1.0 m/s with speed generally reduced towards the bottom.

Water Masses

Water masses offshore the Ghanaian coast are formed by five principal layers (Longhurst, 1962). The topmost layer is the Tropical Surface Water (TSW), characterised by variable salinity and warm temperatures, which extends down to the thermocline, up to a maximum of about 45 m. Below the thermocline the South Atlantic Central Water (SACW) is found up to 700 m deep and presents cooler waters and high salinity values. Below the SACW there are three consecutive cold layers, namely the Antarctic Deep Water (ADP, 700-1,500 m depth), the North Atlantic Deep Water (NADP, 1,500-3,500 m) and the Antarctic Bottom Water (ABW, 3,500-3,800).

Upwelling

An upwelling event occurs when cold, nutrient-rich, sub-thermocline water rises to the surface from depth, leading to an increase in nutrient availability and associated increase in biological productivity. These events influence fish migration patterns and fish catches.

The coasts of Ghana are characterised by the existence of two periods of upwelling each year. The major upwelling occurs throughout the long cold season (June to October). The minor upwelling lasts for about 3 weeks and generally coincides with the short cold season (January to February), although it has been known to occur anytime between December and March (Roy 1995, Koranteng 1998). The two upwelling seasons are characterised by decreasing sea surface temperature (SST), typically <25°C, increasing salinity and decreasing dissolved oxygen.

The rest of the year the sea is characterised by a strong stratification and the presence of a thermocline.

Tides and Waves

The tides in the Guinea Gulf and specifically in the coasts of Ghana are regular and semi-diurnal of two almost equal high tides and two low tides each day. The average range of tides increases from west to east.

Existing data (Noble-Denton, 2008) indicates that tidal ranges at Takoradi vary between 0.58 and 1.22 m. These values could result in an additional increase of 0.3 m as a result of squalls or other processes such as the transfer of energy from internal to surface tides. The tidal currents are low and are understood to have insignificant influences on coastal processes except within tidal inlets.

Waves reaching the shores of Ghana consist of swells originating from the oceanic area around the Antarctica Continent and seas generated by locally occurring winds (Noble-Denton, 2008). Wave heights are generally between 0.9 m and 1.4 m and rarely greater than 2.5 m or more. Occasionally, during swells, the wave amplitude may increase to five or six meters, though the periodicity of such events is about 10 to 20 years. The swell wave direction is almost always from the south or south-west.

6.4.5 Bathymetry

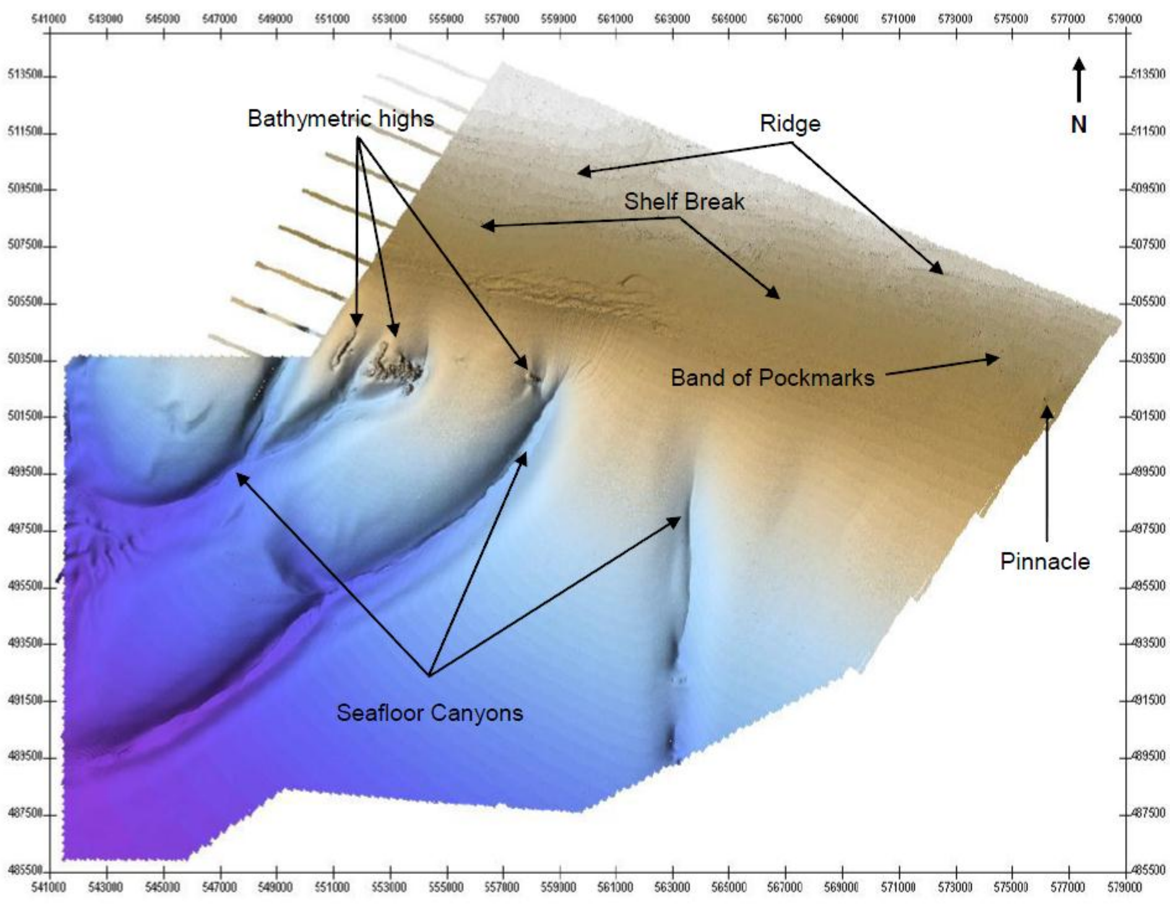
The continental shelf off the coast of the Western Region of Ghana is 20 km wide on its western section on the border with Ivory Coast and widest (90 km) off Takoradi. It is about 40 km wide in the Project area.

The bathymetry of the Project area is characterised by water depths that range from a minimum of 0 m in the north at the landfall location to a maximum of 1,390 m in the south-west part.

The shelf slopes gently with an average gradient of 0.5° up to the 175 m depth and is followed by the steep continental slope where depths increase sharply up to 300 m depth with a gradient between 7º and 10º. Finally, in waters deeper than 300 m the slope gradients are moderate at an average of 2º until it reaches approximately 1,500 m at the deepest part of the slope.

Superimposed on this surface are a profusion of topographic features, including complex canyon systems, sedimentary mounds, scour features and high standing knolls. Seabed dips reach values in excess of 40° on the flanks of some of these features and exceed 14° over large areas (*Figure 6.14*).

Figure 6.14 Bathymetry in the Project Area



Source: Fugro (2013)

Please note: For orientation, the area covers from about 100 mbsl and proposed wells are located towards the bottom and centre of the figure. The offshore pipeline route passes between the two eastern canyons. Please note that the scour features are not visible on this figure (due to scale).

Seafloor Geomorphology and Hazards

A series of geophysical surveys along the offshore section of Project were carried out in 2013 (Fugro, 2014a), including seismic reflection surveys, assessment of seabed features, geohazard core logging and geomorphological mapping of the seafloor, by means of Multibeam Echo Sounder (MBES). According to these studies and based on distinct geological character and seafloor morphology five different soil provinces have been defined as follows (Figure 6.15).

- **Soil Province 1: Continental Shelf.** This portion covers the continental shelf from the landfall area (150 m north of the coastline) to the shelf edge at roughly 125 m water depth. The coastal section hosts newer sediments that are getting older toward the shelf break, typically consisting of very loose to medium dense sand or very soft clay with locally sand layers. The seafloor here is reasonably smooth and featureless from the coastline to about 1.5 km offshore, as measured along the export pipeline route. From 1.5 km offshore, the seafloor displays a more irregular character, with localised areas of seafloor scour, ribbons of fine to coarse sand and areas of coarse rippled sand. There are outcrops of competent strata with small ridges whose height does not exceed 3 m and isolated small depressions of 30 m in diameter in the southern parts. The seafloor slope ranges in general from 0.2° to 0.7°. At the seafloor outcrops and ridges, slopes may be as high as 5° to 10°.

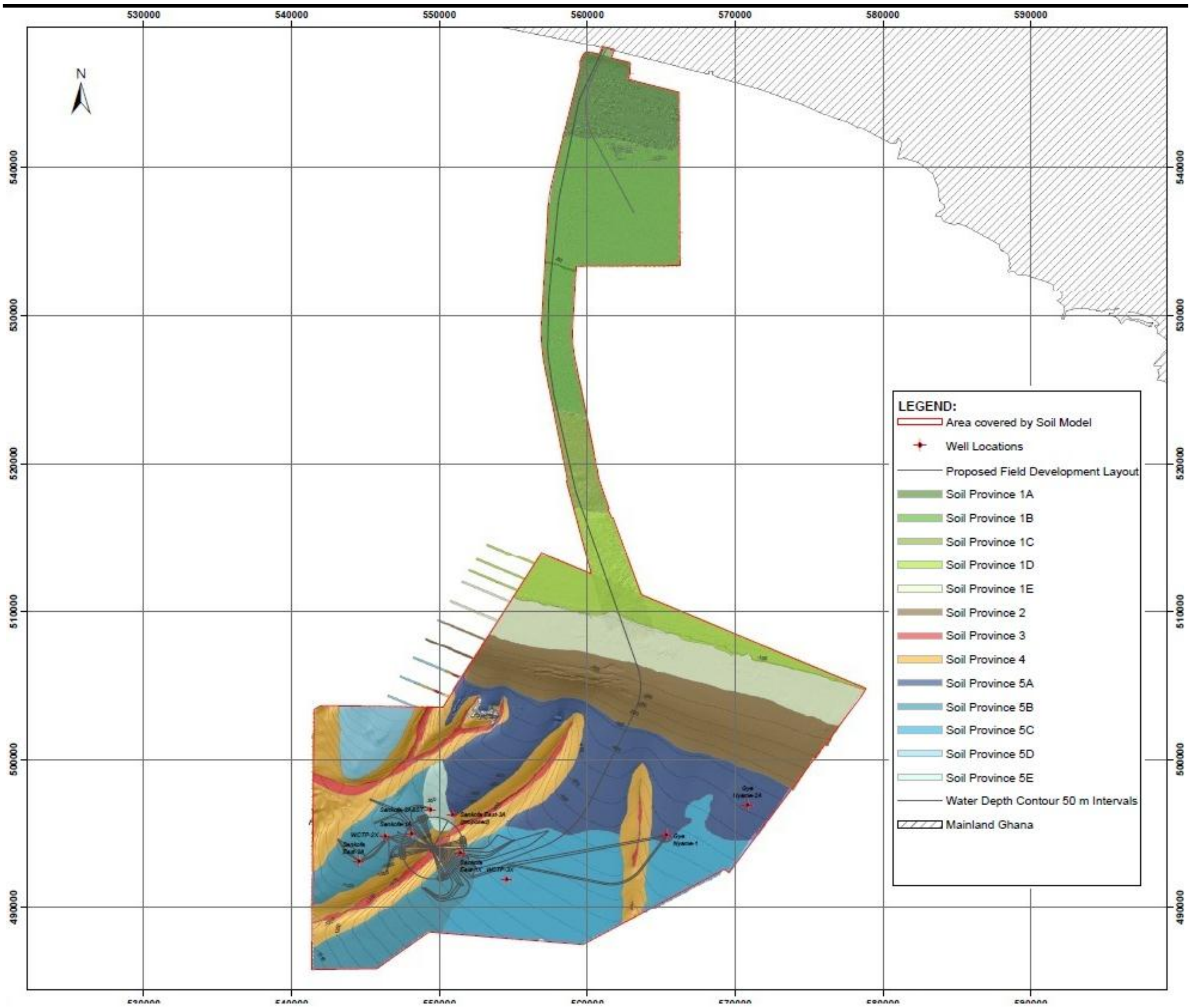
- **Soil Province 2: Shelf Break.** This area covers the transition from continental shelf to continental slope, between water depths of 125 m at its northern boundary and 325 m to 350 m at its southern boundary. The seafloor in this soil province is generally smooth though locally rough and textured, where bottom currents eroded the surficial sediments down to approximately 10 m below the surrounding unaffected seafloor. The area of this intensive seafloor scour is located to the west of the proposed gas export pipeline route. Seafloor slope ranges on average from 2° to approximately 6°. In areas highly affected by scour, slopes are up to 14º.

- **Soil Province 3: Canyons.** This area constitutes one of the main morphological features of the upper continental slope where three submarine canyons are located. Two canyons are located in the western part of the Project area. The soil province coincides roughly with the bases of the canyons. The heads of the canyons are in water depths ranging from approximately 400 m to 500 m and the canyons extend southwards beyond the Project area in water depths exceeding 1350 m. One of the planned intrafield flowline routes crosses the eastern canyon area. A number of geohazard locations are present within these canyons. Seafloor topography is variable from smooth and featureless where a canyon base is wide and more irregular where a canyon's base is narrower. Average seafloor slope in the canyons ranges between 1° and 4°.

- **Soil Province 4: Flanks.** These are present as elongated, lenticular-shaped areas following the axis of the three canyons in the Project area. The soil province coincides roughly with the slopes of the submarine canyons. It is present in water depths from approximately 400 m to beyond the southern limit of the Project area. Intrafield flowlines, the FPSO and deep water structures will be located along this type of seabed.

- **Soil Province 5: Broad Seafloor.** This area covers parts of the continental slope between large submarine canyons and flanks. The borders are delineated in the north by the steepest part of the continental slope, roughly situated between the 325 m and 350 m isobaths at the boundary with shelf break. The broad seafloor expands to the southern edges of the Project area where the maximum water depth is approximately 1350 m. The seafloor is generally smooth except for areas of seafloor scour, where seafloor is rougher and textured. The seafloor is mostly affected by scour in areas with water depth less than 500 m. In these areas the surficial sediments were locally eroded by bottom currents down to approximately 1 m below seafloor. Drilling rig anchor scars are present in the vicinity of existing wells. Seafloor depressions with diameters of 20 m to 30 m and up to 1 m deep are also present. Seafloor slope ranges on average from approximately 1° to 4°, though it may reach 10º in depths around 700-900 m.

Figure 6.15 Soil Provinces in the Project area



Source: Fugro (2014a)

In addition to the different areas, features and characteristics of the seafloor recorded in the Project area are presented below, including associated geohazards.

Table 6.21 presents a summary of observed hazards.

- **Seafloor Outcrops:** These occur as distinct ridges of pronounced seafloor topography present on the continental shelf. These are considered to be ridges composed of competent material or rock that may have been affected by marine processes (eg, wave action, near-seafloor currents, chemical/ biological activity) exposing more erosion resistant material. Some of these outcrops are crossed by the proposed offshore pipeline and may affect pipeline trenching operations and lead to wear of trenching equipment. Thus, several intervention works will be necessary to manage pipeline stress. Such works will be carried out mostly before the pipeline is laid by levelling portions of outcrops that are unsuitable for pipeline laying. In some cases, post trenching works with the same purpose will be carried out after pipeline laying.

- **Seafloor Knolls**: Three large seafloor knoll areas occur at the head of the western canyon of the Project area in water depths ranging between 375 m and 500 m and are associated with irregular surface topography with slopes that may exceed 40°. The planned subsea infrastructure (ie, the export pipeline) is more than 4 km away from any of the seafloor knolls.

- **Contourite Deposits**: They are sediments deposited by or significantly affected by the action of bottom currents generally in water depths in excess of 300 m (Stow et al., 2002). Where bottom current velocities are large enough, they may erode, transport and deposit sediments, especially of the clay fraction size. They have been identified along the eastern flanks of the central and western canyons.

- **Slope Failure Deposits:** An area of localised shallow slope failures was identified within the western most part of shelf break and buried slope failure deposits were identified in the canyons. No tension cracks (which may hint at future slope failures) are evident but future slope failures cannot be excluded.

- **Seafloor Scours:** Evidence for seafloor scour and sediment transport as a result of near-seafloor currents is present on the continental shelf and the upper continental slope. Extreme scour has also been identified related to the central canyon. Structures installed on the seafloor, including pipelines and flowlines may obstruct near-seafloor currents causing turbulence around the structures and current velocities may locally increase and result in increased scour at the base of the structures.

- **Potential Liquefaction:** This may occur on the continental shelf only along the export pipeline route. Locally, the shallow seabed sediments comprise layers (thickness in excess of approximately 1 m) of very loose to medium dense sand. These strata may be susceptible to liquefaction under wave action and events such as earthquakes.

- **Debris Flows:** Although currently covered by hemipelagic sediments, turbidity currents and debris flows have occurred in the geological past. There is no direct evidence that turbidity currents and debris flows are active under the present geological conditions (ie, sea level high stand, with little sediment transport from the continental shelf to the continental slope).

Table 6.21 Summary of Subsea Geohazards

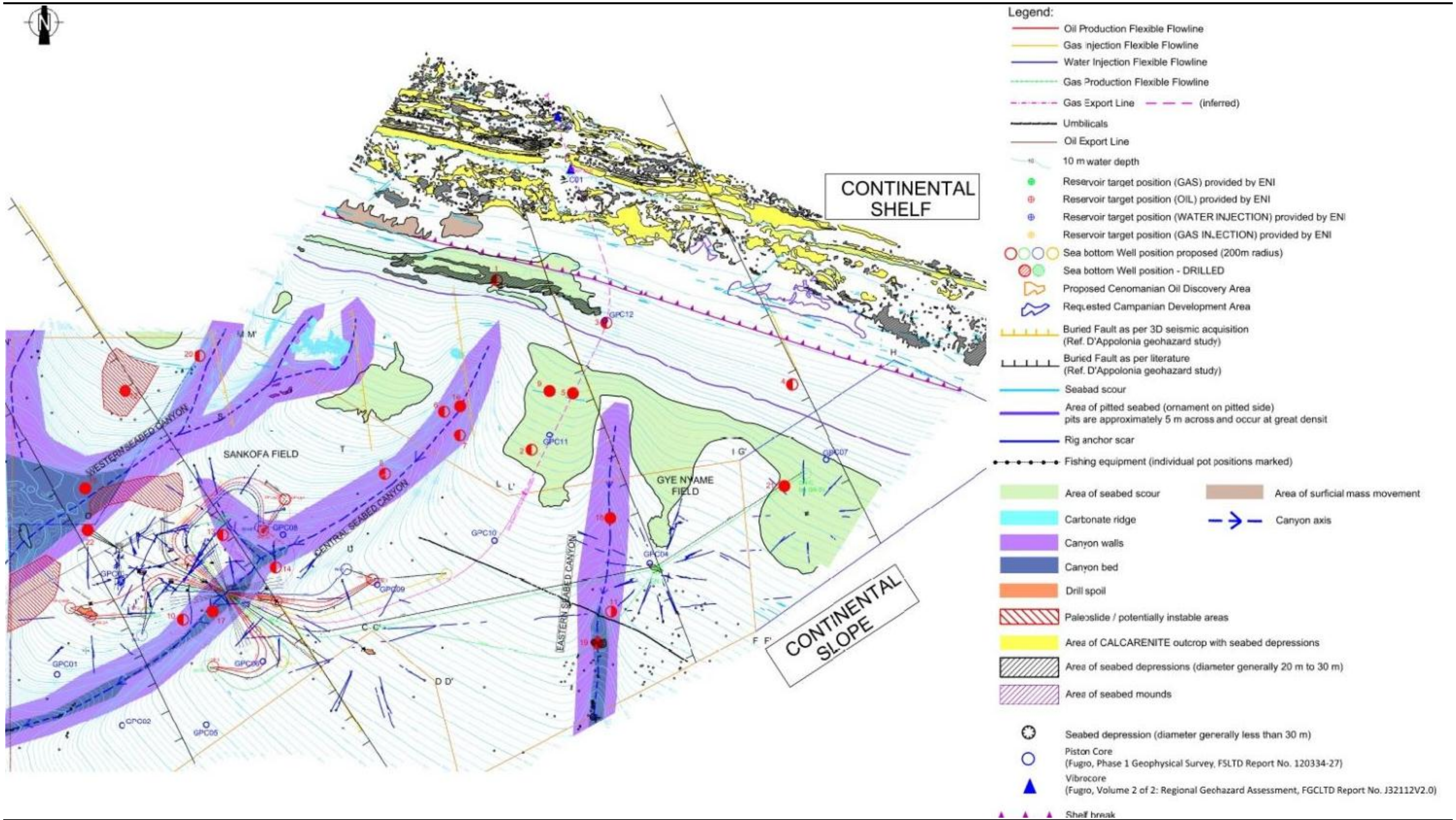
Potentially hazardous condition	Comments	Occurrence in Soil Province					Constraints on planned facilities
		1	2	3	4	5	
Irregular seafloor, steep slopes and seafloor outcrops	Irregular seafloor is associated with seafloor outcrops. Presence is specially evident at the continental shelf and at knoll areas	x	x	x	x	x	Outcrops may impair trenching for pipeline installation. Irregular seabed may damage the pipeline.
Soil liquefaction	Increased risk in sandy soil areas (thickness of at least 1 m) on the continental shelf and shelf break.	x	x				Potential loss of support of facilities and sinking of foundations. May also lead to slope instability.
Seafloor knolls	Three large knolls at the head of the western and central canyons					x	Unlikely to have an impact given the distance to the proposed Project features (more than 4 km away).
Slope failures	Evidence found at shelf break and continental slope.		x			x	Unlikely to have an impact given the distance to the proposed Project features (more than 6 km away from shallow slope failures).
Debris flows	No evidence of recent active debris flows. Past debris observed at continental slope.					x	Considered unlikely in the present environment.
Turbidity currents	No evidence of recent active turbidity currents. Past activity recorded in the canyons.			x		x	Considered unlikely in the present environment.
Seafloor currents – Scouring	Evidence of scouring recorded along all the types of soil, specially in the shelf break where deep scouring has occurred.	x	x	x	x	x	Seafloor currents may increase in the vicinity of installed facilities. Pipeline crosses a scouring area that may be enhanced due to installation.

Slope stability

There is no evidence of general instability along the continental slope or at the flanks of the canyons nor sediment accumulations from mass gravity flows at the toe of the slopes (occurring at a time scale of interest for design) (Fugro, 2014a). However, as potential mudslides are a risk on sloped seabeds, the stability of the area was investigated by Fugro (Fugro, 2014b) considering both minor soil degradation (classic limit equilibrium approach and displacements evaluation) and potential for soil strength loss (potential liquefaction and related consequences assessment).

The results of the study indicate that even with reference to the most severe earthquake events (3100 and 10,000 years return period) the effect on slope stability is minor and limited displacements are expected (less than 50 cm). No potential for mass flow development is envisaged. Liquefaction flow development cannot however be excluded in the shelf area and in the bordering part of the upper slope area of Soil Province 5 (broad seafloor). Given the point nature of available data sets and the spatial variability of predicted liquefaction-induced effects, it is difficult to assess with confidence the spatial distribution of higher- and lower-magnitude effects on the seabed. The occurrence of severe effects is generally localised and is related to seismic events having high return periods.

Figure 6.16 Subsea Geohazards in the Project area



Source: Fugro (2014b)

Note: Red circles indicate geotechnichal testing points. Half red circles indicate geotechnichal and age dating testing points, both by Fugro.

6.4.6 Seawater Quality

Seawater samples were collected across the Project area to determine exisiting water quality. Samples were collected using a five liter Niskin water sampler mounted on a Rosette sampler. Samples were taken at three depths (surface, mid-depth and close to the seabed) at each station, with the exception of the shallowest station where only surface and seabed samples were taken. Location of sampling stations is presented in Figure 6.17 and coordinates in *Table 6.22*. Profiles of temperature and salinity through the water column were also measured.

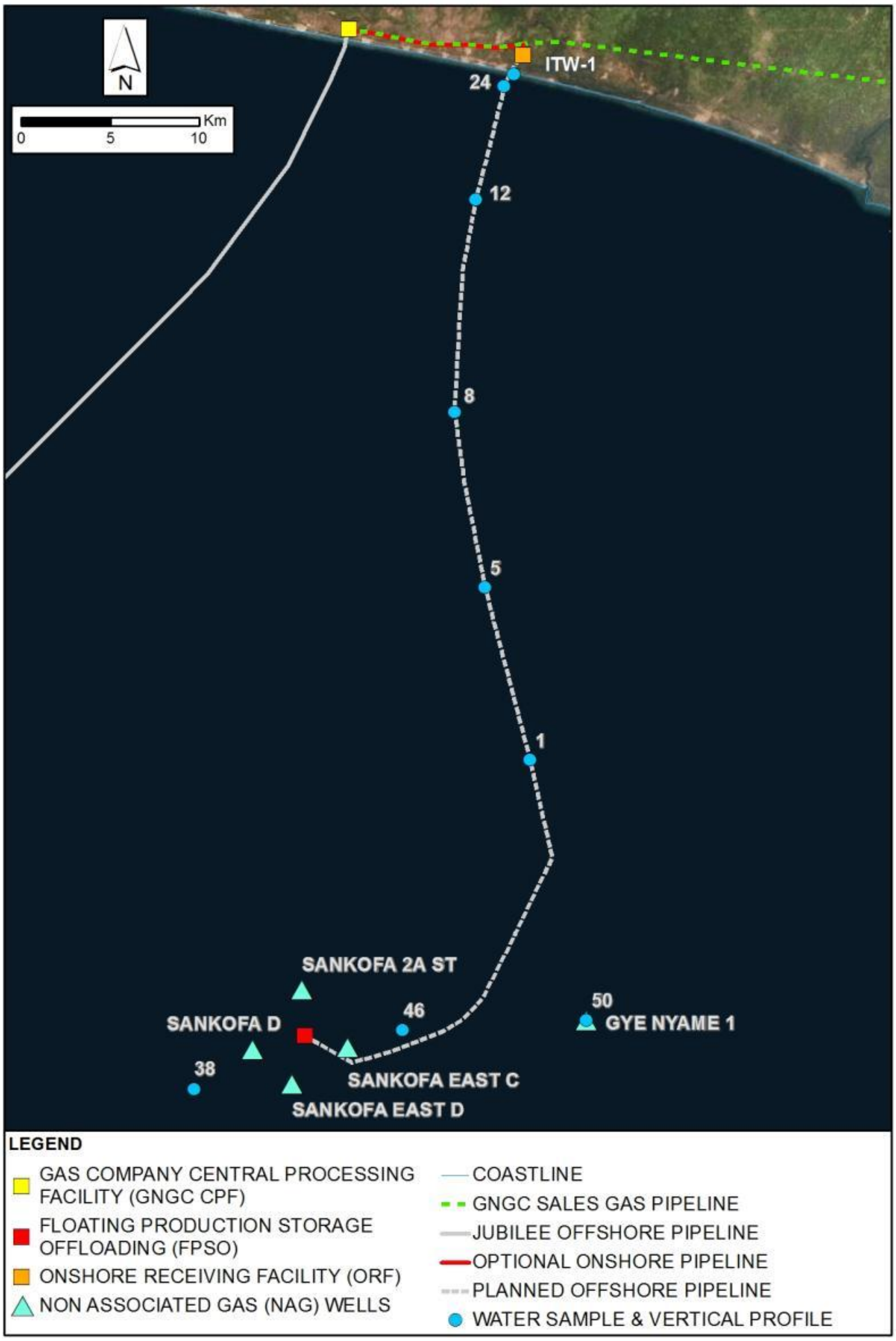
Table 6.22 Seawater Sampling Locations

Sampling station name	Coordinates		Sampling Depth [m]	Description
	Easting (m)	Northing (m)		
1	562,187	509,492	Surface, middle and bottom	Offshore pipeline
5	559,668	519,164	Surface, middle and bottom	Offshore pipeline
8	557,952	529,003	Surface, middle and bottom	Offshore pipeline
12	559,139	540,911	Surface, middle and bottom	Offshore pipeline
24	560,755	547,268	Surface and bottom	Nearshore
38	543,343	491,021	1, 100 and 200 m	Wells and intrafield flowlines
46	555,058	494,309	1, 100 and 200 m	Wells and intrafield flowlines
50	565,341	494,894	1, 100 and 200 m	Wells and intrafield flowlines

Source: Fugro, 2013

Two water samples were also collected from the intertidal zone at the beach in the vicinity of the pipeline landfall to the east of Sanzule. These samples were taken in two different seasons, on March 2014 (dry season) and in October 2014 (wet season) at the same location (Sampling station ITW-1). The UTM coordinates of the sampling site are 561,292 m E and 547,946 m N.

Figure 6.17 Seawater Sampling Locations



Source: Fugro (2013)

Temperature and Salinity

Conductivity, Temperature and Depth (CTD) profiles of the water column were acquired from near the surface to close to the seabed during the two offshore surveys. Eight locations were chosen for water sampling and profiling, five along the proposed pipeline route and three in the wells area (*Figure 6.17*), together with the two seasonal samples collected in the intertidal zone.

Sea Surface Temperatures (SST) in offshore Ghana typically vary between 27 - 29°C, although strong seasonal cooling occurs as a result of the seasonal upwelling processes (see Section 0 above). During upwelling, the thermocline weakens and rises to the surface resulting in a vertically homogeneous salinity profile above the shelf (Mensah and Anang, 1998). The results showed that surface temperatures were approximately 28.5°C at all stations. Temperatures gradually decreased with depth, with the presence of a slight thermocline at around 20 m to 30 m. The results in the station located farthest from the coast (station 1) showed temperature decrease to 16.8°C at approximately 87 m. Temperature in the intertidal area was higher averaging 31.7ºC in March and 34.2ºC in October.

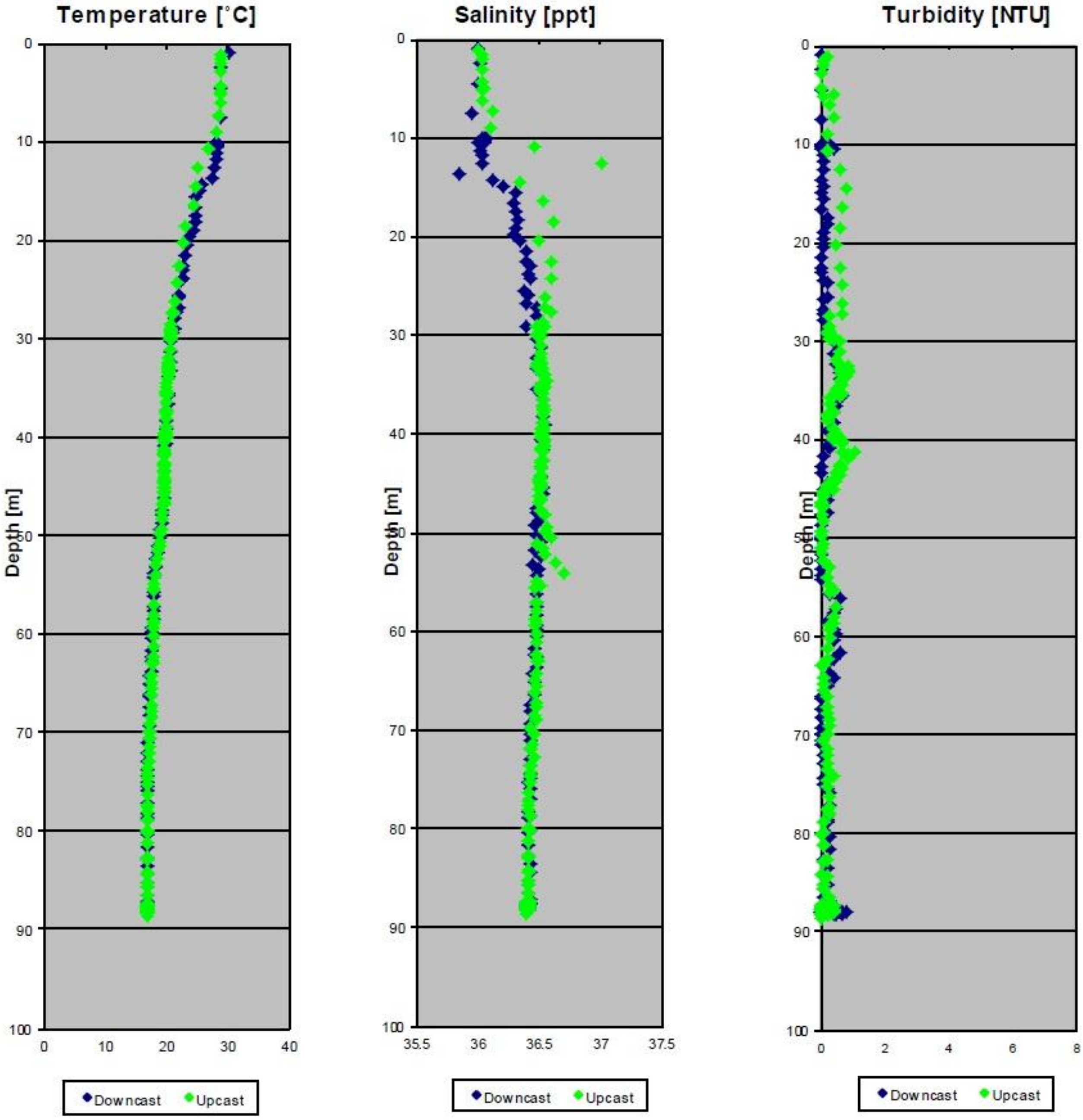
Salinity in the warm surface water layer is generally low (33.7 – 34.2 parts per thousand) 30 – 40 m above the thermocline and presents its maximum values (35.1 – 35.4 ppt) just below it at 60 – 80 m depth. Surface salinity was approximately 36 parts per thousand (ppt) at all stations. At the majority of stations there was a slight decrease in salinity at approximately 20 m to 30 m, with values decreasing to approximately 36.4 ppt. This weak halocline was most notable farthest from the coast and occurred at approximately the same depth as the slight thermocline. At approximately 40 m salinity began to increase slightly again with depth with a recorded value of 36.4 ppt at 87 m. Salinity values in the intertidal zone were slightly lower in October (32.1 ppt) and much lower in March (15 ppt), probably due to the influence of riverine water or discharges from land.

Similar salinity and temperature profiles were observed in the previous surveys in neighboring areas (TDI Brooks, 2008).

Regarding the turbidity, the water profiles at all stations across the survey area showed a non-turbid, clear water column which did not vary with depth. The turbidity was less than 1 NTU at all stations. There were no distinguishable differences in turbidity observed between the deeper and shallower stations throughout the site. *Figure 6.18* presents the results of the vertical profile at station 1 as an example.

Turbidity at the intertidal zone was, however relatively higher with values that averaged 4.0 NTU in October to 8.8 NTU in March as correspond to an area subject to the activity of waves.

Figure 6.18 CTD Profiles at Station 1



Source: Fugro (2013)

Nutrients, Chlorophyll and Dissolved Solids

Summary results for total organic carbon (TOC), nitrate, phosphate, chlorophyll a, total dissolved solids (TDS), biochemical oxygen demand (BOD), chemical oxygen demand (COD), and faecal coliforms are displayed in *Table 6.23*. Total organic carbon, nitrate and phosphorus concentrations were all below their respective detection limits at all stations along the proposed pipeline route, with the exception of nitrate in the 100 m and 200 m depth samples at the stations located further from the coast on the wells area.

Phosphate (PO_4) is compound used by plants and is not toxic for human, animal, or fish. Natural source of phosphor is mineral rock weathering. Besides, phosphor may also come from organic material decomposition. Excessive phosphorous and nitrogen content can stimulate algal bloom. Waters with high fertility level have total phosphate between 0.051 and 0.1 mg/L (Effendi, 2003). Phosphate concentrations tended to be slightly higher at the surface of the water column compared to the bottom, with the highest concentrations found in the surface waters (stations 1 and 5). At concentration of >0.2 mg/L nitrate can trigger eutrophication or phytoplankton blooming. At concentration of >5 mg/L, there is indication of anthropogenic pollution. Nitrate and phosphate content in study location arte expected to be a natural phenomenon.

TDS, which ranged from 29400 mg/l 40000 mg/l, did not present any spatial trend in the water column or between stations, while BOD levels were below the limit of detection at all stations (<2 mg/l), indicating clear water and absence of organic pollution.

Chlorophyll a concentrations ranged from 0.55 µg/l to 3.40 µg/l in the stations along the pipeline route while it was under the detection limit on the area of the wells. The differences between near surface and at depth can be attributed to differences in primary productivity and organic mineralisation. In surface waters photosynthesis will be active resulting in an uptake of nutrients, reducing concentrations of nitrogen and phosphorus whereas at depths below 100 m organic mineralisation will be greater resulting in higher concentrations.

Table 6.23 Seawater Quality

Sampling Station	Depth (m)	TOC	Nítrate (mg/l)	Phosphate (mg/l)	TDS (mg/l)	Chlorophyll A (µg/l)	COD	BOD	Faecal Coliforms
1	Surface	nd	nd	0.58	37500	1.3	305	nd	nd
	Middle	nd	nd	0.45	38400	0.55	440	nd	nd
	Bottom	nd	nd	0.36	29400	0.55	215	nd	nd
5	Surface	nd	nd	0.27	37500	1.94	450	nd	nd
	Middle	nd	nd	0.22	38600	1.32	460	nd	nd
	Bottom	nd	nd	0.2	39200	2.1	430	nd	nd
8	Surface	nd	nd	0.15	38000	0.84	384	nd	nd
	Middle	nd	nd	0.13	38800	0.75	450	nd	nd
	Bottom	nd	nd	0.06	39000	1.31	430	nd	nd
12	Surface	nd	nd	0.1	38400	1.3	405	nd	nd
	Middle	nd	nd	0.03	38500	1.24	430	nd	nd
	Bottom	nd	nd	0.06	38600	3.4	350	nd	nd
24	Surface	nd	nd	0.03	38200	3.40	405	nd	nd
	Bottom	nd	nd	0.02	37800	-	440	nd	nd
38	1 m	nd	nd	0.06	39900	0.44	840	nd	nd
	100 m	nd	0.2	0.08	39400	nd	510	nd	nd
	200 m	nd	0.3	0.09	40000	nd	490	nd	nd
46	1 m	nd	nd	0.06	39500	nd	530	nd	nd
	100 m	nd	0.2	0.08	38900	nd	180	nd	nd
	200 m	nd	0.2	0.09	39700	nd	nd	nd	nd
50	1 m	nd	nd	0.14	39900	nd	640	nd	nd
	100 m	nd	0.3	0.08	39900	nd	520	nd	nd
	200 m	nd	0.4	0.09	39400	nd	480	nd	nd

Source: Fugro (2013)

Results obtained in the intertidal zone do not present significant differences with those gathered offshore, with the exception of nitrate, COD and BOD values. Nitrate in March averaged 15.8 mg/l suggesting anthropogenic inputs. Values in October had returned to more normal values averaging 0.62 mg/l. Biological oxygen demand values varied between 86.2 mg/l in March and 220 mg/l in October, indicating higher biological activity.

Total Hydrocarbons and Polycyclic Aromatic Hydrocarbons (PAH)

The hydrocarbon analysis results are presented in Table 6.24, and show that total hydrocarbon concentrations (THC) were low at all stations along the pipeline route ranging from 2.9 to 5.9 µg/l, with the maximum value recorded at the bottom of the station closest to the coast. Total PAH concentrations ranged from 36 ng/l (station 5 bottom) to 199 ng/l (station 12 middle). These results are comparable to other deep-water surveys conducted worldwide and indicate good water quality.

The results from the survey in the deeper offshore areas where the wells will be located (station 38, 46 and 50), revealed higher concentrations of THC, ranging between 9.8 µg/l to 23.3 µg/l. Maximum values are approximately four times greater than those recorded along the proposed pipeline corridor (2.9 µg l-1 to 5.9 µg). These values in the water samples may be attributed to natural sources as well as shipping activities (eg, leaks and minor spills from marine vessels) or other highly dispersed sources.

Total PAH concentrations in the wells area, on the other hand, show no differences when compared to the proposed pipeline route, as the results range from 32 ng/l (Station 46 at 1 m) to 61 ng/l (both Station 38 and 50 at 200 m depth). Levels of PAHs would therefore typically be expected to be greater in sediments than in overlying waters in the absence of any water born contamination (e.g. oil spills or produced waters from vessels or oil and gas platforms) as PAHs are generally insoluble in water and readily adhere to suspended particles, eventually being accumulated in bottom sediments.

The analysis of the intertidal samples taken at Sanzule beach in March and October 2014 were below detection limits for THC.

Table 6.24 THC and PAH in Seawater

Sampling Station	Depth (m)	THC (µg/l)	PAH (ng/l)
1	Surface	4.4	73
	Middle	2.9	56
	Bottom	3.3	39
5	Surface	5.6	57
	Middle	4.4	87
	Bottom	5.2	36
8	Surface	4.3	67
	Middle	4.3	49
	Bottom	5.7	44
12	Surface	5.2	68
	Middle	4.6	199
	Bottom	5.6	64

Sampling Station	Depth (m)	THC (µg/l)	PAH (ng/l)
24	Surface	3.5	63
	Bottom	5.9	73
38	1 m	17.5	52
	100 m	9.8	47
	200 m	15.7	61
46	1 m	9.9	32
	100 m	14.4	35
	200 m	15.2	46
50	1 m	15.5	52

Source: Fugro, 2013

Heavy Metals

With regards to the heavy and trace metals analyzed, all were detected at very low levels, or below detection limits in all of the water samples (Table 6.25). No substantial differences were found between the stations or within the water column.

In this context, barium, cadmium, cobalt, iron and mercury were all at or below their respective detection limits at all stations and depths. Aluminium was 0.01 mg/l at all depths and stations. Copper ranged from 0.002 to 0.006 mg/l and nickel varied from below the detection limit (<0.001) to 0.003 mg/l. Finally, lead concentrations ranged from below the detection limit (<0.001) to 0.002 mg/l, while and zinc varied between 0.008 mg/l to 0.026 mg/l. Selenium concentrations were all below 0.104 mg/l, though it showed higher values on those stations located in the wells area. All heavy and trace metal concentrations are markedly below the chronic Ambient Water Quality Criteria (AWQC) set by USEPA.

Table 6.25 Heavy Metals in Seawater (mg/l)

Sampling Station	Depth (m)	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Ni	Pb	Se	Zn
1	Surface	0.01	0.018	nd	nd	nd	0.002	0.006	nd	nd	0.002	nd	0.046	0.012
	Middle	0.01	0.019	nd	nd	nd	0.002	0.006	nd	nd	0.002	nd	Nd	0.012
	Bottom	0.01	0.019	nd	nd	nd	0.003	0.005	nd	nd	0.002	nd	0.029	0.018
5	Surface	0.01	0.019	nd	nd	nd	0.003	0.004	nd	nd	0.001	nd	0.039	0.013
	Middle	0.01	0.020	nd	nd	nd	0.003	0.004	nd	nd	0.001	nd	0.039	0.026
	Bottom	0.01	0.021	nd	nd	nd	0.003	0.003	nd	nd	0.001	nd	0.029	0.011
8	Surface	0.01	0.020	nd	nd	nd	0.003	0.003	nd	nd	0.001	nd	0.059	0.009
	Middle	0.01	0.021	nd	nd	nd	0.003	0.002	nd	nd	nd	nd	0.043	0.008
	Bottom	0.01	0.021	nd	nd	0.001	0.003	0.005	nd	nd	0.002	nd	0.049	0.010
12	Surface	0.01	0.020	nd	nd	0.001	0.003	0.005	nd	nd	0.002	nd	0.042	0.010
	Middle	0.01	0.020	nd	nd	0.001	0.003	0.005	nd	nd	0.002	nd	0.040	0.011
	Bottom	0.01	0.021	nd	nd	0.001	0.003	0.005	nd	nd	0.002	nd	0.014	0.013
24	Surface	0.01	0.021	nd	nd	0.001	0.003	0.005	nd	nd	0.002	0.002	0.038	0.016
	Bottom	0.01	0.022	nd	nd	0.001	0.003	0.005	nd	nd	0.003	nd	0.052	0.013
38	1 m	nd	0.025	nd	nd	0.001	nd	0.006	0.18	nd	0.003	Nd	0.037	0.011
	100 m	0.01	0.028	nd	nd	0.001	0.002	0.006	0.02	nd	0.003	Nd	0.065	0.013
	200 m	0.01	0.028	nd	nd	0.001	0.001	0.006	nd	nd	0.003	Nd	0.071	0.011
46	1 m	0.01	0.026	nd	nd	0.001	0.001	0.006	nd	nd	0.002	Nd	0.072	0.011
	100 m	0.01	0.029	nd	nd	0.001	0.001	0.006	nd	nd	0.002	Nd	0.087	0.011
	200 m	0.01	0.029	nd	nd	0.001	nd	0.006	nd	nd	0.002	Nd	0.071	0.010
50	1 m	0.01	0.028	nd	nd	0.001	0.002	0.006	nd	nd	0.003	Nd	0.078	0.015
	100 m	0.01	0.030	nd	nd	nd	nd	0.006	nd	nd	0.002	Nd	0.052	0.013
	200 m	0.01	0.029	nd	nd	nd	0.002	0.006	nd	nd	0.002	Nd	0.104	0.013

Source: Fugro, 2013

With regards to the intertidal samples collected in dry and wet season surveys at Sanzule beach, results on heavy metal concentrations revealed also low concentrations of heavy metals in the nearshore marine waters.

Copper, cadmium, arsenic and lead were below detection limits in the wet season, while in the dry season values detected were all below 0.006 mg/l. Manganese (maximum of 0.406 mg/l in wet season), chromium (maximum of 0.08 mg/l in dry season) and zinc (maximum of 0.106 mg/l in wet season) were all also within the WHO guideline values of 0.40 mg/L, 0.050 mg/L and 3.0 mg/L respectively. Concentration of mercury ranged from 0.003 to 0.008 mg/ while that of iron ranged from 0.349 to 24 mg/L. As a result the concentrations of Hg and Fe were both higher than the WHO guideline, established as 0.001 and 0.3 mg/l respectively.

6.4.7 Marine Sediment Quality

Seabed sediment characteristics were determined during the marine survey. Seabed sediment samples were taken at 48 locations along the offshore pipeline route and in the nearshore area close to Sanzule (Table 6.26 and Table 6.27). Seabed samples were acquired using a 0.1 m^2 Van Veen type grab sampler. Sediment samples were analysed for both biological and physicochemical parameters.

Table 6.26 Seabed Sediment Sampling Locations

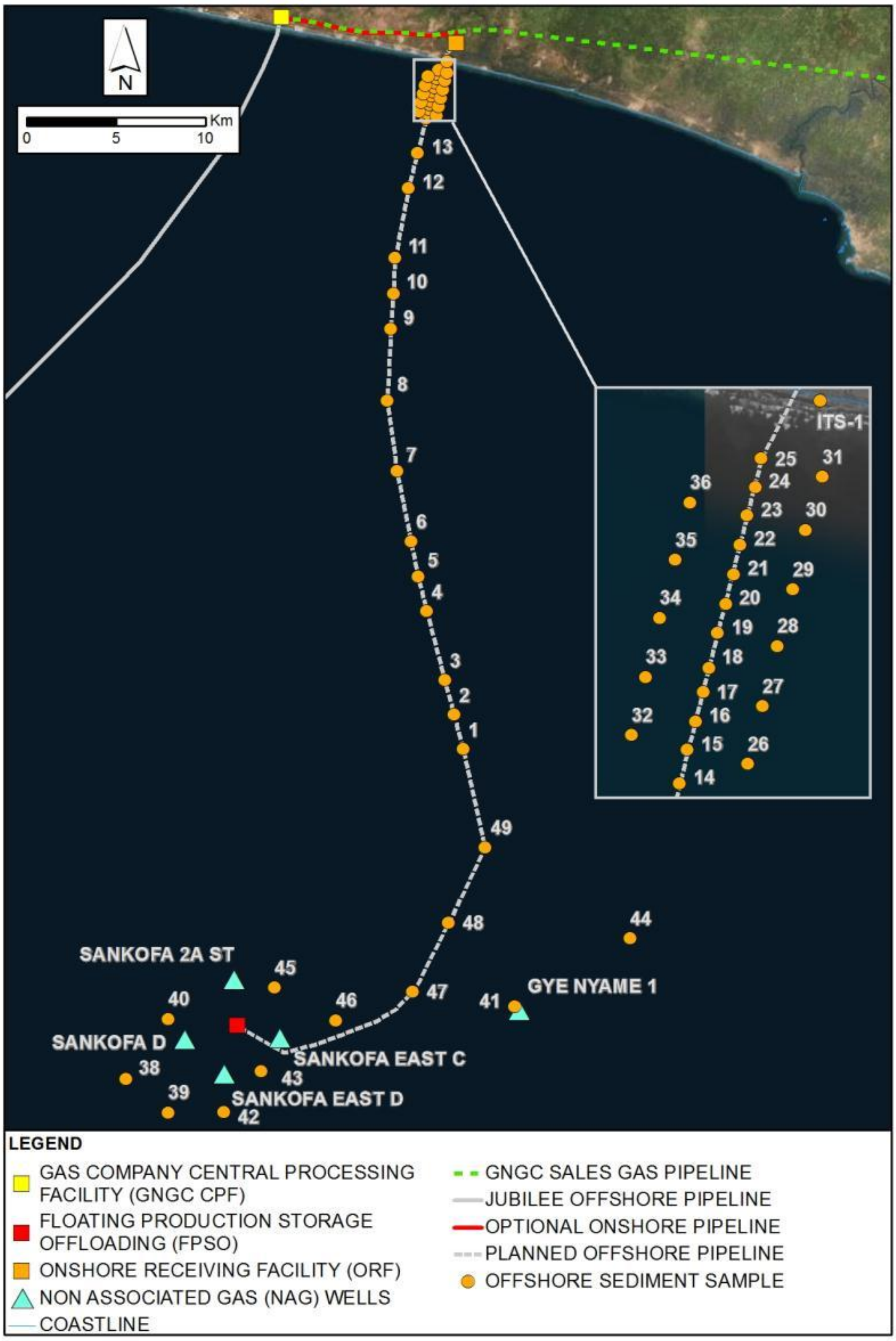
Sampling station name	Coordinates		Depth (m)	Description
	Easting (m)	Northing (m)		
1	562,187	509,492	99	Offshore pipeline
2	561,683	511,424	88	Offshore pipeline
3	561,172	513,358	84	Offshore pipeline
4	560,159	517,224	77	Offshore pipeline
5	559,668	519,164	75	Offshore pipeline
6	559,275	521,131	72	Offshore pipeline
7	558,499	525,051	65	Offshore pipeline
8	557,952	529,003	56	Offshore pipeline
9	558,164	532,999	51	Offshore pipeline
10	582,85	534,993	47	Offshore pipeline
11	558,399	536,994	44	Offshore pipeline
12	559,139	540,911	33	Offshore pipeline
13	559,634	542,846	27	Offshore pipeline
14	560,126	544,799	22	Offshore pipeline
15	560,191	545,082	20	Nearshore
16	560,257	545,318	20	Nearshore
17	560,321	545,564	19	Nearshore
18	560,369	545,760	18	Nearshore
19	560,440	546,057	17	Nearshore
20	560,509	546,294	16	Nearshore
21	560,574	546,540	15	Nearshore

Sampling station name	Coordinates		Depth (m)	Description
	Easting (m)	Northing (m)		
22	560,628	546,786	13	Nearshore
23	560,686	547,035	13	Nearshore
24	560,755	547,268	9	Nearshore
25	560,806	547,507	7	Nearshore
26	560,692	544,963	20	Nearshore
27	560,814	545,443	19	Nearshore
28	560,936	545,943	17	Nearshore
29	561,070	546,417	15	Nearshore
30	561,172	546,910	12	Nearshore
31	561,313	547,354	6	Nearshore
32	559,723	545,203	20	Nearshore
33	559,844	545,687	18	Nearshore
34	559,961	546,178	17	Nearshore
35	560,086	546,662	15	Nearshore
36	560,214	547,138	12	Nearshore
38	543,343	491,021	1122	Wells and intrafield flowlines
39	545,701	489,148	1112	Wells and intrafield flowlines
40	545,700	494,399	922	Wells and intrafield flowlines
41	565,070	495,100	519	Wells and intrafield flowlines
42	548,811	489,177	1007	Wells and intrafield flowlines
43	550,892	491,487	883	Wells and intrafield flowlines
44	571,549	498,903	327	Wells and intrafield flowlines
45	551,632	496,142	834	Wells and intrafield flowlines
46	555,058	494,309	708	Wells and intrafield flowlines
47	559,369	495,933	561	Wells and intrafield flowlines
48	561,383	499,794	427	Wells and intrafield flowlines
49	563,419	504,013	219	Wells and intrafield flowlines

Source: Fugro (2013)

Additionally, two sediment samples were taken at the beach in the vicinity of the pipeline andfall site in the intertidal zone, east of Sanzule. These samples were taken in two different seasons, on March 2014 (dry season) and in October 2014 (wet season) at the same location (Sampling site ITS-1). The UTM coordinates of the sampling site are 561,295 m E and 547,988 m N.

Figure 6.19 Marine Sediment Sampling Locations



Source: Fugro (2013)

Grain Size Distribution

Grain size analysis was performed using wet and dry sieving and laser diffraction techniques. Summarized results are given in Table 6.27.

Sediment granulometry along the survey route ranged from poorly sorted, coarse silt to moderately sorted, coarse sand. Sand was the main component at all stations with the exception of station 28 in the nearshore area, which contained a high proportion of fine sediment (55%). This trend is reversed at stations in water depths greater than 600 m, where sediments all consist of more than 79% silt and less than 21% sand. The granulometric analysis found coarse sediment to be low at most stations, however, a higher coarse fraction was present at station 13 (32%) and station 4 (18%). These results are consistent with the seabed features interpretation, which suggests sediments on the outer shelf comprise silty sand, while slope sediments largely consist of slightly silty sandy clay.

The intertidal sediments collected at Sanzule beach presented a sand fraction over 90%, in line with the sediments found in the shallower offshore stations.

The results of the granulometric analysis for the current survey appear also to be consistent with previous literature describing this region which suggested the presence of a range of sediment types, varying between soft sediments (mud and sandy mud), sandy sediments and hard substrate (Martos et al., 1991).

Table 6.27 Marine Sediment Grain Size Distribution

Sampling Name	Sediment Composition		
	fines [%]	Sand [%]	Coarse [%]
1	27.6	71.7	0.7
2	29.0	70.1	0.9
3	31.4	60.9	7.8
4	24.2	57.6	18.2
5	37.4	61.8	0.9
6	42.9	56.5	0.6
7	43.6	52.7	4.3
8	35.0	64.4	0.6
9	29.9	69.4	0.7
10	39.0	60.5	0.5
11	30.7	69.1	0.2
12	26.7	72.6	0.8
13	7.5	60.5	32.1
14	3.6	95.1	1.2
15	24.2	75.4	0.5
16	15.7	84.0	0.3
17	27.4	72.5	0.2
18	25.2	74.7	0.0
19	30.7	66.7	2.6

Sampling Name	Sediment Composition		
	fines [%]	Sand [%]	Coarse [%]
20	40.2	59.8	0.0
21	1.5	89.0	9.5
22	27.8	71.6	0.6
23	28.7	71.2	0.1
24	3.2	96.7	0.1
25	2.5	97.5	0.0
26	32.7	66.6	0.7
27	0.8	98.6	0.6
28	55.5	44.4	0.1
29	31.4	68.6	0.0
30	34.4	65.6	0.1
31	2.9	97.1	0.0
32	28.7	71.0	0.2
33	8.0	91.6	0.4
34	19.9	80.1	0.0
35	0.4	97.0	2.6
36	4.6	95.4	0.0
38	90.6	9.4	0.0
39	86.7	13.2	0.1
40	88.6	11.4	0.1
41	57.8	42.2	0.1
42	86.9	13.1	0.0
43	85.4	14.6	0.0
44	36.2	63.6	0.1
45	81.4	18.6	0.0
46	79.9	20.1	0.0
47	38.7	61.2	0.0
48	75.4	24.6	0.0
49	14.4	84.7	0.0
ITS-1	2.3	97.7	0.0

Source: Fugro (2013); ESL, 2015

Heavy Metals

Results for the heavy and trace metal analyses are provided in Table 6.28, alongside National Oceanic and Atmospheric Administration of the United States (NOAA) guideline values, which indicate the lower threshold at which adverse biological effects have been identified from ecotoxicological studies (Buchman, 2008), and Dutch quality standards for comparison purposes. Dutch quality standards for marine sediments are internationally recognised for assessing the chemical quality of dredged material and are commonly used to evaluate the risk of sediment mobilization.

Metal concentrations were generally low and seabed sediment quality is good, though levels of arsenic, cadmium, chromium and nickel were found to exceed their respective NOAA ERL concentrations at one or more stations (*Table 6.28* numbers highlighted in bold). These levels were also exceeded in the intertidal sediment samples taken at Sanzule beach. Levels of the majority of metals (excluding arsenic and cadmium) increased with proportions of fine sediment across the survey area. Aluminium, barium, cobalt, nickel, lead and zinc concentrations also showed a positive correlation with depth. Arsenic on the contrary appeared to be less abundant on the shallowest stations on the wells area. As a result those stations located on the wells area in deeper waters present higher levels of metals, especially chromium, nickel and barium.

Heavy and trace metal concentrations also showed some variability between stations along the proposed pipeline route, with slightly higher levels recorded at stations 5 and 6 which also had slightly higher proportions of fine sediment. Among them, a particularly high chromium concentration was observed at station 5 (167.2 µg/g), this may indicate some localised contamination in the area.

Arsenic concentrations ranged from 2.2 µg/g at station 35 to 58.8 µg/g at station 13, with the majority of stations exceeding the ERL value. As station 13 contains the highest proportion of coarse grained sediments (station 13), it suggest a possible influence of local geology rather than anthropogenic contamination.

Barium, in the form of barite, is used as a weighting material to increase the density of drilling muds and can be present in concentrations ranging from 720 µg/g to 449,000 µg/g (Neff, 2005). Barium concentrations were low throughout the site, from 6.3 µg/g at station 35 to 189 µg/g at station 5 in the shallower areas, while it reaches 1,890 µg/g in the deeper areas close to the proposed wells. As barium is persistent in marine sediments it is possible that the barium levels in sediments in the current survey may indicate a highly dispersed very low level barium contamination from wells already existing in the local area. Specifically, barium levels at station 41 are highly indicative of possible past drilling-related contamination from the drilling muds, however it is notable that other metals are not equally elevated at this location suggesting drilling muds are not heavy contaminated with impurities. Station 41 is located 340 m from the Gye Nyame-1 exploration well (*Figure 6.19*) drilled in 2011 and considered as the potential source.

Overall the metals data do not indicate significant localised or area wide contamination.

Table 6.28 Heavy Metals in Marine Sediments (µg/g dry weight)

Sampling Station	As	Ba	Cd	Co	Cr	Cu	Hg	Ni	Pb	Se	Zn
1	**9.0**	188.0	0.3	4.2	43.3	11.7	0.03	14.6	5.5	0.6	56.2
2	**12.5**	57.9	0.1	3.9	45.2	9.5	0.01	**27.8**	5.1	Nd	40.4
3	**10.0**	57.8	nd	3.6	37.3	9.2	0.01	15.1	4.7	0.7	35.3
4	**11.1**	52.4	0.1	3.4	34.9	7.3	0.02	13.3	4.7	Nd	32.9
5	**10.9**	189.0	0.1	6.6	**167.2**	17.5	0.06	**91.3**	17.3	nd	70.0

Sampling Station	As	Ba	Cd	Co	Cr	Cu	Hg	Ni	Pb	Se	Zn
6	**10.8**	108.0	0.1	6.2	49.3	13.3	0.03	**27.1**	8.2	nd	62.4
7	7.7	84.3	0.1	3.9	48.9	8.6	0.01	14.2	5.8	nd	44.6
8	**8.2**	95.4	0.2	4.0	53.3	14.9	0.02	14.5	6.0	nd	43.9
9	**12.1**	96.2	0.1	4.0	59.4	12.3	0.02	12.9	6.1	nd	45.5
10	**15.0**	106.0	0.1	4.8	58.2	9.3	0.01	14.4	7.0	nd	48.6
11	**19.4**	88.9	0.2	4.9	68.8	9.6	0.01	13.0	7.2	nd	49.9
12	**25.9**	85.4	nd	6.6	71.2	10.5	0.01	13.9	23.5	nd	60.7
13	**58.8**	36.8	0.2	2.3	25.3	3.4	0.01	6.6	4.9	nd	26.6
14	**9.8**	15.3	nd	0.9	9.1	3.0	nd	2.7	nd	nd	15.6
15	**16.7**	56.9	**1.4**	3.8	44.0	7.0	0.01	6.7	5.4	nd	45.5
16	7.0	26.0	0.2	1.5	15.3	3.4	nd	3.6	2.0	nd	21.1
17	**10.3**	59.8	0.3	2.7	34.8	4.9	0.01	6.4	4.2	nd	34.6
18	**12.9**	65.5	0.4	3.0	37.2	5.3	0.01	6.6	4.8	nd	55.7
19	**14.7**	88.6	0.4	3.2	45.2	5.0	0.01	7.6	5.6	nd	45.2
20	**18.2**	106.0	0.5	3.5	52.0	5.2	0.01	8.8	6.9	nd	45.5
21	2.3	12.7	nd	0.6	6.0	3.3	nd	2.2	nd	nd	15.1
22	**13.7**	70.0	0.3	2.9	39.5	4.1	nd	6.6	4.0	nd	39.4
23	**16.4**	67.3	0.4	3.1	37.5	4.1	0.02	6.7	4.0	nd	42.7
24	**15.1**	33.1	0.1	2.6	25.6	3.5	0.01	5.0	2.5	nd	30.9
25	**11.9**	26.8	0.1	2.1	18.8	3.5	nd	4.2	1.5	nd	26.8
26	**10.9**	60.5	0.3	2.4	32.9	4.9	0.01	7.1	4.1	nd	29.1
27	**17.1**	16.5	nd	1.0	10.8	2.8	nd	2.8	nd	nd	19.5
28	**18.6**	125.0	0.6	3.9	59.7	5.8	0.01	10.4	6.8	nd	51.9
29	**16.1**	84.3	1.0	4.0	57.9	13.9	nd	9.0	6.4	nd	53.1
30	**14.1**	67.3	0.6	3.3	45.4	7.9	nd	7.0	4.6	nd	43.8
31	**17.4**	32.1	0.2	3.2	31.8	16.0	nd	6.2	3.0	nd	37.7
32	**14.3**	52.0	0.4	2.5	33.8	18.9	0.01	7.4	4.2	nd	29.5
33	**9.3**	14.6	nd	1.3	14.4	3.7	nd	3.7	nd	nd	17.5
34	**12.4**	60.9	1.1	3.5	46.9	21.8	nd	7.0	5.0	nd	43.1
35	2.2	6.3	0.0	0.6	6.3	13.3	nd	2.4	nd	nd	19.6
36	**15.8**	27.7	0.4	2.9	31.0	4.9	nd	5.2	3.0	nd	33.7
38	6.6	406.0	0.6	11.1	**109.6**	18.4	0.05	**57.4**	13.6	nd	92.8
39	7.0	410.0	0.7	10.9	**109.1**	19.9	0.05	**57.3**	13.8	nd	92.8
40	6.3	293.0	0.6	10.3	**108.0**	17.9	0.03	**57.1**	13.5	nd	93.0
41	**8.7**	1890.0	0.5	8.4	**102.6**	9.3	0.03	**44.4**	10.7	nd	71.3
42	6.8	562.0	0.5	10.8	**108.8**	16.4	0.03	**54.4**	13.5	nd	88.9
43	nd	406.0	0.4	5.7	62.3	8.0	0.04	**32.6**	7.5	nd	47.2
44	**13.3**	111.0	0.3	7.8	**98.5**	10.0	0.01	**32.0**	7.5	nd	72.6

Sampling Station	As	Ba	Cd	Co	Cr	Cu	Hg	Ni	Pb	Se	Zn
45	7.5	290.0	1.1	9.0	**99.4**	15.7	0.02	**47.0**	11.1	nd	80.1
46	6.9	284.0	0.6	9.4	**99.0**	15.5	0.03	**51.4**	11.7	nd	80.2
47	nd	231.0	0.4	4.9	54.0	7.2	0.02	**27.2**	5.7	nd	37.6
48	**21.8**	109.0	0.3	7.2	**138.3**	10.1	0.01	**28.6**	7.2	nd	64.2
49	**32.3**	64.6	0.3	9.3	71.5	3.4	nd	19.6	5.6	nd	71.5
ITS-1	0.08	-	0.04	-	9.9	0.18	0.006	**181.3**	0.02	-	0.2
NOAA Guideline values	8.2	-	1.2	-	81.0	34.0	0.15	20.9	46.7	-	150.0
Dutch Wuality Standards (reference)	55		7.5		380	90		45	530		720

Note: values in bold indicate exceedances of the guideline values
Source: Fugro (2013); ESL (2015)

Total Hydrocarbons and Polycyclic Aromatic Hydrocarbons

PAH and THC are present throughout the marine environment as a result of natural processes, including plant synthesis and natural petroleum seepage (Laflamme and Hites, 1978). The main source however is derived from anthropogenic sources, such as the combustion of organic material that are deposited into the marine environment and remain, or from localised drilling activities or vessels, and therefore their presence in elevated values is associated to pollution. THC and PAH concentrations are shown in *Table 6.29*.

THC concentrations were low throughout the site, ranging from 0.3 µg/g to 15.2 µg/g (stations 33 and 47 respectively) and showed a significant positive correlation with the proportion of fines within the sediment, with higher levels being found in the lower energy finer sediment areas where organics are known to accumulate. At Station 41 however, levels ar considerable higher (787 µg/g).

PAH levels were also consistently low along the survey area, ranging from below the detection limit (<1 ng/g) at seven stations to 58 ng/g at station 47. Station 41 again presents highly elevated values of pollution with 180 ng/g of PAH. With the exception of Station 41, PAH values in the deeper area (station 38 to 49), where wells and intrafield flowlines will be installed, are similar to those in the pipeline route and nearshore areas. THC values, however, are slightly higher, indicating potential contamination from previous drilling activities, as indicated by results from station 4.

Both, THC and PAH showed a similar spatial distribution, with maximum concentrations found to be highest at Stations 5, 6, 20 41 and 47, possibly due to localized areas of disturbance. In this context, concentrations of TPHs and PAHs were generally higher in the offshore stations along the pipeline route compared to the nearshore stations. This is likely to be related more to sediment grain composition than to depth. The spatial variability of hydrocarbons is therefore considered to be related to local hydrographic and topographic conditions affecting sediment and discharge transport, and also to the drilling activity in the area as revealed by Station 41 and the higher values of THC in the deeper stations.

There are no defined standards for hydrocarbons as they vary depending on location, anthropogenic activities, natural seeps and, where applicable, their nature and composition. The Dutch quality standards for mineral oil in soil sediments have an action level of 5,000 µg/g for the reuse of sediment material. Based on these standards the concentrations recorded during the surveys are considered to be very low. Candler et al., (1995) reported that 1,000 µg/g of THC from SBMs was required before benthic community structure was affected. This data also indicates that values of THC currently observed in the sediment can be considered as low. For PAHs, a concentration of 100,000 ng/g is used as a screening criteria for disposal of marine sediments in the UK. Based on this figure concentrations along the Project area would be considered to be very low.

Table 6.29 THC and PAH in Marine Sediments

Sampling Station	THC (µg/g)	PAH (ng/g)
1	4.1	22
2	2.6	15
3	3.4	26
4	2.5	15
5	7.0	56
6	6.1	48
7	5.5	15
8	2.7	6
9	1.2	10
10	1.4	4
11	1.1	3
12	1.3	3
13	5.0	17
14	0.6	1
15	2.6	7
16	0.6	nd
17	1.7	3
18	1.7	4
19	1.7	7
20	6.5	34
21	0.4	nd
22	2.0	9
23	3.3	17
24	1.4	4
25	0.4	nd
26	1.3	3
27	0.4	nd
28	3.0	14
29	1.6	4
30	2.8	13
31	1.2	7
32	1.5	3
33	0.3	nd
34	1.5	2
35	0.3	nd
36	0.7	nd
38	7.1	34
39	7.8	30
40	8.4	36
41	787.0	180
42	5.9	26
43	4.0	21
44	2.9	25
45	7.2	28
46	7.7	31

Sampling Station	THC (µg/g)	PAH (ng/g)
47	15.2	58
48	2.2	8
49	1.5	3
ITS-1	nd	nd

Source: Fugro, 2013; ESL, 2015

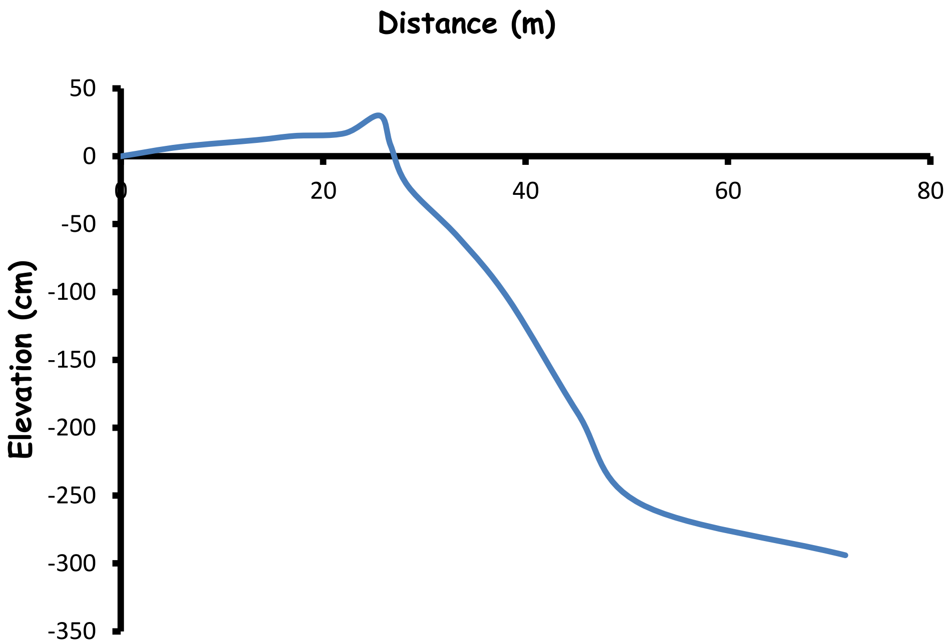
6.4.8 Beach Profile and Coastal Processes

Beaches are common features of coastlines. They are made up of eroded materials that have been transported from elsewhere and deposited by the sea. Beaches are made up of predominantly sand which can be moved on, off and along the coastline, by constant erosion and deposition processes lead by existing waves, winds and coastal currents.

Beach profiling is a method used in sedimentology and coastal geomorphology to study dynamic beach processes and the effect of wave, current and anthropogenic structures on a beach. In March 2014, and in order to understand the dynamics of the beaches, beach profiling was performed along the proposed pipeline landing and at points to the east and west.

The results indicate that the profile of the eastern side of the proposed pipeline is steeper than the profile of the pipeline site and Sanzule village based on the beach gradient. The beaches showed steep profiles with gentle scarps indicative of the impact of shore waves leading to erosion of the beach material (especially at the eastern side of proposed pipeline). Although a greater part of the project area appeared firm, erosion was observed at about 200 m eastwards of the proposed pipeline route in Eikwe community.

Figure 6.20 Beach profile at pipeline landfall site



Source: ESL, 2014

In addition, several high resolution images from the period 2000-2013, covering the coastal environment around Atuabo and Sanzule, were analysed to characterize the coastal dynamics in the Project Area of Influence (Saipem, 2014).

The comparison of image interpretation from 2000 to 2013 shows that the shoreline is stable and that no important beach modification has occurred in this area in the last at least 14 years. This would imply stable conditions in the sediment balance, with similar erosion and deposition rates. However, in Bakanta, located 2 km east of the pipeline landfall the perception of the community is that the coast has retreated significantly in the last 30 years

This is despite the evidence of satellite photographs which indicate that the coastline has remained stable in that period (CRC-URI, 2013). This perception is considered to possibly be due to the effects of tidal waves that led to a massive flood and destruction of properties and houses in Bakanta in 2007 (CRC-URI, 2013). In any case, a 1 m retreat per year in the beaches has been reported along coastal area, as in Kikam (12 km away from pipeline landfall), where sea erosion triggered the relocation from their former settlements (CRC-URI, 2013).

The prevalent beach type is dissipative, in which waves dissipates energy over a wide surf zone. These beaches are typically made up of graded sand sediment with a definite but progressive fining seaward and possible presence of berm bars that can be divided by shallow troughs (2-3 m below breaker zones). Shoreward with respect to the last bar there is a large swash zone, were wave setup and set down takes place. This swash zone is often wide, flat and firm as in the case of most of the shoreline in the Project area.

6.5 Onshore Biological Components

A field survey of flora diversity, a field fauna observation and information from interviews with community members was undertaken specifically for the Project. The survey included a field flora observation in eight sampling locations and at six 10m x 10m transects within the Project area. Complete species listings and field survey reports can be found in Annex B.

6.5.1 Flora

Regional Flora

Ghana is part of the Upper Guinea Forest ecosystem, a region once characterised by dense forests. Human influence and the growth of cities in the region have resulted in the shrinking of natural forests (CRC-URI, 2010, World Bank, 2006). Deforestation is a national problem and is estimated to occur at a rate of approximately 65,000 ha per annum, at a cost of 3.5 percent of Ghana's GDP and habitat and species losses (World Bank, 2006).

The exisiting natural vegetation in the Western Region is primary rainforest but as a result of anthropogenic disturbance to this habitat, secondary forest comprising pioneer species and successors, now dominates over naturally forested areas. As a result of continued collection of wood for fuel/cooking and poor agricultural practices, disturbed areas are prone to increasing rates of desertification (Allotey, 2007).

The coastal areas are dominated by regenerating vegetation comprising of palm trees and thorny shrubs (HPI, 2009). Previously forested land is now used for crop plantations (coconuts, palm oil, rubber), forestry activities and farming. The physical environment of the area has been affected by human activities and no fully natural habitats were observed, although natural areas are reported to occur within the broader AoI.

The Project area lies in the Wet Evergreen forest type of Ghana. This forest type is floristically very rich and has more characteristic species than any forest type in Ghana (Hall and Swaine, 1981). The sand bar is occupied by a narrow band of Coastal Strand type vegetation typified by the Cyperus – Ipomoea Association (Taylor, 1960). Coconut plantations are also common along the dune at numerous places in this zone.

The rain forest vegetation of the project site is also characterised by trees such as *Baphi anitida*, *Petersianthus macrocarpus, Diospyros gabunensis, Rinorea oblongifolia and Blighia welwitschii* (Hall and Swaine, 1981). The shrub species in this vegetation zone include *Heisteria parvifolia, Mussaenda chippii,* and *Byrsocarpus coccineus*. Climbers in this zone include *Airyanthascheinfurthii, Dichapetalum toxicarium* and *Acridocarpus smeathmannii* (Hall and Swaine, 1981).

Flora within the AoI

Terrestrial flora sampling was carried out at the locations identified in Figure 6.23 and Figure 6.24 in both the wet and dry seasons.

The following paragraph describes the vegetation within the concession area (Figure 6.21, yellow polygon).

- **Concession Area.** The pipeline will land at the Sanzule beach which has a narrow band of Coastal Strand vegetation. The vegetation here is poorly developed and the land has mostly been converted into a coconut plantation. It is dominated by species such as *Diodia vaginalis, Remirea maritima* and *Ipomoea pes-caprae*. The Strand transitions into Secondary Forest and Thicket type vegetation which has also been converted into coconut and arable crop farms. Notable crops include cassava and pineapple. The thicket vegetation is up to 10 m high and found mostly as undergrowth of coconut plantations that have not been cleared for several years while farm re-growths occupy fallow lands. The plant species that occur here are mostly pioneer trees such as *Funtumia africana, Albizia adianthifolia, Macaranga hurifolia* and shrubs such as *Chromolaena odorata, Acridocarpus smeathmannii* and *Carpolobia lutea*. The Freshwater Swamp forest occurs in places which are permanently wet and has species such as *Cyrtosperma senegalense*, *Bambusa vulgaris*, *Pterocarpus santilinoides*, *Raphia hookeri* and *Pandanus abbiwii, Alchornea cordifolia* and *Macaranga barteri*.

Main findings of the two surveys performed, in terms of floristic composition of the concession area are indicated as the following:

Wet season. A total of 86 plant species belonging to 46 families and 79 genera were identified in the Concession area during the wet season survey, with the dominant vegetation type being trees (44.19% of the total). Only two species encountered are listed as Vulnerable by the IUCN, namely *Albizia ferruginea* and *Hallea stipulosa*, which are species used for timber and which can frequently be associated with disturbed sites. Note however that the majority of the species identified (87.21%) have not yet been assessed by IUCN. The only Blue Star species ([1]) encountered in the survey was *Syzygium guineense*. The

(1) • Blue Star rating is a system to indicate when species may be widespread internationally but relatively rare and therefore sensitive within Ghana. In the star categories of conservation; Black, Gold and Blue stars are of concern due to their rarity at at one

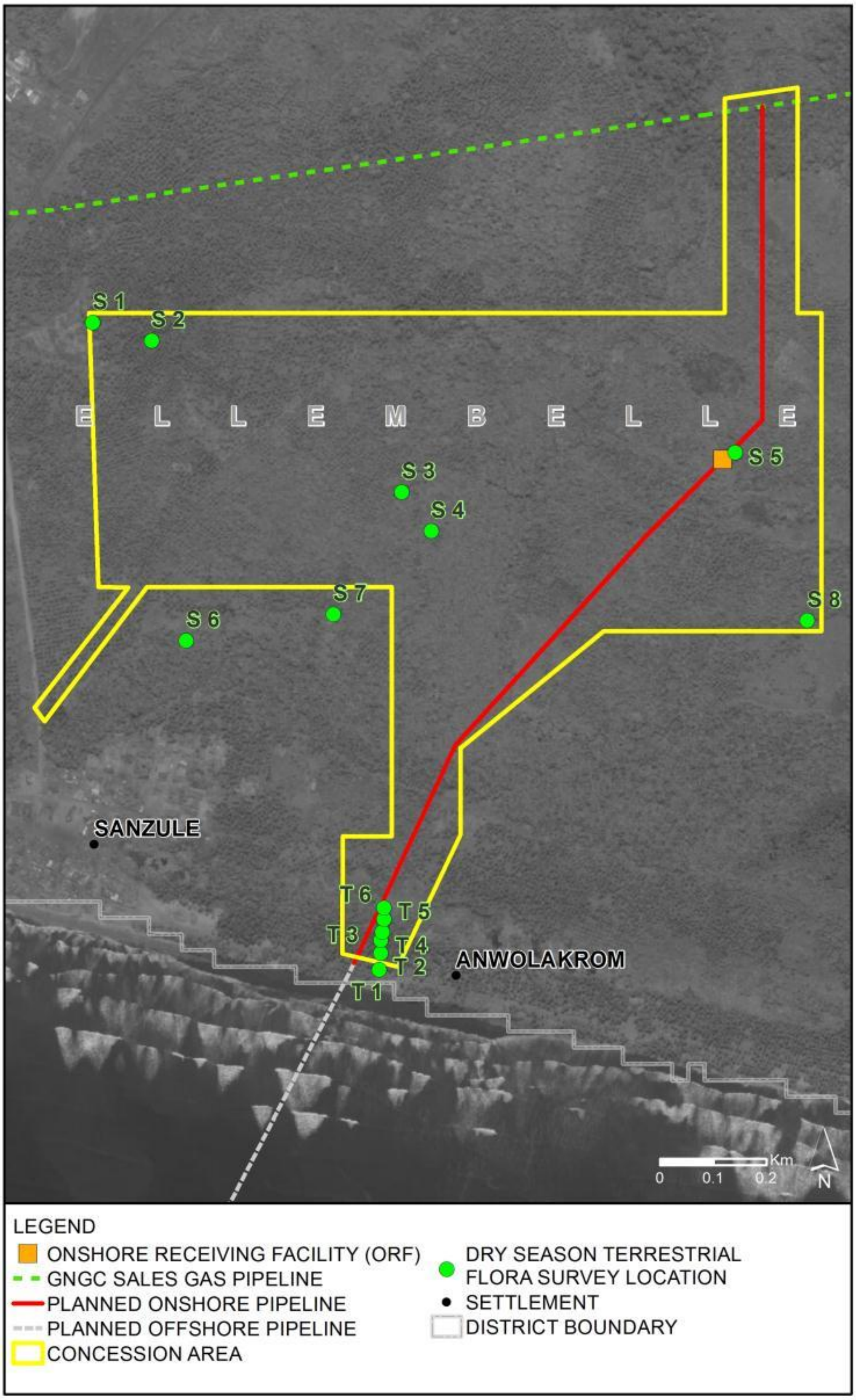
Pioneer Index (PI) is an indicator of pioneer plant species on the site. The majority of the samples had PI values above 100 meaning that locations were well populated with pioneer species. Pioneer species encountered include Alchorneacordifolia, *Cleistopholis patens*, *Flagellaria guineensis, Macaranga barteri, Rauvolfia vomitoria, Sterculia tragacantha* and *Voacanga africana*.

- **Dry season.** A total of 148 plant species in 124 genera belonging to 56 families were recorded during the dry season survey. The family Euphorbiaceae dominates the flora with 12 species. This was followed by Papilionaceae with 11 species, Rubiaceae (10 species), Apocynaceae (eight (8) species) and Annonaceae (six (6) species). Pioneer species formed the majority of the species present. The majority of the species which commonly occur are of no conservation concern (ie, green star) with only one (1) Scarlet and one (1) Red Star species identified. Two species are categorized as Vulnerable: *Albizia ferruginea* and *Coffea macrochlamys*. The majority of the species in the Project area have not yet been assessed by the IUCN.

Figure 6.22 Coconut Plantation within the AoI (oil palm, cassava and banana also present)

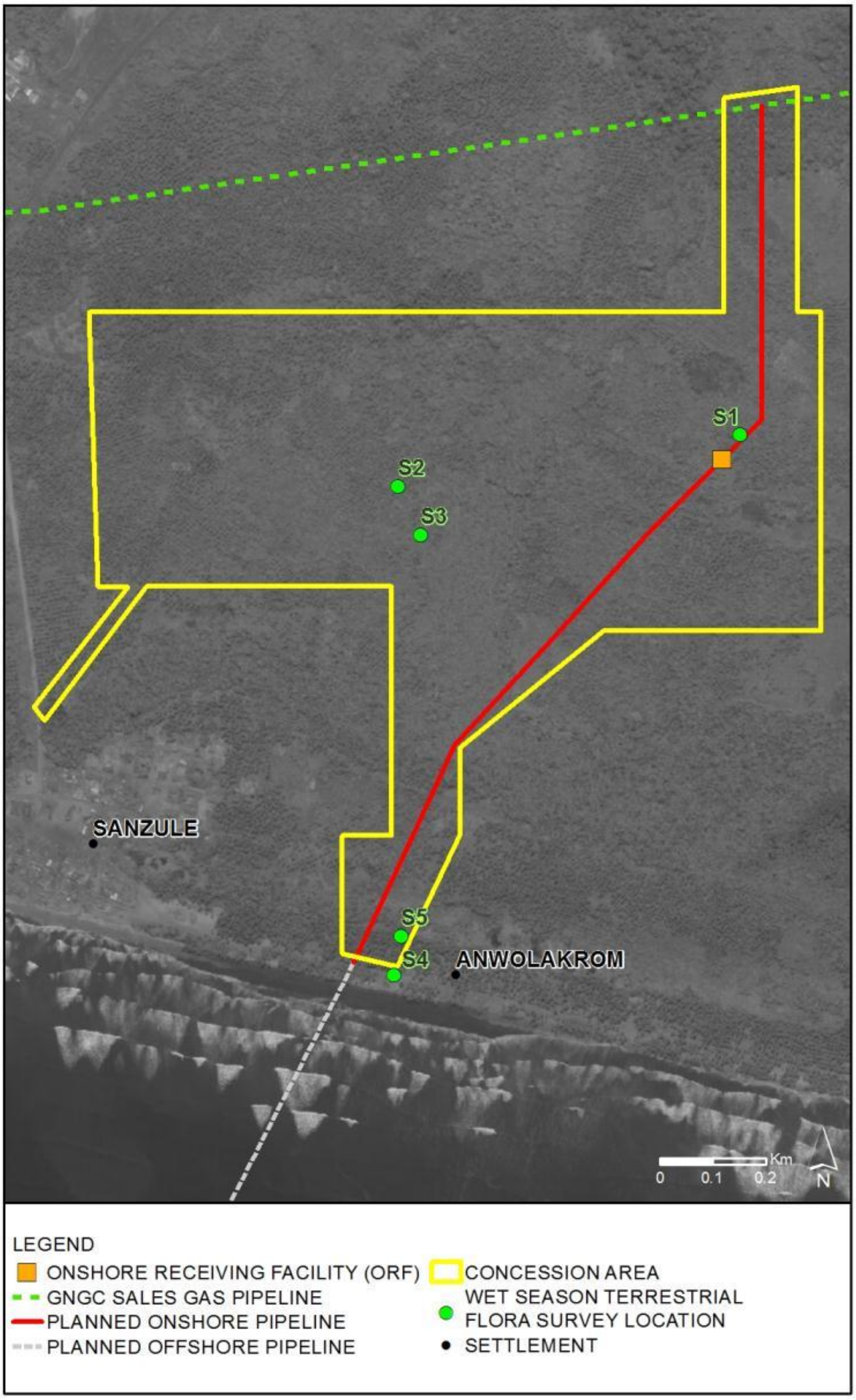
scale or another with Scarlet, Red and Pink stars being of concern due to threats from exploitation. Green stars have no particular conservation status.

Figure 6.23 Flora Sampling Locations (dry season)



Source: ESL (2014)

Figure 6.24 Flora sampling locations (wet season)



Source: ESL (2014)

Figure 6.25 *Pneumatopteris afer* and Raphia Growing in a Swampy Area

6.5.2 Habitats Classification within the Area of Influence (AoI)

Habitat is defined as a terrestrial, freshwater, or marine geographical unit or airway that supports assemblages of living organisms and their interactions with the non-living environment (IFC PS6, 2012). According to IFC Performance Standard 6 (PS6), habitats are classified as modified or natural. Critical habitats are also recognised which can be based on a modified or natural habitat. The definitions of these habitats are:

- *Modified Habitat:* Modified habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands. The developer is required to mitigate impacts to biodiversity within modified habitats as appropriate.

- *Natural Habitat*: Natural habitats are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition. Based on IFC PS6 mitigation for any impacts is required to show No Net Loss of Biodiversity. Biodiversity Offsets may be required on a basis of like-for-like or better.

- *Critical Habitat:* Critical habitats are areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered (1) species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes. Avoidance is the preferred mitigation promoted by the IFC PS6, alternatively mitigation must demonstrate Net Gains within the key Biodiversity Values. There is a high likelihood for developments within Critical Habitats to require a Biodiversity Offset.

A land cover map showing existing landcover can be seen in Annex C and is supported by Figure 6.26 below. A map showing the distribution of the natural, modified and critical habitats along the AoI and the Concession Area is included in Annex C "Habitat Classifiction within the Concession Area**"**. The vegetation within the concession area is in a state of regeneration and the composition is dominated by plant species associated with disturbance, includes many alien species and a number of cultivated species. There was virtually no change in the structure and composition of the wet season vegetation of the site earmarked for the ORF compared to the dry season. The farms and plantations of oil palm and coconut had not seen any expansion in size. Two threatened species were detected but are typically associated with disturbed sites. These tree species are used for timber in a number of countries in West Africa and have been designated for this reason (Hawthorne, 1998). Migratory bird species are known to occur over the general area with their habitat including the wetland areas, the seasonally inundated areas on and around the Project site, and particularly the wetlands to the west and north of the site. Although these species can be expected to occur on the Concession Area, the Concession Area does not contain large areas of wetland habitatsaand the ecological functions will not be modified. Thus, the overall biodiversity value is considered low as this is a small area, has been in a modified state over a period of time and the natural habitat supporting migrating birds is not considered irreplaceable and/or extremely vulnerable.The human activities have changed the ecological functioning and habitat functioning through agricultural uses of the land ie planting of palms as well as the construction of roads. Most of the habitat within the Concession Area can therefore be classified as a Modified Habitat and Natural Habitat. A description of these habitats is reported in the following pararaphs.

Habitats within the AoI

The AoI surrunding the concession area consists of mainly secondary thicket (with coconut and oil palm plantations), freshwater swamp forest and grassland. The freshwater swamp ares are interspersed with grassland with isolated thicket clumps, disturbed areas, and areas of agricultural use. Some of the species identified in the swamp forest are *Hallea stipulosa, Symphonia globulifera* and *Raphia hookeri*. The grassland is dominated by grasses and sedges such as *Panicum maximum*, *Oplismenus burmanii*, *Sporobolus pyramidalis*, *Mariscus longibracteatus*, *Imperata cylindrica*, *Fimbrystylis littoralis* and *Fuirena umbellata*.

<u>*Modified Habitat*</u>

The habitat within the concession area consists largely of modified habitat with a large proportion of the area covered by degraded coconut palm plantations, degraded vegetation and wet evergreen forest with palms. The ecological functing is understood to be modified.

(1) As per the IUCN list of Threatened Species. The determination of critical habitat based on other listings is as follows: *"(i) If the species is listed nationally / regionally as critically endangered or endangered, in countries that have adhered to IUCN guidance, the critical habitat determination will be made on a project by project basis in consultation with competent professionals; and (ii) in instances where nationally or regionally listed species' categorizations do not correspond well to those of the IUCN (e.g., some countries more generally list species as "protected" or "restricted"), an assessment will be conducted to determine the rationale and purpose of the listing. In this case, the critical habitat determination will be based on such an assessment."* (IFC PS 6)

To the south of the concession area and within the AoI coastal coconut palm plantations are planted parallel to the coastline and interspersed between the communities. The areas in vicinity of the communities are also characterised by the presence of modified habitats.

The coastal areas are dominated by regenerating vegetation comprising of palm trees and thorny shrubs (HPI, 2009). Previously forested land is also now understood to be used for tree crop plantations (coconuts, palm oil, rubber), forestry activities and farming. The physical environment of the area has been affected by human activities and no fully natural habitats were observed, although natural areas are reported to occur within the broader AoI.

Natural Habitat

The area to the east of the concession area (approximately 0.5 km from the concession area boundary) 500 is classified as Swamp and Mangrove Forest. Mangroves are expected to occur along the coastal areas of the Western Region at similar locations close to river mouths and provide a habitat for various organisms including maintaining nearshore fisheries as well as being an important area for fish and shellfish production and are highly sensitive to development. These areas have not been cultivated and although there may have been some felling of mangroves, the natural ecosystem processes are expected continue to function and these areas could be described as natural habitat.

The Mangrove swamp woodlands in the area show the typical characteristics of a natural mangrove habitat, with minimal species diversity dominated by Rhigozum and Avicennia species. The presence of very tall Rhigozum trees along the river has also been recorded. The mangrove species are widespread and can be found in other areas along Ghanaian coastline and are not threatened. As such, this area is not considered critical, but as natural habitat with some areas, particularly older stands of mature mangroves, as having particular ecological value.

Critical Habitat

Areas which have the potential to contain critical habitats occur along the coastal beaches where turtles nest, and protection of these beaches is essential to ensure continued breeding by turtles there. Marine turtles spend most of their time at sea except during their breeding season when they lay eggs on sandy beaches. Five species of marine turtles are known to occur along the coast of Ghana all of which are considered to be Critically Endangered or Endangered by the IUCN, except for the olive ridley turtle and the leatherback which are considered Vulnerable. Potential nesting sites cover the whole coast from from the Cote D'Ivoire border to the city of Axim, including the beaches close to human settlements.

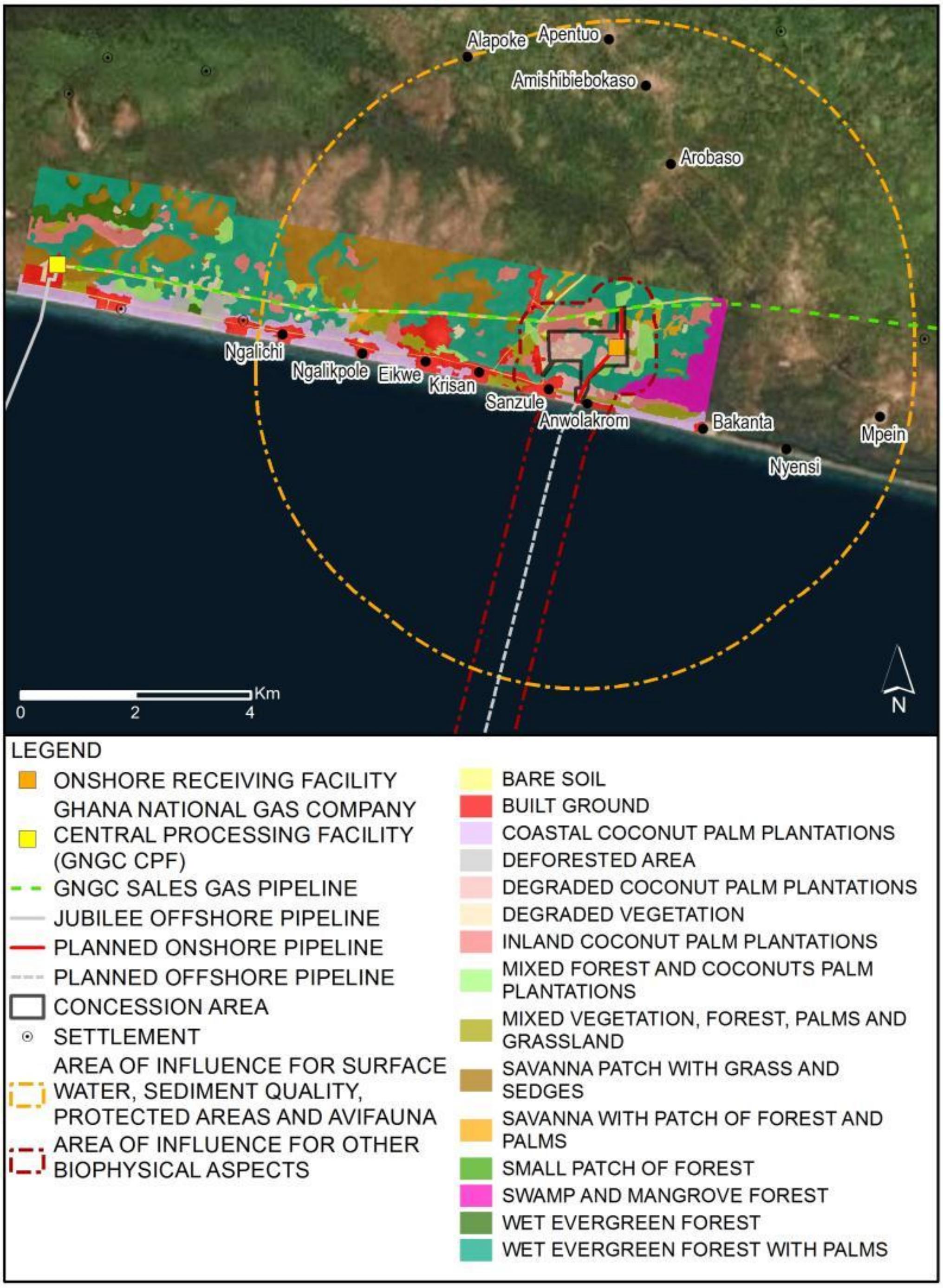
As in the definitions provided above, critical habitats are areas with high biodiversity value including the habitat of Critically Endangered and/or Endangered species. As such, the full stretch of the beach is considered as an area 'potentially critical' habitat while the nesting sites that could be present along the beach are considered to be areas of critical habitat.

With regard to the presence of critical habitats for migratory species, migratory bird species are known to occur over the general area with their habitat including the wetland areas including the seasonally inundated areas on and around the Project site, and particularly the wetlands to the west and north of the site. Although these species can be expected to occur on the concession area, the concession area does not contain large areas of wetland habitats which ecological function has been modified.

With regard to the presence of IBA triggering species (the sanderling - *Calidris alba* - and the royal tern - *Thalasseus maximus* – as reported in Section 6.5.3, the area cannot be considered as a critical habitat for these IBA triggering species due to the following reasons:

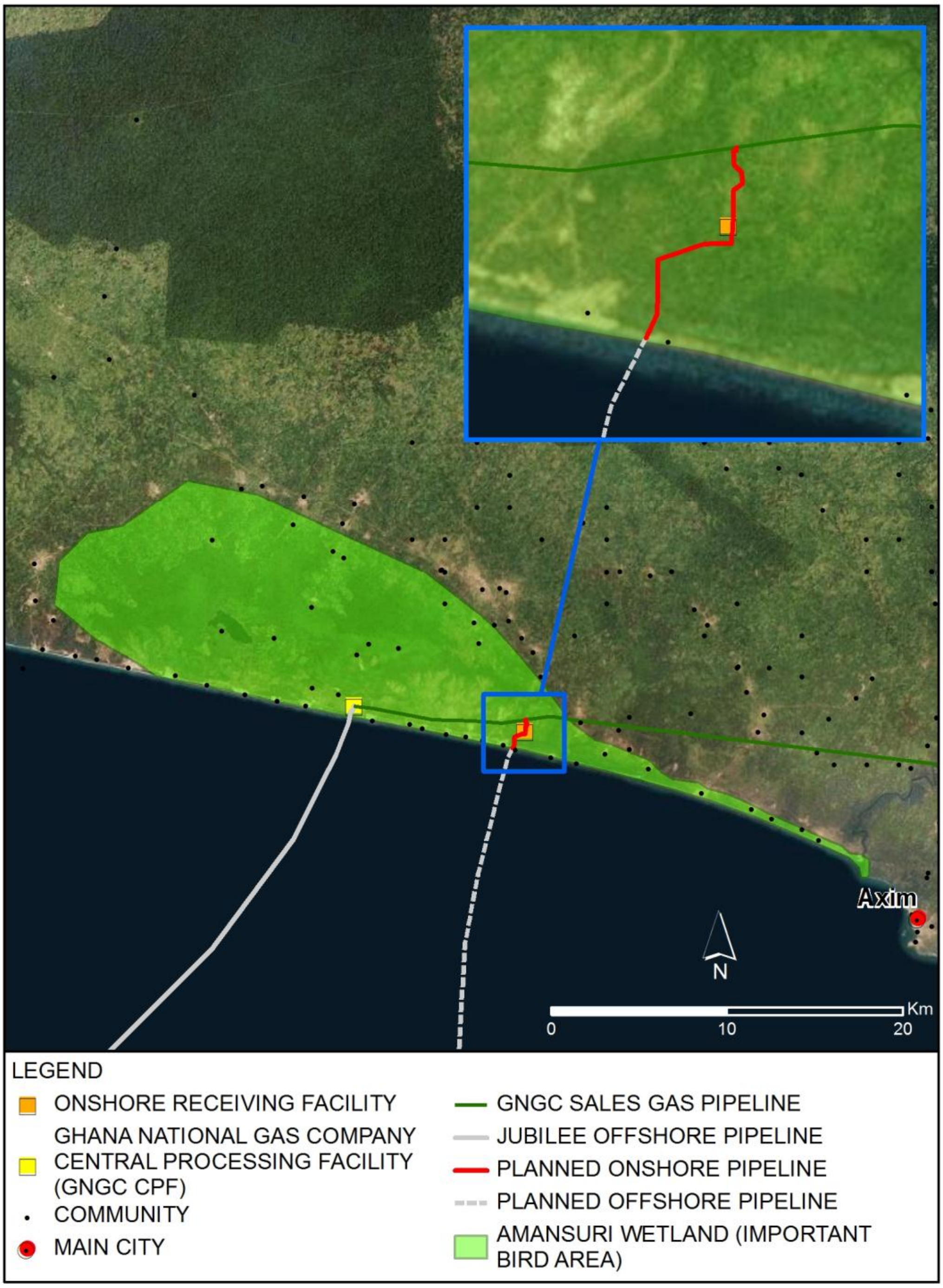
- None of them breed in the area, as they visit the area only in winter and then travel north /East for breeding (in the arctic area), and as a result the habitat does not seem essential for their survival (not a unique habitat in the region, given the different wetlands and beaches along the guinea gulf and the wider region)
- Their conservation status according to the IUCN is Least Concern (not EN or CR as required by IFC PS6).
- There is no evidence that the population visiting the Amansuri wetlands (estimated in 4250 and 700 individuals respectively) constitutes a significant portion of the world population as required by IFC PS6 to design critical habitats. This is supported by the fact that both species can be seen along the western coasts of Africa during wintering period and not only in the Project area.

Figure 6.26 Land cover



Source: ESL (2014)

Figure 6.27 Extent of the IBA



Source: BirdLife International (2015)

6.5.3 Fauna

Regional Fauna

Ghana has large and viable populations of wildlife and a natural environment that support a growing ecotourism industry to complement the nation's strong cultural and historical attractions. Most of these wildlife sanctuaries are located in the Western Region due to the suitable microclimate and diverse habitats provided by the evergreen forest found in most parts of the Region. The wildlife is however largely found in the protected areas which are a refuge from illegal hunting and habitat degradation. Hutterer (2008) reported that in Ghana, the habitats of some forest species are now composed of small, scattered forest fragments being threatened by continuing habitat destruction, fragmentation, and degradation. West Africa more widely has witnessed a large-scale decline in wildlife abundance and diversity mainly due to rapid and widespread loss and fragmentation of habitat.

Terrestrial fauna includes relatively small animals living in areas of primary or secondary vegetation. These include frogs, toads, snakes and mice as well as smaller antelope species such as bushbuck. Notable among the mammals in the Western Region are forest elephant (*Loxodonta cyclotis*), red river hog (*Potamochoerus porcus*), and leopard (*Panthera pardus*). Primates species include Senegalese bush baby (*Galago senegalensis*), Bosman's potto (*Perodicticus potto*), mona monkey (*Cercopithecus mona*), spot-nosed monkey (*Cercopithecus nicticans*), and black-and-white colobus (*Colobus angolensis*).

Eighteen of the mammal species (including *Loxodonta africana cyclotis* (African forest elephant) and leopard (*Panthera pardus))* present in the Amansuri wetland system catchment (including in the the Ankasa Resource Reserve (Section 6.5.4) are of global and national conservation interest (GWS 2006). There are about 27 medium to large mammal species in the Amansuri wetland system indicating a realtively diverse mammalian community.

Reptiles are also well represented in Ankasa (approximately 20 km north of the Project site) and the surrounding areas. The herpetofauna (including turtles) of the wetlands and the nearby coastal area of Western Region comprise about 25 species including three endangered marine turtle species (leatherback turtle (*Dermochelys coriecea*), green turtle (*Chelonia mydas)*, olive ridley turtle (*Lepidochelys olivacea)* and several other species such as the slender-snouted crocodile (*Crocodylus cataphractus)* and Dwarf crocodile (*Osteolamus tetraspis)*. Most of the herpetofauna species are quite common and widespread throughout Ghana (Attuquayefio, 2001).

With the decrease in fish catches in recent years, the hunting of wild animals for sale and consumption of bushmeat has increased sharply. As a result the biomass of terrestrial wildlife species has dramatically declined (World Bank 2006, Brashares *et al.* 2004).

ORF Site

A field survey was conducted across the ORF site and at various locations within the AoI to identify fauna. Survey locations are presented in the Figure 6.28. The findings of these surveys are summarised in the following sections.

Small Mammals

There were eight individuals of three species of small mammals belonging to the order Rodentia (rodents) identified through live-trapping. The species captured were Temminck's pygmy mouse (*Mus musculoides*), soft-furred rats (*Praomys tullbergi*) and the multimammate mouse *(Mastomys erythroleucus)* (Annex B).

Five other small mammal species belonging to the order Rodentia were recorded through direct observation and interviews. These were the giant/pouched rat (*Cricetomys gambianus*), striped ground squirrel *(Euxerus erythropus*), red-headed forest squirrel *(Epixerus ebii)*, brush-tailed porcupine *(Atherurus africanus)* and Beecroft's flying squirrel

(Anomalurus beecrofti) (Annex B). The soft-furred rat (*P. tullbergi*) is a true forest species, while the Temminck's mouse (*Mus musculoides*) is a habitat generalist inhabiting savanna, forest and forest clearings. The striped ground squirrel *(Euxerus erythropus*) is a forest species adapted to forest clearings. *Cricetomys gambianus* is cosmopolitan in Ghana. Both the flying squirrel *(Anomalurus beecrofti)* and squirrel *(Epixerus ebii)* are also known forest species. With the fast degradation of Ghana's forest resources, it is not surprising that typical forest species are being recorded in more open habitats and coastal vegetation.

Large Mammals

No large mammals and and very few spoor were directly observed. The information on large mammals came mainly from interviews conducted with the locals of the area.

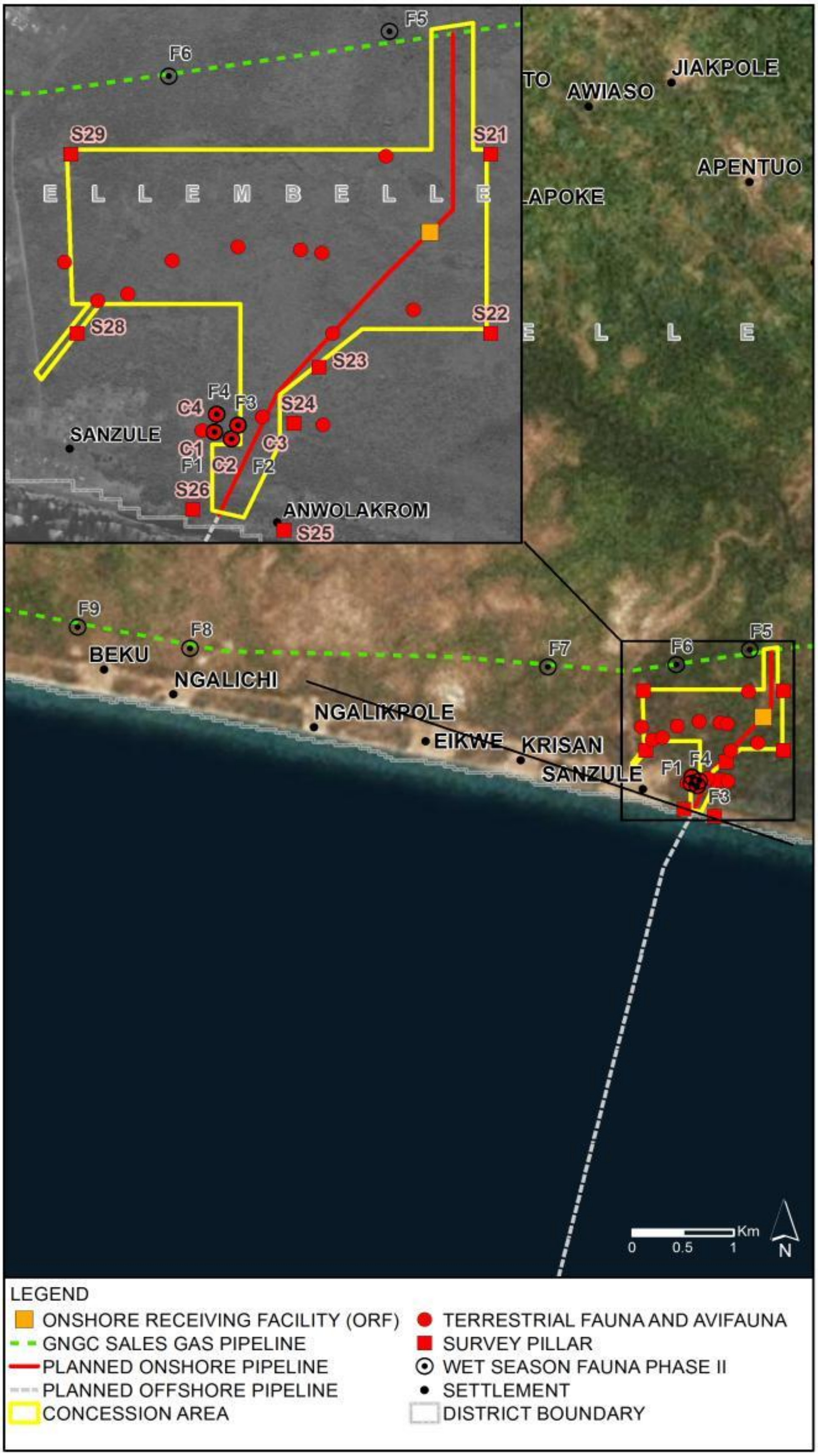
Five orders of large mammals (Pholidota, Primates, Carnivora, Artiodactyla and Hyracoidea) consisting of 21 species are reported to be present (Annex B). All of the large mammals recorded, except two pangolin species *(Phataginus tricuspis* and *Smutsia gigantea)* and the tree hyrax *(Dendrohyrax dorsalis)* are listed as Least Concern by the IUCN. These three species are listed as Near Threatened by the IUCN. The two pangolin species are also listed in the First Schedule of the Ghana Wildlife Conservation Regulations (for complete protection) while the tree hyrax is listed in the Second Schedule (for partial protection). Three of the remaining species are listed under the First Schedule of the Ghana Wildlife Regulations *(Galago senegalensis, Perodicticus potto* and *Colobus polykomos)* while the rest are all Schedule 2 species.

Herpetofauna

Herpetofauna species *(amphibians and reptiles)* are common and widespread throughout Ghana (Attuquayefio, 2001). Tables 1 and 2 present the list of wildlife species with the international and national protection status that oc cur in the Amanzuri and its surrounding areas.

During the surveys, 29 herpetofaunal species belonging to 15 families were recorded at the Project site. These included five amphibian species and 24 reptile species (three chelonian species, seven lizard species and 14 snake species) (Annex B).

Figure 6.28 Fauna sampling locations



Source: ESL (2015)

It was reported by communities in the area that a crocodile was sighted near Eikwe, but this has not been substantiated.

Avifauna

The west coast of Africa forms an important section of the East Atlantic Flyway, an internationally-important migration route for a range of bird species, especially shore birds and seabirds (Boere et al, 2006; Flegg 2004). The highest concentrations of seabirds are experienced during the spring and autumn migrations, around March and April, and September and October. Waders are present during the winter months between October and March.. Seabirds known to follow this migration route include a number of tern species (*Sterna spp*), skuas (*Stercorarius and Catharacta spp*) and petrels (*Hydrobatidae*). Species of waders include sanderling (*Calidris alba*) and knot (*Calidris canuta*) and are associated also with the wetland areas in the Western Region.

The Amansuri wetlands have a relatively rich indigenous avifauna and also receive significant number of migrant species especially at the beach between the Ankobra and Amanzuri Estuaries. This stretch of beach is particularly noted for sanderling, Eurasian oyster catcher and bar-tailed godwit. Over 250 bird species are known in the western coastal areas of the Western Region and this includes the hooded vulture (*Necrosyrtes monachus*) (Endangered), green-tailed Bristlebill (*Bleda eximia*) (Vulnerable), grey parrot (*Psittacus erithacus*) (Near Threatened), and Olive Greenbul (*Criniger olivaceous*) (Vulnerable), Copper-tailed glossy starling (*Lamprotornis cupreocauda*) (Near Threatened) all of which are listed on the IUCN Red List of Threatened species (GWS, 2006). Due to its ornithological importance, the area has been designated as an Important Bird Area (IBA). Populations of IBA trigger species include Sanderling (*Calidris alba*) and Royal Tern (*Thalasseus maximus*) (BirdLife International, 2015), which spend the winter in the coast of Ghana before departing to their breeding areas in the north. The main habitat for these species are the sandy beaches and secondarily they inhabit the shores of lakes and rivers and tidal sand flats.

During the surveys, 52 species of birds belonging to 24 families were recorded (Annex B), of which all are of Least Concern on the IUCN Red List. The common swift, village weaver, African palm swift, orange-cheeked waxbill, red-eyed dove, little bee-eater, pied crow, common bulbul, and the yellow-billed kite were the most abundant species (Annex B). A total of 11 bird species (i.e., 21 percent of total species) known to be associated with forest and forest/ savanna were recorded at the site and 17 percent (nine species) recorded are considered to be strict woodland and savanna woodland species. The intermediate egret (*Egretta intermedia*), black-headed heron (*Ardea melanocephala*), grey heron (*Ardea cinerea*) and the little stint (*Calidris minuta*) were recorded within the concession (in areas associated with water), although the black-headed heron is largely terrestrial, frequenting grasslands and cultivated areas rather than aquatic vegetation.

All the birds of prey belonging to the family Accipitridae recorded are wholly protected under the Ghana Wildlife Conservation Regulations (Wildlife Division, 1998). The presence of the yellow-billed kite, hooded vulture and African goshawk confirm the conservation importance of the area. It was also noted that there is a waste disposal site near Sanzule where domestic waste is disposed. These areas tend to attract large numbers of birds scavenging for food.

This survey has provided only a partial avifaunal species list for the area as results from surveys of bird species for any site depend on many factors, including intensity of surveys and experience of observers (Gartshore *et al*., 1995; Ntiamoa-Baidu *et al*., 2000). Therefore it is acknowledged that a complete list for a site would require a longer period (at least all-year-round) of survey effort and that at least 20 counts are necessary for the accumulation of species to show to the level characteristic of an area (Gartshore *et al*., 1995; Ntiamoa- Baidu *et al*., 2000). This survey lasted two days and cannot be considered to have produced an exhaustive list for the site. The 52 species recorded in the whole area and total numbers of birds compare well with data from forest reserves in southern Ghana (Holbech, 1996; Ntiamoa-Baidu *et al.,* 2001). Although the information obtained for the period surveyed provides a sufficiently robust baseline of the avifauna of the area to define the sentivity of the receptors, it is expected that additional species may occur, which were not observed during these surveys.

6.5.4 Legally Protected and Important Areas

Officially Designated Areas

Protected areas worldwide have been created with the purpose of contributing to the protection of biodiversity by limiting the activities that can be carried out in these areas and in some cases they have been stablished for tourism development.

Currently across Ghana there are 18 wildlife protected areas that include seven national parks, six resources reserves, four wildlife sanctuaries and five coastal Ramsar sites. All of the areas are located onshore; no marine protected areas have been designated. In addition to the mentioned areas, the country also hosts several forest reserves.

The coastal districts of the Western Region, hold one of these protected areas, namely the Ankasa Conservation Area, and several forest reserves. The full list and the distances to the protected areas from the Project are presented in Table 6.30 and can be seen in Figure 6.29.

Table 6.30 Protected Areas in the Vicinity of the Project

Name	Type of protection	Minimum distance to Project footprint
Ankasa	• National Park • Resource reserve	25 km
Ebi Shelterbelt River	• Forest Reserve	18 km
Draw River	• Forest Reserve	25 km
Ndumfri	• Forest Reserve	32 km
Cape Three Points	• Forest Reserve	42 km
Neung South	• Forest Reserve	40 km

Source WDPA, 2014.

There are five RAMSAR areas in Ghana, designated for their important coastal habitats and the presence of rare and endangered species. However none of these sites is located in the Western Region, and the closest Ramsar site, the Muni Lagoon, is located more than 200 km east of the Project area.

The following is further description of the Ankasa Conservation Area and the Cape Three Points Forest Reserve, the most significant protected areas in the general area of the Project.

Ankasa Conservation Area

The Ankasa Conservation Area comprises of two different protection areas: the *Ankasa Resource Reserve* and the *Nini-Suhyien National Park*. Together they occupy a land area of 509 km^2 within three districts in the Western Region: Jomoro District, Nzema East District and Amenfi-West District.

Located 25 km west of the project area, it is a rainforest considered to have the highest biodiversity in Ghana with approximately 800 flora species, including several species that are considered endemic (Allotey, 2007). It represents the only wet evergreen protected area in a natural and almost pristine state. Due to the distance between the location of the onshore Project activities and the Ankasa Conservation Area, it is not expected that the Project will have an effect on this area.

Ankasa hosts at least nine primate species including chimpanzees, Diana monkey, Mangabey and the Geoffrey's pied colobus, the white-naped mangabey and three unconfirmed species which may include western chimpanzee, the Roloway Diana monkey and the western black-and-white colobus. Viable populations of large mammals such as the forest elephant, bongo and yellow backed duiker can also be observed within the boundaries of this reserve, together with the giant forest hog, giant pangolin, water chevrotain and leopards. It has also a diverse avifauna population and up to 600 butterfly species.

Cape Three Points Forest Reserve

The Cape Three Points Reserve is located approximately 42 km to the east of the onshore Project area. This reserve was designated to protect the last remnant of primary coastal forest, in which in the past extended along major segments of the coastline of the Gulf of Guinea (CRC-URI, 2010). It is known to provide habitat for over 170 species of birds (Dowsett-Lemaire, 2005; Ntiamoa-Baidu *et al*, 2001).

The Project activities are not expected to have any effect on the reserve. The transport of materials or personnel between Takoradi Port and Project site will be performed by means of roads that do not cross through the designated area.

Other Areas of Conservation Interest

In addition to the officially designated areas, Ghana hosts approximately 40 Important Bird Areas (IBAs), which are designated by Birdlife International (Birdlife International, 2011). These areas are not officially designated by national or international authorities, though are considered relevant due to their natural values, and especially for their importance for the avifauna.

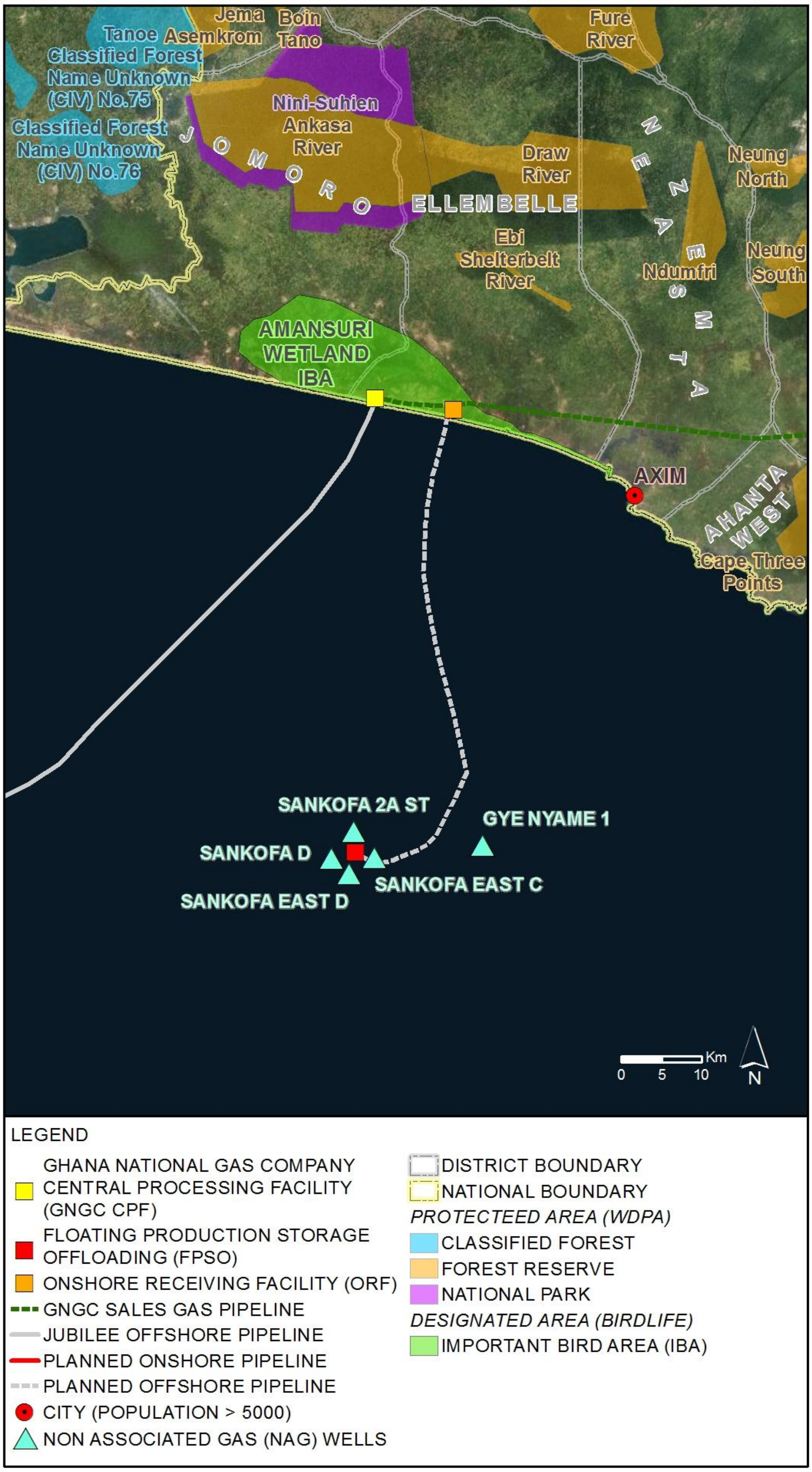
The proposed project location on its onshore component lies within the boundaries of one of these IBAs, the Amansuri wetland (Figure 6.29). Key bird species that trigger the designation of this area as an IBA are the sanderling (*Calidris alba*) and the royal tern (*Thalasseus maximus*). None of them were observed in the area during the dry and wet season surveys. However this could be due to the fact that both species are present in northern hemisphere winter season, while the baseline studies were conducted during April and October.

This wetland system includes the freshwater Amansuri Lake (located northwest of the site, within the Project AoI) as the main element of interest within the site, the floodplains of the Amansuri River up to the coast and the beach (where the project is located), the coastal Amansuri River lagoon and estuary, and the sandy Esiama beach, between the Amansuri and Ankobra Rivers, which hosts the largest stand of intact swamp-forest in Ghana.

The Amansuri wetland is the largest stand of intact swamp-forest in Ghana, with large portions of the wetland still in a relatively pristine condition. It is considered as a blackwater area, and as such, the fauna on the site is species-poor, but distinctive. The extent of the area covered by wetland habitats within the AoI is included in a map in Annex C.

The Ghana Wildlife Society with funding from the Dutch government is involved in a process to designate the Amansuri area as a Ramsar site (Birdlife International, 2012) and the establishment of the area as a Community Nature Reserve. The area is used by local communities such as the Nzulenso, as they fish within the freshwater lagoon. It has been understood from the office of the Executive Director of RAMSAR (Ghana) that the boundary of the RAMSAR site is not currently confirmed but will be within the boundary of the IBA (per comms).

Figure 6.29 Protected and Designated Areas in the Vicinity of the Project



Source WDPA, 2014.

6.6 OFFSHORE BIOLOGICAL COMPONENTS

6.6.1 Plankton

The plankton, including phytoplankton and zooplankton, constitutes the basis of trophic chains in marine ecosystems.

To analyze the plankton community of the Project area, sampling was were undertaken at a total of 8 observation stations located off the coast of Sanzule.

6.6.1.1 Phytoplankton

In the marine ecosystem, phytoplankton occupies the first position in the food chain and plays an important role in determining the existence of biological resources. Phytoplankton organisms are microscopic and range between 30 μm and 60 μm in size. The composition and abundance of plankton is variable throughout the year and depends mainly of water circulation patterns, light, temperature, salinity, and nutrients (Nybakken, 1992 & Odum, 1971). However, main limiting factor influencing the development of phytoplankton is the presence of nutrients, especially Nitrate and Phosphate (Nybakken, 1992). In the coasts off Ghana it is known that phytoplankton abundance increases during upwelling events when nutrient availability increases.

The productivity, in the form of phytoplankton can be indirectly estimated by the observation of the Chlorophyll-a concentration using satellite image interpretation. Results show that the area can be classified as a Class I, highly productive (>300 gC/m^{2}yr) as values during the upwelling seasons (April and August) reach 1,250 mgC/m^2/day. In the absence of upwelling phenomenon the productivity declines to values below 250 mg C/m^2/day (Sea Around Us Project, 2008). Results of the sampling are presented in table below and in the following sections.

Table 6.31 Phytoplankton Distribution

Station	Sampling Depth	Abundance [Ind/l]	Number of Taxa
1	1 m	58740	30
	Middle	6048	26
	Bottom	5828	24
5	1 m	95085	30
	Middle	22272	31
	Bottom	8627	26
8	1 m	14484	27
	Middle	34525	31
	Bottom	22782	33
12	1 m	17835	31
	Middle	35166	35
	Bottom	223267	25
24	1 m	243191	29
	Bottom	557660	25
38	1 m	20	2
	100 m	2719	8
	200 m	0	0
46	1 m	3609	13
	100 m	2399	8
	200 m	0	0
50	1 m	220	7
	100 m	7546	3
	200 m	10	1

Source: Fugro (2013)

A total of 92 phytoplankton species were identified in the samples along the proposed pipeline route and in the nearshore area in the sampling carried out in February 2013. A total of 27 species were recorded in April 2013 in the area where the wells are planned .

In both samplings more than half the diversity was due to the diatoms (Bacillariophyceae with 51 and 14 species in each sampling period), followed by dinoflagellates (Dinophyceae) (31 and 10 species). The remaining taxa recorded include microflagellates, cyanophytes (blue-green algae), Euglenophyta and a single species of silicoflagellate, *Dictyocha fibula*.

The abundance or the density of phytoplankton from sampling locations ranged from 0 to 557,660 individuals/l, and the number of species monitored varied between 0 and 35. The highest abundance was found at Station 12 in the middle of the water column with 35 different species.

The most abundant group was also the diatoms with 66.5% of all the individuals recorded in the February sampling. The single most abundantly occurring taxon was the diatom *Leptocylindrus danicus* with a mean density of 28,022 ind/l. However, in the April sampling microflagellates were the most abundant taxa with 77% of the individuals, revealing certain differences in plankton communities between the stations located along pipeline route survey and those located on deeper areas where the wells are planned.

A comparison of the data collected in both samplings, reveals that the abundance and diversity of phytoplankton was higher in February than in April, probably due to the effect of the minor upwelling season and the higher nutrient content. It also reveals a coastal effect as the diversity and abundance seem to increase when approaching the shoreline.

6.6.1.2 Zooplankton

Zooplankton organisms are heterotrophic and rely on phytoplankton as a food source, becoming the first consumer in the food chain. Zooplankton includes a range of organism sizes including small protozoans and large metazoans. It includes holoplanktonic organisms, whose complete life cycle lies within the plankton, as well as meroplanktonic organisms that spend only part of their lives in the plankton (i.e. fish eggs). Offshore zooplankton assemblages are dominated by copepods, followed by Ostracods (1), Appendicularians (2) and Chaetognaths (3). Maximum zooplankton abundance usually takes place during the major upwelling (June-October) and to a minor extent during the minor upwelling (December-February) following the increase on primary productivity by phytoplankton.

Results of the sampling are presented in table below and in the following subsections for each of the sampling surveys conducted.

Table 6.32 Zooplankton Distribution

Station	Abundance [Ind/m^3]	Number of Taxa	Copepod density (%)	Meroplankton density (%)
1	4186	62	75.4	3.6
5	7635	67	75.9	1.5
8	14390	44	68.2	1.4
12	12737	39	63.1	4.7
24	29889	31	96.6	1.1
38	211	62	94.2	0.3
46	1892	94	59.0	7.6
50	1758	65	67.9	11.2

Source: Fugro (2013)

A total of 95 zooplankton species were identified in the samples along the proposed pipeline route and in the nearshore area in February 2013. A total of 132 species were identified in in April 2013 the area where the wells. The most diverse group were the Copepoda (13 species) with a large proportion of these belonging to the order Calanoida. Copepoda also dominated

(1) Ostracoda is a class of the Crustacea, sometimes known as the seed shrimp because of their appearance.
(2) Larvaceans (Class Appendicularia) are solitary, free-swimming underwater saclike filter feeders found throughout the world's oceans.
(3) Chaetognatha is a phylum of predatory marine worms that are a major component of plankton worldwide.

the zooplankton in terms of abundance with 80.9% of all individuals belonging to this group in February and 60% in April.

Meroplankton organisms were comparatively rare in the samples constituting less than 4% of the total density in both samplings. Fish eggs (Ichthyoplankton) accounted for a small percentage of the total individuals recorded being only 0.6%.

As in the case of phytoplankton, the abundance of zooplankton is reduced in the offshore areas sampled in April when compared to the more coastal and shallower areas sampled in February. This is a direct consequence of the higher concentration of phytoplankton. In fact, zooplankton utilizes phytoplankton as a food source; therefore, its abundance is highly influenced by the abundance of phytoplankton. In any case zooplankton community composition does not present significant correlation with depth.

6.6.2 Benthos

Benthic community lives in or near marine sedimentary environments, from tidal pools along the foreshore, out to the continental shelf, and then down to the abyssal depths.

Benthos is generally divided into three distinct groups:

- Endobenthos, animals that live buried or burrowing in the sediment, often in the oxygenated top layer (eg, sea pen, sand dollar);
- Epibenthos, animals that live on the surface of the sediment or on other substrate such as debris (eg, sea cucumber); and
- Hyperbenthos, animals that live just above the sediment (eg, rock cod, bottom-dwelling fish, other free moving organisms).

Benthic communites are sensitive to pollution levels, including organic pollution, and respond to this disturbance through measurable changes in population size on a time scale of weeks to years (Warwick, 1993).

Table 6.33 Benthos Biodiversity

Station	Abundance [Ind/0.1m^2]	Number of Taxa	Shannon-Wiener (H') Diversity index
1	65	37	3.4
2	76	49	3.7
3	113	61	3.7
4	78	45	3.6
5	68	36	3.4
6	94	52	3.6
7	120	69	3.9
8	123	74	4.1
9	65	39	3.4

Station	Abundance [Ind/0.1m^2]	Number of Taxa	Shannon-Wiener (H') Diversity index
10	120	56	3.7
11	157	64	3.8
12	274	106	4.2
13	117	53	3.7
14	19	11	2.0
15	34	19	2.7
16	202	59	3.5
17	79	40	3.3
18	102	43	3.5
19	225	64	3.3
20	108	41	3.1
21	54	19	2.5
22	181	44	3.3
23	158	38	3.1
25	48	12	1.7
26	33	19	2.8
27	23	18	2.8
28	322	63	3.0
29	240	70	3.6
30	314	55	2.1
31	26	12	2.1
32	95	34	3.1
33	146	54	3.4
34	184	53	2.9
35	95	20	2.1
36	131	33	2.0
38	5	3	1.0
39	11	8	2.0
40	-	-	-
41	4	4	1.4
42	5	5	1.6
43	10	7	1.8
44	37	23	2.9
45	9	7	1.9
46	9	8	2.0
47	21	7	1.1
48	17	9	1.9
49	36	16	2.5

Source: Fugro (2013)

As reported in the Table above (Table 6.33), abundance of Benthos in stations 38 and 42 was significantly low and thus it could indicate a certain level of impact due to heavy metals and hydrocarbon content in sediments in those stations (high levels of Cr, Ni and Ba, and moderate levels of TPH and PAH). The significantly low presence of Benthos in station 41 could show that the station have been impacted by the drilling of a nearby well as indicated by the hydrocarbon presence in the sediment; while station 40 was sampled but no macrofauna individuals were recovered.

February 2013 Survey

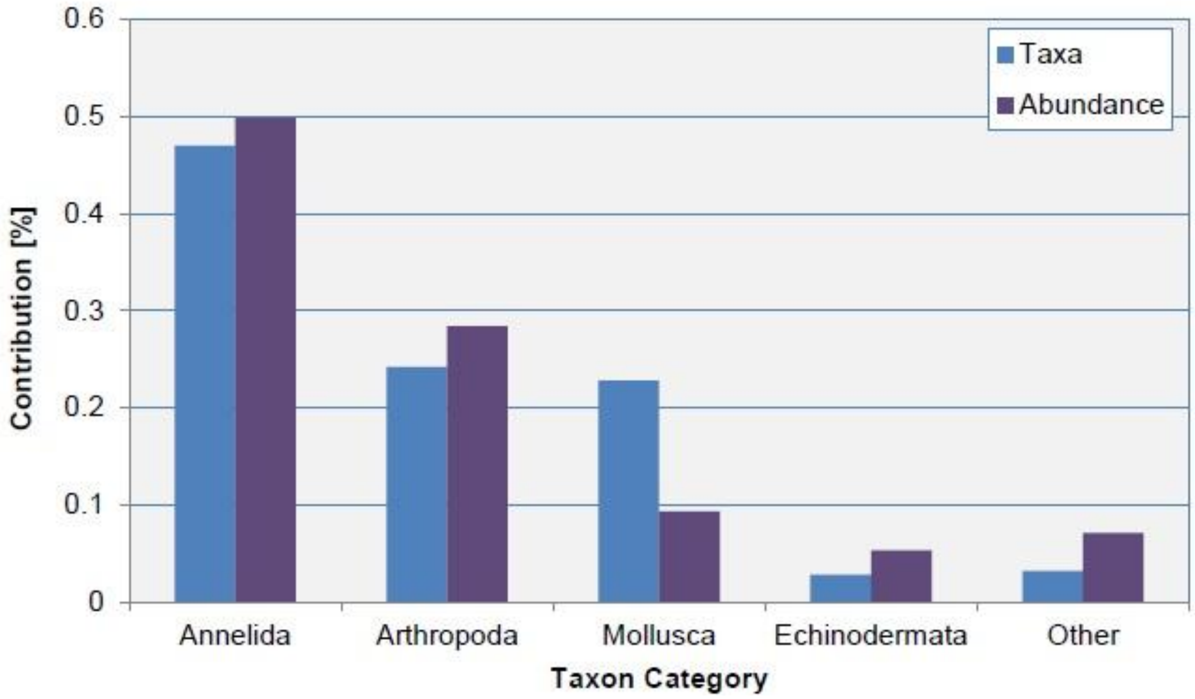
A total of 526 macrofaunal taxa from 11 phyla were recorded along the proposed pipeline route and in the nearshore area. The most diverse group were the annelids (233 species) followed by crustaceans (120 species), molluscs (113 species) and echinoderms (14 species). Representatives of the phyla Sipuncula, Chordata, Cnidaria, Brachiopoda, Nemertea, Phoronida and Echiura were also recorded.

In terms of abundance, Annelida were dominant, representing almost half (49.8%) of the 5,219 individuals recorded. Crustacea, Mollusca and Echinodermata represented 28.4%, 9.4%, and 5.3%, respectively. Other taxa made up 7.1% of the total abundance, of which the Sipunculans contributed 4.4%.

Ampelisca sp. A (325 individuals) was found to be the most abundant species, and identified in 60% of the stations surveyed. The sabellid polychaete *Owenia* spp. (279 individuals) was also abundant but patchily distributed with most individuals found at two stations (188 individuals at station 30 and 77 at station 36). The terebellid polychaete *Pterolysippe bipennata* was the third most abundant taxon (274 individuals) appearing at 57.8% of the stations surveyed. The spinuculid *Onchnesoma steenstrupii* was both abundant (152 individuals) and frequently observed, being found at 60% of the stations surveyed.

Diversity, expressed as the Shannon-Wiener diversity index was moderate along the survey, with a mean for all stations of 3.2 (±0.7, SD), though it ranged from 1.7 to 4.2, suggesting that diversity was much lower at certain stations. Despite some stations showed that a few species dominated the whole composition, in general the results showed that the predominant trend was for abundance to be evenly spread between the occurring taxa.

Figure 6.30 Abundance of major taxonomic groups in benthic samples (February 2013)



Source: Fugro (2013)

<u>April 2013 Survey</u>

A total of 91 macrofaunal taxa from 8 phyla were recorded in the area where the wells are planned. The most diverse group were the annelids (54 species) followed by crustaceans (14 species), molluscs (13 species), suipunculids (4 species) and echinoderms (3 species). Representatives of the phyla Cnidaria, Nemertea and Echiura were also recorded.

In terms of abundance, annelids are dominant, representing half (50.9%) of the 269 individuals recorded. Arthropods, molluscs and echinoderms represent 10.4%, 13.4%, and 1.1% of the total abundance, respectively. Mean macrofaunal density per sample is 11.2 individuals per 0.1 m^2 indicating that abundance was highly variable between samples.

In general, the abundance of macrofauna is low, a maximum of 18 individuals in total recorded for any single species in the 11 stations considered. The most abundant species are the sipunculid *Onchnesoma steenstrupii* and *Echiura sp. A*. (18 individuals each), though both were recorded only from a single station. The sipunculid *Apionsoma sp.* and the bivalve *Medicula ferrigunosa* were also rather abundant (17 individuals each), though appear more widely distributed at approximately 24% and 33% of all stations respectively. Other species which are relatively abundant include the eunicid polychaete *Aponuphis sp. A*., and the terebellid polychaete *Monticellina sp.* (14 individuals each).

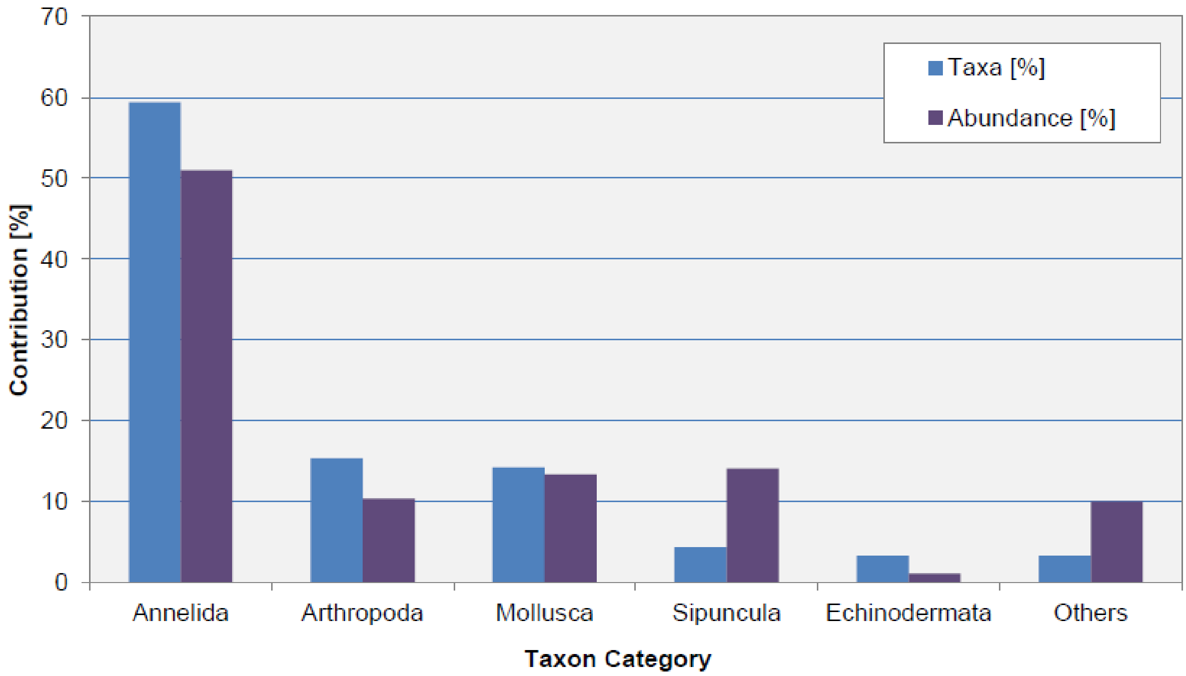
These results indicate that the benthic community is spatially variable. This is possibly a function of differing community assemblages between stations or possibly a result of the very low abundance, resulting in very few characterising taxa per station making it difficult to resolve similarities or differences in the community structure.

Diversity, expressed as the Shannon-Wiener diversity index was low along the survey, with a mean for all stations of 1.5 (±0.8, SD), though it ranged from 0 to 2.9, suggesting that diversity was much lower at certain stations, while it is relatively high at others. Despite some stations showed that a few species dominated the whole composition, in general the results showed that the predominant trend was for abundance to be evenly spread between the occurring taxa, as was the case in the stations in shallower water along the pipeline route.

The total number of species at each station appears to be negatively correlated with depth and the proportion of sediment fines, which is also consistent with the differences found in terms of abundance and diversity between both samplings conducted as the area surveyed around the wells is far deeper than the one where the pipeline will be installed.

No important benthic communities were identified along the proposed pipeline route and in the nearshore area.

Figure 6.31 Abundance of major taxonomic groups in benthic samples (April 2013)

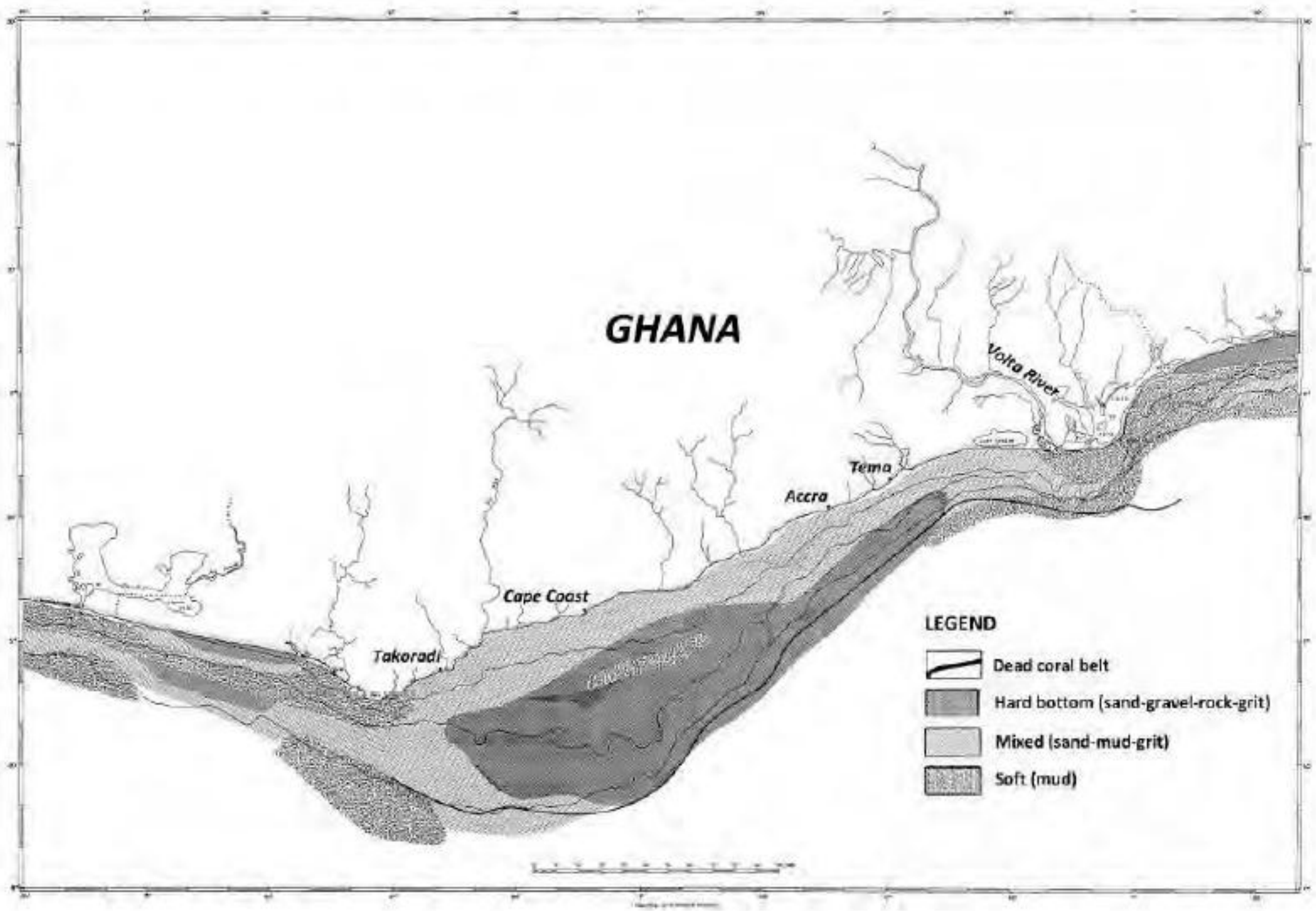


Source: Fugro (2013)

6.6.3 Corals

Corals are rare along the west coasts of Africa, due primarily to upwelling and strong cold coastal currents that reduce water temperatures (Nybakken, 1997). It is known, however that the continental shelf of Ghana, between Takoradi and the border with Togo, about 30 km East of the Area of Influence of the Project , is traversed by a belt of dead madreporarian coral at around 75 m water depth.

Figure 6.32 Location of coral along the coast of Ghana



Source: Martos *et al.*, 1991

In the study area, the presence of corals, according to the several surveys conducted, is limited to isolated individuals. The EAF Nansen cruise in 2009 recorded the presence of two individuals of *Hexacorallia* at 28 meters depth in front of Atuabo, more than 10 km west of the proposed offshore pipeline route.

Additionally, on sampling points 9 and 29 (respectively at 51 m, 15 m depth) isolated individuals of the order Actiniaria were recorded in the vicinity of the proposed pipeline route. Therefore, the presence of additional coral individuals in shallow waters cannot be discarded.

No larger coral communities where identified within the study area of influence during the marine survey.

6.6.1.3 Deep Water Corals

The distribution of deep water corals (also called cold water corals) is poorly known worldwide, given that they inhabit deep areas where few surveys have been conducted. These corals do not form reefs, but they aggregate in small colonies in patches commonly found along bathymetric highs such as seamounts, ridges, pinnacles and mounds in depths up to 2000 m.

Although these corals do not generate reefs, these corals are also key on the formation of deep benthic habitats as they provide substrate, shelter and food for other invertebrates and fish.

The presence of deep corals such as *Lophelia pertusa* and *Oculina varicose* in the waters along the AoI of the project cannot be discarded. However, no individuals or colonies of such corals have been observed as a result of the surveys conducted by Fugro along the proposed pipeline route and in the vicinity of the proposed NAG wells.

6.6.4 Chemosynthetic communities

In water depths where light is absent, there may be communities that rely on seepage of hydrocarbons, venting of hydrothermal fluids or other geological processes as the main source of nutrients as certain organisms are able to process inorganic molecules through chemoshyntesis to convert them into organic compounds.

This type of communities generally lives close to hydrothermal vents and cold seeps. Bacteria that metabolise methane and hydrogen sulphide sustain the community, which also include with tubeworms and several species of molluscs. .

In the Gulf of Guinea these communities have been recorded near the Congo deep channel, the Congo margin, Gabon margin (Olu K., Cordes E. E., Fisher C. R., Brooks J. M., Sibuet M. & Desbruyères D. (2010), as well as in offshore Nigeria at small mounds at depths between 1,600 and 2,200 m (Brooks and Bernard, 2006). In Ghana, Nibbelink and Huggard (2002) reported the evidence of gas seeps in submarine canyons facing the Volta River which could possibly host this type of community.

Within the Project AoI, however, there is no evidence of such structures that could host chemosynthetic communities. During the surveys carried out by Fugro along the proposed wells locations and pipeline route no chemosynthetic communities were recorded.

6.6.5 Molluscs and Crustaceans

A variety of mollusks and crustaceans are known to be found in the coastal waters off Ghana. These species are generally benthic organisms with the main exception of cuttlefishes and squids. They usually can be found over the continental shelf and the slope in depths up to 600 m.

Among this faunal group there are species of fisheries interest for local populations such as the common cuttlefish (Sepia officinalis), pink cuttlefish (Sepia orbignyana), common squid (Loligo vulgaris), common octopus (Octopus vulgaris), green (spiny) lobster (Panulirus regius), deep-sea rose shrimp (Parapenaeus longirostris), southern pink shrimp (*Penaeus notialis*), Caramote prawn (*Penaeus kerathurus*) and Guinea shrimp (*Parapenaeopsis atlantica*).

6.6.6 Seagrasses and Algae

Seagrass beds are rare in the coastal waters of Ghana due to unfavorable environmental conditions such as relatively high turbidity which inhibits their growth. No seagrass beds have been recorded in the Project area.

With regards to algae, the western shores of Ghana have been experiencing since 2012 a significant increase in the presence of floating masses and beaching of a type of macroalgae of two species *Sargassum vulgare*, an intertidal species, and *Sargassum filipendula*, a subtidal species. This increase in algal density has been reported to affect fishing activities. The origin of this increase remains unknown.

In addition, since 1993, green algae blooms occur seasonally along the coasts of the Western Region of Ghana and the Ivory Coast. These blooms were initially dominated by the non-toxic marine green algae (*Enteromorpha flexuosa*), though it has been recently replaced by blooms of *Ulva clathrata.* These blooms occur seasonally, first appearing between August and October and remaining in the inshore region during several months or even a year as was the case of the algal bloom in 2010.

Early indications, coming from assessments of the nitrogen isotopes carried out by the EPA, point to the outflow of untreated sewage into rivers and the sea drifting from the Ivory Coast as the origin of nutient pollution that triggers the abnormal algal development (CRC, 2011).

These blooms of algae in the coastal waters of the Western Region have been of national concern for nearly 20 years, as they seriously curtail fishing activities and fuel food insecurity and poverty in the impacted communities.

6.6.7 Fish

Ghanaian waters host several species of fish, including some of important commercial value. The distribution, abundance and composition of the fish assemblages is largely influenced by the seasonal upwelling that occurs in this area, as it increases nutrient availability and plankton production which allows to sustain larger populations of fishes that are attracted to the area.

The fish species found in Ghanaian waters can be divided into three main groups:

- pelagic species;

- demersal (bottom dwelling) species; and
- deep sea species

Pelagic Species

The pelagic fish are those that live in the water column, and consist generally of species that are exploited commercially. The distribution and quantity of each population largely depend on hydrological conditions, with each species distributed according to the optimum temperature and salinity required for growth and reproduction. These species are not only important for its commercial value, but also are key for the marine ecosystem as they provide food for a number of large predators, particularly other large pelagic fish such as tuna, billfish and sharks.

The main species of pelagic fish in the coastal and offshore waters of Ghana include jack mackerels (*Trachurus* spp.), European anchovy (*Engraulis encrasicolus*), round sardinella (*Sardinella aurita*), flat sardinella (*S. maderensis*), and chub mackerel (*Scomber japonicus*).

These species represent approximately 80 percent of the total catch landed in the country (See Section 7 for the fisheries baseline). In terms of biomass, acoustic surveys have shown that the two sardinella species and the European anchovy represent almost 60 percent of the total biomass in Ghanaian waters (FAO and UNDP, 2006).

European anchovy is mainly a coastal marine species but they can tolerates a wide range of salinities and may be found in lagoons, estuaries and lakes, especially during spawning , that takes place over an extended period from April to November with peaks usually in the warmest months.

Chub mackerel spawning in Ghanaian waters, coincides with the seasonal upwelling. The chub mackerel is an opportunistic and non-selective predator, feeding on copepods and other crustaceans, fish and squid. Its predators include tuna, billfish and other fishes, as well as sharks and pelicans.

Other commercially important pelagic species found in Ghanaian waters include horse mackerel (*Trachurus* spp), little tunny (*Euthynnus alletteratus*), bonga shad (*Ethmalosa fimbriata*), African moonfish (*Selene dorsalis*), West African Ilisha (*Ilisha africana*), largehead hairtail (*Triciurus lepturus*), crevalle jack (*Caranx hippos*), Atlantic bumper (*Chloroscombrus chrysurus*), barracuda (*Sphyraena* spp), long-finned Herring (*Opisthopterus tardoore*), kingfish / West African Spanish mackerel (*Scomberomorus tritor*) and frigate mackerel (*Auxis thazard*).

In addition to the small pelagic species indicated above, stocks of large pelagics, as tuna and billfish, can also be found in Ghanaian waters. These are highly migratory species and occupy the surface waters of the entire tropical and sub-tropical Atlantic Ocean. They are important species in the ecosystem as both predators and prey for sharks, other tuna and cetaceans as well as an important commercial resource for industrial fisheries.

The tuna species potentially present in the Project area include skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*) and bigeye tuna (*Thunnus obesus*). Billfish species, which occur in lower numbers, comprise species as the swordfish (*Xiphias gladius*), Atlantic blue marlin (*Makaira nigricans*) and Atlantic sailfish (*Istiophorus albicans*).

Sharks are also common in the local pelagic ecosystem, being the blue sharks (*Prionace glauca*) and hammerhead sharks (*Sphyrna* spp) the ones most commonly targeted by local fisheries.

Demersal Species

Demersal fish species are those that live on or near the seabed. They are usually found over the continental shelf and the continental slope. As the pelagic fishes their distribution and composition is influenced by oceanographic conditions and specifically by the upwelling which results in changes of the bathymetric extension suitable for different species. This can also be observed by the differences recorded between the communities found above the thermocline, above 40 m depth and dominated by sciaenid species, and those living below (Koranteng, 1998). The density of demersal species is higher on shallower waters up to 50 m depth.

Trawl surveys conducted between 1956 and 1992 have shown that demersal fish are widespread on the continental shelf along the entire length of the Ghanaian coastline (Koranteng, 2001). Species composition is a typical tropical assemblage including the following families:

- Porgies or Seabreams (Sparidae) (eg bluespotted seabream Pagrus caeruleostictus, Angola dentex Dentex angolensis, Congo dentex Dentex congoensis, canary dentex Dentex canariensis and pink dentex Dentex gibbosus);
- Grunts (Haemulidae) (eg bigeye grunt Brachydeuterus auritus and to a lesser degree sompat grunt Pomadasys jubelini and bastard grunt Pomadasys incisus);
- Croakers or drums (Sciaenidae) (eg red pandora Pellagus bellottii, Cassava croaker Pseudotolithus senegalensis);
- Goatfishes (Mullidae) (eg West African goatfish/red mullet Pseudupeneus prayensis);
- Snappers (Lutjanidae) (golden African snapper Lutjanus fulgens, Goreean Snapper Lutjanus goreensis);
- Groupers (Serranidae) (eg white grouper Epinephelus aeneus);
- Threadfins (Polynemidae) (eg lesser African threadfin Galeoides decadactylus);
- Emperors (Lethrinidae) (eg Atlantic emperor Lethrinus atlanticus); and
- Triggerfish (eg grey triggerfish Balistes capriscus).

As mentioned previously, the seasonal upwelling causes changes in the geographical distribution of some of the demersal fish species (Koranteng, 2001). As a result, during the upwelling season, the Croakers's bathymetric range is reduced to a minimum, while the deep water Porgies are found nearer the coast than at other times of the year.

The most important demersal species in terms of commercial interest based on their annual catches include the cassava croaker (*Pseudotolithus senegalensis*), bigeye grunt (*Brachydeuterus auritus*), red pandora (*Pellagus bellottii*), Angola dentex (*Dentex angolensis*), Congo dentex (*Dentex congoensis*) and West African Goatfish (*Pseudupeneus prayensis*).

The considered as the most important species among them, the cassava croaker, has suffered an important decline in recent years in Ghana (Froese and Pauly, 2009). This species occupies both marine and brackish water down to a depth of 70 m and are found in coastal waters over muddy, sandy or rocky bottoms.

Deep Sea Species

Froese and Pauly (2009) lists 89 deep-sea fish species from 28 families including Alepocephalidae, Gonostomatidae, Myctophodae and Stomiidae that are likely to be found in Ghanaian waters over at depths over 1,000 m. Information on the distribution of specific deep water species is in Ghanaian waters is limited.

Maintenance of deep-sea fish communities depends on the presence of large fish and small amphipods. Large fish species break up the bulk of the carrion falls, allowing the majority of fish species to access a vital food source. Amphipods, located at the base of the food chain contribute also to sustain deep sea fish populations that feed on them.

Protected or Endangered Species

The sensitive fish species in offshore Ghana, according to the International Union for Conservation of Nature (IUCN) red list (IUCN, 2014), are presented in Table 6.34. Main species of concern include two species of sawfish (*Pristis pectinata*, and P. *perotteti*), two species of angel sharks (*Squatina aculeata* and S. *Oculata*) and a grouper (*Epinephelus itajara*) all considered as critically endangered. Other species are subject to commercial fishing and to international regulations and monitoring, as is the case of all tuna species by the International Commission for the Conservation of Atlantic Tunas (ICCAT). Sharks are one of the groups most represented within the list.

Table 6.34 Threatened fish species in Ghanian waters

Scientific name	Common name	Red List Category
Alopias superciliosus	Bigeye thresher shark	Vulnerable
Alopias vulpinus	Common thresher shark	Vulnerable
Carcharhinus falciformis	Silky shark	Near Threatened
Carcharhinus longimanus	Whitetip oceanic shark	Vulnerable
Carcharias Taurus	Sand tiger	Vulnerable
Carcharodon carcharias	Great white shark	Vulnerable
Centrophorus lusitanicus	Lowfin gulper stark	Vulnerable
Dalatyas licha	Kitefin shark	Near Threatened
Dasyatis margarita	Ray species	Endangered
Epinephelus aeneus	White Grouper	Near Threatened
Epinephelus itajara	Goliath Grouper	Critically Endangered
Epinephelus marginatus	Dusky Grouper	Endangered
Galeocerdo cuvier	Tiger shark	Near Threatened
Galeorhinus galeus	Whithound	Vulnerable
Hippocampus algiricus	West African Seahorse	Vulnerable
Isurus oxyrinchus	Shortfin mako	Vulnerable
Isurus paucus	Longfin mako	Vulnerable
Kajikia albida	White marlin	Vulnerable
Makaira nigricans	Blue marlin	Vulnerable
Manta birostris	Giant manta ray	Vulnerable
Mobula rochebrunei	Lesser Guinean devil ray	Vulnerable

Scientific name	Common name	Red List Category
Negaprion brevirostris	Lemon shark	Near threatened
Prionace glauca	Blue shark	Near Threatened
Pristis pectinata	Wide Sawfish	Critically endangered
Pristis perotteti	Largetooth Sawfish	Critically endangered
Raja clavata	Thronback skate	Near Threatened
Raja undulata	Undulate Ray	Endangered
Rhinobatos cemiculus	Blackchin Guitarfish	Endangered
Rhinobatos rhinobatos	Common Guitarfish	Endangered
Rhynchobatus luebberti	Lubbert's Guitarfish	Endangered
Rostroraja alba	Bottlenose Skate	Endangered
Sphyrna lewini	Scalloped Hammerhead	Endangered
Squatina aculeata	Sawback Angel Shark	Critically endangered
Squatina oculata	Smoothback Angel Shark	Critically endangered
Thunnus alalunga	Albacore Tuna	Near threatened
Thunnus albacares	Yellowfin tuna	Near Threatened
Thunnus obesus	Bigeye Tuna	Vulnerable

Source: IUCN, 2014

In the global context there is concern about the bigeye tuna stocks. The International Commission for the Conservation of Atlantic Tunas (ICCAT) has listed it as the species of greatest concern, after the bluefin, in terms of its population status and the unsustainable levels of exploitation exacted on this species.

Section 7provides additional information on fishing activities within the nearshore, inshore and Project-affected areas.

6.6.8 Marine Mammals

The Gulf of Guinea and Ghana's waters are considered to be favorable habitat for marine mammals, especially due to the seasonal upwelling which boosts productivity and ensures food availability for these species. Although their ranges are known to include the Gulf of Guinea and Ghanaian waters, there is a lack of knowledge on the distribution, population estimates and ecology of cetaceans in the region.

According to the data gathered from by-catches and beach strandings, up to 18 cetacean species belonging to five families could be present, permanent or temporary, in Ghanaian waters: 14 species of Delphinidae (dolphins) and one species each of families Ziphiidae (beaked whales), Physeteridae (sperm whales), Kogiidae (pygmy sperm whales) and Balaenopteridae (rorquals).

Table 6.35 presents the list of species potentially present within Project Area and their conservation status according to IUCN their preferred habitat and the seasonality of their expected presence. In those cases where information available did not allow identification of a period where the species are present in Ghanaian waters, all year has been considered as a conservative approach. This list is based on strandings and by-catches and is not exhaustive .

Based on their ecology and habitat requirements it is possible that other species, in particular baleen whales, could be present in the area, both in deeper waters in the vicinity of the wells and FPSO as well as in the shallow waters (coastal areas) over the continental shelf nearshore and close to pipeline route.

Table 6.35 Dolphins and Whales of Ghana

Scientific name	Common name	Red List Category	Seasonality	Main Habitat
Delphinus capensis	Long-beaked common dolphin	Data Deficient	All year	Coastal (continental shelf)
Feresa attenuata	Pygmy killer whale	Data Deficient	All year	Offshore (slope and deep water areas)
Globicephala macrorhynchus	Short-finned pilot whale	Data Deficient	All year	Offshore
Grampus griseus	Risso's dolphin	Least Concern	All year	Coastal and offshore
Kogia sima	Dwarf sperm whale	Data Deficient	All year	Offshore
Lagenodelphis hosei	Fraser's dolphin	Least Concern	All year	Offshore
Megaptera novaeangliae	Humpback Whale	Least Concern	August-December	Coastal
Orcinus orca	Killer whale	Data Deficient	All year	Coastal and offshore
Peponocephala electra	Melon-headed whale	Least Concern	All year	Offshore
Physeter macrocephalus	Sperm whale	Vulnerable	All year	Offshore
Pseudorca crassidens	False killer whale	Data Deficient	All year	Coastal and offshore
Stenella attenuate	Pantropical spotted dolphin	Least Concern	All year	Offshore
Stenella clymene	Clymene dolphin	Data Deficient	All year	Offshore
Stenella frontalis	Atlantic spotted dolphin	Data Deficient		Coastal and offshore
Stenella longirostris	Spinner dolphin	Data Deficient	All year	Offshore
Steno bredanensis	Rough-toothed dolphin	Least Concern	All year	Offshore
Tursiops truncatus	Common bottlenose dolphin	Least Concern	All year	Coastal and offshore
Ziphius cavirostris	Cuvier's beaked whale	Least Concern	All year	Offshore

Source: IUCN, 2014

It must be noted that despite not being included as endangered in the IUCN Red Data List, the West African population of the Clymene dolphin (*Stenella clymene*), which is Ghana's principal dolphin species, was included in Appendix II in the 2008 Conference of the Parties of the Convention for the Conservation of Migratory Species (CMS/UNEP), and therefore recognizing formally its vulnerable status.

Regular landings in several Ghana ports of by-catches including Clymene dolphin, pantropical spotted dolphin (*Stenella attenuata*), common bottlenose dolphin and, to a lesser degree, short-finned pilot whale (*Globicephala macrorhynchus*), Risso's dolphin (*Grampus griseus*), Atlantic spotted dolphin (*Stenella frontalis*), rough toothed dolphin (*Steno bredanensis*) and melon-headed whale (*Peponocephala electra*) suggest that these species are not rare in the northern Gulf of Guinea, although any estimate of population abundance is lacking. Rarely captured species may be characterised by a lower abundance in the areas that are near the continental shelf and slope.

The only recorded baleen whale in Ghana, the humpback whale, is thought to occupy Ghana's shelf zone as a calving and breeding area from early August until December. distributions

In addition to the recorded species and despite lack of confirmation, baleen whales such as minke whales (*Balaenoptera acutorostrata*), blue whales (*Balaenoptera musculus*), sei whales (*Balaenoptera borealis*) and fin whales (*Balaenoptera physalus*) are considered as potentially present along Ghanaian waters. This presence is, however, considered rare and not expected based on the absence of records and sightings of these species in the area, though it cannot be totally discarded given the wide distributions they present as a result of their migration patterns which eventually could result in some individual visiting the Ghanaian coasts. Of these, the blue, fin and sei whales are classified as Endangered on the IUCN's Red Data List.

6.6.9 Turtles

Five species of marine turtles are known to occur along the coast of Ghana: loggerhead (*Caretta caretta*), green turtle (*Chelonia mydas*), olive ridley (*Lepidochelys olivacea*), leatherback (*Dermochelys coriacea*), and hawksbill (*Eretmochelys imbricate*) (Armah et al, 1997, Fretey, 2001).

All of them are considered to be Critically Endangered or Endangered by the IUCN, except for the olive ridley turtle and the leatherback which are considered Vulnerable (Table 6.36*)*.

Table 6.36 Turtles in the Gulf of Guinea

Scientific name	Common name	Red List Category
Caretta caretta	Loggerhead turtle	Endangered
Chelonia mydas	Green turtle	Endangered
Dermochelys coriacea	Leatherback turtle	Vulnerable
Eretmochelys imbricata	Hawksbill turtle	Critically Endangered
Lepidochelys olivacea	Olive ridley	Vulnerable

Source: IUCN, 2014

Marine turtles spend most of their life at open seas, though they can also be observed in coastal areas and ashore during their breeding season when they lay eggs on sandy beaches. This nesting period in West Africa stretches from July to December, with a peak in November (Armah et al, 1997). The five species considered are known to nest in Ghana (Irvine, 1994) though in the last decades nesting activity has only been documented for the green, leatherback and olive ridley turtles (Armah, et al. 1997; Amiteye, 2002; Agyekumhene, 2009).

In Ghana, turtle nesting may occur all along the sandy coast of the country, accounting for approximately 70 % of the country's coastline. Turtles are known to nest in the Western

Region in beaches at Kengen, Metika Lagoon, Elonyi, Anochi, Atuabo and Benyin (Baker et al., 2012). Potential nesting sites cover therefore the whole coast from the Cote d'Ivoire border to the city of Axim, including the beaches close to human settlements. As such, all the beaches within the AoI are considered to potentially contain nesting sites (and therefore are considered to potentially contain critical habitats), although their use for fishing activities However, given that the beaches close to villages are used for fishing purposes (that include mooring and canoe storage sites), those sections are considered as less suitable for turtle nesting.

According to the existing scientific literature, olive ridley is the most common turtle species in the coasts of Ghana with more than 85 % of the individuals recorded. Table 6.37 presents the population estimates of the three main species.

Table 6.37 Reported Sea Turtle Nest in Ghana

Author, year	Leatherback	Olive Ridley	Green
Amiteye, 2002	46	412	32
Agyemang, 2005	30	190	10
Allman, 2007	418	134	0
Agyekumhene, 2009	74	103	0
Average	**142**	**210**	**21**

For the purposes of the current Project, a field survey was conducted along the stretch of beach between Sanzule and Bakanta, in the vicinity of the onshore Project location, as it is an area considered to be suitable for nesting activities. The survey included interviews with inhabitants of the local communities about sightings of turtles in the area as well as night and day beach surveys to locate nests or turtle individuals along the beaches.

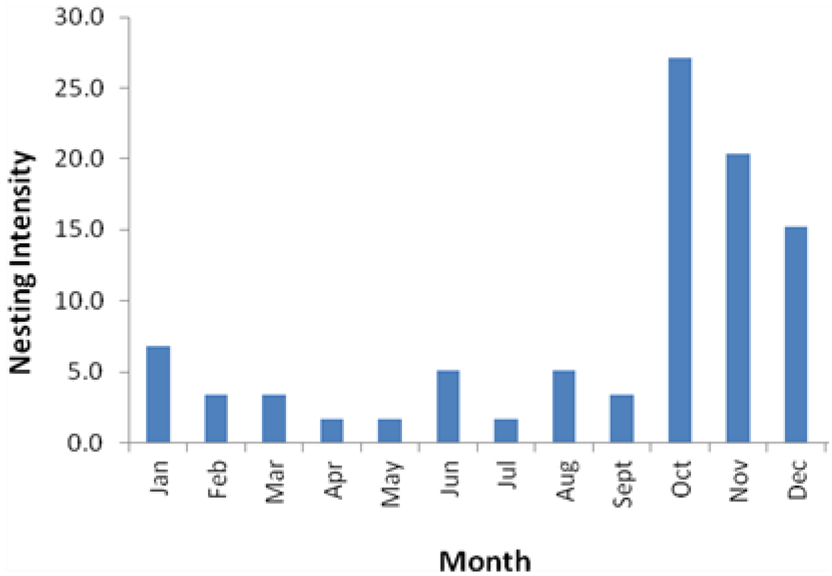
Observations of the Project area confirmed that the Project area is a suitable nesting site for sea turtle, as it has very gentle sloping beaches which allow turtles to nest. The gentle slopes at the beaches indicate very little erosion or high accretion of sediment on the beach which implies also that the nesting habitats in the area face no threat from erosion. The vegetation at the back beach is mainly coconut with no dense grass underneath, which is also considered a positive feature for turtle nesting since the existence of dense grasses at the back of the beach difficult the construction of egg chamber and thereby reducing successful nesting.

According to the interviews, the five species of turtles potentially present in the area had been observed in the past to use the study area as nesting habitats. However, the interviews also revealed that in recent times only the leatherback, green turtle and olive ridley had been seen nesting in the area in appreciable numbers.

The survey also confirmed that sea sightings in the area take place throughout the year, though mostly between October and December. Nesting activity by green turtles has been observed to occur from June to August whlist the olive ridley has been reported to nest year round with the primarily nesting period between October and December. The leatherback also nest primarily in November and December (Agyekumhene, 2009).

Community interviews revealed that local communities consider sea turtles as an important resource in terms of food (meat and eggs) and hunting of these species remains a threat.

Figure 6.33 Monthly variation in sea turtles nesting activity



Source: ESL, 2013

6.7 ECOSYSTEMS SERVICES

The Ecosystem Services guide developed by IPIECA (2011) identifies the categories of oil and gas activities that could have a dependence or impact on ecosystem services..

Oil and gas *provisioning* service dependencies include use of water, aggregates and wood for consumption by staff, and for the construction and operation of facilities, while, oil and gas *regulating* service impacts are typically more indirect, and include a range of physical functions provided by vegetation and habitats such as erosion control, water filtration and flood control. Furthermore, c*ultural* services can be important for remotely operating workforces that can benefit in terms of enjoyment, health and motivation, from activities such as ecotourism and simply from appreciating the surrounding landscapes.

Based on the IPIECA methodology following habitats occur in the Project area:

6.7.1 Forest Habitats

Forest habitats are areas dominated by trees and woody vegetation. Almost all forests provide abundant provisioning services in the form of wood, wild game, fruits, berries, mushrooms and medicines. Examples of regulating services from forests include carbon sequestration, climate and nutrient regulation, local temperature and humidity control, and, in many places, regulation of water quality and stream flow. Forests also offer numerous cultural services such as recreation, bird and wildlife watching, and spiritual areas. This habitat in the Area of influence of the project is represented by the primary rainy forests and the secondary forest formed by palm trees (including those in plantations) and thickets.

6.7.2 Wetlands

Wetlands encompass a range of habitats such as tidal marshes, mud flats and bogs. They may be seasonal, inland, or coastal and may be tidal or non-tidal. Note that crossover with the near shore/transition zone habitat type may occur. Rivers (and streams) are bodies of water that flow into lakes or the sea.

In the Area of Influence wetlands are represented by brackish and freshwater lagoons, wetlands in the low lying coastal areas and river habitats (See Annex C for the location and extent of wetlands within the AoI). They provide provisioning services in the form of water, food, fuel and materials for construction. Regulating services in this habitat include groundwater recharge, water storage, flood control and water purification. Ecotourism and bird watching are examples of cultural services typically found in this type of habitat

6.7.3 Deep Water

Deep water environment refers to areas of ocean with a depth if 300 meter or more. Commercial fishing is the most important provisioning service, together with genetic and pharmaceutical products from benthic species. Regulating services of this habitat comprise: waste assimilation, temperature, current regulation and carbon sequestration (plankton, shells, corals). In terms of cultural services, marine tourism is less prevalent in deep water environments, but deep waters are used as migration routes for culturally iconic species such as whales and turtles, and are also relevant in terms of landscape and visual stimulus.

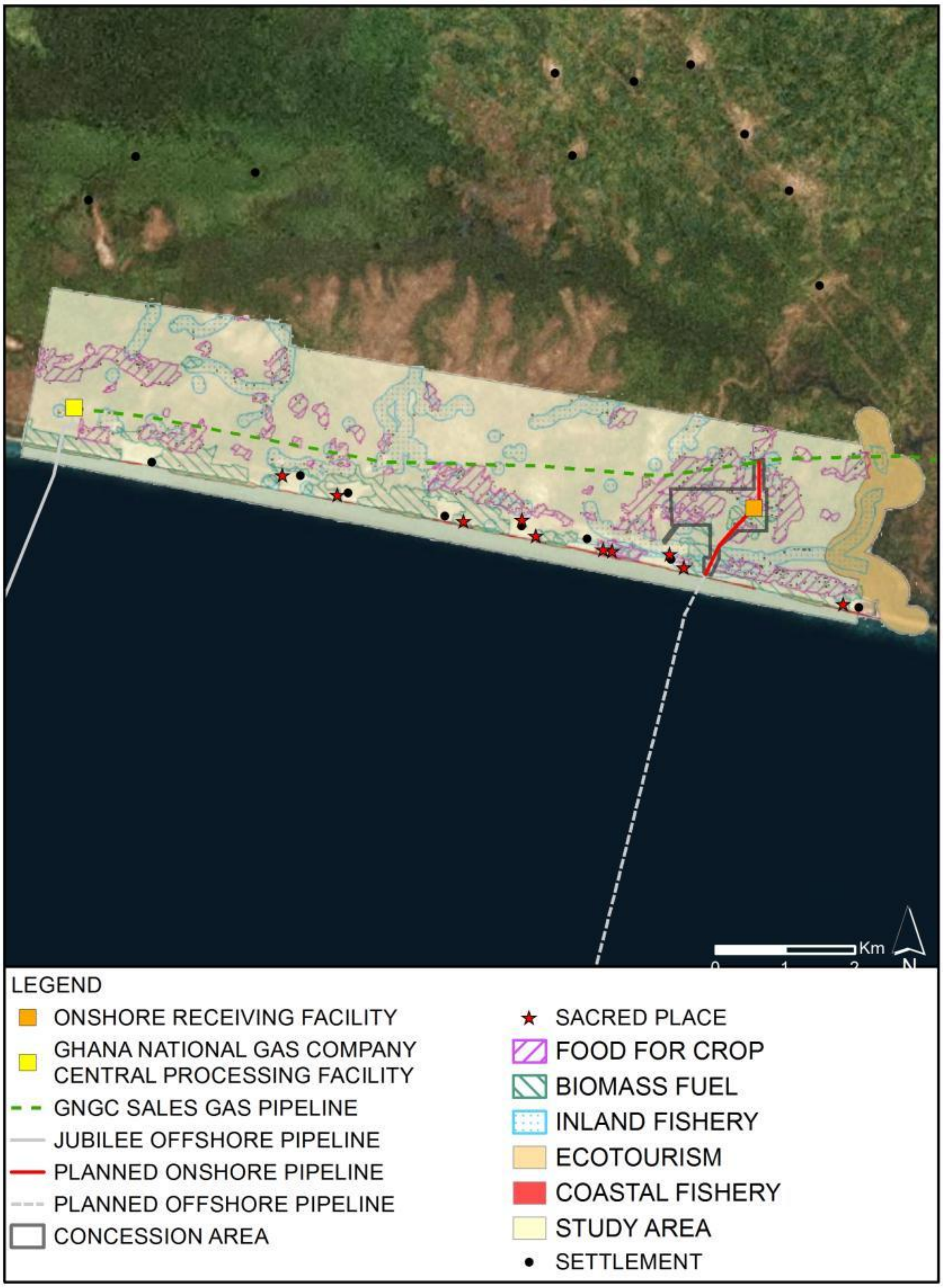
6.7.4 Nearshore / Transition zone

The nearshore/transition in the area of influence of the Project includes beaches, rocky tidal zones and the mouths of Amansuri river. Further east of the Project area there is also a dead coral belt offshore and mangroves along the Amansuri river.

In nearshore waters, artisanal and subsistence fishing are critical provisioning services for the livelihood of local populations. Wooden and non-wooden forest products from mangroves, construction materials (eg, sand, shingle, and rocks) and ornamental and pharmaceutical products are other common provisioning services found in the nearshore environment. The protection from storms, flooding and erosion are among the main regulating services provided by these habitats. The nearshore environment offers also cultural services in the form of tourism and recreation (eg, swimming, diving, sunbathing) and supports a variety of iconic species such as sea turtles. The Ecosystem Services identified in the Area of Influence by Habitat type are presented in

Table 6.38 and Figure 6.34.

Figure 6.34 Ecosystem services in the AoI



Source: eni Decision Support document

Figure 6.35 Ecosystem services around Sanzule

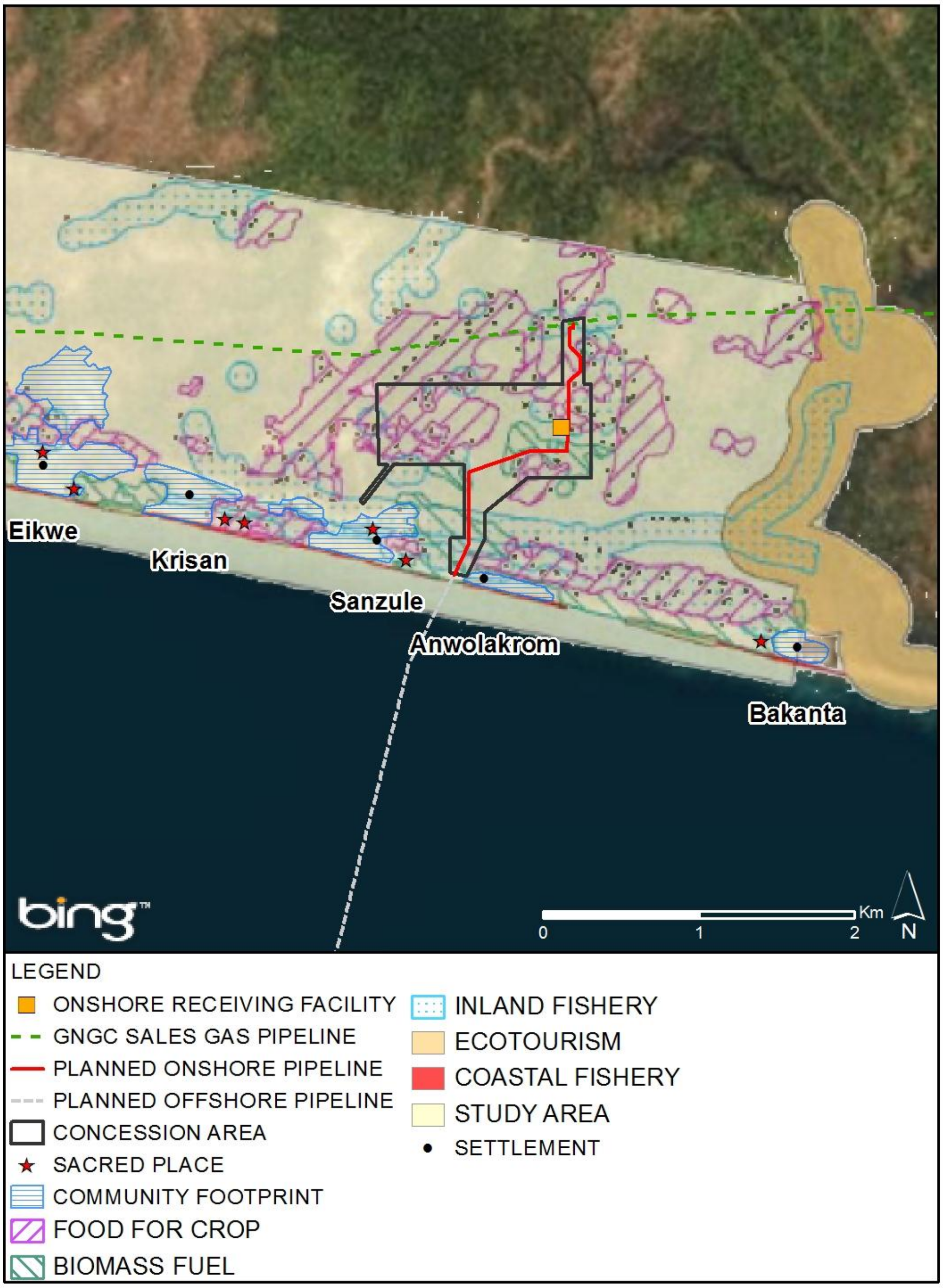


Table 6.38 Ecosystem Services by Habitat Type*

Ecosystem Services	Lowland Forest	Rivers and wetlands	Deep Water	Near shore habitats
Provisioning				
Crops	X			
Livestock	X	X		
Capture fisheries		X	XX	XX

Ecosystem Services	Lowland Forest	Rivers and wetlands	Deep Water	Near shore habitats
Aquaculture				
Wild foods	XX	X		X
Wood and other fibres	XX	X		X
Fibres and resins	X	X		
Animal Skins	X			
Sand, gravel, etc.		XX		X
Ornamental	X	X		X
Biomass fuel	X	X		
Freshwater	X	XX		
Genetic resources	X	XX	XX	XX
Biochemical, natural medicine	XX	X	X	XX
Regulating				
Air quality	XX	X	X	X
Global climate	XX	X	XX	X
Regional/local climate	XX	X	X	X
Water	XX	XX		
Erosion	XX			XX
Water purification	XX	XX		X
Waste assimilation	X	X	X	X
Disease	X	X		
Soil quality	XX	X		X
Pest/invasive species	XX	X		
Pollination	XX	XX		
Natural Hazard	XX	X		X
Cultural				
Recreation	X	X		X
Ethical/non-use values	X	X	X	X

X= Medium/Low importance; XX= High importance

* = The table covers all the Area of Influence; all of listed Ecosystem Services can be applicable to Sanzule.

6.8 Extreme Events

Though Ghana is far from the major earthquake zones of the world, an earthquake disaster cannot be discarded given the historic data. A number of major and minor earthquakes have occurred in past and present. Earth tremors of magnitude ranging from 1.0 to 4.8 on the Richter scale have been recorded in recent times. The records of damaging earthquakes date as far back as 1615 (Amponsah, 2004). The last three major events occurred in 1862, 1906 and 1939, though less relevant earthquakes have also occurred in recent years, including magnitudes greater than 6.0 on the Richter scale (Amponsah, 2004).

The most destructive one, in 1939, took place in the Accra area and was estimated as a magnitude of 6.5 on the Richter scale.

According to Bacon and Quaah (1981) most of the earthquakes in Ghana occur between Accra and Winneba at the junction of the two major fault systems namely, the Coastal boundary fault and Akwapim fault zone. This area is located more than 200 km east of the Project area.

However, one of the earliest recorded earthquakes in Ghana, with an intensity of 5.7 and dating from 1636 took place in the Axim district in the vicinity of the Project Area, resulting on the collapse of a gold mine and the associated buildings (Claridge, 1915).

Flat areas along the coast of western Ghana are also subject to flood risk. Many coastal areas are known to be subject to seasonal floodings on the wet season due to a rise in the water table, reaching approximately 1 m of water above the soil surface. This areas are, however, located mainly in the vicinity of the Amansuri River and Amansuri lagoon and do not include the proposed ORF location.

Tidal waves also lead to flooding events along the coast. A tidal wave with a 14 days periodicity is known to occur along the coast of Ghana (Clarke and Battisti, 1983) and in some areas weekly floodings are experience, as is the case of Sanwoma (CRC-URI, 2013) located 20 km East of the ORF site in the mouth of a River. The topography of project site, that includes the presence of an elevated sand barrier in the beach diminishes the risk of floodings due to tidal waves.

The flat characteristics of the region make it also vulnerable to climate change effects and specifically to the rise in sea level, that could result in an increase of the effects of tidal waves and even the permanent flooding of certain areas with a retreat in the coastline.

6.9 SUMMARY BASELINE CONCLUSIONS

6.9.1 Offshore

Physical Oceanography

Water circulation in offshore Ghana is dominated by an eastward superficial flow known as the Guinea Current that runs parallel to the coast from Senegal to Nigeria. The main oceanographic feature in the areaa that is the existence of two periods of upwelling each year, one major upwelling between June and October and a minor one between January and February. This phenomenon is considered key for the sustainability of marine life in the area as it contributes to an increase in productivity.

The bathymetry of the Project area ranges from a minimum depth of 0 m in the north at the landfall location to a maximum of 1,390 m in the south-west part. Seafloor is mostly flat with slope gradients that vary between 0.5 and 2 º, with the only exception of the submarine canyons and the continental slope where gradients may reach more than 10º. Additionally, there are certain topographic features, including complex canyon systems, sedimentary mounds, scour features and high standing knolls.

The geophysical studies conducted have revealed that there is no evidence of general instability along the continental slope or at the flanks of the canyons nor sediment accumulations from mass gravity flows at the toe of the slopes and no potential for mass flow development is envisaged.

Sediments

Seabed sediments along the pipeline route and in the vicinity of the wells ranged from poorly sorted, coarse silt to moderately sorted, coarse sand with a general trend showing more sandy sediments in shallower areas and more silty on greater depths. Metal concentrations in sediments were generally low, though in the vicinity of the proposed wells sediments present higher levels of metals, especially chromium, nickel and barium. Specifically, barium levels at station 41, located 340 m from the Gye Nyame-1 exploration well, are highly indicative of possible past drilling-related contamination from the drilling muds, however it is notable that other metals are not equally elevated at this location suggesting drilling muds used are not heavy contaminated with impurities.

Hydrocarbon concentrations in sediments are also generally low along the whole Project area. At Station 41 however, levels are considerable high (787 µg/g) probably as a result of past drilling activity.

Seawater

Seawater quality in the whole offshore Project AoI is generally good, showing low or very low levels including those samples taken in the intertidal area more subject to be influenced by antrhopogenic pressure. Total hydrocarbon concentrations (THC) and aromatic hydrocarbons (PAH) were also low at all stations, though they were a bit higher in the area where the wells are planned and could be detected in the analysis suggesting certain degree of pollution, probably related to shipping activities or a dispersed effect arising from the numerous wells in the area. Nutrients, total dissolved solids, biochemical oxygen demand, phenol index, cyanide and faecal coliforms are also low at all stations and depths analyzed.

Marine biota and habitats

The phytoplankton community is dominated by microflagellates and diatoms. Phytoplankton abundance is generally greater at 1 m and 100 m sample depths and denuded at 200 m as a result of reduction in light. Zooplankton community is dominated by copepods. Both phytoplankton and zooplankton biomass seem lower in offshore stations may be due to the lower phosphate concentrations, compared to the inshore sites.

Benthic macrofauna is characterised by low abundance and low diversity assemblages in the wells area and moderate diversity and abundance along the pipeline route in the shallower stations. Annelida is the dominant group, representing half the abundance recorded. The total number of species at each station appears to be negatively correlated with depth.

No important benthic communities were identified along the proposed pipeline route, in the vicinity of the wells and in the nearshore area. As a result no critical habitats, such as coral reefs, seagrass beds or chemiosynthetic communities, are present in the area surveyed. Communities recorded are therefore related to muddy and sandy bottoms and mainly formed by annelida followed by crustaceans and molluscs.

As previously enlightened station 41 is characterised by contaminated sediment but considering the paucity of fauna and the general lack of abundance at all stations surveyed it is not possible to determine if the faunal composition has been affected. Furthermore, no increase in density of opportunistic or pollution tolerant fauna is observed at Station 41.

In Porject AoI, the presence of corals, according to the several surveys conducted, is limited to isolated individuals, including two in the vicinity of the pipeline route. However, no large communities have been recorded.

In deeper waters, no cold corals have been observed along the pipeline route or on the wells area, though their presence cannot be discarded in the wider area.

The AoI of the Project may also host up to 18 cetacean species belonging to five families. Their distribution and ecology in the area remains widely unknown, though it has been considered that most of them could be present throughout the year and specially during the upwelling season when food availability increases. It is known, however, that the humpback whale migrates to ghanaian continental shelf for breeding, remaining in the region mainly from august to december.

The Gulf of Guinea serves also as an important migration route, feeding ground, and nesting site for sea turtles, where five species may be observed, though only three are known to regularly nest in the AoI of the Project, as whole coastline between Ivory Coast border and Axim is considered as a suitable site for nesting turtles. As a result the beaches in the area are considered a critical habitat for the conservation of turtles, with the exception of the beach sections where fishing activities take place, that usually correspond to the area where the villages are located. Nesting activity in the area is reportedly more intense between October and January.

6.9.2 Onshore

Climate and Meteorology

The regional climate of southwest Ghana is driven by the Inter Tropical Convergence Zone (ITCZ), resulting during the boreal (northern hemisphere) winter in a climate dominated by dry and continental air from the Sahara. There are two well-marked seasons: a dry season, between December and April; and a wet season, between May and July and September and November.

Air Quality, Light, Noise and Vibration

There are no major industrial activities in the Project area and thus no significant sources of air pollutant emissions. During primary data collection, high levels of SO_2 were monitored, as a result of the fish smoking process or waste burning. The measured levels of NO_2, CO_2, TSP and VOC were generally within Ghana EPA and IFC limit values. High levels of SO_2 were instead monitored, as a result of the fish smoking process or waste burning.

Light and vibration levels in the Project area are currently low due to the general lack of industrial activities in the area. Current levels were found to be relatively high for a rural environment and are associated to domestic activities and natural sounds such as the ocean, waves, wind, and insect noise as well as fishing activities (beach seine) and vehicle movements.

Surface and Groundwater

The Western Region of Ghana is characterised by the presence of many brackish and freshwater lagoons and wetlands in the low lying coastal areas due to the high level of annual rainfall. In the Project AoI, the main watercourse is the Amansuri River which flows eastward from about 1.4 km northeast of the Project site until it enters the sea approximately 7 km east of the eni concession area. Field surveys indicated that surface water bodies sampled showed elevated concentrations of nutrients, concentrations of metals (Cu, Cd, Cr and As) within the WHO guideline limits, except for Hg (unknonw source), no significant concentrations of TPH or oil and grease detected in the samples analyses but widespread load of total coliforms, faecal coliforms, E.coli and total heterotrophic bacteria. Fresh water plankton analysis showed a relatively small number of taxa with small numbers of individual zooplankton species.

Two main hydrogeological provinces are found within Ghana, namely the Basement Complex (consisting of Precambrian crystalline igneous and metamorphic rocks and covering 54% of Ghana) and Voltain Formation (a Paleozoic consolidated sedimentary formation and covering 45% of Ghana). The groundwater quality from three existing wells indicated some contaimation by human users such that of the water samples conformed to the WHO Guidelines and Ghana Standards for total and faecal coliforms and BOD5 levels were higher than the EPA's permissible limit. There were also high levels of phosphorus although heavy metal concentrations were generally low with As, Cr, Cd and Cu contractions all below detection limit and WHO guideline levels but Zn, Pb, Mn and Fe concentrations above the WHO limits at few monitoring points. No significant concentrations of TPH or oil and grease were detected.

Geology, Topography and Soils

The coastal region of Ghana is primarily formed by hard granites, granodiorites, metamorphosed larva and pyroclastic rock dating from 135 million years ago (Cretaceous period), while certain areas are covered by Ordovician, Silurian and Devonian sandstone and shale. In general the soils observed within the Project area are predominantly sandy soils indicating a well-drained substrate and the onshore Project area is characterized by being a flat area of low altitude (0-10 m) with very few headlands or rocky outcrops. The ground elevation increases from the sea for several meters within the beach up to around 4 m high when it decreases again below 2m high resulting on the generation of flat and low-lying area that occupies the central section of the ORF site. The higher grounds are located at the north-western most corner of the ORF site with 8.9 m elevation, while the site generally varies between 3.9 and 4.6 m. According to the soil samples analysis performed in the Project area, the levels of nickel, zinc, chromium and iron in the soil were relatively high. Considering the absence of known anthropogenic sources of metal pollution in the area, it is considered likely that elevated values may reflect local geological conditions.

Flora and Habitats

Ghana forms part of the Upper Guinea forest ecosystem, a region once characterised by dense forests which have shrunk in response to human influence and the growth of cities. The coastal region also includes vegetation comprising of palm trees and thorny shrubs. A total of 86 plant species belonging to 46 families and 79 genera were identified in the Project area during the wet season survey, with the dominant vegetation type being trees (44.19% of the total). During the dry season, a total of 148 plant species in 124 genera belonging to 56 families were recorded. The family *Euphorbiaceae* dominates the flora with 12 species. This was followed by *Papilionaceae* with 11 species*, Rubiaceae* (10 species), *Apocynaceae* (eight (8) species) and *Annonaceae* (six (6) species). Pioneer species formed the majority of the species present. With regards to IUCN status, only three species encountered are listed as Vulnerable: *Albizia ferruginea*, *Coffea macrochlamys* and *Hallea stipulosa*. The majority of the species in the Project area have not yet been assessed by the IUCN.

The habitat within the concession area consisting largely of modified habitats with a large proportion of the area covered by degraded coconut palm plantations, degraded vegetation and wet evergreen forest with palms. The coastal areas are dominated by regenerating vegetation comprising of palm trees and thorny shrubs. To the east of the concession is a natural habitat that is classified as Swamp and Mangrove Forest. Areas of potential Critical habitat occur along the coastal beaches where turtles nest.

Fauna

Ghana has large and viable populations of wildlife and a natural environment with most of the wildlife sanctuaries are located in the Western Region due to the suitable microclimate and diverse habitats provided by the evergreen forest found in most parts of the Region. A field survey identified eight individuals of three species of small mammals belonging to the order Rodentia (rodents) but no large mammals and very few spoor were directly observed. The information on large mammals came mainly from interviews conducted with the locals of the area, that report the presence of five orders of large mammals (Pholidota, Primates, Carnivora, Artiodactyla and Hyracoidea) consisting of 21 species. Three of these species are listed as Near Threatened by the IUCN. Amphibians and reptiles (herpetofauna) are common and widespread throughout Ghana. During the surveys, 29 herpetofaunal species belonging to 15 families were recorded at the Project site.

The west coast of Africa forms an important section of the East Atlantic Flyway, an internationally-important migration route for a range of bird species, especially shore birds and seabirds. The highest concentrations of seabirds are experienced during the spring and autumn migrations, around March and April, and September and October. During the surveys, 52 species of birds belonging to 24 families were recorded, of which all are of Least Concern on the IUCN Red List. The common swift, village weaver, African palm swift, orange-cheeked waxbill, red-eyed dove, little bee-eater, pied crow, common bulbul, and the yellow-billed kite were the most abundant species. The Amansuri Lake to the northwest of the site is an Important Bird Area (IBA).

Protected Areas

There are 18 wildlife protected areas that include seven national parks, six resources reserves, four wildlife sanctuaries and five coastal Ramsar sites in Ghana. All of the areas are located onshore; no marine protected areas have been designated. The coastal districts of the Western Region, hold one of these protected areas, namely the Ankasa Conservation Area, and several forest reserves. The Ankasa Conservation Area and the Cape Three Points Forest Reserve are the most significant protected areas of the Project site but are located 25 and 42 km to the northwest and east, respectively, of the concession area.

In addition to the officially designated areas, the proposed project location on its onshore component lies within the boundaries of an Important Bird Area (IBA) designated by Birdlife International to reflect their natural values, and especially for their importance for the avifauna despite the absence of legal protection. Core areas of this IBA correspond to the Amansuri lagoon and the nearby wetlands. Project area is included within the IBA boundaries mainly due to the nearby beach, as the triggering species (sanderling and the royal tern) usually dwell in the beach. The core areas of this site have been proposed as a Ramsar site.

Table 6.39 summarises the sensitivity of the different environmental receptors considered, taking into account the different Project aspects and activities.

Table 6.39 Environmental receptors sensitivity

Environmental Receptor	Sensitivity
Air quality at human settlements	Moderate
Noise levels at human settlements	Moderate
Surface water (Amansuri wetlands)	High
Surface water (Amansuri river)	Moderate
Groundwater	Moderate
Soils	Moderate
Terrestrial flora and habitats	Moderate
Terrestrial fauna	Moderate
Landscape	Moderate
Seawater	Moderate
Seabed	High
Marine Fauna, flora and habitats	Moderate
Coastline (erosion)	Low
Fisheries	Low
Ecosystem services	Moderate
Protected areas	Moderate

ESHIA – Phase 2 OCTP Ghana

ABSTRACT

Chapter 7 provides a description of the fisheries baseline, including details on fishing fleets, fish landings, and commercially important species.

Date	Revision	Revision Description	Prepared	Checked	Approved
July 2015	06	Final version	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago

Summary of Revisions

July 2015	05	Issued for Disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
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March 2015	03	Interim Draft Issued for Disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
27-02-2015	02	Issued for submission to Authorities	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
20-02-2015	01	Issued for comments	ERM	eni SEQS/SAL	G. Nicotra
06-02-2015	00	-	Cristina O.	Henry C.	Daniele S.
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

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7 FISHERIES BASELINE

7.1 INTRODUCTION

This Chapter describes the current condition of fish and fisheries in Ghana. It describes the fish species present in Ghanaian waters, provides information on fishing fleets and supporting infrastructure (eg, fishing ports), and fish landing data. It also describes the status of the Ghanaian fishing industry and its role in the national economy and people's livelihoods.

The fishing industry in Ghana is based on resources from both marine and inland (freshwater) waters and from coastal lagoons and aquaculture (Quaatey, 1997; NAFAG, 2007). There is a long tradition of both artisanal and distant-water fishing fleets. The fisheries sector contributes 4-5% to agricultural Gross Domestic Product (GDP) and offers employment to about 10% of the population and their dependents. Fishing constitutes an important livelihood source not only to coastal communities but also to communities inland.

Fish and fish products provide the greatest proportion of animal protein in the country contributing over 60% of the total animal protein intake. Average per capita consumption is estimated to be between 27 kg and 31 kg annually, thus, rating Ghana as the 3rd highest consumer of fish worldwide. Marine fisheries contributes over 80% of all fish consumed and exported in and from the country and approximately 75% of the total domestic production of fish is consumed locally. Thus, the extensive population dependency on fishing constitutes a critical factor; consequently, impact on fisheries will be seen as one of the main potential impacts of this project.

Ghana has a coastline of 550 km and a relatively narrow continental shelf with depth between 75–120 m and a total area of approximately 24,300 km^2. Most commercial marine fishing undertaken by Ghanaian vessels takes place within the 200 mile (322 km) Exclusive Economic Zone (EEZ). The fishing industry in Ghana consists of three main sectors namely (i) small scale (or artisanal) marine and onshore fishing, (ii) semi-industrial (or inshore) and (iii) industrial fisheries. Targeted fish species within the marine sector include pelagic, demersal and shellfish resources.

7.2 DATA SOURCES

Various data sources were used to develop this baseline description. It draws on the Fisheries Impact Assessment (FIA) prepared as part of the OCTP Phase 1 EIS which included primary data collection along the coastline in the Project area. Information from that study has been supplemented with a catch study undertaken and further stakeholder engagement during social baseline data gathering activities with fishing communities.

In summary secondary sources used to develop the description of the baseline include:

- FIA of the OCTP Phase 1 Development;
- Environmental assessment reports in the public domain;
- Technical studies commissioned by eni Ghana; and

- Government reports and data from Marine Fisheries Research Division and the Fisheries Commission.

Primary Sources include:

- Catch study of the coastal fisheries at Sanzule and Bakanta that included two seasons of sampling, one in April 2014 and a second one in October 2014, the latter during the upwelling season.
- Focus Group Discussions undertaken as part of the EIS for the OCTP Phase 1 Development: During the period of November 2013 to March 2014 consultations were carried out with the chief fishermen and fishermen of some of the fishing towns in the six coastal districts of the Western Region. These included Sekondi, Axim, Dixcove, Half Assini, Shama, Sanzule and Bakanta. There were also discussions held with the Western Region Fisheries Commission.
- Stakeholder engagement undertaken as part of the EIS for OCTP Phase 2 Development. Consultations were carried out in December 2014 with chief fishermen and fishermen of the extended AoI. Stakeholders consulted include: fisherman of Essiamam, Chief Fisherman of Upper Dixcove, Chief Fisherman of Upper Axim, Chief Fisherman of Half Assini, and Chief Fisherman of Sekondi. Additionally, as part of the social baseline data gathering, consultations with Fishers of the 10 communities within the Direct Area of Influence took place in December 2014. Details can be found in Annex A, SEP.

7.3 RELEVANT SPECIES AND ECOSYSTEMS

The marine environment offshore Ghana is located within the Central West African Upwelling System. Oceanic upwelling is an important feature in this area and influences primary productivity and fishery resources. Upwelling off the coasts of Ghana and Cote d'Ivoire occurs seasonally, with a weak upwelling around January to March, and intense upwelling from July to September. The cold, nutrient rich water of the upwelling system drives the biology of the area extending from Liberia to Benin.

The composition and distribution of fish species found in Ghanaian waters, and the wider Gulf of Guinea, is influenced by the seasonal upwelling. The transport of colder, dense and nutrient-rich deep waters to the warmer, usually nutrient-depleted surface water during periods of upwelling stimulates high levels of primary production in phytoplankton. This primary productivity in turn increases production zooplankton and fish.

The fish species found in Ghanaian waters can be divided into groups, namely:

- small pelagic species;
- large pelagic species (Tuna and Billfish);
- demersal (bottom dwelling) species;
- molluscs and crustaceans; and
- deep sea species.

A review of these groups of species, as well as of threatened and endangered species is found in the following sections.

7.3.1 Small Pelagic Species

The main small pelagic fish species found in the coastal and offshore waters of Ghana are Round Sardinella (Sardinella aurita), Madeira/ Flat Sardinella (S. maderensis), European Anchovy (Engraulis encrasicolus) and Chub Mackerel (Scomber japonicus). Other notable species that are caught include horse Mackerel (Trachurus sp.), Little Tunny (Euthynnus alletteratus), Bonga Shad (Ethmalosa fimbriata), African Moonfish (Selene dorsalis), West African Ilisha (Ilisha africana), Crevalle Jack (Caranx hippos), Atlantic Bumper (Chloroscombrus chrysurus) and Barracuda (Sphyraena spp.). These species have important functions within in the ecosystem as both predators and prey.

7.3.2 Large pelagic fish species

Large pelagic fish species include the key tuna species, namely Skipjack Tuna (Katsuwonus pelamis), Yellowfin Tuna (Thunnus albacares) and Bigeye Tuna (Thunnus obesus). These species are highly migratory and occupy the surface waters of the entire tropical and sub-tropical Atlantic Ocean. They are important species in the ecosystem as both predators and prey. Billfish species are also exploited in much lower but notable numbers and include Swordfish (Xiphias gladius), Atlantic Blue Marlin (Makaira nigricans) and Atlantic Sailfish (Istiophorus albicans).

Juveniles and small adults of these species of fish school at the surface either in mono-species groups or together and these schools are often associated with floating objects such as floating seaweed, pieces of wood and stationary, anchored or drifting vessels. The attraction to these objects is likely to be linked to predator avoidance and a focus of aggregation behaviour. Some species are also attracted to floating objects to feed on readily available prey that is attracted to floating objects.

7.3.3 Demersal fish species

The composition and abundance of demersal fish fauna of the western Gulf of Guinea has been shown to change with depth. This is partly due to substrate and food preference, and partly due to temperature preferences. Two distinct groups or demersal assemblages are noted: those that inhabit soft to muddy bottoms (usually above the base of the thermocline); and those found on hard bottoms (which are above the base of the thermocline at approximately 50 m, while below the thermocline they inhabit a much wider variety of habitats).

In addition, environmental factors such as total organic matter content, temperature, salinity and dissolved oxygen have also been shown to determine the distribution of demersal fish species within the Gulf of Guinea.

In general, demersal fish are widespread on the continental shelf along the entire length of the Ghanaian coastline.

Demersal species include the following: Porgies or Seabreams (Sparidae) (eg, Bluespotted Seabream Pagrus caeruleostictus, Angola Dentex Dentex angolensis , Congo Dentex Dentex congoensis, Canary Dentex Dentex canariensis and Pink Dentex Dentex gibbosus); Grunts (Haemulidae) (eg, Bigeye Grunt Brachydeuterus auritus and to a lesser degree Sompat Grunt Pomadasys jubelini and Bastard Grunt Pomadasys incises); Croakers or Drums (Sciaenidae) (eg, Red Pandora Pellagus bellottii , Cassava Croaker Pseudotolithus senegalensis); Goatfishes (Mullidae) (eg, West African Goatfish Pseudupeneus prayensis); Snappers (Lutjanidae) (eg, Golden African Snapper Lutjanus fulgens, Goreean Snapper Lutjanus goreensis); Groupers (Serranidae) (eg, Qhite Grouper Epinephelus aeneus); Threadfins (Polynemidae) (eg, Lesser African Threadfin Galeoides decadactylus); Emperors (Lethrinidae) (e.g. Atlantic Emperor Lethrinus atlanticus); and Triggerfish (eg, Grey Triggerfish Balistes capriscus).

7.3.4 Molluscs and Crustaceans

A variety of molluscs and crustaceans known from the wider/coastal study area are the Common Cuttlefish (Sepia officinalis), Common Squid (Loligo vulgaris), Common Octopus (Octopus vulgaris) and the Green (Spiny) Lobster (Panulirus regius), Deep-sea Rose Shrimp (Parapenaeus longirostris) and other Shrimps (mainly Southern Pink Shrimp Penaeus notialis, Caramote Prawn Penaeus kerathurus and Guinea Shrimp Parapenaeopsis atlantica). Of these species the highest catches are of the Cuttlefish species, followed by the Crustaceans, particularly Green (Spiny) Lobster. The Cuttlefish species, including the Common Cuttlefish and the Pink Cuttlefish, are both caught in Ghanaian waters and are both eastern Atlantic species.

7.3.5 Deepwater Fish species

Deepwater sea species are those beyond and below the depth of the continental shelf, and these can be pelagic or demersal. Over 180 deepwater species have been reported off Ghana, including approximately 110 that are principally pelagic, 60 that are principally demersal and 10 that migrate between the bottom and higher layer of the seabed. Of these deepwater species, approximately 90 from 28 families have been reported to have been found within the depth range in the Jubilee Field (1,100 and 1,700 m) (located adjacent to the offshore Project area). Apart from this, there is little information on the distribution of these species within the project area and, generally, within Ghanaian waters.

7.3.6 Threatened and Endangered Species

Fish species in Ghanaian waters that are identified on the IUCN Red List as 'Sensitive' include: Epinephelus itajara (Goliath Grouper – Critically endangered), Pristis pectinata (Wide Sawfish– Critically endangered), Pristis perotteti (Largetooth Sawfish – Critically endangered), Dasyatis margarita (Ray species – Endangered), Epinephelus marginatus (Dusky Grouper – Endangered), Raja undulata (Undulate Ray – Endangered), Rhinobatos cemiculus (Blackchin Guitarfish– Endangered), Rhinobatos rhinobatos (Common Guitarfish – Endangered), Rhynchobatus luebberti (Lubbert's Guitarfish – Endangered), Rostroraja alba (Bottlenose Skate – Endangered) and Sphyrna lewini (Scalloped Hammerhead – Endangered). The full list of fish species included in the IUCN red data list that inhabit Ghanaian waters is presented in Table 6.34 of Chapter 6 – environmental Baseline.

None of these species are found in depths below 550 m with most being found shallower than 200 m.

There is also a global concern regarding Tuna stocks. Bigeye Tuna, is listed as 'Vulnerable' on the IUCN Red List and Southern Bluefin Tuna is listed as 'Critically Endangered'. The International Commission for the Conservation of Atlantic Tunas (ICCAT) has listed Bigeye Tuna as the species of greatest concern after the Bluefin Tuna, in terms of population status and the unsustainable levels of exploitation.

In addition, two species of Angle Sharks (Squatina aculeata and S. Oculata) are considered as Critically Endangered.

7.4 FISHING FLEETS AND GEARS

The Ghanaian marine fishing fleet can be classified into four main groups: artisanal, nearshore and inshore, industrial/offshore and Tuna. Additionally there are a large number of vessels from these groups dedicated to the fishing of sharks for their fins.

The number of vessels operating in Ghana for each of the fleets is included in Table 7.1. As can be seen, the vast majority of operational vessels are involved in the artisanal sector (more than 95%), highlighting its importance in terms of employment.

Table 7.1 Number of vessels operating in Ghana (2000-20012)

Fishing Fleet	Number of vessels	
	2000	2012
Artisanal	8,610	11,219
Inshore (semi-industrial)	173	381
Industrial* (offshore distant)	49	102
Tuna	37	34
Total	**8,871**	**11,736**

Source: Marine Fisheries Research Division, 2012
* excluding Tuna fleet

7.4.1 Artisanal Fleet

Artisanal fishing is mainly operated from beaches by means of canoes and provides employment in coastal communities to more than 124,000 people. The 11,200 operative artisanal fishing boats in 2012 are estimated to contribute 70-80% of the marine fish output in Ghana (FAO, 2010).

This fleet is mainly wooden canoes (Figure 7.1). There are three types of canoe in Ghana ranging from 3 to 5 m small dugout canoes mainly propelled by paddle, through medium 6 to 11 m wooden canoes propelled by paddle, sail and outboard engine, to large 12 to 18 m wooden canoes mainly motorized by outboard engine (Doyi, 1984). Approximately 50 to 60% of the canoes are powered by outboard motors with engine power of less than 40 hp (FAO 2010; Kwadjosse 2009). Crews for the larger canoes range between 4 and 30 people, depending on the canoe size and fishing gear.

Generally, artisanal fishing targets small pelagic and demersal species but also large pelagic species and some molluscs and crustaceans. The type of fishing gear used depends on the species being targeted and the geographic distributions of the species along the Ghanaian coast. For example, beach seine is widely used in the Volta Region in the eastern part of Ghana, particularly around the mouth of the Volta River and other estuarine areas, to exploit juvenile fish. These areas are nursery grounds for several important fish species such as mullet, carangid and croakers as well as shrimps.

Purse seine nets are prominent in the Greater Accra and Central Region where small pelagic species are heavily exploited. Drift gill nets and set-nets are the most common gear used in the Western and Central Regions. The small pelagic species are mainly exploited by the artisanal purse seines and beach seines. Purse seiners target adult Sardinella species and Chub Mackerel and beach seiners target the Sardinella species and during the non-upwelling periods, both target Anchovies and juvenile Sardinella species in coastal waters. Beach seines are operated from the beach and exploit adult Sardinellas, during the upwelling periods and Anchovies and juvenile Sardinellas during the non-upwelling periods (www.fao.org).

Hook and line, and beach seines are the main artisanal gears used to exploit demersal fish. Hook and line canoes operate in waters of about 80 m on hard bottoms. The main species targeted are Seabreams (eg Pink Dentex, Bluespotted Seabrean and Canary Dentex), Snappers (e.g. Golden African Snapper, Gorean Snapper), Grunts (e.g. Bigeye Grunt), Goatfishes (e.g. West African Goatfish), Mullets Cutlassfish and Groupers (e.g. White Grouper) (FAO, 2010) . The beach seine exploits both adult and juvenile demersal fish but mainly juvenile fish. Some of their target species include Burrito (Brachydeuterus auritus), Red Snapper (Lutjanus fulgens) and Grey Snapper (www.fao.org).

Drifting gillnets are used offshore to exploit mainly large pelagics such as Sharks (Carcharhinus spp.), Tunas (Thunnus albacares, Thunnus obesus), Sailfish (Istiophorus albicans) and Swordfish (Xiphias gladius) (www.fao.org).

Artisanal gears are also used to exploit molluscs and crustaceans. Beach seines are used to exploit shrimps, mainly adult and juvenile Guinea/White Shrimp and Tiger Shrimp/Camarote Prawn and Juvenile Pink/Candied Shrimp as they move from the estuaries into marine waters. Lobster set nets target Royal Spiny Lobster, on rocky bottoms and in depths of about 40 m. In addition cephalopods (Common Cuttlefish, Common Squid, and Common Octopus) are targeted (TFS, 2011).

Figure 7.1 Typical Large Artisanal Fishing Canoes

Source: ERM 2014

7.4.2 Nearshore and Inshore Fleet

The inshore (or semi-industrial) fishing fleet consists of locally built wooden vessels fitted with inboard engines of up to 400 hp ranging between 8 m and 37 m in length. Vessels with lengths less than 12 m are referred to as small-sized while those between 12 and 22 m are referred to as medium-sized vessels (FAO, 2010). There are about 300 inshore vessels, operating from seven landing centres, the larger centres being Takoradi, Tema, Elmina and Sekondi and the smaller centres being Apam, Axim, Mumford (TFS, 2011). Currently this sector is estimated to land about 2% of the total marine fish production (Kwadjosse, 2009).

The inshore fleets are mainly multi-purpose and operate as purse-seiners during the upwelling periods and switching to bottom trawling for the rest of the year. Most purse-seine nets measure 400 to 800 m long, are 40 to 70 m deep and have a mesh size of approximately 25 to 40 mm. Bottom trawl gear has a mesh of 40 mm at the end of the net (cod end), 45 m head rope and 40 m foot rope. The fishermen in this category can stay offshore for three to five days depending on the availability of catch and as such carry ice for preserving fish. The purse-seiners target the small pelagic species including Sardinella species, chub mackerel, fishing in the same coastal waters as the artisanal fleet during the upwelling seasons. Demersal species are targeted through trawling, with the small sized vessels targeting species including grey triggerfish. The medium-sized trawlers exploit Seabreams (Bluespotted Seabream and Canary Dentex), Snappers (e.g. Golden African Snapper, Gorean Snapper), grunts (e.g. Bigeye Grunt), Croakers (e.g. Red Pandora, Cassava Croaker) and Groupers (e.g. White Grouper) (FAO, 2010). Bottom trawling is undertaken in waters greater than 30 m depth.

Figure 7.2 Nearshore Fishing Boats and Gear

Source: ESL 2014

7.4.3 Industrial Fleet

The industrial fishing fleet is composed of trawlers, shrimpers and Tuna boats that may remain at sea for periods that last up to one month. According to FAO (2014) the fleet in Ghana includes approximately 60 trawlers and about 29 Tuna boats. Trawlers are normally over 35 m in length and have engines of over 600 hp.

As deep-sea vessels, they are required by the Fisheries Act of 2002 (Act 625) to operate outside the Inshore Exclusion Zone (IEZ), that is in waters greater than 30 m depth, but as they cannot trawl in depths greater than 75 m due to the state of disrepair of vesells and engines, their operational area is limited to areas between these two depths.

Main targets are semi pelagic and demersal species including Porgies or Seabreams, Jacks (Caranx rhonchus), Groupers, Snappers, Croakers (Pseudotolithus senegalensis), Goatfishes (eg Pseudupeneus prayensis), Soles and Flounderss (Soleidae) as well as Cuttlefishes (eg Sepia officinalis) and Shrimps.

In 2007 the landings of demersal fishes were approximately 70,000 tonnes (FAO, 2014).

Illegal trawling is reported also to occur in Ghanaian waters by foreign vessels entering and fishing illegally within the waters.

7.4.4 Tuna Fleet

The gulf of Guinea hosts a very productive Tuna fishery as a result of oceanographic conditions that attract Tuna species due to the water temperatures, high densities of prey due to the upwelling, and the existence of spawning grounds for at least two Tuna species, Yellowfin and Bigeye Tuna. As a result a Tuna fleet has developed in the area that catches between 50,000 and 90,000 tonnes annually of three species: Skipjack Tuna, Yellowfin Tuna and Bigeye Tuna.

According to the assessments of the International Commission for the Conservation of Atlantic Tunas (ICCAT), that regularly assesses the Tuna populations, the Tuna fishery of Yellowfin and Bigeye Tuna in the Atlantic are exploited to full capacity and do not allow an increase in catches without risk for the species. A 2008 report indicated that the stock of Skipjack Tuna is not thought to be overexploited despite the difficulties with assessing the real status of the population (ICCAT, 2008).

The geographic range for Tuna fishery is between 20NM and 200 NM EEZ, while the FPSO is about 60 km from the shore.

7.4.5 Shark Fishing

Despite it not being considered a specific fleet, the exploitation of Shark Fins has become a widespread business in Ghana, where species like Silky Shark (Carcharhinus falsiformis), Black Tip Shark (Carcharhinus limbatus), Oceanic Whitetip Shark (Carcharhinus longimanus), Sandbar Shark (Carcharhinus plumbeus) and Night Shark (Carcharhinus signatus) are commonly targeted throughout the year, and specially in October and December (DoF, 2003). The fishing gears used for the Sharks are mainly driftnets.

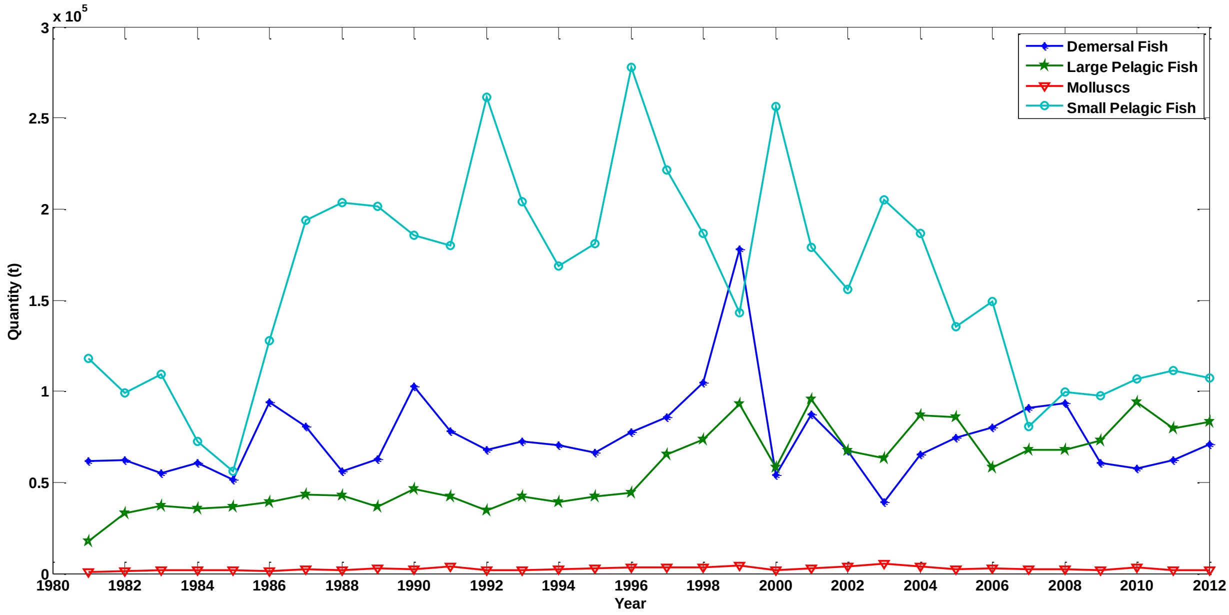
Shark fishing is performed by the inshore artisanal fishermen at very few locations (eg Dixcove) who use outboard motors. This fishery is on the decline as new enforcement regimes are being implemented.

7.5 MARINE FISH LANDINGS

In general, marine fish landings in Ghana are declining, though landings of small pelagics have shown slight increase since 1997. The landings of large pelagics have remained fairly stable, demersal species show a general increase, while landings of molluscs and crustaceans have remained consistently low.

These data represent the total annual catches of the major target groups as seen in Figure 7.3 but do not indicate fishing effort, which is an influential factor for quantity of catches.

Figure 7.3 Total Landings of Major Target Fish Groups in Ghana (1981 to 2012)



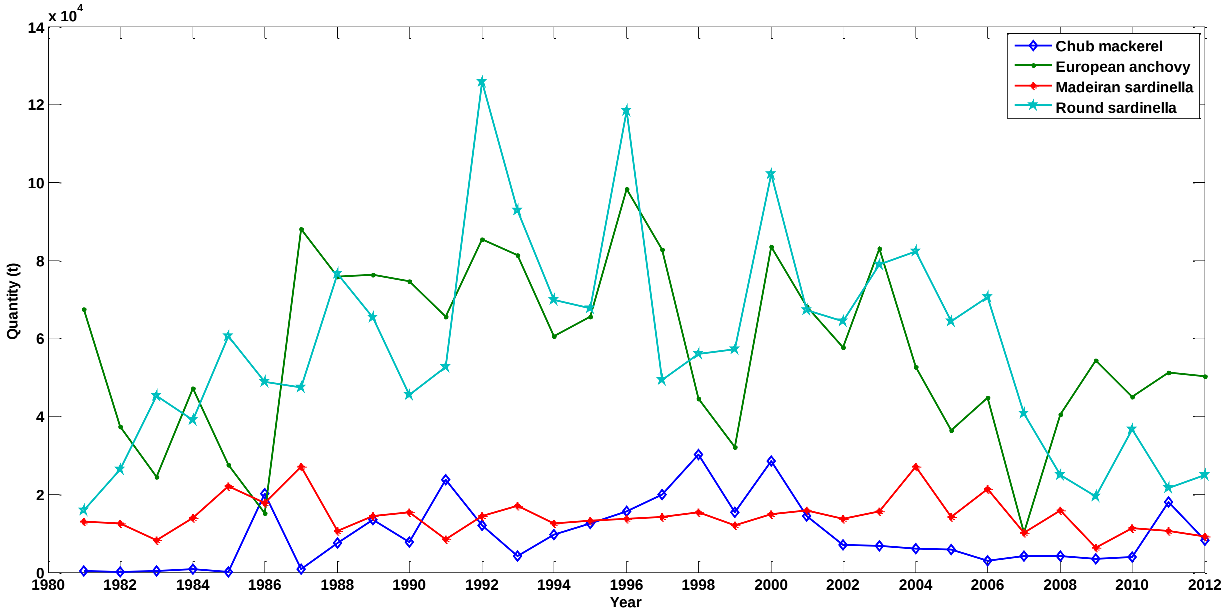
Source: (FAO FishStat, 2014)

7.5.1 Landings of Small Pelagic Fish Species

Data obtained for the landings of small pelagic species were limited to that of the four species of the highest economic value: Round Sardinella, Madeira/Flat Sardinella, European Anchovy and Chub Mackerel. Annually, these four species account for approximately 80% of the total landings of small pelagic fish in Ghana (MoFA, 2004).

The potential annual yield of these species was estimated to be in the region of 200,000 t in 2004 (MoFA, 2004) but data from 1981 to 2012 show an average annual catch landing of 139,308 t (Standard Deviation: 47,730). The annual reported catches of the key four small pelagic species from 1988 to 2012 showed a gentle rise in the landings of both Round Sardinella and European Anchovy in the past two decades while landings of the Flat Sardinella and Chub Mackerel was relatively constant (see Figure 7.4).

Figure 7.4 Landings of Small Pelagic Fish in Ghanaian Waters (1981 to 2012)



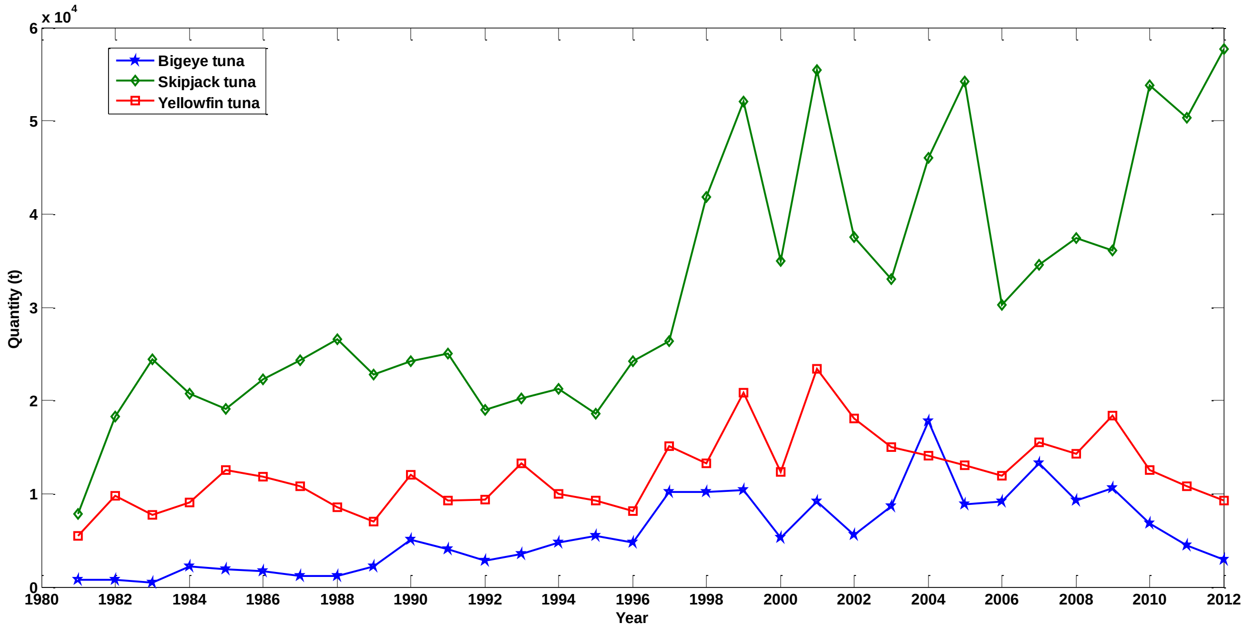
Source: (FAO FishStat, 2014)

7.5.2 Landings of Large Pelagic Fish Species

The landings of this group of fish species found in Ghanaian waters are estimated from the catch estimates of Tuna species. The Tuna species that occur in Ghanaian waters are part of a wider population found throughout the Atlantic Ocean. More than 60% of all Tuna species caught are Skipjack Tuna due to the fact that Skipjack are resident species and hardly migrate from their spawning/ breeding grounds in Ghanaian waters. According to ICCAT, approximately 60% of Tuna caught are undersized since Tuna fishing usually occurs in spawning areas and as such Tuna caught are not mature (TFS, 2011)

From Figure 7.5, the total annual landings of Yellowfin Tuna, Bigeye Tuna and Skipjack Tuna have fluctuated between approximately 52,000 t and approximately 70,000 t from 2000 to 2012 with catches of Skipjack Tuna consistently being larger than the other two. Catches of Yellowfin Tuna reached a peak in 2001 at just over 33,500 t and has shown a steady decline ever since. The annual mean landing of Large Pelagic fish is approximately 50,000 t with a standard deviation of approximately 19,000 t estimated between 1981 and 2012.

Figure 7.5 Landings of Large Pelagic Fish Species in Ghanaian Waters (1981 to 2012)



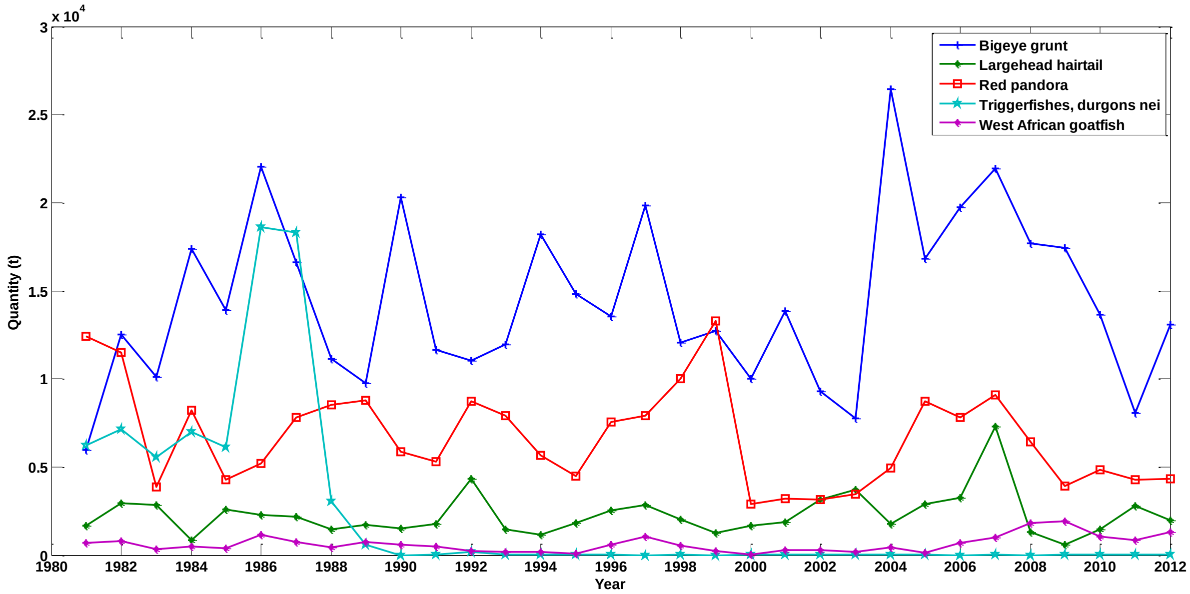
Source: (FAO FishStat, 2014)

7.5.3 Landing of Demersal Fish Species

Landings of key demersal species have varied considerably from 1998 to 2012. There was a marked increase in the landings of Bigeye Grunt (Brachydeuterus auritus) up to 2007, after which landings have fallen dramatically. Red Pandora (Pellagus bellottii) landings were consistently low between 2000 and 2004, with higher levels between 2005 and 2007, after which catch has been declining. An annual average of approximately 26,000 t (standard deviation of approximately 8,000 t) of Demersal fish was landed between 1981 and 2012.

Generally landing of the key demersal species has declined in recent years with the exception of the West African Goatfish (Pseudupeneus prayensis) which appear to have increased steadily since 2005 (Figure 7.6).

Figure 7.6 Landings of Demersal Fish Species in Ghanaian Waters (1981 to 2012)

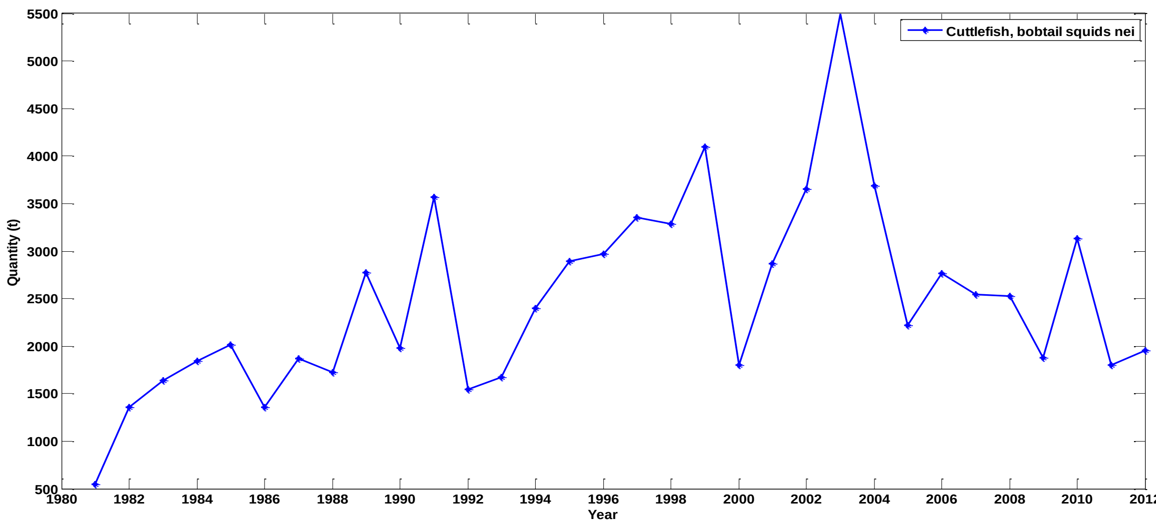


Source: (FAO FishStat, 2014)

7.5.4 Landings of Molluscs and Crustaceans

Cuttlefish are the most important species in this group of fish species. The annual landings of Cuttlefish peaked in 2003 and then declined to 2000 levels from 2005 with marginal fluctuations.

Figure 7.7 Landings of cuttlefish in Ghanaian waters between 1981 and 2012



Source: (FAO FishStat, 2014)

An annual average of approximately 2,500 t (standard deviation of approximately 1,000 t) of molluscs and crustaceans was landed between 1981 and 2012 (Figure 7.7).

7.5.5 Bycatch

Bycatch from the industrial fishing sector are important commercially in Ghana as trawlers sell unwanted bycatches of non-target species to smaller vessels at sea (Marquette et al 2002; Nunoo, 2009). The efficiency of this process has been enhanced by the use of modern communications and navigation equipment (Nunoo, 2009). The operation of the bycatch business is centred mainly in Elmina, Apam and Tema.

It is difficult to quantify the importance of this trade since most of the bycatch is not recorded as catch by fisheries officers at the landing locations (the bycatch are transhipped at sea to local artisanal fisherman). The market demand has led to offshore vessels to fish closer to shore and it has been reported that illegal mesh sizes have been used to enhance bycatch quantities.

Some key species of bycatch traded in this way are Snakefish (Trachinocephaleus myops) (approximately 32%), Wedge Sole (Dicologoglossa cuneata) (approximately 25%), Pearly Razorfish (Xyrichtys novacula) (approximately 13%), and Atlantic Bigeye (Priacanthus arenatus) (approximately 6%) (Nunoo, 2009).

7.5.6 Sharks and Rays

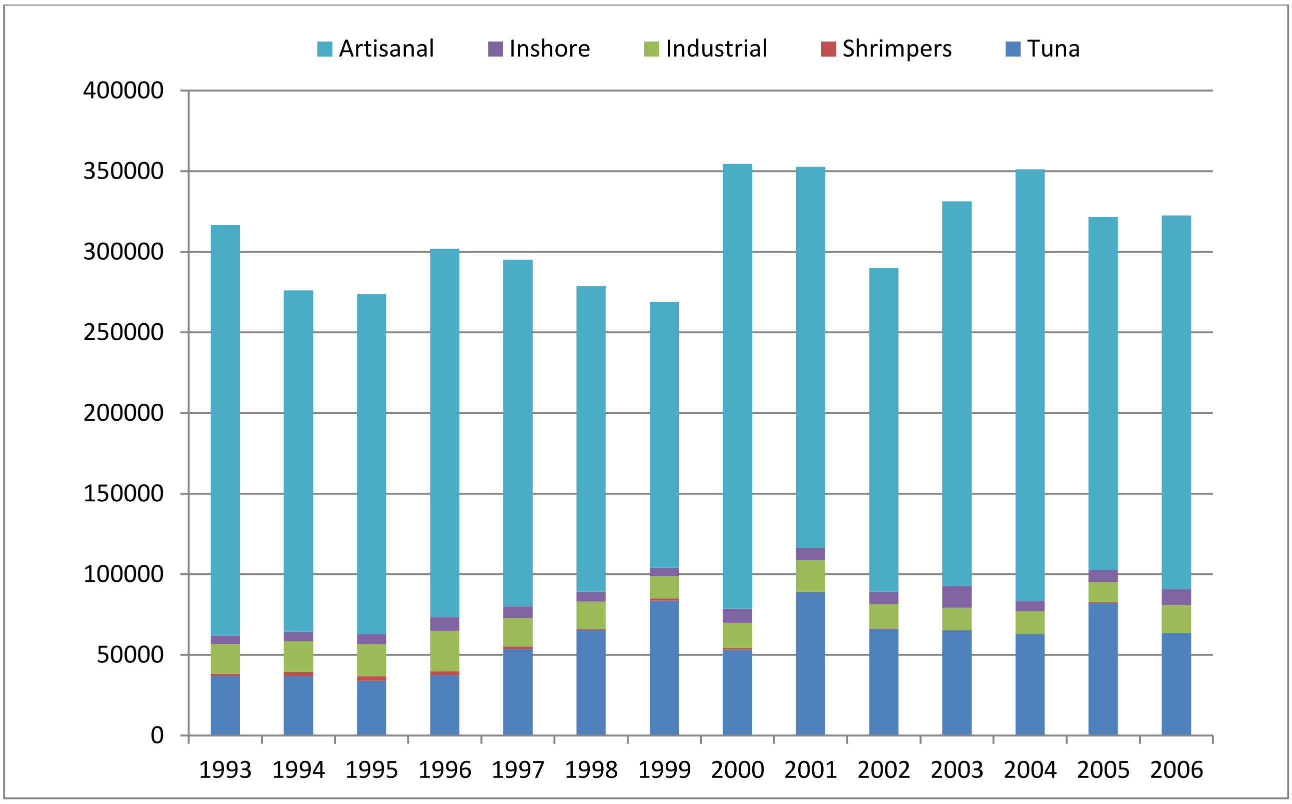
Some Shark and Ray fishing is officially reported for Ghana, however, little data is available. The exploitation of Shark Fins has become a widespread business in Ghana. Dixcove is one location where many fishermen fish for Sharks and there is a trade in Shark Fins. Shark fishing is a year-round operation with a peak in October and December (IMM, 2003).

Shark fishing is conducted from different types of vessels, including artisanal, inshore and industrial and it is understood that as many as 150,000 fishermen might be involved in it (Mensah and Koranteng 1988). The sharks are caught using driftnet. Species caught comprise Blue Shark (Prionace glauca), Hammerhead Sharks (Sphyrna spp.), Silky Shark (Carcharhinus falsiformis), Black Tip Shark (Carcharhinus limbatus), Oceanic Whitetip Shark (Carcharhinus longimanus), Sandbar Shark (Carcharhinus plumbeus) and Night Shark (Carcharhinus signatus). In addition, sharks can be caught as bycatch by purse-seiners as well as bottom set gill nets. The Shark Fin fishery poses threats to some species listed as 'Endangered' or 'Critically Endangered' on the IUCN Red List.

7.5.7 Marine Fish Landings by Fleet

Fish landings for each fleet in the Ghanaian fishing industry has been fluctuating over the years, but the artisanal sector has always landed the majority of the catch in terms of total weight (approximately 70 to 80%). The industrial fleet is the second largest in terms of catch landings followed by the inshore fleet. Within the industrial fleet, the tuna vessels have the largest landings followed by the trawlers (Figure 7.8 and Figure 7.9). The landings for the shrimpers have declined over the years and now none are operational in Ghanaian waters.

Figure 7.8 Fish landings by Fleet operating in Ghana between 1993 and 2006



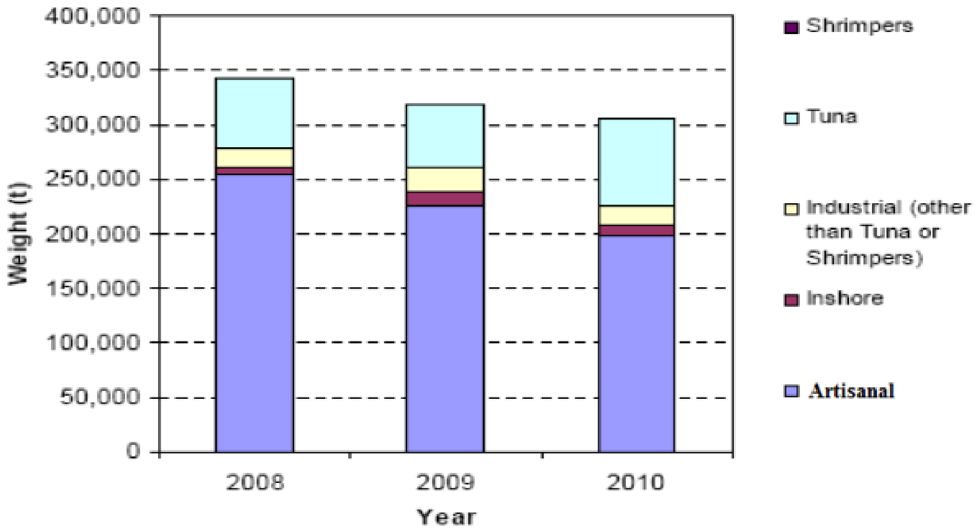
Source Marine Marine Fisheries Research Division, 2011

Table 7.2 Fish landings by Fleet operating in Ghana between 1993 and 2006

	1993	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Tuna	36856	36973	33935	37255	53625	65568	83552	53255	88806	66046	65153	62742	82226	63252
Shrimpers	1548	2442	2689	2590	1652	653	1410	1224	310	249	296	292	443	297
Industrial	18323	18966	20049	25104	17528	16847	13945	15455	19644	15159	13848	14010	12494	17419
Inshore	5230	6037	6371	8353	7294	6137	5150	8668	7606	7785	13319	6331	7591	9877
Artisanal	254724	211747	210659	228606	215125	189459	164829	275965	236355	200769	238796	267910	218872	231681

Source: Marine Fisheries Research Division, 2011

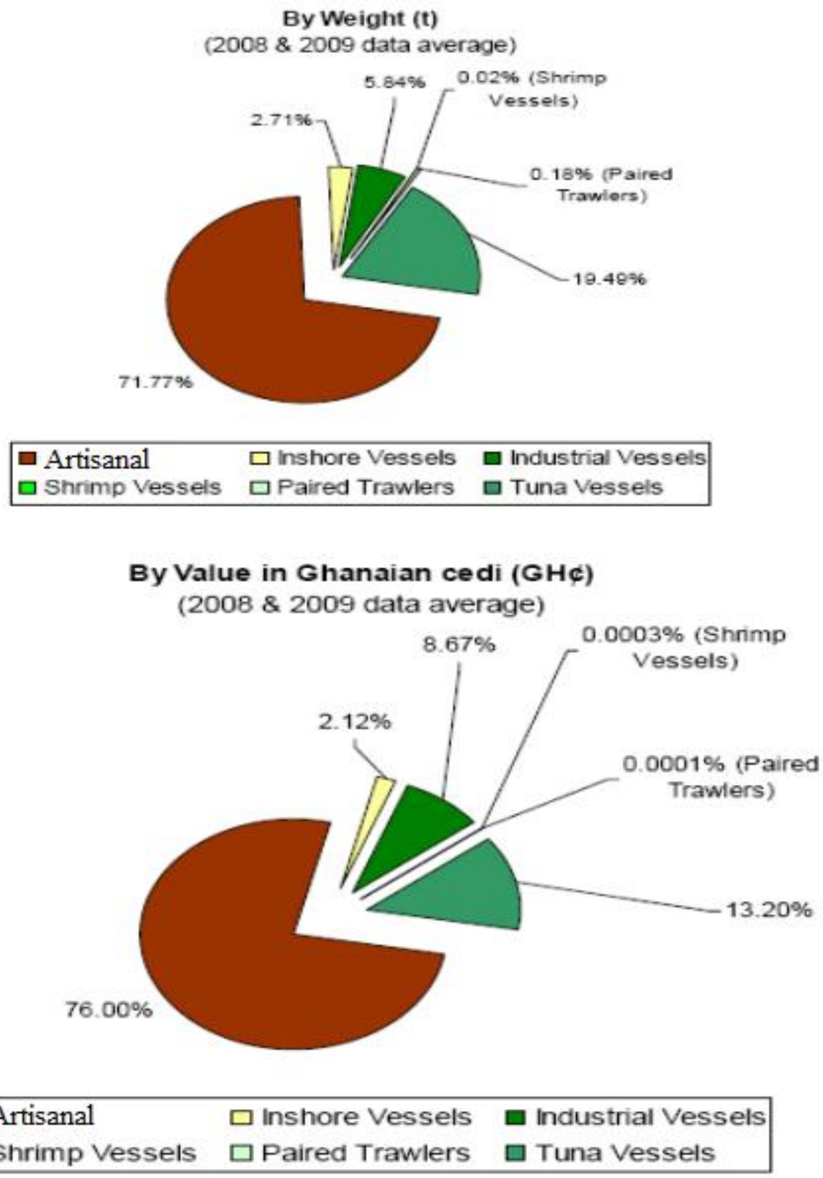
Figure 7.9 Fish landings by Fleet operating in Ghana between 2008 and 2010



Source Marine Marine Fisheries Research Division, 2011

Fish landings from the artisanal fleet have been fluctuating over the years. The causes include both natural and man-made factors. Naturally, climatic factors (e.g. increasing sea surface temperature resulting in increasing salinity) as well as man-made pressures in the form of over exploitation and the use of illegal fishing practices (e.g. dynamite and destructive chemical practices, light fishing etc.) are believed to have contributed to this situation.

Figure 7.10 Marine Fish Production in Ghana (Averaged for 2008 and 2009, by vessel type according to weight and value)



Source: (TFS, 2011).

Even though the fish landings from the artisanal fleet fluctuates it is estimated to account for about 90% of total landings of the small pelagic resources and about 50% of total demersal fish landings annually (FAO, 2010). With regard to molluscs and crustaceans, until the early 1980s artisanal fishers accounted for over 60% of landings annually. More recently the exploitation of this resource has been dominated by the industrial trawlers (FAO, 2010). In recent times, artisanal fisheries have accounted for 65 to 75% of total landed catch, the tuna vessels an additional approximately 20% and the other industrial vessels (trawlers) for approximately 6%. It is understood also that shrimpers have effectively not been operational over the previous five years (MFRD, 2011).

These statistics translate directly into the amount of revenue generated from the landings of these fleet. Artisanal fleets contributed to about 76% of the revenue generated from marine fish landings while revenue from tuna fleet accounted for 13.2%, industrial fleet (trawlers) (8.7%) and inshore fleet (2.1%) as shown in Figure 7.10.

7.6 Fish Cath Surveys

A survey of fish catch was conducted in Sanzule and Bakanta near where the onshore component of the proposed Project will be located. The survey was conducted twice: once in April 2014, end of the dry season, and again in October 2014, during the upwelling season.

7.6.1 Fishing Fleet and Gear

The Sanzule and Bakanta landing beach covers a shore line approximately 4 km long and about 0.5 km wide into the sea. The total number of canoes recorded in the study area includes five canoes at the Sanzule community and four canoes at Bakanta. The average length of the canoes in these beaches is 4.3 m and none of them use an outboard motor. Beach seine is the fishing technique used by the fishermen of Sanzule and Bakanta. The particular gear used by fishermen observed during the survey was a net bag about 27.7 m long, and a 19.6 m circumference mouth opening. The mesh size of the end of the net bag is about 5/8th of an inch (approximately 1.6 cm).

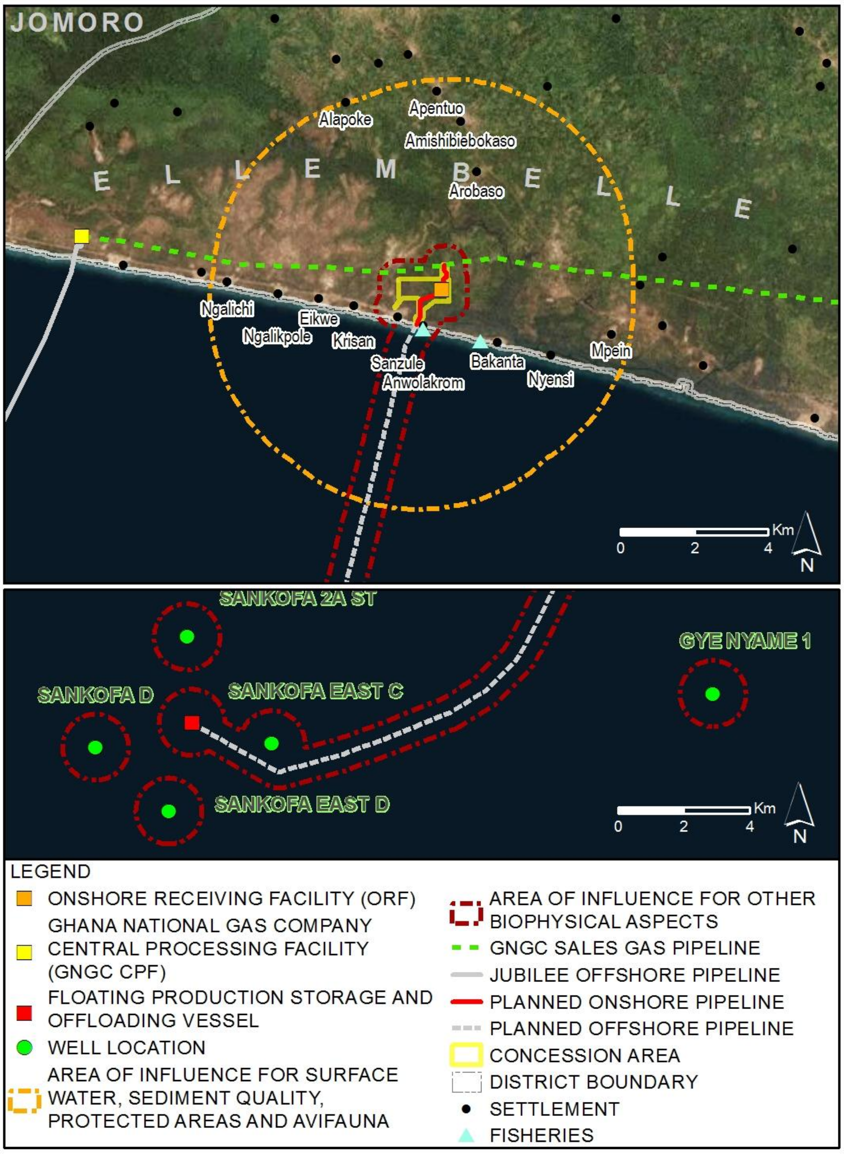
The canoes at the study site are solely used for beach seining and operate throughout the year except on days when there sea is much turbulent and risky for fishers to go fishing. In addition, canoes are not allowed to operate on Tuesdays.

Fishing operations usually last for four hours and are labour intensive with more than 30 people involved in each hauling process. The beach seine fishery is the only fish producer in the area. The towns have a combined fishing population of over 1500 inhabitants hence, beach seine fishing makes an important contribution to providing employment to the population in that area.

7.6.2 Fish Catch

As detailed in Section 7.2, a catch study was undertaken in April and October 2014 at Sanzule and Bakanta. Figure 7.11 shows the location of Bakanta and Sanzule beaches in relation with the project footprint and its environmental area of influence (orange and red dotted lines).

Figure 7.11 Location of Bakanta and Sanzule within the environmental Area of Influence



Source: ERM, 2015

Fish Catch data collected during April 2014 survey

A total of 34 different species of fish, cephalopods and crustaceans was caught, including 26 species at Bakanta and 22 species at Sanzule. Table 7.3 shows the total catch of each species. Most common species of fish of commercial importance caught in beach seines in the Western Region include the two species of Sardinella (Round and Flat), Pompanos, Croakers, Bumpers, and Groupers. The catch included also Rays, Flounders, Crabs and Puffer Fishes.

The hauls sampled at both Sanzule and Bakanta in April 2014 contained significantly large amount of the Seaweed Sargassum spp. that accounted for the 85% and 89% of the total catch weight respectively. The remaing catch, composed by-catch incluiding Fin-fish, crustaceans and mollusks, was 154 kg at Sanzule and 109 kg at Bankata. This indicates a Catch Per Unit Effort (CPUE) of 38.5 kg/hr and 27.25 kg/hr for Sanzule and Bankata respectively.

The catch was dominated by juveniles of commercially important species. None of the species captured were of conservational importance as listed in IUCN in Ghanaian waters.

Table 7.3 Fish Catch Composition at Sanzule and Bakanta (April 2014)

Scientific name	Common name	Total weight (kg	
		Sanzule	Bakanta
Balistes punctatus	Grey Triggerfish	0	1.6
Tylosurus acus rafale	Atlantic Agujon Needlefish	10	0
Bothus podas	Flounder	0	1.6
Alectis alexandrines	Alexandria Pompano	0	2.4
Selena dorsalis	Moon Fish	0.8	0
Trachinotus teraia	Shortfin Pompano	1.2	14.8
Lichia amia	Leer Fish	8	0
Chloroscombrus Chrysurus	Atlantic Bumper	9.2	20
Caranx crysos	Blue Runner	10	0
Ethmalosa dorsalis	Bonga Shad	0	4
Ilisha Africana	West African Ilisha	1.6	0
Sardinella aurita	Round Sardinella	2	2.6
Sardinella rouxi	Yellowtail Sardinella	8	4
Cynoglossus senegalensis	Senegalese Tongue Sole	1.6	2
Dasyatis margarita	Daisy Stingray	2	2
Epinephelus goreensis juv.	Dungat Grouper	1.6	2.4
Callinectes amnicola	Blue Swimming Crab	0	2
Pomadasys incises	Bastard Grunt	0	1.6
Pomadasys jubelini	Sompat Grunt	3.2	0
Brachydeuterus auritus	Bigeye Grunt	22.8	2
Holocentrus hastatus	Squirrel Fish	0	1.6
Medusa (Aurelia sp.)	Jellyfish	0	10.4
Mugil cephalus	Flathead Grey Mullet	6	2
Galeoidis decadactylus	Lesser African Threadfin	6.8	2.8
Psettodis belcheri	Spottail Spiny Turbot	0	1.6
Raja miraletus	Brown/ Peacock Ray	2	0
Pomadisus juv	Burro	0	2.8
Umbrina canariensis	Canary Drum	2	0
Pseudotolithus moorii	Cassava Fish	2.4	10
Pseudotolithus typus	Cassava Fish	50	2.4
Scomberomous tritor	Spanish Mackerel	0.8	1.2
Sepia officinalis	Common Cuttle Fish	0	6.4

Scientific name	Common name	Total weight (kg	
		Sanzule	Bakanta
Sphyraena sphyraena	Guinea Barracuda	2	0
Ephippion guttifer	Prickly Puffer	0	1.6
Total		**154**	**105.8**

Source: ESL, 2014

October 2014

In October 2014, three hauls were sampled: one in Sanzule and two in Bakanta. A total of 21 species was recorded. Only three fish species, namely, Caranx chrysus, Sphyraena sphyraena, and Trichirus lepturus were common to all the three catches. None of the species captured were of conservational importance as listed by IUCN .

Fish catch at Sanzule was dominated by the Anchovy Engraulis encrasicolus (approximately 21% of total fish catch weight), Caranx chrysus (18%), and Brachydeuterus auritus (15%). Fish catch from the two beach seine operations at Bakanta was dominated by Trichirus lepturus and Caranx chrysus.

The total fish catch weight after the four hour average fishing duration period for was 185.9 kg, 81.32 kg and 109.7 kg respectively for Sanzule, and the two Bakanta hauls. The Catch Per Unit Effort (CPUE) was therefore of 46.5 kg/hr, 20.3 kg/hr and 27.4 kg/hr for Sanzule and Bakanta respectively.

The primary seasonal difference was a lower presence of Seaweeds (Sargassum spp.) during the October study as only 5 kg were recovered (2.6% of the total catch) in Sanzule and none at Bakanta.

Although the diversity recorded in October is lower than the one recorded in the dry season, the total fish catch recorded at Sanzule was relatively higher than that recorded in April. Total fish catch weight recorded for each of the two beach seine operations at Bakanta, howeverwas lower in October. Table 7.4 shows the total catch for of each species captured.

Table 7.4 Fish Catch Composition at Sanzule and Bakanta (October2014)

Scientific name	Common name	Total weight (kg		
		Sanzule	Bakanta	Bakanta II
Caranx chrysus	Blue Runner	33.6	10.4	49.5
Chloroscrombus chrysirus	Atlantic Bumper	5.6		0.05
Vomer setapinnis	Moon Fish	8.4		0.25
Harengula rouxi	Yellowtail Sardinella	2.1	1	
Illisha africana	Long-finned Herring	5.6		0.1
Sardinella aurita	Round Sardine		2.2	
Drepane africana	African Sicklefish		0.5	
Elops lacerta	West African Lady Fish	4.9		
Engraulis encrasicolus	Anchovy	38.5		
Brachydeuterus auritus	Big eye Grunt	27.3		

Scientific name	Common name	Total weight (kg		
		Sanzule	Bakanta	Bakanta II
Pomadasys incisus	Bastard Grunt	8.4		0.25
Pomadysis jubelini	Sompat Grunt	3.5	1.3	
Medusa spp.	Jelly Fish	12		
Panulirus	\`Spiny lobster	1.4	0.02	
Polydactylus quadrifilis	Threadfin			0.25
Pseudutolithus senegalensis	Cassava croacker	8.4		0.25
Sarda sarda	Atlantic Burito		0.6	
Sepia officinalis	Cuttle Fish	1.4		
Sphyraena sphyraena	Guinea Barracuda	10.1	1.8	27.5
Stromateus fiatola	Butter Fish	3.5	0.5	
Trichirus lepturus	Ribbon Fish	11.2	63	31.5
Total		**185.9**	**81.3**	**109.7**

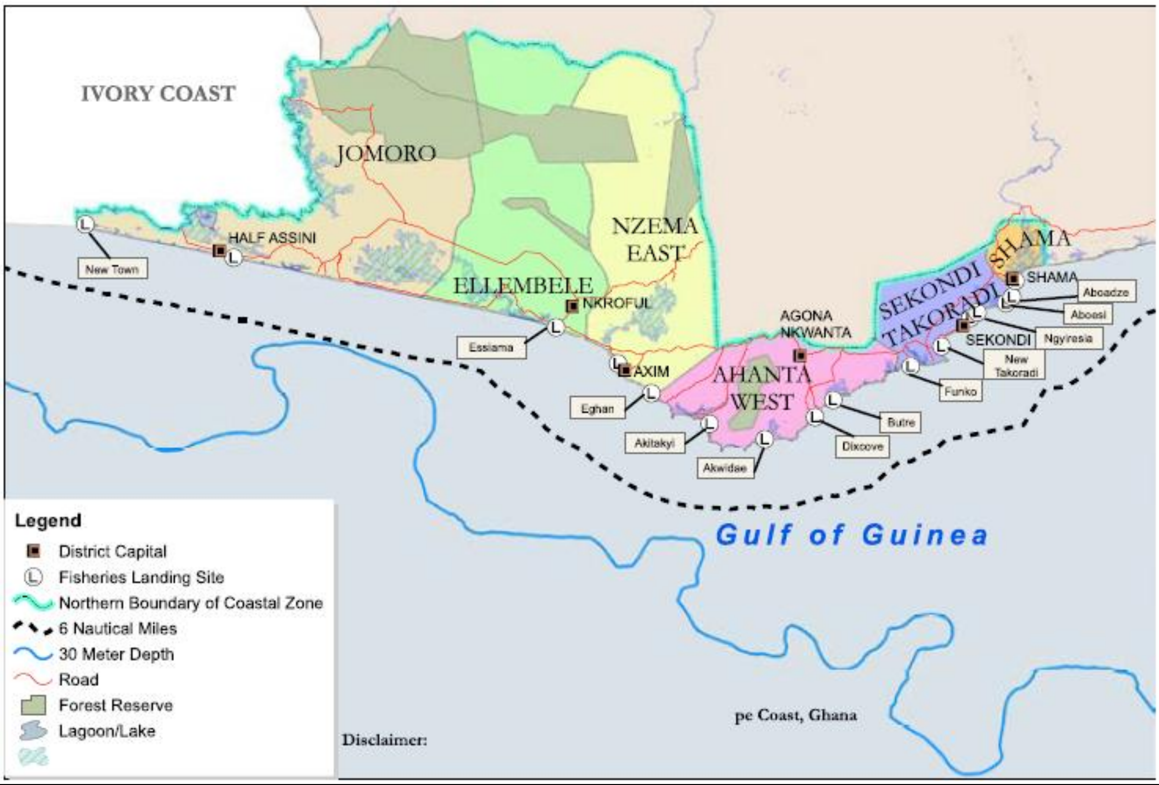
7.7 Source: ESL, 2014Socio-Economic Aspects of The Fishing Sector

The information in this section is based on a desktop study supplemented by the engagements undertaken in 2014 by ESL and ERM. Additional information will be collected in the future thorugh the Fisheries Monitoring Programme (see Chapter 12 for details).

The fishing industry in Ghana is based on fishery resources from the marine and to a lesser extent, inland or freshwater fisheries and aquaculture (Bank of Ghana, 2008). Marine fishing is an important traditional economic activity of the coastal communities in Ghana and contributes over 80 per cent of the total fish catch. Artisanal fishing in particular contributes about 70 – 80% of the total annual volume of marine fish catch of the country (Bank of Ghana, 2008). The importance of the fisheries sector in the socio-economic development of coastal communities in the Western Region and the country as a whole cannot be overemphasised.

The Western Region has a 202 km long coastline, divided into six coastal districts namely: Jomoro, Ellembelle, Nzema East Municipality, Ahanta West, Sekondi-Takoradi Metropolis, and Shama (Figure 7.12). Comprising approximately 20-30% of the country's landing sites, the Western Region produces marine fish destined for markets throughout Ghana and beyond (deGraft-Johnson et al., 2010; Finegold et al., 2010; Gordon et al., 2011).

Figure 7.12 Map of the Six Coastal Districts of the Western Region



Source: CRC, 2013

A 2010 appraisal of 89 selected fishing communities in the six coastal districts indicated that most of the fishing communities in the six coastal districts were homogenous as portrayed by their socio-cultural characteristics (CRC / FON, 2010). The few heterogeneous communities were mainly found in the Sekondi-Takoradi Metropolis (CRC / FON, 2010).

There are many stakeholders providing services at each point in the fisheries value chain. The chain is, nevertheless, relatively straightforward involving only fishers, fish traders at the landings, fish processors and retailers (Adupong et al., 2011). Like in other coastal areas of Ghana, men of Western Region are involved in fish harvesting while women are the key players in post-harvest activities undertaking fish processing and storage and trade activities (Adupong et al., 2011, Bank of Ghana, 2008).

Studies indicate that fishing and farming livelihoods in these coastal districts are interlinked (CRC, 2013). In the farming season (rainy seasons) income from fishing is used to purchase farming inputs. Investments shift back to fishing during the fishing seasons (CRC, 2013).

The 2010 population and housing census indicates that a population of 76,067 of the active labour force in the six coastal districts of the Western region are skilled agricultural forestry and fishery workers (Ghana Statistical Service, 2010). The population distribution for the six coastal districts is shown in Table 7.5.

Table 7.5 Population Distribution of Agricultural, Forestry and Fishery Workers in the Six Coastal Districts of the Western Region

District	Total Population	Economically active (15 – 64 years)		Skilled agricultural, forestry, and fishery workers
		Employed	Unemployed	
Jomoro	150,107	54,297	3,572	20,477
Ellembelle	87,501	27,945	1,664	9,447
Nzema East Municipality	60828	22,416	1,436	12,664
Ahanta West	106,215	41,729	22,416	14,503
Sekondi-Takoradi	559,548	207,912	26,017	10,119
Shama	81,966	28,875	2,496	8,857
Total	**1,046,165**	**383,174**	**57,601**	**76,067**

Source: Ghana Statistical Service, 2010

7.7.1 Fish Harvesting

Fishing, fish processing and fish trade are among the most important sources of livelihood in coastal communities in Western Region.

The fish harvesting system in the region involves a chain of activities including: purchase of inputs (canoes, mechanized wooden boats, nets, corks, weights, hook and lines); casting and dragging of nets; and on-board preservation using ice blocks (Gordon et al., 2011).

At most landings in Western Region, marine fishing is dominated by small-scale (artisanal) fishermen (CRC, 2013; Gordon et al., 2011). Studies indicate that roughly 5000 canoes operate in Western Region (Finegold et al., 2010 in Gordon et al., 2011).

For comparative purposes, Table 7.6 shows the various fishing activities and number of fishers in the Central and Western Regions of Ghana in 2004 and 2013. In 2004, a total of 118 fishing villages with 203 landing beaches were being operated, whereas in 2013, 116 fishing villages with 194 beach landing sites were operated.

Table 7.6 Composition of the Fishing Sector in the Central and Western Regions of Ghana in 2004 and 2013

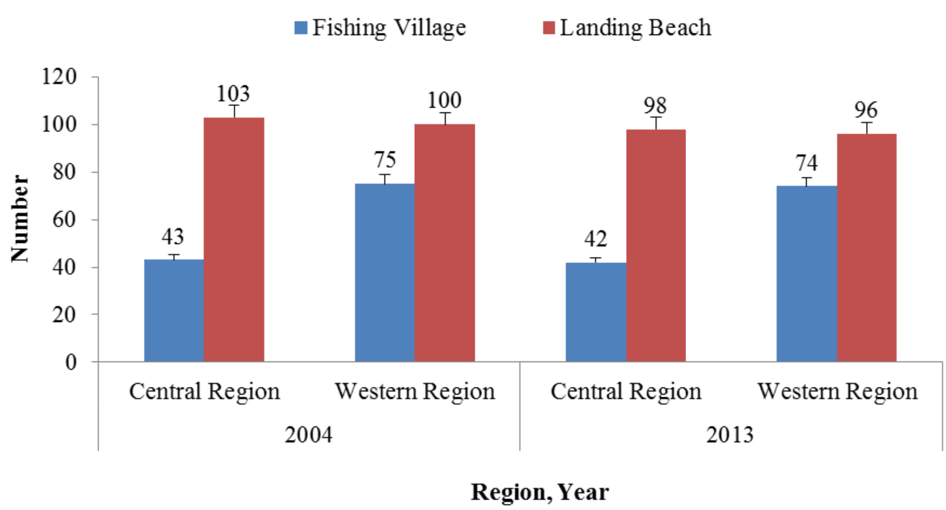
	2004			2013		
Fisheries Component	**Central Region**	**Western Region**	**Total**	**Central Region**	**Western Region**	**Total**
Fishing Village	43	75	**118**	42	74	**116**
Landing Beach	103	100	**203**	98	96	**194**
Pursing Nets	931	382	**1,313**	975	577	**1,552**

	2004			2013		
Fisheries Component	**Central Region**	**Western Region**	**Total**	**Central Region**	**Western Region**	**Total**
Beach Seine	198	163	**361**	221	236	**457**
Line	280	67	**347**	343	163	**506**
Lobster Nets	296	407	**703**	190	1,004	**1,194**
Other Set Nets	1,788	768	**2,556**	1578	679	**2,257**
Ali Net	710	761	**1,471**	527	1,084	**1,611**
Drifting Net	63	373	**436**	32	819	**851**
One-Man Canoe	184	325	**509**	23	452	**475**
Canoes	4,450	3,246	**7,696**	3,895	5,014	**8,909**
Total Motors	2,097	1,841	**3,938**	3,016	3,454	**6,470**
Fishermen	44,303	27,366	**71,669**	40,563	40,705	**81,268**

Source: Marine Fisheries Research Division, Ministry of Fisheries.

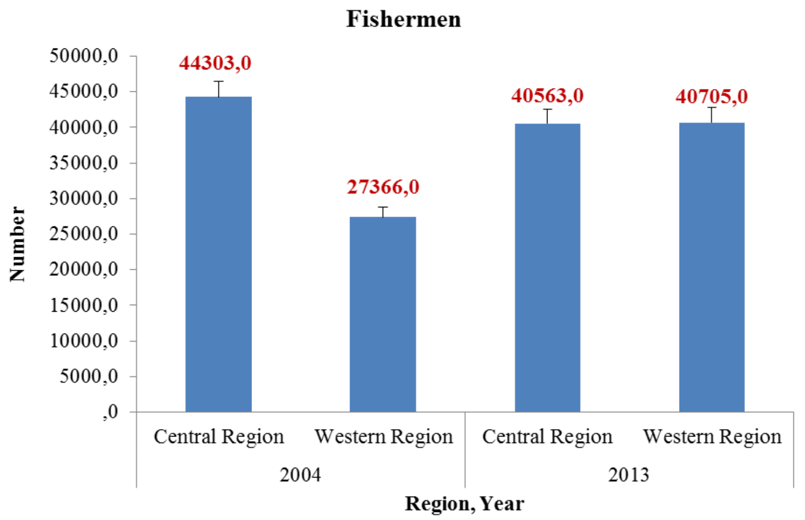
Although there was a small decline in the number of fishing villages and landing beaches (Section 7.7.4) between 2004 and 2013, the number of fishers (Figure 7.14), canoes (Figure 7.15) and operated gears (Figure 7.16) increased. In 2004, 47 % of canoes in the Central Region were motorized, by 2013, 77 % were motorized. In the Western Region, 57 % of canoes were motorized; whiles in 2013, 69 % were motorized. This implies that, more effort is being channeled into fishing activities in both regions.

Figure 7.13 Number of Fishing Villages and Landing Beaches in Central and Western Region in 2004 and 2013



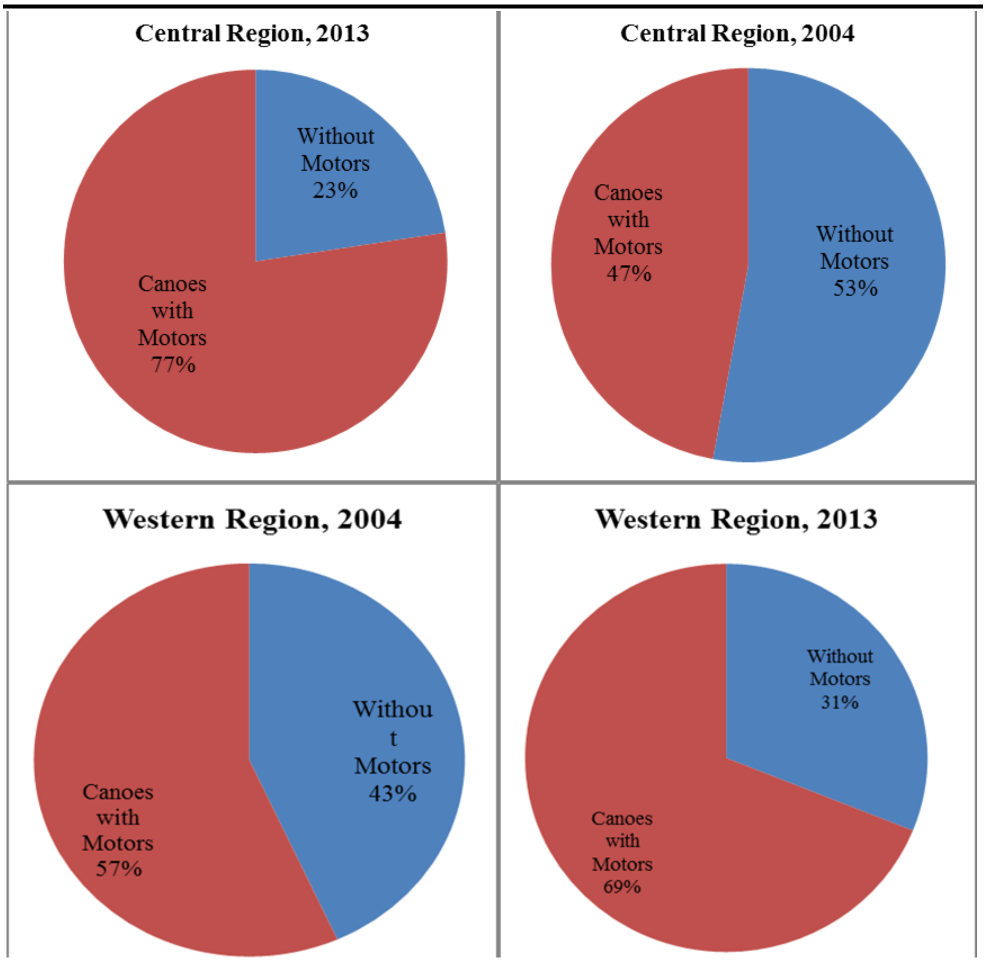
Source: Marine Fisheries Research Division, Ministry of Fisheries

Figure 7.14 Number of Fishers in Central and Western Region in 2004 and 2013



Source: Marine Fisheries Research Division, Ministry of Fisheries

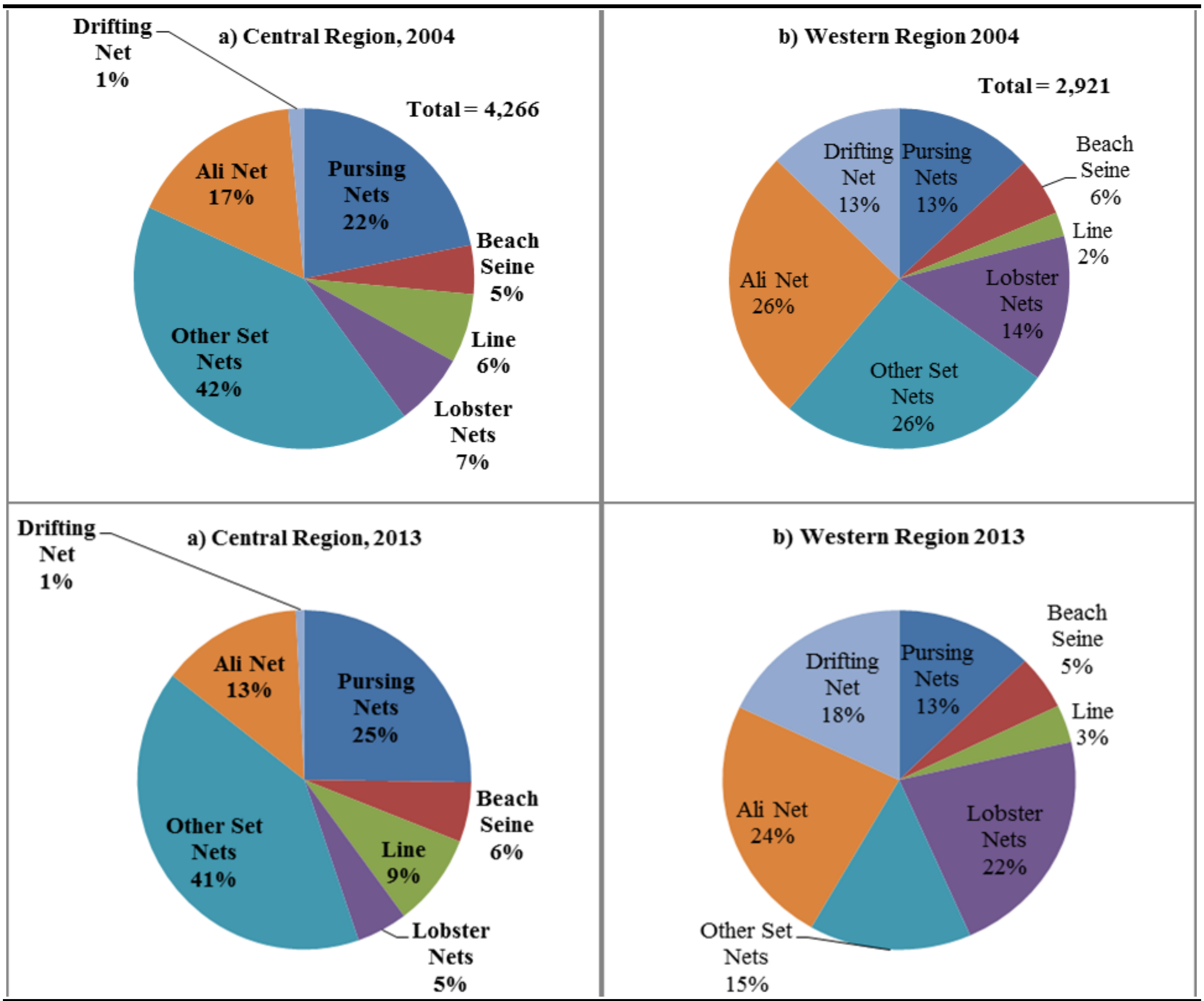
Figure 7.15 Number of Canoes (motorised and non-motorised) in Central and Western Region in 2004 and 2013



Source: Marine Fisheries Research Division, Ministry of Fisheries

As at 2005, a total of 700 canoes were registered in the Ellembelle District. The Ellembelle District has 20 fishing villages (Ellembelle District Assembly, 2012), being the second District in the country with the largest number of marine fishing villages. Thirty-one (31) out the 90 landing beaches in the Western Region are located in the Ellembelle district (Ellembelle District Assembly, 2012).

Figure 7.16 Fishing Gears Used in Central and Western Region in 2004 and 2013



Source: Marine Fisheries Research Division, Ministry of Fisheries

7.7.2 Fishing Gear and Catch Type

Gear used in the artisanal fishing industry include Lobster net, set net, ali/poli/watsa net, drift gill net, ring net, purse seine, beach seine, cast net and Crab traps (CRC/FON, 2010).

As detailed in Section 7.4.1, the artisanal purse seines and beach seines are exploiting mainly small pelagics in Ghanaian waters such as Anchovies, Sardinellas and Chub Mackerel. Figure 7.17 below shows beach seine fishing.

Figure 7.17 A Typical Beach Seine in Use

Source: ESL catch assessment study, April 2014

As detailed in Section 7.4.1, hook and line and beach seines are the main artisanal gears used to exploit demersal resources (e.g. Seamers, Snappers and Groupers) in Ghanaian deep waters of about 80 meters on hard bottoms. Some of the hook and line canoes have facilities for storing ice to preserve fish and are therefore capable of staying up to three days at sea.

As detailed in Section 7.4.1, drift gill nets deployed by artisanal fishers are used to target small pelagic species and , but some drift gill nets are used offshore to exploit large pelagic species such as Tunas, Sailfish, Swordfish and Sharks (FAO, 2010).

Artisanal gears are also used to exploit molluscs and crustaceans. Until 1983, the beach seines were the main exploiter of Cuttlefish in Ghanaian waters; accounting for over 60 percent of landings annually. Presently, the industrial trawlers account for majority of landings annually (www.fao.org). Beach seines are used to exploit Shrimps mainly Parapenaeopsis atlantica and Penaeus kerathurus (both adult and juvenile) and juvenile Penaeus notialis as they move from the estuaries into marine waters. Lobster set nets target the Spiny Lobster, Panulirus regius on rocky bottoms and in depths of about 40 m (www.fao.org).

Dug-out tree trunks are used to make canoes and although the use of the preferred wood (wawa) is officially illegal to harvest (to protect the dwindling numbers of this tree), it seems this trade still occurs (Gordon et al., 2011). Vessel size varies from the small-sized paddled canoe to large-sized outboard motor-powered one. The most common motor being 40HP outboards (CRC /FON, 2010; Gordon et al., 2011). Boat owners employ a number of fishers for fishing activities. The size of the crew ranges between 2 and 30 depending on the size of the canoe. Crew members are paid after every trip once operational costs are deducted from the proceeds, with larger shares going to the owner of the boat (/nets) and 50% of the profit shared among other crew members (Gordon et al., 2011).

7.7.3 Fishing Seasonality

During the major (June to September) and minor (February and March) upwelling periods, significant increase in fish catches (bumper seasons) is experienced, particularly of small pelagic species such as sardinella. The rest of the year is associated with little or no catches (lean season) in the pelagic fishery. The seasonality in marine fishery creates seasonal unemployment and also affects the balance of power in the market system: in the peak season, it is a buyer's market with the fishermen having less influence over prices, whilst in the low season; the fishermen have a stronger bargaining position (Gordon et al., 2011).

The use of lights (increasingly used by canoe fishers since 2003, but declared illegal in 2010) has to some extent taken the seasonality out of fishing – with lights attracting fish (even juveniles) and fishers able to maintain a reasonable catch year-round. However, with the enforcement of the new regulations, the marked seasonality in fishing is expected to return (Gordon et al., 2011). There is therefore the need to introduce sustainable fishing innovations, apart from the use of the outboard motor, to improve fish catch.

Fishers typically fish on a daily basis and most observe a "day of rest" once a week (Tuesdays in most places), especially in small fishing communities. A typical fishing trip can last up to 20 hours with the exception of hook-and-line fishers and those utilising drift gill nets, who go on 3 - 4 day trips and carry ice to preserve catches (Gordon et al., 2011). While some fishermen are fishing at sea, others are also onshore, mending and making nets and fishing gear (CRC, 2013). During the lean season some fishermen do not go fishing at all, because the small catches do not cover their costs (Gordon et al., 2011).

7.7.4 Fishing Criticalities

A 2010 rapid assessment of 89 selected fishing communities in the six coastal districts of the Western region, including 17 fishing communities in the Ellembelle district, indicated that fish landings in most of the fishing communities like Sanzule, Atuabo, Bakanta etc., have declined in recent years, and this has led to declining fishery livelihoods in the fishing communities (CRC / FON, 2010; CRC, 2013). The decline in fish catch is attributed, among other issues, to increasing population leading to over-fishing, and use of damaging or illegal fishing methods such as light fishing, use of monofilament nets, dynamite, carbide, pair trawling and fishing with obnoxious substances. Illegal fishing practices also result in poor fish quality and reduces the shelf-life of processed fish (CRC, 2013). Added to this is the arrival of algae bloom which adversely affects artisanal marine fishing. Since 1993, marine algal blooms caused by the filamentous green alga Enteromorpha flexuosa - known locally as green-green, have been occurring every year (December- February) from Newtown to Cape Three Points. The presence of algal blooms has also been reported in the rivers and wetlands of the Amansuri at Bakanta and Ankobra at Sanwoma (CRC, 2013).

Post-harvest losses of fresh fish are manifested in down-grading of fish to less remunerative uses. There are reports that, during the peak season, about 10 - 30% of fishermen's catch are down-graded, as a result of poor on-board icing and handling (Gordon et al., 2011). Hence, fish that is not fit for smoking is re-graded and used to make a popular fermented fish product (locally known as "momone''). Fish that is completely unfit for human consumption is traded for use as fishmeal (Gordon et al., 2011; CRC / FON, 2010). Processed fish may also suffer losses due to insect infestation. Though none of the "spoilt" fish is discarded, it fetches around half the price of fish which is in good condition (Gordon et al., 2011).

7.7.5 Fish Marketing, Processing and Selling

Marketing

Most of the Western Region catch enters the processed fish marketing chain. Fish is purchased at the beach by resident traders, or by "short-term migrant" traders there temporarily during periods of abundant catch and low prices (sometimes sub-contracting the processing locally, or it is immediately transported back to the home base of visiting traders and sold to processors there). These outcomes depend on relative prices, with traders juggling considerations of fresh and processed fish prices, as well as processing and transport costs, all of which will vary depending on market conditions (Gordon et al., 2011).

Power is strongly concentrated in the hands of fish traders (at the landings) who pre-finance fishing operations, buy from the fishermen and sell to fish processors (CRC / FON 2010; Gordon et al., 2011). Particularly in smaller landing sites, the Queen Mother ("konkohene" – the fish mothers' leader), negotiates a price with the first boat that arrives and this price is generally valid for the rest of the day. In larger landing sites like Sekondi Harbour, this role has reportedly lost its importance and prices are negotiated on a boat-by-boat basis. The position of the konkohene is analogous to the Chief Fisherman. The konkohene is appointed by the fish mothers. She remains in power indefinitely or until her elders (also fish mothers) advise her to step down. Exchanges between fish mothers and processors/consumers are typically carried out at the landing site where the fish is purchased, although, fish mothers sometimes travel to the large landing sites to buy fish (Gordon et al., 2011).

Apart from acting as intermediaries at the various fishing harbours, fish mothers can also play important roles in informal finance. They almost always pre-finance the fishing trips with fuel, gas oil, kerosene, and food, thus securing access to that boat's catch. Depending on the financial position of the fish mothers and fishermen's need for credit, one fish mother can support more than one fisherman. It is rare for fish mothers not to pre-finance fishers. Their support is not only restricted to fishers since, in some cases, they support processors by selling to them on credit. This however depends on the specific relationship between the processor and the fish mother. Transactions at the harbours are mainly based on informal agreements and mutual trust. It is this ability to command significant funds that gives fish mothers unique access to fish catches and why they are able to collectively influence fish prices.

Processing

Processing of fish, which represents an important sector for women, seems to be concentrated at the small- and medium-scale levels. Processing technology is mainly traditional using manual labour. Fish is processed using several methods but the most common form of fish processing in the Western Region is smoking.

Studies indicate that although some of the larger landings have cold storage facilities, most of the facilities are non-operational or have low fish cold storage capacities (Ellembele District Assembly, 2012; Gordon et al., 2011). For instance, in the Ellembelle district, there are cold storage facilities at Kikam, Esiama and Aiyinasi. However, these cold storage facilities in the district have low capacities and lack adequate working capital. Furthermore, there are neither developed landing sites nor fish handling or processing facility in the district (Ellembele District Assembly, 2012).

Women engaged in fish smoking use the so-called "Chorkor Smoker" kilns, (where fish is slowly smoked on stacked racks, with relatively efficient use of fuel wood and producing a relatively evenly-smoked product) and utilise various inputs such as baskets, basins, grills, basket nets, fuel wood, and brown paper (Gordon et al., 2011). Most of the processing takes place at the individual or household level and the most common species of fish processed is Sardinella, known locally as "ɛban" (also known as "Amane" in some areas), though it is common to see other types of smoked fish.

Processors mostly purchase fish from the fish traders, but there are cases where they purchase directly from fishermen. If there is insufficient supply of fish, processors travel to other landings to purchase fish (CRC / FON, 2010; Gordon et al., 2011).

Selling

Studies indicate that most fish processors do not wait for traders to come to them, but rather, they actively seek market opportunities by transporting smoked fish to various large markets within and outside their district or region of origin. In these markets, processors are excluded from selling directly to consumers (Gordon et al., 2011). They sell fish in packs of hundred to retailers who in turn retail to consumers in the same markets or smaller neighbouring markets. In some cases women who act as itinerant traders go to processors in their communities to buy the fish, which they sell to retailers in central markets (CRC / FON, 2010; Gordon et al., 2011).

Retailers sell smoked fish to consumers (individuals and food vendors) at the same (central) markets or in smaller, surrounding markets whilst others transport it to villages for retailing. The majority of these traders deal solely in smoked Sardinella. However, a few sell other types of smoked fish as well. Though they operate as individuals, most retailers are members of trader associations. Members of these associations help each other in times of need and also share information on prices and supplies. They are typically headed by so called "commodity queens". The queen's main functions include the establishment of informal market rules as well as the settling of disputes between retailers. The commodity queens are appointed by an overall market queen whose role is inherited. In the lean season, when fish is scarce, those retailers that are able to afford it resort to purchasing frozen fish from local cold stores and smoke it themselves (CRC / FON, 2010; Gordon et al., 2011).

Smoked fish from Western Region is mainly destined for the domestic market where demand is very strong. Small quantities of smoked fish are traded in Togo, Benin and Nigeria (Gordon et al., 2011). For instance, processors from Shama sell their produce in Denu, a market on the Ghana-Togo border (Gordon et al., 2011). Smoked fish for export to regional countries is prepared and presented in a visually more attractive way and commands a higher price. However, the regional market for this product seems to be limited because the processors co-ordinate to sell on alternate market days, or risk flooding the market. The number of people engaged in this type of processing is small and limited to very few processing villages (only one (Shama) reported in the Western Region).

One study found that the average price per basin of smoked Eban during the lean season in March 2011 was GHc 360 in Denu, compared to GHc 270 in other markets (Gordon et al., 2011). Basins (or pans) (Figure 7.18 and Figure 7.19) are widely used to transport fish. With wet fish (live weight), a single basin weighs about 30 kgs. With smoked Sardinella, usually packed to hold 500-600 pieces each of roughly 25 g, then the basin weighs about 13 kg. For transportation, smoked fish is placed in wicker baskets, which are in turn bundled into packs of two. A single basin of smoked fish is equivalent to three packs (or 6 baskets).

Figure 7.18 Fishers Sorting a Catch

Source: ERM, December 2014

Figure 7.19 Women Fishmongers Sorting a Catch

Source: ERM, December 2014

7.7.6 Fishing Profile of the Ellembelle District

It is estimated that over 65% of the economically active population in the District are engaged in agriculture (including fishing) and agro-processing (Ellembelle District Assembly, 2012). In Sanzule for instance, the local economy is highly dependent on fishing (CRC /FON, 2010). The Ellembelle District ranks second in the country with regard to number of marine fishing villages. Thirty-one (31) out of the 90 landing beaches in the Western region are found in the district. Fishing sites in Ellembelle District (where the Project is located) are shown in Figure 7.20, while statistics of the districts marine fishing industry are presented in Table 7.7.

Figure 7.20 Fishing Sites in Ellembelle District

Source: CRC, 2013

Table 7.7 Marine Fishing Statistics of the Ellembelle District

Item	Number
Fishing Villages	**20**
Landing Beaches	**31**
Total Canoes (registered as at 2005)	**700**

Source: Fisheries Department, Axim in Ellembelle District Assembly, 2012

A study conducted in 2010 estimated that, there are a total of 1,400 fishermen in Ellembelle District (CRC /FON, 2010). The size of fishing vessels used in the District varies from the small-sized paddled canoe to large-sized outboard motor-powered ones. Gears used in the artisanal fishing industry include lobster net, set net, ali/poli/watsa net, ali net, drift gill net, ring net, purse seine, beach seine, cast net and crab traps. There are only few motorized canoes using 40HP outboards (CRC / FON, 2010). The major fishing season is between July - September with a minor season occurring in November – January (Ellembelle District Assembly, 2014).The main species caught include Anchovies, Sardinellas, Sail Fish, Lobsters, Shrimps, Burrito, Big Eye Grunt, Bumper, Barracudas, Ribbon, Cassava Fish, King Fish, Tunas, Sole, Squid, Snapper, Sea Breams, Groupers, Threadfin, Mackerels, Sword Fish, and Sting Ray.

Though there are cold storage facilities at Kikam and Esiama and Aiyinasi, these facilities have low capacities and lack adequate working capital. Furthermore, there are neither developed landing sites nor fish handling or processing facilities in the District (Ellembelle District Assembly, 2012). The traditional stoves or kilns (Chorkor smokers) used for fish smoking as modern fish processing facilities are non-existent. Thus, similar to that pertaining in other coastal districts in the region, there is poor processing, storage and handling of fish in the Ellembele District (CRC / FON, 2010).

Inland fishing (in fish ponds) is not well developed in the district. Most ponds are small in size usually 7 x 10 feet. It is estimated that there are 40 fish farmers with a total of 64 fishponds in the district (Ellembelle District Assembly, 2014).

In recent years, the area has experienced poverty in the coastal areas due to declining fish catches and invasion by algae bloom in the sea (CRC / FON, 2010). There are reports that fishers from neighbouring districts, especially Nzema-East come to decimate the waters with light fishing and other unapproved, unsustainable and dangerous fishing methods (eg, chemicals, dynamite) (CRC / FON, 2010).

Furthermore, there is a decline of traditional authority in fisheries management. The roles of Chief fishermen and Konkohene have been modified by rapidly changing market and demographic conditions. Political interference by government has further reduced the efficiency in their authority.

Traditionally, the sea is considered as a deity containing lesser gods. Abundance or scarcity of fish was attributed to the activities of these lesser gods (e.g. mermaids and mermen). In the event of fish scarcity, the gods are pacified through performance (CRC / FON, 2010).

A brief socio-economic profile of some of the fishing communities in the Ellembele District nearest to the onshore Project locationis given below. These communities are: Akonu-Bakanta, Sanzule, Krisan, Eikwe and Atuabo. The information used was sourced from a 2010 report by Coastal Resources Center (CRC) and the Friends of the Nations (FoN).

Akonu-Bakanta

This is one of two towns closest to the onshore Project location (the other is Sanzule). The nearest towns to the west and east of Akonu-Bakanta are Ampain and Sanzule respectively. Ala Bokazo and A. B. Bokazo towns share boundaries with Akonu on the north.

The community is located on a flat sandy landscape. The Amanzule River runs on the north of the town and it is surrounded by mangroves. The population of Akonu-Bakanta was estimated at 1,099 comprising 494 males and 605 females as at 2000. The economy of the community is based on fishing. Farming is also practiced but on a small scale. It was reported in 2010 that there were fourcanoes in Akonu with all them being wooden paddle-propelled. The common gear used is the beach seine net. The canoes were on average 18 yards in length. The average crew per canoe for an expedition is 6-8. About 25-30 fishers haul the net after the casting. Species caught include Eban, Akole, Amoei and Manye. Fish processing is undertaken in settlement areas by smoking. The major marketing centres for harvested fish are Agona-Nkwanta, Tarkwa, Ainyinasi and Asasetre.

Regarding the sharing of fish proceeds, sales are divided into two parts. One part is reserved for maintenance and repair of gear while the other part is shared among the crew-members and the canoe owner. The community has a chief fisherman who is in charge of management of the coast and fisheries issues. A 2010 study in the area reported that, there was no 'konkohene' (queen of Fishmongers) in the community.

Key coastal and fisheries issues reported in the area are decline in fish catch, coastal erosion and incidence of algal blooms, unsustainable fishing practices (such as light fishing and use of dynamite), and lack of access to capital and credit facility.

Sanzule

The neighbouring towns to the east and west of Sanzule are Bakanta and Krisan respectively. Ala-Bokazo is the nearest community to the north. The landscape is flat and sandy with no major peaks. Coconut plantations border the eastern, western and northern perimeter of the community. About 500m on the north after the coconut plantations is the Ser lagoon. A few meters from the lagoon are swamps. Another lagoon known as Manzule also runs on the north a few metres from the farm lands.

Sanzule is inhabited predominantly by Nzemas. A few Fantes as well as Ewes also live in the community and are mainly fishers. The 2000 population and housing census report indicated the total population of Sanzule at 1,617, consisting of 843 females and 774 males. The total number of houses recorded was 180 with an average household size of 5. The settlement areas are highly concentrated towards the coast. The local economy is based on farming and fishing, but highly dependent on the latter. Residents remarked the decreased fish landings in the area have been reported to have declined due to incidence of algae bloom, and has thus contributed to the decline in commercial activities.

As at 2010, there were seven canoes in the community with none of them motorised. The canoes are approximately 18 yards in length and 3 yards in width and depth. The fishers widely deploy 2, 1.5 and 1 inch sized mesh beach seine nets. The major fish landings include

Wanwanya, Nkanfona, Ekan, Eban, Sukue, Ebueakwa, Apae and Ahenemandzi. In the past, the fisherfolks reported that they could fish in the near shore areas, but presently they have to go out further. They attributed this to light and chemical fishing and increasing fishing effort. The lay system reported by the fishers indicates that costs for maintenance of canoe and gear are deducted from the gross income, then the canoe and gear owner takes one-half and the other half goes to the crew. Harvested fish are widely smoked and marketed in Ainyinasi, Agona-Nkwanta and Tarkwa.

Key coastal and fisheries issues reported in the area are coastal erosion and decline in fish catch (due to increased fishing population, algal blooms and bad fishing practices such as light fishing and pair trawling), and lack of access to capital and credit facility.

Krisan

The population size of the community is estimated to be about 550. Fishing is done throughout the year with the major season occurring in July-September and minor season falling between November-January. Fishing employs over 80% of the population during the major fishing season. Also, unemployment level rises during the lean season. The community has no organisation which oversees the operation of fishermen and fishing activities. The type of fish catch include Edoi, Ekpoku, Akole, Ankoawona, Atianuawole, Nkafona, Manye Konsoanu. The type of gears used include, ring net, beach seine net of one inch, two inches and three and half inches. Key coastal and fisheries issues found in the area are decline in fish catch and coastal erosion.

Eikwe

Eikwe is the twelfth largest community in the Ellembelle District and is located in the western coastal zone. It has a flat land surface with a long sandy beach. The population of Eikwe is 1,777 according to the 2000 population and housing census with females numbering 1,026 and males 751. The major economic activity in the community is fishing and farming. Fishing is done all year round with the major seasons between July-September and minor season occurring in November-January. Almost everybody in the community is engaged during the fishing seasons and plays a role. Unemployment levels rises during the off-seasons resulting in low economic activities in the community. Types of fish catch include Manye (sardinella), Ekan, Ebonyi, Akoa, Nrafonla, Abowinba, Eduei, Amgboloma and Sezeke. They use ring net, beach seine net and hook and line (1, $3^1/_4$, 7 inches)

The community is governed by the traditional authorities and other government institutions such as the District assembly, the assembly member and the unit committee members. Key coastal and fisheries issues found in the area are decline in fish catch, coastal erosion and lack of fish storage facilities.

Atuabo

Atuabo is located in the western part of the Ellembelle District on the border with the Jomoro District. It shares boundaries with Menzezor on the north, west and east with Ekabaku and Anochi communities respectively. The population of Atuabo is about 1,500 with men and women in the ratio of 2:3. Economic activities in Atuabo are mainly fishing, farming and livestock production. About 25% of the inhabitants are engaged in fishing.

Atuabo fishers mainly use beach seine nets with mesh sizes of 2 inches and $1^1/_2$ inches. There were six non-motorised canoes which deploy 2 inches and $1^1/_2$ inches beach seine nets since two decades ago. A study conducted in 2010 found that the community has four canoes with one of them powered by a 40HP outboard motor. The canoes are approximately 3 ft in width and depth, and 40 ft in length. The non-motorised canoes have 8 to 10 crew members on board during fishing expeditions. About 45-50 people help haul the net after the expedition. Edue, Eban, Sukue, Ekan, Apae and Ahenemandzi are the major fish species caught during the major season. Reports suggest that significant changes in fishing grounds have occurred over the past two decades. Fishermen are said to have stated that fishes were caught within 700-800m off shore two decades ago, but the current fish grounds are 1,500m from the shore. The use of light and dynamite in fishing and the increasing number of motorised canoes were noted as the causes for the changes of fishing grounds.

Harvested fish is usually sold to fishermongers on credit especially in the major seasons or in the event of bumper catch. During the minor seasons, fish sales are strictly on 'cash and carry' basis. The proceeds from fish sales are shared as follows: the entire fishing crew take 50%; 33% goes to the canoe owner and 17% is used for canoe and net maintenance. Smoking is the major processing method employed by Fishmongers in the community. The processed fish is mainly marketed in Agona-Nkwanta, Ainyinasi and Asasetre.

Key coastal and fisheries issues confronting the fishing community includes decline in fish catches, unsustainable fishing practices (e.g. light-fishing and pair trawling), incidence of algal bloom, lack of access to credit capital for small business operations, and high rate of teenage pregnancy.

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ABSTRACT

Chapter 8 describes the current socio-economic baseline conditions in the Project's Area of Influence at various levels: national, regional, district, and community.

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8 SOCIO-ECONOMIC BASELINE

8.1 INTRODUCTION

This Chapter describes the current socio-economic baseline conditions in the Project's Area of Influence at various levels: national, regional, district, and community. The baseline description focuses on the Western Region, the Ellembelle District, and the five communities that are either geographically closest to the Project site or that will be key service centres to the Project. These five communities are Sanzule, Krisan, Bakanta,Eikwe and Atuabo.

This Chapter is structured as follows.

- Administrative structures.
- Demographics.
- Land tenure and land use.
- Economy and livelihoods.
- Education system.
- Health care services.
- Utilities, infrastructure and services.
- Marine infrastructure.
- Social investment projects.

The relationship between the Project and the different levels of this environment is two-way, with the Project impacting on its host while simultaneously being impacted by the structure and functioning of that host environment. The Project is anticipated to impact particularly upon communities located nearest to the Project Site, but also on the wider region in general. Therefore, this baseline Chapter examines the macro socio-economic environment, the regional and district context and the way in which towns, households and individuals, directly affected by the Project, currently live.

8.2 DATA SOURCES

Various data sources were used to determine the baseline conditions. These include secondary sources (eg, published information) as well as primary data acquired through surveys specifically for this EIS. All data sources are cited in the Bibliography. Data sources include:

- Government reports including development plans and statistical reports
- EIS reports in the public domain for other developments near the Project;
- Studies commissioned by eni Ghana;
- Community-wide meetings;
- Focus Group Discussions (FGD) with community groups; and
- Key Informant Interviews (KII) with community stakeholders.

- Primary data was collected through a field survey conducted between the 1st and 10th of December 2014. Methods of data collection used during the field survey included Focus Group Discussions, Key Informant Interviews and community meetings. These ethods are discussed in more detail in the Stakeholder Engagement Chapter (Chapter 5).

8.3 ADMINISTRATIVE STRUCTURES

This Section describes the government administrative structures of relevance to the Project. The government will have varying jurisdiction over the Project, and the presence of the Project will impact on the operations of some of these structures.

8.3.1 Formal Structures

There is a dual system of governance in Ghana made up of formal government structures and traditional leadership structures. These systems of authority are recognised as complementary structures with different responsibilities. Formal structures are described in this Section.

Overview

Ghana is a multi-party democracy with a President as head of state and head of the government. Legislative power rests with the parliament and the judiciary is independent of both the executive and the legislature.

The government administration in Ghana is decentralised and is made up of ten administrative *Regions*. Regions are further subdivided into *Metropolitan*, *Municipal* or *District* areas. Metropolitan areas cover urban areas while Municipalities cover single towns. Districts cover rural areas and small towns. Each District has an administrative assembly (known as the District Assembly) comprised of a combination of appointed and elected officials. At the national level, the Ministry for Local Government and Rural Development is responsible for oversight of local government.

In 2010 the Government of Ghana issued a National Decentralization Action Plan intended to improve decentralisation. The Action Plan has ten primary objectives for the decentralisation of government (Box 8.1).

Box 8.1 National Decentralization Action Plan Objectives

- To clarify the status, roles and relationships between levels of government and different actors to strengthen their participation in and contribution to local governance.
- To improve the administrative and human resource capacity of the MMDAs and other local government stakeholders to ensure quality service delivery.
- To strengthen the capacity for, coordination and implementation of spatial, physical and development planning at the local level and its integration with budgeting and the national agenda, generally.
- To facilitate economic growth, employment and income generation in order to promote household welfare and alleviate poverty.
- To improve funding and financial management of MMDAs.
- To promote local democracy, participation and accountability through strong and more viable stakeholder involvement in local governance.
- To promote a rights-based orientation to local level development, ensuring equitable access to public resources and inclusiveness in decision-making.
- To clarify and strengthen the roles and relationships between key non-state actors such as the traditional authorities and civil society groups in local governance.
- To streamline, harmonize and coordinate development partner interventions to ensure optimal use of donor resources for local level development.
- To facilitate effective policy coordination and collaboration for smooth devolution of political, administrative and financial authority from the centre to the assemblies.

Source: Participatory Local Democracy (n,d)

Regional Administration

The Project will be located in the Western Region of Ghana.

The local government system is defined by the Local Government Act 462 of 1993. The regional government is made up of the Regional Coordinating Council (RCC), four-tier Metropolitan and three-tier Municipal/District Assemblies with Urban/Town/Area/Zonal Councils Unit Committees.

The RCC is the head of the local government system and is the highest decision-making body. In each Region, the RCC is made up of the following:

- Regional Minister as Chairman and deputies;
- Presiding Member of each District Assembly;
- District Chief Executive of each District in the Region;
- Two Chiefs from the Regional House of Chiefs;
- Regional Coordinating Director (as secretary to the RCC and the head of the civil administration of the Region); and
- Regional Heads of decentralised ministries.

The RCCs' key roles are to ensure effective coordination of regional development activities. Moreover, additional functions include the formulation of district development plans, the approval of building by-laws, the issuance of building permits and the approval of development permits (Commonwealth Local Government Forum, 2012).

District Administration

The Project wil be located in the Ellembelle District. The Ellembelle District was created through a division of the Nzema East District in 2008 with the capital located in Nkroful.

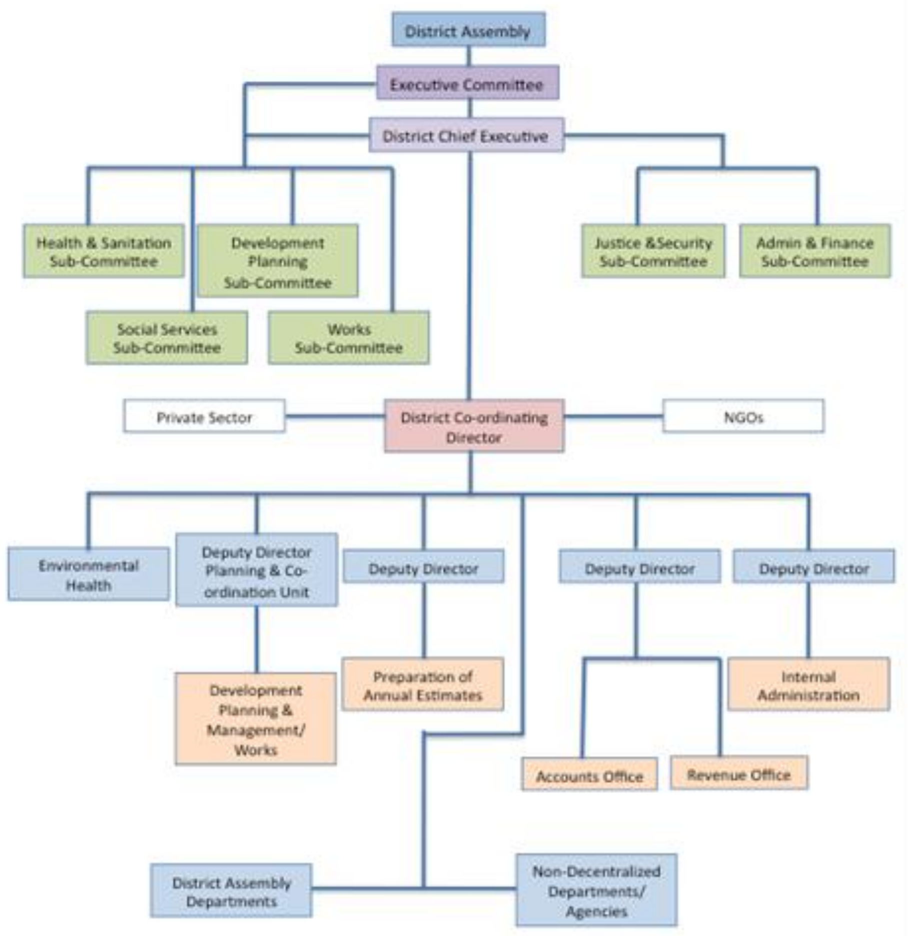
The District is administered by the Ellembelle District Assembly (EDA) headed by the District Chief Executive. The District Assembly is in place to reinforce the government's decentralisation process. The EDA is, therefore the highest administrative and political body in the District,

EDA members are elected by the communities and each member represents a ward. The EDA has four elected Assembly Members. They are the liaison between the District Assembly and the communities and play a critical role in community development. The Assembly Members participate in the work and activities of the Assembly such as attending meetings and taking part in discussions. Moreover, they educate the electorate on government policies and Assembly projects, maintain close contact with the electorate and consult with them on regular basis, consult them before each Assembly meeting on issues to be discussed in the Assembly, collate views, opinions and proposals on matters affecting the district and present the issues to the Assembly. They play a significant role in the socio-economic development of the communities.

An organisational chart of the EDA is presented in Figure 8.1. The Ellembelle District has an executive committee, which formulates and executes policies of the Assembly through a number of sub-committees including finance and administration, social services, development planning, works, justice and security and health and sanitation.

The EDA, and specifically the District Planning Coordinating Unit, is responsible for infrastructure, housing and development planning within the District.

Figure 8.1 Ellembelle District Organogram



Source: Ellembelle Medium Term Development Plan (2010)

The EDA also comprises seven Area Councils. The Area Councils also provide and interface between the Assembly and local communities. The Area Councils are a sub-structure of the District Assembly created for a number of settlements/villages which are grouped together, but whose individual populations are less than 5000. Area Councils cover areas with predominantly rural populations and, in some cases, are aligned with a particular traditional authority sphere of influence.

The Project will be located in area covered by the Atuabo Area Council.

There are seven Area Councils in the District namely: Asasetre, Kikam, Esiama, Nkroful, Awiebo, Atuabo and Aiyinase. The Project falls within the Atuabo Area Council The Atuabo Area Council includes the communities of Atuabo; Eikwe; Sanzule; Krisan; Ngalichi Atuabo; Anochi and Asemda-Suazo and has the second lowest population according to the 2000 census(1). It is also considered to have lower development and service delivery relative to other Area Councils in the District.

The Unit Committee is the final sub-structure in the local governance system. A Unit is typically a settlement or a group of settlements with a population of between 500 and 1000 in rural areas, and a higher (1500) for urban areas. The Unit Committee consists of not more than 15 persons made up of 10 elected persons ordinarily resident in the unit and not more than 5 other persons resident in the unit. Unit Committee members are nominated by the District Chief Executive acting on behalf of the President. Unit Committee Members perform various functions including assisting in revenue collection, organizing communal labour and voluntary work, educating the people in their rights, privileges, obligations and responsibilities, monitoring the implementation of self help and development projects, assisting in enumerating and keeping records of all taxable persons and properties, and making proposals to the Disttrict Assembly regarding levying and collection of rates for projects and programmes.

8.3.2 Traditional Authority Structures

Traditional Authorities are the custodians of local tradition, morals, and traditional practices. The traditional system of authority is managed at a national level through the Ministry of Chieftaincy and Culture with the objective to preserve, sustain and integrate regal, traditional and cultural values and practices within Ghanaian society and communities.

At the local level, the Paramount Chiefs is the traditional head of the people and custodian of the land. The Paramount Chief carries great influence locally. Each Chief has a Traditional Council composed of the elders who carry out the instructions of the Chief and safeguards traditional customs and local knowledge for future generations. Traditional structures are intended to be politically impartial as they are responsible for supporting all members of the community, irrespective of political affiliation.

The Nzema is the dominant ethnic group in the DAoI. It is made up of seven clans. The dog is the symbol of the royal clan. The Paramount Chief of Eastern Nzema is *Awulae* Amehere Kpanyinle II. All the towns within the DAoI fall within his stool. Traditional rule in the Nzema area follows the basic Akan model based on four levels of hierarchy, namely *Omanhene*, *Belemgbunli kpanyini*, *Ohene,* and *Odikro,* which are explained further below.

The *Omanhene* is a *twi* word for Paramount Chief of Traditional Area. In Nzema, the highest position within the hierarchy is clearly displayed in the words "*Arelemgbunli nu Belemgbuni*", meaning "First among the Chiefs". The *Omahene* is the one who holds the *ebi kpole,* the "big stool" of the state (the highest position of authority). The stool represents the allodial [(1)] title of Chief in regards to the jurisdictional area of their towns and is characterized by *anwoserebe*, the spiritual powers of the ancestors held within the stool, which goes beyond the existence of any Chief as an individual.

Belemgbunli kpanyini, meaning the Divisional Chief, holds a critical position within the Advisory Council of the Paramount Chief. The *Ohene*, a twi word for a Chief of a town, is

1) Wherever possible data from the 2010 National census has been used. No population data has been made available at the Area Council or community level at the time of this report so the 2000 data is listed.

subordinate to the Paramount Chief but who is head of community. The *Odikro* is the head of a village.

The feminine element of traditional power is represented by the *Obahema*, twi word to mean "Queen Mother". Typically, the Obaheme is one of the Chief's sisters but may also be Chief's mother, or a sister of the Chief's mother. She is the official holder of the genealogical recollection of the abusua (2). Besides the Chief and the *Obahema,* there is also the *abusua kpanyinli,* the male elder maternal lineage considered as the head of the family. A variety of dignitaries make up the remainder of the Nzema Chief court. Among them is *kpormavole*, the linguist, who speaks for and runs errands for the Chief. Other administrative positions of the town are primarily of militaristic origin. For instance the *tufuhene*, principal advisor to the Chief, was once Captain General of the advance guard of the army, and presently is the community's representative to the Chief. Under the *tufuhene*, there are *asafohene*, formerly the captains of the *asafo* (military companies), who at present maintain public order, as well as organize festivals and developmental projects

The Paramount Chief of the Eastern Nzema Traditional Area exerts control over the divisional and sub-chiefs. The Queen Mother is mainly responsible for selecting a new chief. The traditional structure is hierarchical and inheritance is by matrilineal descent.

In each town in the DAoI, there is traditional council that assists the Chief to administer his area of jurisdiction. The Council is typically comprised of the Chief, the Queen Mother, various family heads and the linguist. The Council is the supreme organisation of the stool and must approve all decisions taken by the Chief. This traditional structure is used to address family and land disputes, as well as make decisions around town development issues.

In addition, each fishing community has a Chief Fisherman. This person is in charge of all matters pertaining to fishing, either the community or the landing site level (in the case of communities with more than one landing site). He also represents the local fishers at the fishers' association at the district level. The Chief Fisherman works with a council of elders, which represent descent groups and/or representatives of gear groups and may or may not have to report back to other community leaders. Chief Fishermen are elected, but they typically come from a certain clan or family.

Despite changes and challenges to the traditional structures, in most cases the Chief continues to wield considerable authority, respect and influence at the local level, including in a quasi-judicial role. The Chief and traditional council are often involved in disputes around family and property matters, including land disputes. They may also mediate on issues such as petty theft and domestic conflict. The Chief usually also takes on the role of encouraging communities to participate in development activities in the area.

The Nzema East, Ellembelle and Jomoro Districts constitute the Nzema Manle Council in the District House of Chiefs. The Ellembelle District is covered by the Eastern Nzema Traditional Council. The Paramount Chiefis *Awulae* Amehere Kpanyinle II who is situated in Atuabo.

(1) Allodial title constitutes ownership of real property (land, buildings and fixtures) that is independent of any superior landlord. Allodial title is related to the concept of land held "in allodium", or land ownership by occupancy and defense of the land. (http://en.wikipedia.org/wiki/Allodial_title)
(2) Abusua is the central concept in the Akan culture, meaning "family" or "clan" or "lineage", and is at the heart of the matrilineal system

8.4 HISTORICAL CONTEXT

Evidence found in the Volta Region suggests that Ghana was first inhabited approximately 300,000 years ago. Between 300,000 B.C. and 5000 B.C., hunter-gatherers gave way to herders and agriculturalists that introduced cattle and agricultural crops. From 100 A.D onwards, more complex settlements appeared and trading began. Traders brought Arabic literacy and the Islamic faith to Ghana around this time. Evidence of old mosques can be found in abundance in Northern Ghana.

The Portuguese began to explore West Africa in the mid-15th century. They brought slaves to the area and traded them for gold, to be taken back to Portugal. The Christian faith was introduced by the Portuguese during this time. By 1650, slaves became main item of trade and city states and kingdoms developed as a result of the wealth generated by trade.

In 1844, the British signed an agreement with the Kings and people of the coastal regions, giving the British authority over the region. By 1874, British Law had been authorised along what was referred to as the Gold Coast. From the early 1800's cocoa and palm oil production began and had gained momentum through the century. By 1911 Ghana was the world's leading cocoa exporter (National Commission on Culture, 2006).

In 1894, with the passage of the lands bill the colonial government began expropriating land. This eventually provoked the formation of the first nationalist movement. In 1949 the Convention Peoples Party was formed by Kwame Nkrumah and in 1957 Ghana gained independence from Britain.

Ghana was the first sub-Saharan nation to gain independence from European colonialism. The first president, Kwame Nkrumah, was overthrown in 1966 and over the following 25 years the country faced military coups, political instability, decreasing GDP and increasing national debt. In 1981, Lt. Jerry Rawlings took power and banned all political parties. In 1992, a new constitution was approved, multiparty politics was restored and Ghana held a multiparty election. Since 1992, Ghana has held successful multiparty elections every four years and is now considered a stable democracy.

8.5 MACRO-ECONOMIC CONTEXT

Similarly to other African countries, Ghana has endured a number of economic challenges throughout the 70s, 80s and 90s. In response to the "African economic crisis" during the 1980s, the Government of Ghana agreed to implement the International Monetary Fund's (IMF) Economic Recovery Programme (ERP), which focused on stabilisation, rehabilitation and liberalisation. This structural adjustment plan resulted in the changing of many economic policies. Nevertheless, Ghana continued to struggle with the accumulation of large foreign debt and was classified as a "poor" nation by the World Bank (1) .

The recent discovery of oil and gas off the coast of Ghana and resultant extraction and production activities, however, has contributed to an increasing GDP. In 2012, Ghana had a GDP growth rate of 7.9 percent, ranking 13th in the world (CIA World Factbook, n.d).

(1) Defined as countries with a per captia income of less than 1 USD per day.

As described in Chapter 3, a number of development policies exist at a national, regional and district level. These policies have been formulated in response to key political and development milestones in Ghana's history and are summarised in Table 8.1 below.

Table 8.1 Development Policies Relevant to the Project

Policy	Key Aspects
National Level Policies	

The Coordinated Programme of Economic and Social Development Policies, 2010 – 2016 (Agenda for Shared Growth and Accelerated Development for a Better Ghana) (Adopted June 2011)	• Designed to address historical economic and social challenges that are seen to have hampered national development.
	• Driven by a medium-term vision of shared growth through accelerated job creation, integrated industrial development and agricultural modernisation, via policy measures that the government plans to pursue in order to "transform the economy from its over-dependence on primary raw materials to a diversified economy".
	• Priority interventions include:
	  • Economic Development;
	  • Social Development;
	  • Science, Technology & Innovation;
	  • Infrastructure Development;
	  • Spatial Development Zones;
	  • Natural Resource Management;
	  • Environmental Governance; and
	  • Transparent and Accountable Governance.

Land Commission Guidelines for Considering Large-Scale Land Transactions for Agricultural and other Purposes (Approved February 2012)	• Provides guidelines for acquisitions of tracts of land lager than 50 acres. • Highlights that most of the land users in rural areas (where the majority of large scale land acquisitions are occurring in Ghana) are smallholder farmers without registered title deeds or interests on those lands. • Emphasises that most of these farmers have only use rights to the land and are thus vulnerable to negotiations undertaken by a higher interest holder (like a chief or family head) over the release of the land. • Emphasises the participation of all stakeholders in the process of such transaction.
Regional Level Policies	
Western Region Spatial Development Framework 2013--33 (WRSDF) (Draft April 2012)	• Presents a spatial plan for the integration of social, economic and environmental development for the Region. • Zones the Region into three spatial zones. • Identifies the Project Area within Zone 3: Coastal - Industrial Districts. • Recognizes the discovery of oil and gas as a key driver of development in the Region and the DAoI. • Takes account of a specialist oil and gas harbour with associated supply facilities at Atuabo (Ellembelle). • Recognises that to maximise employment opportunities requires long term strategic planning for training as well as wide access to business procurement in institutional, structural and future land use and infrastructure terms.
District Level Policies	

Ellembelle District Assembly Medium-Term Development Plan 2014-2017 (Prepared November 2014)	• The overarching goal of the plan is to:
	  • co-ordinate social services and environmental sustainability;
	  • improve security and develop accessibility to production areas; and
	  • strengthen local institutions to support equitable growth and sustainable development.
	• Priority focus areas include
	  • ensuring and sustaining macroeconomic stability,

Policy	Key Aspects
	• enhancing competitiveness of ghana's private sector, • accelerated agriculture modernization and sustainable natural resource management, • oil and gas development, • infrastructure and human settlements, • human development, productivity and employment, and • transparent and accountable governance. •

8.6 LAND TENURE AND LAND USE

8.6.1 Land Tenure and Land Rights System

Ghana maintains a dual land tenure system, comprised of customary and statutory land tenure. Customary tenure is based on local practices and norms, which are flexible and vary according to location. Such tenure is typically unwritten and is managed by a traditional ruler (the paramount chief or local chiefs); a council of elders; or family or lineage heads. The principles stem from rights established through first clearance of land, conquest or settlement.

The National statutory land tenure system is based on officially documented statutes and regulations, formalised in a legal system that is rooted in the colonial law. These laws define processes, acceptable behaviours and consequences for noncompliance. Administration of this legal system sits with government structures and individuals delegated with relevant authority. The state-recognised land rights are allocated and confirmed through the issue of titles or other forms of registration of ownership. The customary owners - stools, clans, families, and tendamba own about 78 percent of the total land area in Ghana. Of the remaining 22 percent, the state owns outright about 20 percent while the remaining 2 percent is held in dual ownership: the legal estate in the government and the beneficiary/equitable interest in the community (FAO, 2003). In addition, There are no comprehensive data on land ownership and defined boundaries for the 78 percent of the land held by the customary sector (FAO, 2003)..

Under the 1992 Constitution, three distinct land tenure systems are recognised:public lands, stool or customary lands and private freehold lands. Public lands are owned by the government and are for public use. Customary lands are communal and are held by traditional communities or groups thereof and are characterised by various land tenure. Finally, Private Freehold land is not owned by government or a traditional authority, but rather an individual or entity and includes the building and the land it is built on. The land acquisition area falls under the classification of customary land.

Under customary lands, there are three forms of right to land, and due to the nature of the land tenure system, an individual can hold multiple rights to one piece of land. The land use rights are described below:

- **Use Rights**: the right to use the land (conferred either to "natives" or "settlers").
- **Control rights**: the right to make decisions on how the land should be used and to benefit financially from the sale of the crops etc.

- **Transfer rights**: the right to sell or mortgage the land; to convey the land to others through intra-community re-allocations or to heirs; and to reallocate use and control rights.

Under the traditional system, any person who wants to buy or lease land has to request permission from the chief and follow the correct traditional protocols. Family land can be bought or leased, and if leased, the family and the lessee have to agree on the rent before the transaction is regarded as complete. The same applies if the person wants to buy the land and a selling price must be agreed upon. Once this transaction is completed the buyer becomes the legal owner of the land.

Land ownership is also determined by the systems of matrilineal (maternal) and patrilineal (paternal) inheritance. In the Ellembelle District matralineality is the dominant form of inheritance and family land may be handed down through the female line from mother to child but not from father to child. If a man owns family land he is only able to pass the land on to his sisters' heirs thereby keeping the property within the family through the female line. Chiefs remain the custodians of traditional lands but do not have absolute control as land acquisition registration and revenue collection is done through the Office of the Administrator of Stool Lands. In addition, there is a legal obligation to distribute revenues from Stool Land (Article 267 of the Constitution and Section eight of the Stool Lands Act 1994) as follows:

- The first ten percent of the revenue accruing from Stool Lands shall be paid to the Administrator of Stool Lands to cover administrative expenses.
- The remaining revenue shall be disbursed in the following proportions by the Administrator;
  - 25 percent to the Stool through the traditional authority for the maintenance of the Stool in keeping with its status;
  - 20 percent to the traditional authority; and
  - 55 percent to the District Assembly within the area of authority in which the Stool Land is situated.

8.6.2 Local Land Tenure and Use Rights

Traditionally, land was in the "customary ownership" of chiefs, who dispensed and allocated it on behalf of their people. Subsequently the colonial authorities negotiated treaties under Romano-British law which led to individual land titles and leases being granted, and substantial land being taken into government ownership.

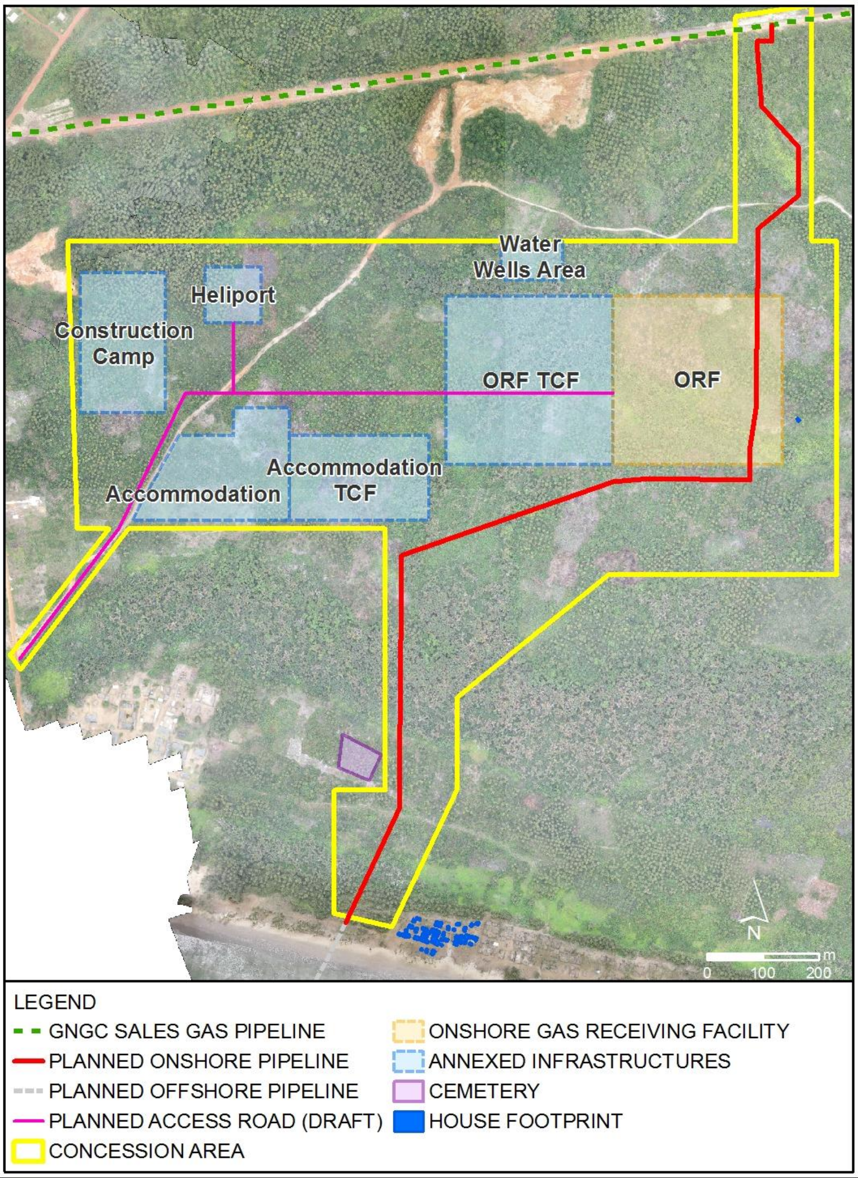
The land in the DAoI is in the "customary ownership" of chiefs, who dispense and allocate it on behalf of their people. This land access category is usufruct rights to stool land. Under the customary system, the land is viewed as a common heritage from God to the indigenes, through their ancestors and must be preserved and handed to their successive descendants.

Land Use within the Land Acquisition Area

The land area identified for the construction of the ORF is shown in Figure 8.2. There is a small settlement located adjacent to the south-eastern border of acquisitionacquisitionarea but none within its boundary. The housing structures in this closest settlement are temporary in nature, constructed from raffia poles and palm leaves as shown in Figure 8.14.

The remainder of the acquisitionacquisitionarea consists primarily of cultivated palm groves, croplands or the remains of natural vegetation and water bodies. Land use and land based livelihoods in the Land Acquisition Area, is discussed in more detail in Section 8.7.3.

Figure 8.2 Project Land Acquisition Area (settlement of Anwolakrom in the south-east corner, blue houses)



8.7 NATIONAL, REGIONAL AND DISTRICT SOCIO- ECONOMIC ENVIRONMENT

8.7.1 Demographic Profile

Population Growth

According to the 2010 Population and Housing census, Ghana had an estimated population of 24 658 823 people, with a population density of 114 people per km2 (Ghana Statistical Service, 2013). However, more recently population is estimated to be approximately 25.9 million. The Western Region comprises nine percent of the total population (2.3 million people) and has a population density of 97 people per km2 making it the fifth most densely populated region in the country (Ghana Statistical Service, 2012). The Ellembelle District has a population of 95,306, with a population density of 80 people per km2, lower than both the national and regional population density.

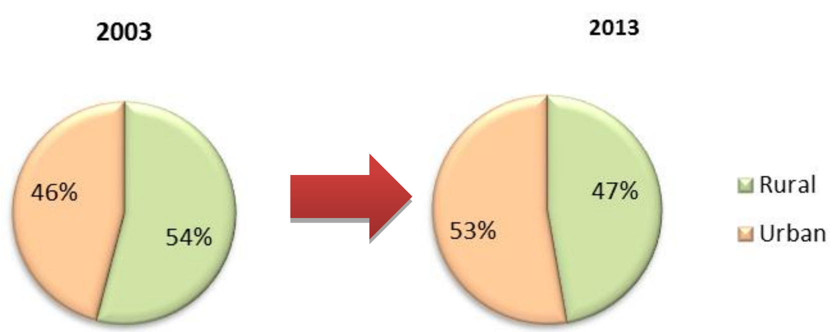
The annual growth rate of the national population is approximately 2.1 percent and according to the World Bank, the growth rate has slowly been declining since 2006. The growth rate in the Western Region mirrors the national growth rate at 2 percent (Ghana Statistical Service, 2012).

Population growth in the Western Region are from the 2010 Population and Housing Census, and therefore, pre-date the recent oil and gas developments industry in the region. No more up to date national population statistics are available at the time of writing. The Region is expected to experience population growth in the future as people migrate to the area in search of employment opportunities.

Population Patterns

Over half the population of Ghana (53 percent) now live in urban areas and Figure 8.3 shows the change in split between rural and urban populations over the past decade.

Figure 8.3 Change in the Distribution of the Population



Source: World Bank (2014)

The Western Region has a larger proportion of the population living in rural areas than the national average, with 57.6 percent of the population living in rural areas (Ghana Statistical Service, 2012). The Ellembelle District is considered largely rural, with 84 percent of the population living in rural areas. According to the Ellembelle District Profile (EDP) there has been a marked increase in the number of people living in urban areas. The EDP nnotes that the increase in the urban population is due largely to an unequal distribution of socio-economic resources. Skewed development investment has led to an over-concentration of social amenities in the small number of urban centres. This is a situation that the District is consciously addressing by developing a rural strategy for development that is also in line with regional and national planning policies.

Population Density

Population density, being at 104 persons/km^2 in Jomoro, 80 persons/km^2 in Ellembelle and 62 persons/km^2 Nzema East, and 167 persons/km^2 in Ahanta West Districts, would indicate no great pressure of population on the land tout-court. However, the same cannot be said of pressure on resources and existing infrastructure. As an example, settlements or growth points such as Esiama and Aiyinasi in Ellembelle District, though urbanised areas, have been experiencing relatively higher population densities with corresponding pressure being exerted on existing and limited infrastructural facilities.

Households

According to the 2010 Census, there are 553,635 households in the Western Region, occupying 380,104 housing units, which give an average of 1.5 households per house. Comparable past averages are 2.2 for 1970 and 2.0 for 1984. This may be the result of increases in supply of houses.or a slow-down in the formation of new households.

The head of the household is the one who is identified as the head by members of the household and not necessarily the one who maintains the household. The Western Region is characterised by 72% male-headed households against 28% female-headed households. Other relatives and grandchildren, who are an extension of the nuclear family, make up 26% of the household structure.

42.4 % of the Western Region is urbanised and the remaining 57.6% is rural (the rural/urban classification of localities is population based, with a population size of 5,000 or more being urban and less than 5,000 being rural).

Age and Gender Distribution

Ghana has a young population with over a third (38.3 percent) of population under the age of 15 years, and only 4.7 percent of the population over the age of 65 years (Ghana Statistical Service, 2012). According to the National Population Census 2010, the number of people under the age of 15 has declined since 2000, when it was 41.3 percent. The population of the Western Region and Ellembelle District reflect a larger population of youth than that of the national population and a smaller population of economically active people, as shown Table 8.2.

Table 8.2 Age Distribution in the Project District, Region and Ghana

Age	**Ellembelle District**	**Western Region**	**Ghana**
0 – 14	43	45	**38**
15 – 64	51	52	57

Age	Ellembelle District	Western Region	Ghana
65+	6	3	5

There are more females in Ghana than there are males (51.3 percent females to 48.7 percent males), however, in the Western Region, the opposite is true and there are more males than females.

This age and gender distribution could be as a result of migration out of the area in search of job opportunities. Together with the high number of youths in the District, these figures indicate that there is a high dependency level in the District, which places a heavy burden on the economically active sector of the population and contributing to high levels of poverty (2010 Population and Housing Census Provisional Results).

Ethnicity Language and Religion

In Ghana ethnicity is characterised by one's mother toungue language. The official language of Ghana is English, and it is the main medium for teaching in schools from the fourth year of basic schooling. Other languages include Akan, Dagaare, Dagbani, Dangme, Ewe, Ga,

Gonja, and Kasem. The dominant ethic group in Ghana is Akan, which is made up of a number of smaller ethnic groups, each of which has its own language. Within the Western Region and the Ellembelle District Akan is also the dominant ethnicity. However, the dominant languages are Twi and Fante which are dialects of Akan.

Nationally, Christianity is the religion practiced by the majority of the population. This trend is reflected in the Western region where 81 percent of people are Christian, followed by Islam (8.5 percent). According to the EDP, Christians constitute about 79 percent of the population, while Muslims comprise eight percent, traditionalists three percent and others ten percent. Christian denominations include Methodist, Catholic, Anglican and Penticostal.

Although Christianity is widely embraced in Ghana, traditional beliefs and practices such as animal sacrifice to a smaller god are often incorporated into religious ceremony. There are "taboo" days around some activities. For instance activity in the lagoon is prohibited on Wednesdays, fishing is not undertaken on the seas on Tuesdays, and Thursdays are taboo days for farming.

Festivals and Cultural Practices

The major festival in the Western Region for Ahanta and the Nzema people is the Kundum Festival. The festival is celebrated between September and October, roughly coinciding with the harvest period. During Kindum, food is offered to the gods and it is an occasion for thanksgiving, unity and peace (amongst other tidings).

Other festivals of cultural importance to the local populations are the Odwira (Yam Festival) celebrated by the Gwira Traditional Area (in Nzema East), the new Clan Festival which takes place at the end of the year.

Demography at the District level

An overview of the population characteristics according to the 2010 Population and Housing Census for the six coastal Districts that form part of the study is hereby provided.

Jomoro District. The District has a total population of 150,107 and a population growth rate of 3.2 percent. The District is mainly rural (29.6 percent urban) with only four settlements having populations in excess of 5,000. The major settlements with larger populations are Bonyere, Elubo, Half Assini and Tikobo No.1. Population density has increased over recent years with 2010 figures being 103.7 persons per km^2. Almost 15.8 percent of the population are immigrants, mainly settled in the northern part of the District. About 53 percent of immigrants are male and 58 percent are in the age group of 18 - 35 years.

Nzema East Municipality. The District has a total population of 60,828. The population density was 62 per km2The area is largely rural (26.6 percent urban) with most communities having a population of less than 5,000. However, a steady rural to urban migration has seen an increase in the urban populations in recent years. According to the municipal planning office, migrations tend to be seasonal with persons migrating to farming areas during the farming season and to the coast during the fishing season. There is, however, no data to indicate whether there has been an increased migration into the District recently.

Ellembele District. The District has a total population of 87,507..The population density of the District is 80.1 persons per km^2 The District is mainly rural with only 26 percent of the population living in urban centres.

Ahanta West District. A population of 106,215 was reported for this District in 2010.. The District is characterised by a high population density of 198 persons per km^2in 2010 compared with regional population density of 51 per km^2. The high population density of the District indicates population pressure on land and other limited facilities and services within various settlements. Approximately 80 percent of the population lives in rural settlements making Ahanta West a rural District.

Sekondi-Takoradi Metropolis (STM). The population of STM was 559,548 in 2010. It is the most populated area in the Western Region and comprised about 23.5 percent of the regions total population in 2010. Population density is 2,712.3 people per km^2. The STM has 49 communities and approximately 14 of these settlements have a population exceeding 7,000. The major settlements are Takoradi, Effia-Kwesimintsim, Effiakuma, and Sekondi. Built up areas in the Metropolis can be classified into urban and rural settings. The urban portions constitute about 32 percent of the land area and accommodate close to 70 percent of the population. Sekondi-Takoradi, serves as a destination as well as transit point for approximately 80,000 migrants mostly from rural portions of the country that commute to the area in for work. This has resulted in the increased development of slums in the city.

Shama District. The population of the District was reported as 81,966 in the 2010 census. Population density is 549 people per km^2. The population growth rate of 3.5 percent in 2000 was higher than the regional and national averages of 3.2 percent and 2.7 percent respectively. The District experiences emigration of economically active people in search of employment in major urban centres.

8.7.2 Migration Patterns

Estimates of the Ghanaian emigrant population range from one and a half million (Twum Baah, 2005) to three million (Black et al., 2003). The majority of Ghanaian emigrants remain in West Africa (71 percent) (2008 figures) (IOM, 2009). A significant number of skilled

Ghanaians have been leaving the country since the early 1990's. Ghana has the highest emigration rates for the highly skilled in West Africa (46 percent) (OECD, 2005; Docquier and Marfouk, 2005) with the health profession (doctors and nurses) being severely impacted by loss of skilled personnel.

In terms of economically forced emigration, Ghana experiences low rates and the number of Ghanaian asylum seekers and recognized refugees under the United Nations High Commissioner for Refugees' (UNHCR) protection has decreased from 15879 in 2003 to only 6717 in 2007 (UNHCR, 2008).

The majority of immigrants into Ghana are from other African nations, in particular the ECOWAS bloc. In 2000, 58.9 per cent of non-Ghanaian residents were nationals from ECOWAS countries, while 23 per cent of immigrants came from African countries outside ECOWAS (IOM, 2009). The number of immigrants has increased since the early 2000's and in 2007 Ghana hosted the largest refugee population in West Africa. More specifically, in 2008 approximately 77 percent of refugees in Ghana were from Liberia with a large proportion of those being minors (IOM, 2009).

Migration on a regional level in Ghana is driven by limited employment opportunities in many of the districts within the Western Region. Job seekers tend to migrate to areas where there are employment opportunities, for example Ahanta West and the Sekondi- Takoradi Metropolitan Area. The recent surge in oil and gas activities based out of the Sekondi – Tekoradi twin city has resulted in a significant increase of migrants from different parts of the country to the area. The Western Region also attracts migrant labourers due to its active mining and forestry (cocoa plantation) sectors. Moreover, seasonal migration is also prevalent as people migrate to key fishing areas during the fishing season and return to their crops for the farming season.

8.7.3 Economic Activity and Livelihoods

Ghana is West Africa's second largest economy (behind Nigeria). The largest contributor to GDP is the service industry followed by industry and agriculture (AFDB, 2012). Ghana's economic growth in recent years has been spurred by the discovery of oil in commercial quantities and commencement of oil production. However, Ghana's oil reserves are estimated to be modest in comparison to Nigeria and Angola - although exploration is still ongoing. After slowdown of economic activity in 2009, the Ghana economy picked up in 2010 and grew in real terms by 7.7 percent. In 2011, real GDP is estimated to have increased sharply by 13.7 percent (7.5 percent excluding oil) aided by oil revenues and the strong export performance of cocoa and gold in volume and prices (AFDB, 2012). GDP growth in 2013 was estimated at 7.9 percent. Ghana has a favourable tariff structure for international trade and good trade relations with both the UK and the US.

The official unemployment rate in Ghana is estimated at 3 percent, however, only approximately 8.5 percent of the working population is in formal employment. This indicates that the formal definition for unemployment disguises the high level of underemployment and unemployment in the informal sector (AFDB, 2012).

Fishing

The fisheries sector in Ghana primarily comprises of marine fisheries, inland (fresh water) fisheries, and aquaculture as well as related processing activities in storage, preservation, marketing, and distribution (Ghana Investment and Promotion Centre, 2014). The fisheries sector plays a key role in the national economy and contributes an estimated 3 percent of the total GDP. About 10 percent of the country's population is engaged in various aspects of the fishing industry. In addition, marine fisheries account for approximately 80 percent of the fish consumed in Ghana.

Please see Section 7:7.8 of this baseline for more detailed description and discussion on socio-economic and livelihoods aspects of Fishing and the Fisheries sector in the DAoI.

Farming

The agriculture sector in Ghana can be categorised into three main vegetation zones (Ghana Investment and Promotion Centre, 2014):

- **Forest vegetation zone** consists of parts of Western, Eastern, Ashanti, Brong-Ahafo and Volta Regions. The climate in this area is conducive for the cultivation of cocoa, coffee, oil palm, cashew, rubber, plantain, banana and citrus crops.
- **The northern savannah vegetation zone** includes the Upper East, Upper West and Northern Regions. The nation's supply of rice, millet, sorghum, yam, tomatoes, attle, sheep, goat and cotton are grown in this region.
- **The coastal savannah** includes mainly the Central, Greater Accra and parts of Volta Region. Crops grown here include rice, maize, cassava, vegetables, sugar cane, mangoes and coconut, as well as livestock.

Agriculture contribution to GDP over the years has shown a steady reduction from 35.4 percent in 2006 to 25.6 percent in 2011 even though the agriculture sector recorded a growth rate of 2.6 percent against a target of 4.8 percent in 2012. Cocoa is by far the most profitable export, with cocoa bean exports generating USD 847 395 000 and cocoa butter generating USD 86 459 000 in 2010. The country's main export markets are the Netherlands, Burkina Faso, the United Kingdom and South Africa.

Agriculture is a key component of the Elembelle District economy involving a large proportion of the economically active population. Given the undulating topography, mechanised systems of cultivation are unsuitable and most activities are done on a small scale for family subsistence and trading. The coconut sector has developed and has historically been a large contributor to the Ellembelle District's economy. A common market between Jomoro, Nzema East and Ellembelle has been established, increasing the profitability from this sector. Coconut derivatives such as coconut oil are produced and exported regionally as well as internationally (for example to Nigeria).

The majority of households in communities along the Ellembelle District coastline participate in a one form of farming to supplement fishing. The sizes of plots vary and are dependent on the availability of family (or hired labourers) to work. Moreover, crops are rain fed and not irrigated and thus dependent on rainfall patterns. The primary planting season occurs between March and April before the rainy season in June and July and secondary planting takes place in September and October. Primary crops include cassava, groundnuts, corn, tomatoes, banana and plantain.

Oil and Gas

In 2004 Ghana issued licences for offshore oil exploration and production to various oil and gas development companies. In July 2007, Tullow Oil and joint venture partners discovered oil in commercial quantities in the Jubilee Field off the Western Region of Ghana (Kastning, 2011). Commercial production came online in December 2010. Since the Jubilee Field discovery the sector has grown significantly and now represents a key business sector in Ghana contributing significantly to GDP and economic development. Gross domestic product (GDP) growth decelerated from 14.4% in 2011 (the Jubilee Oil Field contributed 7% to the growth) to 7.1% in 2012. Ghana's medium-term GDP growth of 8.0% (6.5% non-oil) was projected in 2013 and 8.7% (8.9% non-oil).

Since the Jubilee Field came online, production in Ghana has increased from 7,000 barrels per day bbl/d in 2009 to 99,000 bbl/d in 2013. The offshore Tweneboa, Enyenra, and Ntomm (TEN) project, also being developed by Tullow Oil and partners, is expected to come online in 2016. Expected output for the TEN development is expected to peak at 80,000 bbl/d of crude oil and 50 million cubic feet per day (MMcf/d) of natural gas (US EIA, 2014).

The Ghana National Petroleum Corporation (GNPC) is the state-owned corporation responsible for petroleum exploration, development, and production and marketing. Currently there are about 11 Petroleum Agreements between the Government of Ghana, GNPC and petroleum operators, signifying the increased interest in Ghana's oil industry. Oil and gas exploration is ongoing along the coastline and more discoveries are anticipated in the future.

The country also has an active downstream oil and gas industry including a refinery at Tema and numerous storage and distribution systems for refined product.

Informal Economy

The Ghana Statistical Service estimates that approximately 86 percent of all employment in Ghana is in the informal economy (Osei-Boateng and Ampratwum, 2011). More specifically, almost 91 percent of women and 81 percent of men are working informally.

The informal sector in Ghana consists of various small-scale businesses. For example; producers, wholesalers and retailers. Informal sector workers are largely self- employed persons such as farmers, traders, food processors, artisans and craft-workers (Osei-Boateng and Ampratwum, 2011).

The rural informal economy centres on (Osei-Boateng and Ampratwum, 2011):

- Agricultural activities focused on family farming units or community owned assets. Farming is generally on a low technology basis dependent on family labour.
- Fishing and fish processing activities predominantly undertaken by males (between 18-40 years old) along Ghana's coastline. The processing activities, including smoking and marketing the fish, are undertaken by women in the village

- Rural agro-based processing activities of local crops. These include processing cassava, palm kernel, groundnut and copra oils, brewing distilling, and traditional soap-making. The activities are generally undertaken by women.

The urban informal economy centres on the:

- Services sector, for example urban food traders, domestic workers and repair men and women;
- Construction sector, for example masons, carpenters, and small-scale plumbers (mainly men between 18 and 40 who have dropped out of school); and
- Manufacturing sector which includes, food processing, textile and garments, wood processing and metal works.

Tourism

In 2011, 1 087 000 tourists visited Ghana from a variety of geographies. Ghana's all year round tropical warm climate and attractive landscape make it a key tourist destination in West Africa. Major attractions in Ghana include the Kintampo Waterfalls (largest waterfall in West Africa), Lake Volta, and colonial-era castles and forts (some of which are UNESCO World Heritage Sites). Ghana has 16 National Parks and has an established ecotourism sub-sector. Key ecotourism attractions include the Kakum National Park and Boabeng-Fiem Monkey Sanctuary (Commonwealth Network, 2014).

The total contribution of travel and tourism to GDP was 7.2 percent in 2013, and is forecast to rise by 9.0 percent in 2014. The size of the sector is projected to rise by 4.4 percent per annum until 2024 (World Travel and Tourism Council, 2014). In 2013, the total contribution of travel and tourism to employment, including jobs indirectly supported by the industry, was 5.8 percent of total employment (311 000 jobs). This is expected to rise by 6.3 percent in 2014 to 330,500 jobs and rise by 2.3 percent pa to 414,000 jobs in 2024 (6.0 percent of total) (World Travel and Tourism Council, 2014).

8.7.4 Manufacturing and Light Industry

Manufacturing constitutes about 6 percent of Ghana’s GDP (2011) and provides employment for over 250 000 people (2009) (Commonwealth Network, 2014). The majority of manufacturing companies are small to medium sized enterprises with more than half of registered companies located in the greater Accra Region.

Major industries include mining, light manufacturing, aluminium smelting, food processing, cement and small commercial ship building (Commonwealth Network, 2014). Other industries include food and beverages production, textiles, chemicals and pharmaceuticals, and the processing of metals and wood products.

Generally, the manufacturing and light industry sector is underdeveloped and dominated by agro-industries and medium sized firms. Despite this, there is the presence of subsidiaries of multinational companies including Unilever, Coca Cola, and Toyota.

Ghana’s political and macroeconomic stability creates a conducive platform for Foreign Direct Investment. However, the manufacturing industry has struggled to recover since the 1980s (where the manufacturing’s share of GDP was more than 10 percent) due to structural adjustment programmes and failed state-led industrialisation policies (Commonwealth Network, 2014).

8.7.5 Utilities and Social Infrastructure

Road Infrastructure and Transport

Roads

Ghana has an extensive road network however, only 13 percent of the roads are paved. There are three tiers of roads in Ghana, namely: national roads connecting major population centres; regional roads consisting of secondary and main roads which feed the national roads; and inter-regional toads connecting major settlements across the regions of Ghana.

The road network in the Western Region is limited and the conditions of the roads can be very poor, particularly in the rainy season. The Ellembelle District road network consists of 154 km of trunk roads, of which 64 km are paved. The paved trunks form part of the Trans-West Africa Highway. The rest of the trunk roads are gravel or earth-surfaced. Apart from the trunk roads there are smaller feeder roads, most of which are in poor condition.

The Ghana Private Road Transport Union (GPRTU) and other transport organisations provide transport services within the districts in the Region. In small communities, private taxis and small buses owned by private individuals are also operational.

Airports

There are a total of ten airports in Ghana, seven of which have paved runways. The main international airport is in Accra. Takoradi Airport is a military airbase that allows civilian flights and is the main airport serving the Western Region. The airport has one runway and there multiple daily scheduled domestic flights.

Telecommunications

Fixed line and mobile telephone systems are in operation in Ghana, as well as wireless, radio telephone and satellite communication systems. Vodafone Ghana Telecom Company operates over 95 percent of the fixed line telephones in the country. In the Western Region there are 0.3 telephones per 100 persons, which is below the national average of 0.7.

Mobile telephone operators MTN, Vodafone, and Ghana operators of Vodafone, Tigo, Kasapa and Zain, cover the Western Region. The Region has the second highest locality coverage by MTN, which is the largest mobile telephone system in the country. According to the National Communication Authority (NCA), in August 2012, the total cellular/mobile subscriber base in Ghana stood at 24 438 983, which was 98 percent of the population at the time (Ghana Statistical Service, 2013).

Water and Sanitation

There are three major sources of drinking water: piped (inside, outside, tanker supply), well (well, borehole) and natural (spring, river, stream, lakes, rainwater, dugout). In the Western Region, 32 percent of houses have access to treated piped water with 8.5 percent having this available within their dwellings. The highly urbanised districts have almost 100 percent availability of, or accessibility, to piped water. This is in contrast to rural districts where over 60 percent of households use rivers, streams, wells, spring or rainwater as their main source of water.

Ellembelle District has seen some improvement in water services over the years with an increase in the number of facilities and coverage. Table 8.3 below outlines the Ellembelle water and sanitation infrastructure improvement plan for 2010 to 2013. The implementation of the plan is the responsibility of the EDA.

Table 8.3 Water and Sanitation in Ellembelle District

Type of Facility	2010 Total	2013 Total
Water		
Hand dug well	105	189
Borehole	9	70
Pipe System	6	9
Toilet Facility		
KVIP	43	79
VIP	426	1 040
WC	213	369

Source: EDP (2012)

In terms of sanitation, approximately 70 percent of Ellembelle households do not have toilets. Where facilities do exist, the most common types are Kumasi Ventilated-Improved Pit (1) (KVIP), pit latrine or bucket/pan systems. Where no facilities exist, people make use of the beaches, outlying bushes and gutters. Cultural beliefs, practices and attitudes towards hygiene, sanitation and waste disposal in coastal areas of Ghana contribute to health risks from human waste pollution. The open beach areas are commonly used for defecation either out of necessity or tradition. NGOs and numerous public sources report traditional superstitions widely held in fishing communities that defecation on the beach pacifies the gods and improves fish catch (Ghana News, 2014, Friends of the Nation, 2014).

Energy

Ghana has an installed power generating capacity of approximately 2,100 MW, 59 percent of which is generated by hydroelectric plants, and 41 percent from fossil fuels. The Electricity Company of Ghana is responsible for the distribution of power across southern regions of Ghana, including the Western Region. It is a government owned enterprise and operated under the Ministry of Petroleum. The Northern Electricity Department, a subsidiary of Volta River Authority, is responsible for power distribution in the northern regions. Ghana is experiencing a power deficit, and load shedding for residential and industrial customers is common.

In the Western Region, electricity and kerosene lamps are used as the main sources of lighting. In the urban areas, the majority of households use electricity while in the rural districts, kerosene lamps are the main source of lighting. Rural households are also gradually gaining access to electricity through a rural electrification programme. Charcoal and fuel wood are the main sources of cooking fuel in the Region (including urban dwellers), however liquid petroleum gas (LPG) and coconut husks are also used as a source of cooking fuel. The use of electricity for cooking is minimal being limited to Sekondi- Takoradi with its highly urbanised status and access to electricity.

Waste Disposal

Waste disposal is a challenge in Ghana, particularly in the rural areas. In the Western Region and the Ellembelle District, the most common way of disposing of household waste is to dump it at specified community dumping sites or in the absence of such sites, ad hoc disposal on open land. The Ellembelle District has limited waste handling facilities and equipment and inadequate capacity. It has only two formal waste disposal sites for both solid and liquid wastes at Aiyinase. Only two percent of households within Ellembelle District have their rubbish collected by a waste removal services, Zoomlion and local authorities for disposal. Zoomlion and ZOIL operate as a waste disposal and beach-clearing agent in parts of Ellembelle. Burning and burying of waste accounts for about a tenth of household waste disposal.

8.7.6 Marine Infrastructure

Ports and Harbours

The nearest port is the Port of Takoradi. The Port of Takoradi was built as the first commercial port of Ghana in 1928 to handle imports and exports to and from the country. The port currently has dry dock facilities for vessels that weigh up to 400 tons, a length of 55 m, width of 114 m, and a draft of 35 m (Ghana Ports and Harbour Authority n.d). The capacity of the slipway is 250 tones with dimensions of 11 m wide and 38 m in length. The port currently has a closed storage area of 140,000 m^2 and an open storage area of 250,000 m^2. The port has three tug boats for berthing, sailing and shifting. The tugs are fitted with monitors for firefighting.

The Port receives high traffic volumes and in 2012 handled 31 percent of national sea borne traffic. Moreover, the port handles approximately 18 percent of National seaborne imports annually and 70 percent of National seaborne exports annually (Ghana Ports and Harbour Authority n.d). Major import commodities include clinker, wheat, and quicklime and major exports are cocoa, bauxite, and manganese.

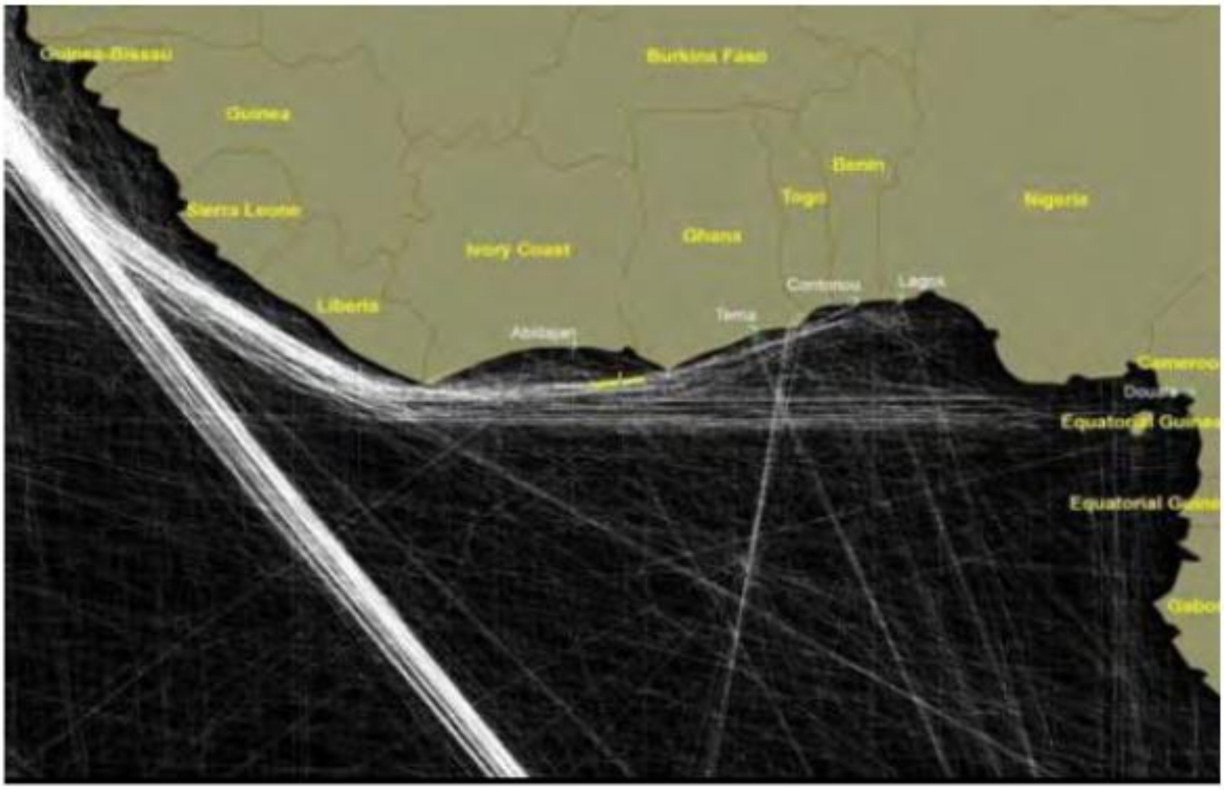
Pipelines and Cables

There are several existing and planned submarine cables and pipelines offshore Ghana. There is an existing subsea pipeline from the Jubilee Field to the Ghana Gas Plant at Atuabo. There is also an onshore gas pipeline from the GNGC Gas Plant in Atuabo. This 110 km onshore gas pipeline to Aboadze is in close proximity to the planned Project site. Gas is transferred from Atuabo to the Aboadze power plant where it is used for fuel.

Shipping and Navigation

The Gulf of Guinea experiences high maritime traffic. Figure 8.4 below illustrates established shipping lanes across the Gulf.

Figure 8.4 Shipping Lanes off the West Coast of Africa



Source: NCEAS Online (n.d)

Oil and Gas

Exploration activities are ongoing in the Deepwater Tano and West Cape Three Points concession blocks. In the Jubilee Field, subsea equipment (wellheads, manifolds, umbilicals and flow lines) has been installed since January 2010 as well as the FPSO Kwame Nkrumah. Crude oil stored on the FPSO is transferred to an export tanker approximately every five to seven days. There is a 1 km safety exclusion zone centred at the FPSO turret and a further 10 km radius advisory zone.

Ghana has one oil refinery, the Tema refinery, with a design capacity of 45 000 bbl/d. However, operations have been plagued by inefficiencies due to old equipment, and the lack of funds to purchase crude oil for processing has hampered its operations (US EIA, 2014).

8.7.7 Safety and Security

Political

Ghana is a stable democracy that has had five elections since 1992 and two peaceful transitions of power between political parties. The last elections took place in 2012 and while there was some sporadic election-related violence, it took place in a relatively peaceful context. In general, Ghanaian politics takes place in a peaceful context, and defeated candidates have stated that any grievances they have regarding the legitimacy of the election would be handled in the courts.

Road Safety

Road safety is a concern in Ghana. Whilst primary roads and roads within urban areas are well maintained, roads outside the city present difficulties and are often in poor condition. This is compounded by unpredictable drivers, poorly maintained vehicles, and overloaded vehicles and as a result poses threats to road safety. Travel in darkness, particularly outside the major cities, is extremely hazardous, due to poor street lighting and the unpredictable behaviour of pedestrians, bicyclists, and livestock (US State Government, 2014).

Maritime Safety and Piracy

The International Maritime Organisation (IMO) estimated that in 2011, West African countries lost nearly over USD 1 billion in oil due to piracy (Save our Seafarers, n.d). The Gulf of Guinea has been identified as the most dangerous maritime area in terms of the success rate of attacks and violence. While in the past Ghana has been largely exempt from this threat, in 2014 Ghana registered it's first significant hijackings. Of the three hijackings report, two were on oil tankers. The Gulf of Guinea has recorded the most attacks against FPSOs in the world, all of which have occured off the coast of Nigeria (Ali Kamal-Deen, 2014).

Acts of priracy in the Gulf of Guinea have been characterised by high levels of violence and brazen pursuit of targets. Oil tankers are the primary target for the pirates, who then transfer the refined oil onto smaller ships for illegal sale (Ali Kamal-Deen, 2014).

There is a lack of legislation with respect to the crime of piracy in the Gulf of Guinea. Thus states able to patrol their coasts, but they are unable to prosecute or punish offenders. The Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation, 1988 (known as the 1988 SUA Convention) is an important tool in counter-piracy and while. Ghana has ratified SUA instruments, they have generally failed to incorporate them into their domestic legal systems (Ali Kamal-Deen, 2014).
Ghana is it at risk of an increase in piracy in the future due to the growth of the oil and gas sector and the current economic growth in the country, (Save our Seafarers, n.d).

8.7.8 Education

The 1992 Constitution of Ghana prescribes that basic education shall be free, compulsory and available to all. Ghana's educational system has undergone several stages of restructuring over the past 25 years. At the Basic Education Level; pre-school education has been officially incorporated into the system and all primary schools are required to have nurseries or kindergarten. The basic school education is mandatory. Children are due to begin primary education at the age of six and finish when they are twelve years old. Pre-school education starts at much earlier age (by age two or three years). After completion of primary school, the child continues to the Junior High School (JHS) for three years. By time they enter the Senior High School (SHS), they will be sixteen years old. At the secondary level, since the 2007/2008 academic year, the three-year Senior Secondary School System has been changed to a four-year Senior High School (GSS, GHS, and ICF Macro, 2009).

At the Junior High School level, the main subjects taught are English, mathematics, integrated sciences, and social studies. The electives subjects include Ghanaian language, Basic Design and Technology (BDT), religious and moral education, French, and Information Communication Technology (ICT).

Schools are predominantly run by the State, however there are also a number that are private or run by faith-based organisations. Although government basic education is freely available, there are a number of additional charges for which parents are responsible including Parent Teacher Association (PTA) levies, uniforms, exam printing fees and purchase of exercise books, notebooks, and occasional textbooks. It is difficult therefore to provide specific figures for the additional schooling costs, and in many cases these costs make school attendance too expensive to manage.

According to the Basic National Profile from the Ministry of Education, in 2012/2013 there were 5 568 977 learners enrolled in public schools and 1 896 241 in private schools (crèche, kindergarten, primary, and junior high school). The Basic National Profile has two indicators for the pupil teacher ratio, firstly a general pupil per teacher ratio (PTR) and secondly a pupil per trained teacher ratio (PTTR). Broadly, the PTR ratio is better in private schools than in public schools, however it is the opposite for the PTTR (this may be in part a result of the lack of qualified teachers).

Table 8.4 and Table 8.5 below illustrate national level statistics for various basic components of school infrastructure.

Table 8.4 National School Infrastructure Statistics (Public)

Type of school	**Total number of schools**	**Schools with toilets**	**Schools with drinking water**
Crèche	511	344 (67%)	312 (61%)
Kindergarten	13 305	7 891 (59%)	6 028 (45%)
Primary	14 112	8 455 (60%)	6 415 (45%)
Junior High School	8 818	5 631 (64%)	4 235 (48%)
Total	36 746	22 321 (61%)	16 990 (46%)

Source: National Basic Profile (2013)

Table 8.5 National School Infrastructure Statistics (Private)

Type of school	**Total number of schools**	**Schools with toilets**	**Schools with drinking water**
Crèche	4 841	4 282 (88%)	4 035 (83%)
Kindergarten	5 972	5 047 (85%)	4 706 (79%)
Primary	5 742	4 875 (89%)	4 524 (79%)
Junior High School	3 618	3 205 (89%)	3 000 (83%)
Total	20 173	17 409 (86%)	16 265 (81%)

Source: National Basic Profile (2013)

There are currently 1 320 primary schools in the Western Region, of which 1,240 are public and 80 are private. The Ministry of Education's policy states that there should be a basic school within five km of a community. Thus, these schools are fairly evenly distributed across ten of the Region's Districts. Ellembelle District education facilities are presented in Table 8.6 below and the enrolment of pupils (by gender) in the District is shown in Table 8.7.

Table 8.6 National School Infrastructure Statistics (Public)

Facility	**Number in District**
Pre-school	75
Primary	94
Junior High	65
Senior High	5

Facility	Number in District
Technical or Vocational	2
Special (Eikwe)	1

Source: EDP (2012)

Table 8.7 Ellembelle School Enrolment by Gender

Category of School	Enrolment		
	Boys	Girls	Total
Pre-school	3,383	3,450	6,833
Primary	7,158	6,589	13,744
JHS	2,532	2,100	4,632

Source: EDP (2012)

Tertiary Education

Tertiary education in Ghana begins after senior high school and there has been an increase in the level of tertiary education attainment in the country in the past 10 years. This increase in part is a result of the recent expansion in private universities. By 2012, there were more than 126 public and private universities accredited by the National Accreditation Board (NAB) in Ghana (Atuahene and Owusu-Ansah, 2013). Ghana tertiary institutions enrol approximately 100 000 students in undergraduate, graduate, certificate and diploma programs annually (NABPTEX, n.d). These students are spread across six public universities, 49 private universities, 38 Teacher Training Colleges (TTCs) that have been upgraded to university status, 18 Nursing Training Colleges, and ten Polytechnics (Atuahene and Owusu-Ansah, 2013).

8.7.9 Cultural Heritage

Cultural heritage resources include both the tangible and intangible. Known tangible resources in the Project area include places of formal religious worship (churches, mosques) as well as places and locations associated with traditional religious practices (sacred forest groves, lagoons, the sea). Also identified in the Project area are places of burial. This includes a cemetery at the coastline at Sanzule and one to the east of the community, designated for burial of relations of the traditional royal family.

Cultural heritage is discussed in more detail in the local socio-economic environment.

8.7.10 Vulnerable Groups

Vulnerable groups in the Project area include the elderly, children, women (particularly Female-headed households), disabled people, and orphans. In women's and men's focus groups, children and the elderly were cited as the most vulnerable groups, in respect of their susceptibility to malnutrition as a result of being reliant on others to provide for them, and to diseases such as malaria. Baseline engagement suggests that sharecroppers, crop farmers refugees and fishers are potentially also vulnerable in this area, due respectively amongst other reasons, to their lack of formal rights to land and their sensitivity to changes in climate and reportedly declining farming yields and fish catch. Finally, migrant fishing communities in the area should be considered especially vulnerable given they have little or no formal security of tenure, limited access to land for farming and are almost solely dependent on marine fishing (and therefore particularlyvulnerable to declining fish catch) for their incomes and subsistence. These groups and their respective vulnerabilities, are described further below:

The elderly

The elderly (aged 65 and above) represent a small percentage of the population. They however are vulnerable as they seldom have an income and rely on remittances from family members. Due to generally poor health (and available health care) they are unable to work their fields or work as petty traders. Furthermore, they are often forced to employ people to help in their fields in return for a share in their yield, diminishing the amount of produce available to them.

Children

Across the DAoI, many children are left in the care of their grandparents (in particular, grandmothers) as their parents leave the area in search of employment. A relatively low number of parents return to the area or send money home to their children. As the grandparents are too old to work, the children are often required to take up such responsibilities and participate in household livelihood activities. As a result, children (12-13 years) are reported to pursue other opportunities: boys primarily become fishermen and girls marry early or get involved in relationships of sexual exchange and often do not return to education.

In Ghana, child labour is prohibited under the Labour Act, 2003 and The Children's Act, 1998, which state that persons under the age of 15 years are not allowed to engage in any economic activity. While it is socially acceptable for children to participate in work at a household level, approximately 10.9 percent (0.57 million) of children (ages 5-14) participate in the labour force and do not attend school (Ghana Child Labour Data Country Brief, International Labour Organisation). Approximately 70 percent of working children are employed in the agricultural sector (including fishing), which is a likely contributing factor more children in rural areas being engaged in child labour, in comparisonto urban areas. Other sectors where child labour is reportedly common is the service industry (22.6 percent) and the industrial sector (6.4 percent) (Ghana Child Labour Data Country Brief, International Labour Organisation).

This trend was observed in the DAoI, where educators noted that some children only attend school three or four days a week, as they are fishing or assisting with the processing and selling of fish, or they are involved in agricultural activities.

Women

Over the years the Ghanaian national government ratified conventions, created structures and extended support to gender work. However progress has been slow. Legally women in Ghana are afforded the same legislative rights as men, and women and girls are provided with the same access to education and healthcare. However, gender inequality continues to undermine local and national efforts for improving living conditions, reduce poverty and enhance national development.

Gender relations vary greatly between regions and rural and urban areas. Wide disparities in regional and district poverty levels and a marked socio-economic divide between the North and the South of the country are further hampering efforts to promote progress. In general, society remains patriarchal, with urban women struggling increasingly to participate in higher education, the workplace and politics. Women in rural areas continue facing greater difficulty translating their labour into paid work and their paid work into higher, more secure incomes. Low education attainment, limited access to resources (i.e. land) and credit, and concerning workloads, are impediments for increasing their productivity. An indicator of Ghana's gender equality progress to date is the Gender Inequality Index (GII). Despite efforts, Ghana has a GII value of 0.565, ranking it 123 out of 148 countries in the 2013 index[1].

Ghana has mainstreamed the Millennium Development Goals (MDGs)[2] into the national development framework that has driven the national socioeconomic development agenda. In 2015 Ghana is likely to achieve a number of MDGs in particular goals 1 and 2 with regards to eradication of poverty and achievement of universal education. However, its status as a middle income country with high GDP growth has not consistently improved human development indicators, in particular gender equality and women's empowerment. MDGs 3 Promote Gender Equality and Empower Women is likely to be partially achieved whereas MDGs 4 Reduce Child Mortality and 5 Improve Maternal Health are unlikely to be achieved despite showing marginal improvements. Maternal mortality rates have fallen from 550 per 100,000 live births in 2000 to 350 per 100,000 in 2010. 23 This rate of change however suggests that Ghana will not achieve the target of 185 deaths per 100,000 live births by 2015. In Ghana, only 8.3 percent of parliamentary seats are held by women, and 45.7 percent of adult women have reached a secondary or higher level of education compared to 61.8 percent of their male counterparts. Female participation in the labor market is 66.9 percent compared to 71.8 for men.

There are a number of challenges that constrain the attainment of gender equality in Ghana and in the Study Area. The key ones are as follows:

- Challenges facing girl-child education still persist, such as socio-cultural practices including early marriages, customary fostering, and puberty rites.
- Socio-cultural practices, norms and societal attitudes prevail that tend to discourage women from engaging in wage employment and some occupations in industrial sectors;
- Low female enrolment at secondary and tertiary level pose a challenge to women's participation in decision-making at higher levels and their access to wage employment and higher level occupations;and
- Higher female than male school drop out rates related to teenage pregnancies, constrain female educational attainment beyond secondary level.

Women in the study area are reportedly generally the more consistent breadwinners as they have a somewhat stable income through their fish mongering and farming activities. They sell

(1) [1] The Gender Inequality Index (GII) reflects gender-based inequalities in three dimensions – reproductive health, empowerment, and economic activity. The GII shows the loss in human development due to inequality between female and male achievements in the three GII dimensions. (http://www.gh.undp.org/content/ghana/en/home/mdgoverview/overview/mdg3/)

(2) [2] The eight Millennium Development Goals (MDGs) – which range from halving extreme poverty rates to halting the spread of HIV/AIDS and providing universal primary education, all by the target date of 2015 – form a blueprint agreed to by all the world's countries and all the world's leading development institutions. They have galvanized unprecedented efforts to meet the needs of the world's poorest. The UN is also working with governments, civil society and other partners to build on the momentum generated by the MDGs and carry on with an ambitious post-2015 development agenda.

fish and sometimes operate small shops where they sell household products, vegetables and smoked fish. However, they must use a significant portion of income for their childrens' education, as well as for household expenses such as food and healthcare, meaning the burden of domestic care lies largely with them. This makes them more economically vulnerable than men. A major factor also contributing to the women's vulnerability is that more men than women migrate in search of other work and often do not return or remit their incomes, leaving the women to take care of the children alone.

Further specific information pertaining to gender relations and equality and the situation of women in the DAoI are presented throughout socioeconomic and health baseline.

Farmers and Fishers

Sharecroppers (farm labourers) have no claim to the land from which they extract their livelihoods. A loss of access to that land would therefore leave them with no income or food source making them more vulnerable than those with more secure claims to their land.

Farmers interviewed during baseline activities reported a general decline in soil fertility and agricultural yield but could provide any more specific explanation for this phenomenon. Many reported more specifically however, that coconut processing industry is not as lucrative as in the past and the reduction in coconut yield has greatly affected the success of this business, attributed to the low yield of coconut farms and the low market value of the product. This has a resulted in lower household incomes and a negative impact on livelihoods for those previously partly reliant on coconut processing, increasing the vulnerability of these households.

Box 8.2 summarises some key factors contributing to the vulnerability of land-based livelihoods, in particular crop farming in the DAoI:

Box 8.2 Key Factors Contributing to Vulnerability of Crop Farmers in the DAoI

- Farming is manual due to the high cost of mechanisation and limited technical agricultural knowledge;
- Crop farming is reliant on work from all family members which can mean children are taken away from school to support harvest or planting activities;
- There are no irrigation systems meaning farming is highly susceptible to rainfall levels and changes in climate – too little or too much rain can severely affect yield;
- All FGDs reported declining soil fertility and crop yield in the Study Area;
- Varying soil fertility some areas sandier than others therefore have a lower yield;
- The elderly or unwell must employ labourers on their plots and must share a portion of their yield – thereby losing some of the value of their production;
- There are no cold storage facilities so farmers can't store food to regulate or manage supply of produce to market. They have to sell what they have when they have it. This can flood the market at certain times of year and drop prices (same effect can occur with periods of more plentiful fish catch since smoking preserves fish but does not prolong shelf life for long);
- Transport of produce largely on foot and long distances to transport produce to market (Ainyase +/- 30km);
- Bad roads and lack of private and public motorised transport;
- Varying reports are given on what is eaten at home versus what is sold for cash – this can depend on the constraints to selling and storing produce noted above, and on yield.

These aspects of vulnerability of crop farmers are discussed further in 8.8.5.

Fishers are partially dependent upon fishing activities and their access to the sea. Thus, the ability to catch sufficient fish to ensure an income makes them vulnerable to changes from any development in the area that could affect fishing. Most fishing communities in the Study Area rely upon a mixture of fishing and farming for their livelihoods however, which reduces this aspect of vulnerability somewhat.

During stakeholder consultation communities noted that fish catches have been steadily declining over the past few years. Fishers cited an increasing occurence of algae blooms as a reason for the decline, as well as overfishing and use of inappropriate fishing methods (such as the use of dynamite) by fishers from other Districts. Some also directly associated the arrival of Oil and Gas developments in the area with the algal blooms and declining catch.

Vulnerability of fishers and fishing livelihoods is discussed in more detail in Chapter 7, Fisheries baseline.

Migrant Fishing Communities

There is a small migrant fishing settlement to the east of Sanzule, known as Awonakrom. It was established in 1974 and the inhabitantscame from the Volta Region. There are an estimated 200 people living in Anwolakrom, and they are represented by Chief Togbe Kalendzi Hutor who reports directly to the Chief of Sanzule. Despite having been in the area for over 40 years, the community are still considered outsiders, and they view presence in the area with uncertainty. During baseline engagements they reported 'expecting to be relocated at some point' ever since settling on the land. This is reflected in the temporary nature of their houses, which are constructed entirely of raffia and thatch. It was also reported that some households in the community began dismantling these structures as soon as eni made first contact about the Project and the possibility of relocation.

This community are considered particularly vulnerable as they have no formal rights to land in the area, and have relied on the good will of the people from Sanzule and the Sanzule Chief to allocate them with land on which to settle. They have no agricultural fields and are solely dependent on fishing for their subsistence and livelihoods. Disruption to fishing activities and a continued decline in fish catch will have an especially negative impact on the wellbeing of this community. The community is also physically located directly adjacent to the gas pipe landfall and is therefore likely to experience the most significant impact on their quality of life and disruption to their livelihood activities during Project construction activities.

<u>Disabled people and orphans</u>

There was little or no visible evidence of persons living with disabilities or of orphans in the communities surveyed in the DAoI nor examples given of these individuals in response to questions on vulnerable persons. As a result it could not be ascertained what proportion of the population in the DAoI is either disabled or orphaned and without family support networks.

Even though it was difficult getting the exact number of the people living with disability or orphans in the project area, anecdotal evidence and observation suggest that this group are not discriminated against or neglected.

Apart from family support, the following social support and protection programmes and facilities exist for these vulnerable groups:

The Livelihood Empowerment against Poverty (LEAP) Program

This is a social cash transfer program, which provides cash and health insurance to extremely poor households across Ghana to alleviate short-term poverty and encourage long term human capital development.

Eligibility is based on poverty and having a household member in at least one of three demographic categories:

- Single parent with orphan or vulnerable child (OVC),
- Elderly poor, or
- Person with extreme disability unable to work (PWD).

The Livelihood Empowerment Against Poverty (LEAP) Programme falls under the social protection mandate of the Ministry of Gender, Children and Social Protection which focuses on empowering the vulnerable, excluded, aged and persons with disabilities.

Through the LEAP bi-monthly payment of GH¢ 48.00 (USD 14) per beneficiary, GH¢ 68 (USD 20) per two beneficiaries, GH¢ 72 (USD 21) per three beneficiaries and GH¢ 90 (USD 26) per four or more beneficiaries, many households and individuals have been able to provide for their basic needs, and had access to education, health and food. Beneficiaries have also had some capital to start small-scale business ventures for sustainable income to ultimately stay out of abject poverty.

The Department of Social Welfare administers the programme at the Ellembelle District Assembly.

The District Assembly Common Fund (DACF) for People with Disability (PWDs)

District Assembly Common Fund, released by the government to the Ellembelle District Assembly for development projects in the district. Two 2 percent of this fund is specifically allocated to disability groups to minimize poverty among all PWDs particularly those outside the formal sector of employment, and enhance their social image through dignified labour. It also provides educational support for children, students and trainees with disabilities.

Disabled Trade School / Home

There is also a pre-vocational education & vocational training centre for physically challenged youths at Eikwe. The facility is supposed to adequately provide an education and training programmes that match students' talents and abilities.

8.8 LOCAL SOCIO-ECONOMIC ENVIRONMENT

8.8.1 Description of Direct Area of Influence (DAoI)

The Area of Influence, and the method for its delineation is described in Chapter 4 and a map is provided in Figure 4.26.

The geographic focus of the socio-economic DAoI has been defined based on the location of the Project and description of the Project components. It consists of the communities of Sanzule, Bakanta, Krisan and Eikwe located within a 3km radius of the ORF site (communities identified as directly affected) as well as Atuabo as it is on of the largest and better serviced of those surrounding settlement likely to impact on or to be impacted by the Project. These five communities, together with the physical footprint of the Project will hereafter be referred to as the "DAoI".

The additional five communities of Ngalikpole, Ngalechi, Beku, Anochi and Asemda-Suazo, which are located along the optional pipeline route originally being considered from Sanzule to Atuabo were also surveyed. These communities are not described in detail in this baseline since they are not considered directly impacted based on the most recent Project Description.However since they are located in the wider vicinity of the Project and were surveyed during the baseline studies these additional communities are still considered to be interested and affected stakeholders and information about them is therefore included in Annex B, Socioeconomic Baseline Reports..

8.8.2 Description of Communities in the DAoI

Profiles of the the communities within the DAoI including their history, demographics, settlement and livelihood patterns as well as social infrastructure are summarised in Table 8.8 to Table 8.12. These descriptions are not exhaustive but based on oral accounts giving during informal one on one conversations, focus groups and key informant interviews with community members collected during the field surveys.

The location of communities within the Socio-economic and health Direct Area of Influence is shown in Annex C. An infographic presenting visually some of the main characteristics of the communities within the direct area of influence is also included in Annex C.

Table 8.8 Characteristics of the Sanzule Community

Characteristic	Description
History	According to the *Safohene* of the town; Sanzule was established in the 10th century when the peoples' ancestors discovered water in their present location. The name Sanzule is in Nzema means "but for water".
Landscape/ Location	The neighbouring towns to the east and west of Sanzule are Bakanta and Krisan respectively. Ala-Bokazo is the nearest community to the north. The landscape is flat and sandy with no major peaks. Coconut plantations border the eastern, western and northern perimeter of the community. The Ser lagoon is located approximately 500 m north of the coconut plantations. Farmlands on which cassava, coconuts, oil palm, vegetables are cultivated are located in the north of the community as well. Another lagoon known as Manzule also located in north of the village. There is a migrant settlement on the southern outskirts of town, along the beach, known as Sanzule Anlo compound (Anwolakrom). It was established by Togbe Dogbe Dafukye in 1974. He migrated to the area from Woe in the Volta region with few of his kinsmen to undertake a fishing expedition. This migrant settlement has an estimated population of 200 people. The current Chief of Anwolakrom is *Togbe Kalendzi Hutor* and he reports directly to the Chief of Sanzule.
Demographics	The Sanzule community estimated its total population of approximately 1 600. The total number of houses recorded however, was 180 with a reported average household size of 5 (http://sanzule.com/region-profile.html). Sanzule is predominantly inhabited by Nzemas with a few Fantes also living in the community. An estimated 10 percent of the population are reported to be unemployed.
Livelihood and Occupation	Approximately 30 percent of the land is used for buildings, 30 percent is utilised for farming and the remaining land is unused. The total extent of the land belonging to the community is approximately 715 ha. The main occupation of the inhabitants is fishing which is undertaken by approximately 60 percent of the population, followed by farming (27 percent) and trading (3 percent) formal occupations reported in the community are teaching and nursing. About 80 percent of the fish caught is sold, mainly to intermediary buyers or fishmongers from neighbouring market centres. Only 20 percent is consumed at home. Livestock reared by the community are sheep, pig and poultry (goats are not reared). A sizable number of the economically active population tend to leave the town in search of employment in the cities, especially during the lean fishing season.
Education and Skills	In general, the highest level of education attained by people in the town is senior secondary school. Only a few have attained advanced level of education up to the university level. Presently, about 70 percent of children of school going age are in school.

Characteristic	Description
Social Infrastructure	There are 2 primary schools (1 public, 1 private), a junior school and a vocational school in Sanzule. There are also three churches in the community. There is a compound for medical care in the community and the Hospital near Eikwe is used by community members when required Houses are largely constructed with raffia or concrete or a combination of the two. The community is connected to the national electricity grid. There are three public toilets (including a new one provided by eni), and a few private toilets in individual homes. The main sources of water for the community are from two boreholes, and a private well. One of the boreholes is powered by a fitted solar panel. The town has a designated site for refuse disposal which located near the beach just before Anwolakrom. The roads leading to the town are laterite and dusty during the dry season.
Cultural Heritage Resources	*Branvien shrine* is found in the community and housed in a small building located in the middle of the town. The town also has a *Royal cemetery* or burial ground for paramount chiefs, located at the eastern outskirts of the town which covers an approximate land area of one acre. The site is characterized by heavy undergrowth, shrubs, and twines such as *seregna, fuba, aloebo teke*, and a handful of coconut trees. There is an open field at the centre of the town, which serves as a recreational ground for soccer and other sporting activities.

Table 8.9 Characteristics of the Bakanta Community

Characterstic	Description
History	The people of Bakanta first lived at Akonu having migrated from Princess town. From there, led by Nana Anwi Nyameke and Nana Nyanzu, they settled at 'Ahweasini' meaning small sand. 'Small sand' because they lived on the thin sandy land between the sea and the Amanzule lagoon. After flooding where the lagoon reached the sea, the villages was named 'Bakanta', meaning 'twin lagoon'.
Demographics	The town has an estimated population of 900 people (larger proportion of females) made up of approximately 100 households. Bakanta has a young population; about half of the inhabitants are 18 years and below. The majority of inhabitants are of the Nzema and Ahanta ethnic groups, with small numbers of Fantes and Ewes present.
Livelihood and Occupation	Approximately 30 percent of the population is reported to be employed or economically active. Fishing and farming are the predominant economic activities. Crops cultivated include maize, cassava, pineapple, cocoyam, coconuts, oil palm and vegetables. Women mainly engage in petty trading and baking, while both women and men are engaged in farming.
Education and Skills	Approximately 27 percent have secondary or higher levels of education. Challenges associated with education in the community include poor infrastructure, inadequate teaching materials, lack of incentive for teachers and delays in provision of school funding from Government. Skills reported in the community include driving, dressmaking, carpentry, masonry and hairdressing.
Social Infrastructure	Bakanta has a primary school and a Kindergarten but no Junior High School. Pupils travel to Sanzule or Eikwe to continue their education after completing primary school. The community has no health facility. People travel to St Martin de Porres Hospital at Eikwe and Sanzule CHPS compound for medical care. One traditional birth attendant operates in the community. Houses in the town are predominantly constructed with raffia with corrugated iron sheet roofing. In terms of sanitation, the community has access to one VIP toilet and has two refuse dumping sites on the town outskirts. The town is connected to the national electricity grid and electricity is used for lighting, while fuel wood and charcoal are the main sources of fuel for cooking. Wells and boreholes are the source of water for domestic use.
Cultural Heritage Resources	Shrines found in the vicinityof the town are Blenviene, Ayera, Bodibodi, Amenzure, Atofokpolo and Adikefele.

Table 8.10 Characteristics of the Krisan Community

Characteristic	Description
History	The original inhabitants Krisan migrated from Adwaa in the northern part of Cote d'Ivoire and first settled at Bansam at the southern part of Cote d'Ivoire before migrating to Krisan. The sand at the location was white so people referred to the place as Kisan (which translates to white calico).
Landscape/ location	Krisan is a flat area bounded on the west by Eikwe, east by Sanzule, north by Ala Bokazo and on the south by the Gulf of Guinea

Characteristic	Description
Refugee Community	The UNHCR has a refugee facility on the outskirts of the community. The Settlement was established in 1996 following an influx of Liberian refugees fleeing conflict in their home country. It is home to 1,700 refugees. After it was established the refugee camp received refugees from; Togo (after the closure of Klikor Camp in the Volta Region in 1997/8); Sierra Leone (after fleeing national conflict between 2000-2002; and Sudanese refugees who began arriving in Ghana from late 2004. In addition, the camp houses a wide range of other nationalities, including Congolese (DRC and Congo Brazzaville), Rwandans, Chadians and Ivoirian's. As with all refugee camps in Ghana, the Krisan Settlement is managed by the National Disaster Management Organization (NADMO) staff seconded to Ghana Refugee Board.
Demographics	The population of Krisan is approximately 1360 (EDA, 2012) and the majority of whom are of the Nzema ethnic group. A few Fantes also live in the community. It is estimated that there are more females than males in the town. The number of houses in the community is estimated to be over 110 with an average household size of about five.
Livelihood and Occupation	The main economic activities in Krisan are fishing and fish processing, as well as farming. Fishing is mainly undertaken by the Fantes and Ewes, while the Nzemas engage in both farming and fishing. Farmlands are located about 1 km inland from the town, and are reported to be declining in fertility. Traditional methods of farming are still used, resulting in low production. The major cash crops cultivated are coconut and oil palm. Food and vegetables cultivated are cassava, maize, tomatoes and pepper. Farmers do not have access to farm inputs such as fertilizers, insecticides and herbicides. A small number of households rear cattle, pig and other livestock. The main fishing area lies between Krisan and Sanzule. However, the destination of fishing is flexible and depends on ocean currents. The community has no organisation which oversees the operation of fishermen and fishing activities. In general, people fish at any time during the day or night depending on the sea and weather conditions. Unemployment levels in Krisan rise during the lean season. Other economic activities include petty trading, beauty and hair dressing, masonry, carpentry. There is one painter and one electrician in the community. Formal employment in the community includes nursing and teaching. Commercial activities of the area are limited in the community. Traditionally, the "main bread winners" in the village households are the men who depend on fish catch. However, increasingly women are competing with men as bread winners with income from fish processing and petty trading activities. Income levels in the village are considered as low and the community attribute this to the lack of higher education. Informal trading constraints for women include low capital, high transportation cost, and low purchasing power of the community.
Education and Skills	Only 5 percent of the students enrol into the Senior High School. Approximately between 80-90 percent of children in the area attend school, however, there is a high rate of absenteeism, (estimated 50 percent) mainly due to poverty and teenage pregnancy in the case of girls. Absenteeism would be higher in boys than in girls (40% boys and 20% girls). The Krisan-Sanzule primary school received students mainly from Krisan, Sanzule and the Krisan Refugee Camp but also from Eikwe and Bakanta.

Characteristic	Description
Social Infrastructure	According to the Elllembelle Medium term Development Plan there is a Kindagarten, primary school and JHS. However, during baseline studies only one school (primary school) was identified located and is located mid-way between Krisan and Sanzule, approximately 2 km from Krisan. The government funds this primary school, however, neither materials nor funds have been received over the past two years. There are no health facilities in Krisan therefore community members use the St. Martin De Porres Catholic Hospital located in nearby Eikwe, which is within walking distance. Water quality is perceived as "bad" by the community. The main source of water is groundwater. Water access is one of the main concerns of the community as they have four broken boreholes in the village (this is reportedly due to the poor quality of materials). Only one community toilet is available in Krisan. Ten households however have their own toilets at home. There is a public and open waste dump pit at Krisan for waste disposal.
Cultural Heritage Resources	The *Ayawale* shrine is located near the Krisan Refugee Camp. Women are not supposed to go there on Thursdays, during their menstrual period, nor carry red material there.

Table 8.11 Characteristics of the Eikwe Community

Characteristic	Description
History	The earlier settlers of Eikwe migrated from Juaben in the Ashanti region to Eikwe. Kofi Amiyiah and his sister Adjoa Sika led them. They settled under a royal palm tree, locally known as *Male Ekwe*. The place was later referred to as Male Ekwebo, which has been altered to be pronounced as Eikwe.
Location/Land scape	Eikwe is the twelfth largest community in the Ellembelle District. It is a flat area with a long sandy beach. Streets and lanes, have been encroached upon due to expansion of houses
Demographics	The community of Eikwe estimated its population to be between anywhere between 1000 and 1500 made up of approximately 200 houses with an average household size of approximately six persons. The population is dominated by native Nzemas with few Fantes and Ewes.. The population size of Eikwe is sometimes influenced by the presence of patients at the St. Martin De Porres Catholic Hospital.
Livelihood and occupation	Fishing and farming are two main livelihood activities undertaken in the community, with fishing activities being the most important income earning activity. It is estimated that 70 percent of the adult population are engaged in fishing activities while 30 percent are engaged in farming. Farming is mostly undertaken by the Nzemas whilst the Fantes are purely fishermen. Fishing occurs across two main fishing periods, High, and low seasons). Fish catch is processed and sold to surrounding markets. Farming is typically small scale with the exception of coconut and oil palm plantations which are large scale. Slash and burn is the common land preparation method. Food and vegetable crops cultivated are cassava, plantain, tomatoes and pepper. Pig farming is done on a small scale and is mostly undertaken by the youth. Poultry, especially chicken is reared in almost every home for domestic consumption. Commerce and trade are busy due to the influx of people who come to the medical centre at Eikwe. Unemployment levels rises during the off-seasons resulting in low economic activities in the community.
Skills and education	Enrolment in primary school is quite high, according FGD's with teachers there are currently 119 learners. However, this decreases as learners proceed to higher institutions, especially amongst females. This trend is attributed to a number of factors ranging from bad attitudes towards education by both parents and students, to financial constraints on the part of parents.

Characteristic	Description
Social Infrastructure	Eikwe has a kindergarten, primary school, junior high school, and vocational training institution for the physically challenged. There is a teachers' living quarters in the community. Almost three quarters of the houses in the community are constructed from concrete, the remaining quarter from raffia. The St. Martin De Porres Catholic Hospital in Eikwe is the largest hospital in the District. It serves a wide catchment area that extends beyond Ellembelle District, covering a population of over 100,000. Patients outside the Eikwe sub-district come to the Eikwe hospital mainly for maternity care. The community has access to potable water from the standpipes. The area around Eikwe hospital is also a small business hub. For example, the Eikwe Manle Microfinance Institution is located in the town.

Table 8.12 Characteristics of the Atuabo Community

Characteristic	Description
History	The history of Atuabo dates back to the 13th Century when ancestors of the current inhabitants migrated from the northern part of Ghana through the Ashanti area, then through the Aowin and the Wassa areas before settling along the coast. Atuabo translates as "under the Tua tree". Before colonization there were no national borders as we know them today and as a result Nzema people are settled on both sides of the Ghana-Cote d'Ivoire border, and are still connected by kinship ties. Historically, the town served as the market centre for the Europeans.. Atuabo was a port town and many people migrated to Atuabo for economic reasons. It was a port for export of raw materials (e.g., timber, coconut, palm nuts, and import of other items to Ghana. Atuabo is the site of the Ghana Gas processing plant.
Landscape/ location	The landscape is relatively flat with no major peaks. There are a number of islands, which are surrounded by the Amanzule River to the north of the community. These are Kpondenli, Borazo and Asemda-Suazo Islands. The land to the north is mainly used for farming and is dominated by coconut plantations and patches of cassava farms. There is also a large swamp located here. The river has mangroves growning on both sides. The shoreline consists of a broad sandy beach with an area of coconut palms extending inland from the beach for a distance of approximately 225 m
Demographics	According the Medium Term development Plan the population of Atuabo is approximately 1765 (larger proportion of women than men). Nzemas form about 97% of the population with Fantes comprising the remaining 3%. The Fantes are reported to have migrated from various parts of the Central Region.

Characteristic	Description
Livelihood and occupation	The houses are built with a combination of raffia and cement blocks. The main economic activities of the people of Atuabo are fishing (60 %) from July to March, farming (40%) and livestock (sheep, cattle and poultry). Some of the educated adult population are employed as teachers, nurses and in other sectors of the local economy. Others are also involved in farming coconut, palm fruit and nuts and cassava . Fresh coconut is exported to Nigeria, dried coconut is sold to people from Takyiman. Cassava and palm nut trees/ fruits are sold at the local market.
Education and Skills	Between 80-90% of children in the area attend school. However, there is a high rate of absenteeism, estimated at 50%. Absenteeism is higher in boys than in girls (40% boys and 20% girls), a situation which affects quality teaching and education. There is also an estimated drop out of 30 % for girls due to teenage pregnancy and poverty sincegirls are not able to go back to school after having children. The standard of education among students is perceived as very low, mainly due to lack of supervision by parents and the lack of teachers.
Social Infrastructure	There is only a public school system at Atuabo comprising three schools: a KG (1-2 years), a Primary (class 1 – 6) and a Junior High School. The primary school serves as the main center for the Basic Education Certificate Examination in the Nzema area. The community is connected to the national electricity grid. Atuabo has CHPS compound for handling simple medical cases. For serious medical issues residents travel to Ekabaku Health Centre in nearby Jomoro District and St. Martin de Porres Catholic Hospital at Eikwe. Residents indicated that malaria is prevalent in Eikwe. The community is served by a two hand-pumped water boreholes. The community has 12 public KVIP toilets constructed from monetary contributions by community members. There is no drainage system or waste collection in the community. Two sites have been designated for dumping refuse and these are located within the coconut plantations towards the east and west fringes of the community. According to residents the refuse dumped is also burnt periodically.

8.8.3 Additional Communities

The socio-economic characteristics of the remaining five communities between Ngalikpole and Atuabo (Ngalikpole, Beku, Ngalichi, Anochi, and Asmde-Suazo) which were surveyed during the Scoping and Baseline Data collection activity are summarised in Annex B, Socioeconomic Baseline Reports.

These communities have similar make up to the communities described in the table above. Primary livelihood activities in these communities include fishing and farming with some agro-processing or natural resource based livelihoods. Social infrastructure and services such as water and sanitation is lacking across all five. Furthermore, education levels are generally low, and children often have to travel to neighbouring communities to attend school after kindergarten. Finally, even though each community has a unique history, culturally the villages share similar characteristics with their main ethnic groups being Nzemas, Fantes and Ewes.

8.8.4 Demographic, Migration and Settlement Patterns

Population and Household Composition

Households in the DAoI typically consist of a man and wife (or wives), children, parents, in-laws, grandchildren and other relatives. The determination of household membership is not always straightforward, particularly with regard to visitors and members who are temporarily absent.

Focus group discussions indicate that average household size in the DAoI is five persons. This is slightly higher than the regional and district average. According to the 2010 Population and Housing Census, the mean household size in the Western Region and Ellembelle District is 4.2 persons and 4.6 persons respectively (GSS, 2012). The relatively larger household size in the Project area suggests that there is pressure on household incomes and, therefore, less saving can be made for investment. A large household size can impose a burden on the household heads unless a large proportion of household members have an income.

Focus group discussions indicate that males head the majority of households in the DAoI, even though women take up a significant responsibility at home. A few female led-households were also reported. Such households are typically composed of women who have been widowed, divorced or abandoned by their husband. It may also reflect a choice made by younger, single women to head their own household.

It is generally assumed that the household head oversees the day-to-day running of a household, and ensures that the needs and wellbeing of its members are addressed.

Age and Gender Distribution

The age structure of the DAoI communities is typical of a young population, which is in keeping generally with the Ellembelle District, recording an age distribution figure of 39 percent of under-15 years of age and 5 percent over 57 years (GSS, 2012). Some of the communities such as Sanzule and Bakanta reported a young population exceeding 40% of the total population. Information gathered also reveals that the female population generally outnumbers that of the male population in all the project communities, reflecting the district trend, where females constitute 52% of the entire population.

Ethnicity, Language and Religion

Three main ethnic groups, namely Nzemas, Fantes and Ewes, are found in the DAoI, with the native Nzemas representing over 80% of the population. The Nzemas are both farmers and fishermen, while the Fantes and the Ewes are predominantly fishermen. The migratory nature of their livelihood activities (fishing) of the latter groups has brought them to settle in the study communities. For instance at the southern outskirt of Sanzule, along the beach is a large migrant Ewe settlement (about 200 people), known as Anwolakrom, established by Togbe Dogbe Dafukye in 1974 purposely to undertake fishing expeditions.

Krisan also has a Refugee Camp located at the northern outskirt of the town, with varied nationalities.

The ethnic groups in the area inter-marry and co-exist peacefully. Nzema is the local language although many people understand Twi.

The dominant religion in the DAoI is Christianity, which, according to focus group discussions and key informant interviews, is practiced by more than 90 percent of households. The Catholic, Methodist and Sacred Action Churches have the largest followings, while the Pentecostal, Church of Christ and Jehovah's Witnesses have smaller followings. A small number of people in the DAoI practice Islam and Traditional Religion.

In the Western Region as a whole, 71 percent of household heads are Christians, 9 percent Muslim, and 1 percent practice Traditional Region, while those who profess to have no religious affiliations constitute 7 percent (GSS, 2012). People's religious faiths are often prominently exhibited during times of religious conventions (renewal of faith), marriage ceremonies (blessing/consecration of marriage), illness (for healing) or even death (funerals/ burial ceremonies).

Migration

Ellembelle District experiences a considerable degree of migration. This can be largely attributed to seasonal fishing activities as well as migrant farm labourers, the influx of people to secure jobs in mining activities, and refugees in the district (Ghana Statitistical Service, 2010). Similarly,the population of coastal towns in the DAoI continues to increase from natural and influx growth. Atuabo and Anochi in particular have seen in-migration of workers and job seekers into their community because of activity associated with the development of the GNGC gas plant at Atuabo. These migrants exert pressure on the limited social services especially, water, sanitation and housing.

There has been a constant presence of refugees in the area at the Krisan refugee camp since it was established in 1997 (the Camp manager estimated that there are as many as 1000 refugees living in the Camp). The initial refugees arrived from Liberia due to the conflict there but now the camp is now home to refugees from approximately 40 countries including Sudan, Sierra Leone, Liberia, Togo, Chad, Ivory Coast, Ethiopia, Eritrea, Burundi, Somalia, Rwanda and the Democratic Republic of Congo.

In terms of out-migration, youth are reported to be leaving to take menial jobs in bigger towns like Abidjan, Takoradi, Sekondi, Tarkwa. This is perceived to be a result of declining community livelihoods (declining farming yields and fish catch) and rising poverty in local communities.

Settlement patterns

There are five communities in the DAoI. Settlement patterns are linear and alongside the main road (see Figure 8.5). In many of the communities, and in particular in Sanzule, the settlement areas are highly concentrated towards the coast with dwellings built on the beach itself. Schools, churches, mosques and health facilities are predominantly located along the main road. It is also a common to see stores, wooden kiosks, metal containers, and tabletop shops along the main road and the side streets running through these towns.

Figure 8.5 Aerial Perspective of Sanzule, Krisan and Eikwe, showing typical village layout in relation to coast

Source: Google Earth Pro, 2015

Most of the buildings in the area are either compound houses, which are older, traditional 'family' houses, or newer, semi-detached and detached houses. A similar type of housing and construction materials are used in all of the communities.

8.8.5 Economy and Livelihoods

Key informant interviews and focus group discussions indicate that livelihood practices in the DAoI are largely focused in three areas: agriculture, fishing, and natural resource use with some agro-processing (e.g. coconut oil production). A minority of the population also relies on income from the informal sector (predominately petty trading) and from formal employment in the public sector(e.g. government or health services). Since the discovery and subsequent production of oil and gas, other supporting sectors of the economy such as tourism, hospitality and auxiliary services are also strengthening locally.

Fishing and farming are the primary livelihood activities in the DAoI with both activities used for a mixture of subsistence and income generaton. Community interviews gave an average split of 60% reliance on fishing, 30% farming and 10% other income generating activities. When catch or yield is poor respondents report both fishing and farming are relied upon for household subsistence, and that in more plentiful periods more of the produce can be sold.

These livelihoods are interlinked as people will transfer between these activities depending on the season. In the farming season (also the rainy season) income from fishing is used to purchase farming inputs whilst investments shift back to fishing during fishing season. At the household level, multiple types of economic activities overlap and are consciously used in conjunction with one another to increase family strengths and livelihood strategies.

Table 8.13 below outlines key seasonal livelihood activities that occur throughout the year. The main fishing season is June to October with minor fishing activity between December and March. Farming occurs for much of the year with planting of one or other crop occurring in every month except December and harvesting occurring every month except November (with pineapple harvested in December and January). The majority of planting is done in March and April however, before the rainy season in June and July and a second smaller season of planting takes place in September and October.

Table 8.13 Seasonal Activities Table

Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fishing (Major)						X	X	X	X	X		
Fishing (minor)	X	X	X									X
Planting	X	X	X	X	X	X	X	X	X	X	X	
Harvesting	X	X	X	X	X	X	X	X	X	X		X
Cultural Festival										X		

Source: Lonhro Port ESHIA

<u>Fishing</u>

The primary income-generating livelihood activity in all of the DAoI communites is seasonal marine fishing and fishmongering.

Most of the marine fish harvested by fishers is either sold outright at the landing beach to fishmongers or handed over to their wives or partners for preservation before selling. Fish mongering is the domain of women and is a key livelihood activity.

Fishing activities typical of the DAoI communities are depicted in Figure 8.6, Figure 8.7

Please see Section 7 of this baseline for more detailed description and discussion on socio-economic and livelihoods aspects of Fishing and the Fisheries sector in the DAoI.

Figure 8.6 Typical Fishing Activity in Local Communities

Fishers repairing and making fishing nets

Fishers hauling in a catch using beach seine or 'dragnet'

Fish catch in nets

Women fishmongers gathering around a catch to buy fish

Source : ERM Baseline Field Survey December 2014

Figure 8.7 A Typical 'Regular' Fishing Canoe Used for Marine Fishing

Source : ERM Baseline Field Survey December 2014

Figure 8.8 Stock Pile of Fire Wood used for Fish Processing (Smoking)

Source : ERM Baseline Field Survey December 2014

<u>Farming</u>

Subsistence and commercial farming takes place in the DAoI, however land suitable for farming in the coastal zone is scarce. The major crops cultivated are maize, pineapple, cassava, plantain, rice and other staples. Vegetables such as garden eggs, pepper and tomatoes are also cultivated. Coconut and oil palm are grown on mainly commercial scales.

Roles in farming are divided along gender lines with men involved in clearing and preparation of fields and women involved in the sowing of seeds and in harvesting produce. A combination of casual and family labour are used to cultivate farms using slash and burn method, since the farms are not mechanized,and farmers reported decreasing soil fertility. Some farmers manage to leave one of their plots fallow and alternate their planting to allow for some soil recovery, but overall fertility rates reportedly reduce as a result of the farming methods and land pressure in the area (Lonhro Port ESIA, Socio-Economic Baseline) . Farming implements used are mainly the cutlass and hoe.

The size of plots reportedly depends on the strength of the individual or family to work an area. Average farm size per household is reported to be 2.5 acres even though some individuals have much bigger farms.

Farmers rely on the rain for agricultural production, as there are no irrigation systems in the DAoI.

Coconut is grown extensively in the project area and a source of livelihood for households. It is processed into coconut oil and exported mainly to Accra, Kumasi, Tarkwa and Obuasi. Copra is mainly exported to Nigeria. According to inhabitants, the coconut processing industry is not as lucrative as in the past and the reduction in coconut yield has greatly affected the business. This is attributed to the low yield of coconut farms and the low market value of the product. This has had serious impacts on the economic lives of the people reliant on coconut processing for income, especially women and the youth, leading to lower household incomes and increased unemployment.

Apart form coconut, palm oil and local gin (*akpeteshie)* derived from raffia are also produced.

For commercial sale, cassava, Figure 8.9, is harvested when plants are young and tender (for fufu), while they can be left to grow for over a year and still provide food for subsistence use as cassava dough, gari and ground cassava flour, kokonte. Most farmers reported consuming a significant and increasing proportion of their food crops (depending on the size of the family), particularly in the light of declining yields. however a precise proportion could not be given. The sale of the produce by communities in the study area is made more difficult by the absence of storage facilities eg cold storage to allow management of supply of produce. This can lead to farmers having surplus produce at a similar time, which floods the local market and keeps prices low (Lonrho OST ESIA, Social Baseline,2013).

Transport of crops for sale at markets is largely on foot and can be challenging, and made more so by bad road conditions, and relative lack of taxis or private motorised transport. Distance is also a significant constraint since the closest large market cited by most farmers for sale of their produce is at being Aiyinase (approximately 30 km away). Where possible farmers reported selling produce direct from roadsides or fields to try and limit the need to transport produce such long distances.

Figure 8.9 Typical Cassava Field Surrounded by Palms at Bakanta

Source : ERM Baseline Field Survey December

Land-Based Livelihoods in the ORF Land Acquistion Area

The land acquisition area required for the ORF and ancillary facilities is approximately 257.01 acres, and the acquisition of this land will lead to the economic displacement of those currently using it for growing and harvesting crops. The land is cultivated by an estimated 184 farmers ([(1)](Delin, 2014)[(2)]. Most of land users/owners in the land acquisition area are known to be Sanzule residents. However, the land owner survey currently being undertaken in the context of LRP indicates that there could be land users/owners from other neighboring communities (e.g. Krisan). Residents from Anwolakrom do not own land but are known to be labourers in the farms of the concession areaThe extent of Sanzule is approximately 1,760 acres (715 ha), of which approximately 30 percent is used for agriculture. This section describes in more details the land-based livelihood (largely crop farming) activities undertaken within the land acquisition area.

(1) The number of farmers is based on the landtake of the original acquisition area, which has now been downsized. The information will need to be updated based on the landtake of the new acquisition area.
(2) Note: during stakeholder consultation, resdients from Anwolakrom and Bakanta also claimed to be cropping in the acquisition area.

A range of crops are grown in the land acquisition area, from cash crops to food crops (perennial and annual): the most common crops grown are cassava, pineapple, coconut and oil palm.

The crop types grown in the area, broken down by percentage of that crop grown by gender are listed in Table 8.14.

Table 8.14 Crops Grown in the Land Acquisition Area

	Male		Female		Total	
Crop	**Number**	**%**	**Number**	**%**	**Number**	**%**
Cassava	26	7.0	68	18.2	94	25.2
Pineapple	28	7.5	54	14.5	82	22.0
Coconut	49	13.1	18	4.8	67	18.0
Oil Palm	49	13.1	23	6.2	72	19.3
Rubber	15	4.0	5	1.3	20	5.4
Mango	2	0.5	2	0.5		
Okro	-	-	1	0.3	1	0.3
Maize	-	-	1	0.3	1	0.3
Plantain	1	0.3	23	6.2	24	6.4
Banana	3	0.8	4	1.1	7	1.9
Beans	-	-	1	0.3	1	0.3
Tomatoes	-	-	2	0.5	2	0.5

Souce: DELIN Consult, 2014

The fresh water bodies in the acquisition area are used for aquaculture. There are also hand-dug fishponds on the land used for mud fish rearing. The fish ponds are located in the muddy areas within the crop lands.

Table 8.15 provides a breakdown of the various farming activities taking place in the acquisition area including fish, snail and livestock farming. Fire wood is also gathered and used for household energy use in the DAoI. The community of Sanzule was observed to be using the surrounding areas to collect firewood including the concession area but the extent of this activity and the relative livelihoods contribution of wood and other non-timber products collected by households is not known from available data. These latter activities were frequently not cited in response to questions on livelihoods and income in FGDs.

From the table, it is clear that the majority of the farmer are reliant solely on crop farming, while less than 15 percent are solely dependent on fish farming. Approximately 17 percent are both crop farmers and have fish ponds.

Table 8.15 Breakdown of Activity on the Land Acquisition Area

Activity	**Number of Farmers**
Crop farmers only	124
Crop farmers with fish-farm	30
Crop farmers with fish & snail farms	1
Crop farmers with fish & animal farms	1
Fish farmers only	24
Crop farmers with wells	2
Animal farmers only	2
Total	184*

Souce: DELIN Consult, 2014

* The information presented above is based on the land take of the original acquisition area, which has now been downsized. The information will need to be updated based on the land take of the new acquisition area.

Most of the crops grown in the acquisition area are sold by the farmers. Some of the farmers reported that crops such as oil palm and rubber trees were not yet mature enough to harvest, so they are currently not making money from these crops. Most of the farmers surveyed report making a profit of between GH¢ 30 and 60 (USD 8.5 and USD 17) a month, with coconut farmers reporting higher earnings for between GH¢ 50 and GH¢ 100 (USD 14 and USD 29) per month. Two banana farmers and those farming bean and tomatoes reportedly make below GH¢ 30 (USD 8.5) in profit (Delin, 2014).

Just under a third of the fish farmers have not made any income from fish farming as they had not yet harvested the fish. For those who sell their fish, the reported monthly earnings vary greatly, from earned GH¢100 – 200 (USD 29 – USD 57) (24.4 percent), GH¢500 - 600 (USD 143 – USD 172) (17.8 percent) to GH¢900 -1000 (USD 258 – USD 268) (6.7 percent), while 4.4 percent earned below GH¢50 (USD 14) (Delin, 2014).

Land Tenure and Availability of Alternative Land

Approximately half of the farmers using land in the acquisition area own the their farms. A higher portion (32.5 percent) of those who own their farms are male, while only 18.1 percent of females own their farms (Delin, 2014). Those that do not own their farms rent the land either through the "Abusa" system (63.4 percent), or they received it as a gift to use in the short –term (26.8 percent), and a small percent pay rent for the land (9.8 percent).

There are mixed perceptions amongst the land users concerning the availability of alternative land. Approximately 60 percent of those farming within the acquisition area are of the opinion that there is no land available for relocation, while 34 percent stated that they did not know. Only 6 percent think that there is land available for the relocation of their economic activities. Community leaders and chiefs, on the other hand, state that there is alternative land available (Delin, 2014).

These conflicting reports mean it is unclear from available baseline data whether sufficient alternative land is available to support like-for-like replacement of agricultural land for those being economically displaced. If land is scarce in the coastal areas, as is suggested by the farmers, and or the alternative land is located some distance away from the current farms, it could increase the vulnerability of the displaced farmers, by increasing the travel time and distances to plant and harvest crops. In worst cases land scarcity and inter-community politics over replacement land allocation could also increase likelihood of conflict over land and natural resources with host communities.

Informal (Petty) Trading

Informal trading is prominent throughout the DAoI, mainly on the side of the main roads, in small kiosks or on small tables. Women also carry their goods and sell by walking through the communities or towns. The majority of trading is directly related to fishing and agriculture, although some manufactured goods are also sold. Women and youth undertake most of the trading and the goods are mainly sold within the local communities. Stocks are usually bought from Ayinasie, Essiama, Axim and sometimes in Takoradi.

Goods traded in the area include cell phone recharge cards, fish related products, agricultural products, food and beverages, ice, household products, medicines and cosmetics, clothing, and electronic products.

Natural Resource Use

Wood and Charcoal

The sale of wood, as well as the collection and use for the family, is a supplementary livelihood activity in the Study Area. Wood is collected almost daily by women and is found both inside and in areas surrounding the Project Area. Wood is used for household cooking although the majority of wood is sold for income. Women tend carry the wood bundles home and sell them from their homes.

A small number of individuals are involved in charcoal making. This activity is reportedly led by the Krisan refugees. The wood is usually collected from the forest nearby and burnt or processed into charcoal for sale and is primary source of income for the refugees.

Non-Timber Forest Products

Non-timber forest products are prevalant in the DAoI and are used for a variety of supplementary livelihood activities. They include food such as edible nuts, mushrooms, grass-cutters, snails, fruits, honey, herbs, spices and condiments, aromatic plants, game as well as fibres used in construction, and furniture or utensils. They are particularly an important component of household subsistence, especially in terms of food consumption, nutrition and househould remedies (for illnesses). Local healers use local plants for medicines and sell them to community members to treat illnesses and afflictions such including malaria, typhoid fever, diarrhoea, arthritis, rheumatism, and snake-bites. In addition, raffia palm fronds are used for roofing materials and walls. The collection and sale of some of these resources can be used as a key additional income source.

Livestock

Pig rearing is the main commercial livestock activity, in particular in the town of Atuabo.. The piggeries are found at the beach in these communities and the pigs are mainly fed with coconut chaff and wheat bran. The coconut chaff is obtained free of charge from coconut oil producers while the wheat bran is purchased from agro-chemical stores in Esiama and Ayinasie. Pig farmers reported declining production because of limited access to coconut chaff due to the collapse of the coconut oil industry and high cost of the wheat bran. There are cattle herders present in Atuabo and Krisan and community members which cattle pool the livestock in these communities, and it is then overseen by Fulane herdsman.

Other livestock keeping in the community is at a household subsistence level only. Almost everybody in the community will keep at least one type of animal (goat, pig or poultry) predominantly for domestic consumption. Goats are however not permitted by the Chiefs to be reared in some communities (eg, Sanzule) for reasons of hygiene and in the interests of managing the spread of disease.

Industry

The major industrial projects in the area are the GNGC gas plant at Atuabo and Anochi and the export pipeline. There is also liquefied petroleum gas (LPG) terminal at Anochi (Figure 8.10), operated by Quantum Terminals Limited. There are no further industrial facilities within the DAoI.

Figure 8.10 LPG Terminal at Anochi

Source : ERM Baseline Field Survey December, 2014

Other Economic Activities Income Sources

A very small number of local residents are formally employed in the DAoI. Jobs include positions at the GNGC gas plant and the Quantum Terminals. Other formal employment positions includes nurses, teachers, hotel workers, and Zoomlion and ZOIL (privately owned waste disposal service providers) employees who are responsible for keeping the streets and the beaches clean. The remainder of those employed are either self-employed or work for local residents as farm labourers or in fishing crews. Salaries do not, therefore, make up a significant portion of household income in the DAoI.

Self-employed workers include hairdressers, food vendors, dressmakers and tailors carpenters, corn millers, tavern operators, mechanics, cooks/caterers, baking, shoemakers and electricians. There are also taxis drivers operating throughout the DAoI and generating income through transporting people and goods along the coastal communities.

Finally, some rely upon supplementary incomes from remittances from migrant workers/ family members; rent from land or property; and pensions in the few cases where these are accessible.

8.8.6 Tourism

Tourism in Ghana has become a major socio-economic activity and an important and fastest growing sectors of the Ghanaian economy. The number of tourist arrivals and amount of tourist expenditure has steadily increased while both public and private investment activity in various tourism sub-sectors has expanded. The Government of Ghana intends to use tourism as an alternative development strategy to help address broad national issues.

The tourism potential in the Western Region is related to the number and extent of tropical beaches as well as wildlife parks, forests and game reserves, inland lakes, and rivers. Currently none are being exploited for tourism in the DAoI.

The closest of the tourism sites is Amanzule estuary ("where two rivers meet") at Azuleloano. This is a transit point for migratory birds flying seasonally between Europe and the southern hemisphere. This is potentially a key tourism site for bird watchers but investment is required in suitable tourist infrastructure. Islands in the Amanzule lagoon between Bakanta and Ampain, which used to house settlements are of archaeological interest and are habitats for game, for example bushbuck and endangered fauna.

The Fort Apollonia Museum of the Nzema Culture and History is located in the ancient Fort Apollonia, founded by the British between 1765 and 1771. The fort is located at Beyin in the Jomoro District and is the only fort in close proximity to the DAoI approximately 1 km away from Atuabo. Fort Apollonia was the last fort to have been built along the Gold Coast. The fort has been restored with funds of the Italian Ministry of Foreign Affairs, and is now the home of an eco-museum dedicated to Osagyefo Dr. Kwame Nkrumah, the first president of Ghana.

The Nzulezu stilted village is a prominent tourist attraction near the project on Lake Tadane about 3.5 km inland of Atuabo. In 2000, it was nominated to be listed as a UNESCO World Heritage Site and is currently on UNESCO's tentative list. The village's name "Nzulezo" in Nzema language, means "surface water". According to local legend, the village was built by a group of people from Oualata, a city of the ancient Ghana Empire and in present day Mauritania. Nzulezo was built over Lake Tadane and consists of stilt-supported structures integrated with the water-dominated landscape (although it is not known why the village has been built over the water). The main activity of its inhabitants is agriculture, while fishing plays a secondary role. The lake is perceived by the local population to protect the community against certain natural hazards such as fires.

There are hotels in the area which have been built to serve tourists visiting these sites as well to meet gorwing demand for accomodation from the oil and gas industry . Locally, accomodation includes the Tenack Beach Resort, Appolonian Beach Guest House, Beyin Beach Resort, and a new a four star hotel (currently under construction close to the Anochi LPG Facility), Karela Hotel and Resort. All of these facilities are located at Beyin. In addition, more hotels are being erected close to the project site to serve the needs of the increasing working and tourist population of the area.

8.8.7 Financial services and access to credit

There are no banking institutions in or near to the DAoI except for Eikwemanle microfinance, which specializes in collecting daily savings from petty traders and individuals. Employees of this microfinance institution are often seen moving from house to house to collect small amounts for savings. For credit facilities, most people will use Nzema Manle Rural Bank at Aiyinase, Lower Pra Rural Bank located at Esiama and GHAMFO at Aiyinasie.

8.8.8 Income and Expenditure Patterns

Focus group discussions and key informant interviews indicate that household income in the area are mainly derived from fishing and fishing related activities, followed by farming, waged employment, petty trading, artisanal work, livestock, rent and remittances in order of importance. The two main areas of expenditure for households in the project area are food and education, which was reported by more than 60 percent of focus group participants.

8.8.9 Utilities and Social Infrastructure

The provision of utilities, infrastructure and services in the DAoI is summarised in Box 8.3**.** Services are generally poor. Regional and district authorities have recognised this and development of services in the area is a strategic planning priority as captured in the regional and district planning documents reviewed. The provision of such services is clearly a government responsibility and the relevant departments are under increasing pressure to provide improved services in response to any influx of migrant population into the area.

Box 8.3 Key Aspects of Infrastructure and Services

- Infrastructure and service delivery is poor across the DAoI. Water quality is said to be low and there are only a few functioning boreholes/wells in each town.
- Realtively poor road infrastructure cannot easily accommodate existing low levels of traffic.
- The towns in the DAoI have one or two designated areas for waste disposal. These areas are not fenced off and are often in close proximity to dwellings.
- Sanitation is poor in all of the towns in the DAoI with an insufficient number of public KVIP facilities and only a small number of private facilities.
- There is one hospital in the DAoI, located in Eikwe. There are Community-based Health Planning and Services (CHPS) in Atuabo and Sanzule.
- All communities in the DAoI have a public primary school financed by the government. However, not all communities with public primary schools have Junior High Schools.

<u>Road Infrastructure and Transport</u>

The majority of roads in the DAoI are unpaved and the main east-to-west road is graded but with areas in poorer condition and regular pot holes. Smaller roads within the towns are sand roads. During the rainy season the roads are reported to erode and become potholed. Because of the oil and gas related activities going on in the area, large trucks regularly use the laterite road and create dust.

There is no public transport servicing the DAoI. A number of small taxis drive the route (with the exclusion of the road to Asemda-Suazo). Taxi fares vary at the discretion of the driver and depending on the cargo that is being transported. Transport is limited and expensive for local residents, possibly due to the conditions of the roads. People hire small trucks (generically referred to as Kia trucks) to transport large loads (eg, wood, coconuts).

Figure 8.11 Typical Streets within a settlement in the Project Area

Source : ERM Baseline Field Survey December, 2014

Telecommunications

Mobile telephone network coverage received in most of the communities. Most adults reported owning a cellular phone. Some youths have small business built around this by selling recharge vouchers, cell phone batteries, chargers and mobile money transfers. There are no landlines servicing the area. There is only one radio station servicing the district, the West End Radio and is located at Esiama. Televisions were observed in very few households.

Water and Sanitation

The majority of households in the DAoI obtain drinking water from a source considered to be 'improved' (ie, private or public tap/borehole). Typically females are responsible for collecting drinking water, however, it is also not uncommon to see children (either male or female) collecting drinking water for the household. Some community members also purchase water packaged in plastic sachets. In Sanzule, for instance the main sources of water for the community are two boreholes and a private well.

Sanitation facilities are poor within the DAoI, and although present in most of the communities they are not adequate. The communities profiles in the DAoI have access to improved toilet facilities (1) however, evidence of the practice of open defecation was observed in the area, and focus group discussions also support the observation that most people use the bush. This is of concern because it is known to increase contamination of water bodies and some food crops (particularly leafy vegetables) with intestinal bacteria, parasites and viruses.

(1) An improved sanitation facility is defined by WHO/UNICEF Joint Monitoring Platform (JMP), as one that hygienically separates human excreta from human contact. E.g. flush or pour-flush to piped sewer system, piped sewer system, piped sewer system and pit latrine; flush or pour-flush to elsewhere; ventilated improved pit latrine (VIP)

Figure 8.12 Typical Bore Hole and Associated Hand Pump in the DAoI

Source : ERM Baseline Field Survey December, 2014

Waste Disposal

Some towns in the DAoI have specifically allocated waste sites. These are informal in structure, unlined, and once full they are covered over and a new area is opened for use. Community members are expected to take their waste to the sites for disposal, while Zoomlion, a private company contracted and paid by government, is responsible for ensuring that the streets are kept clean and ZOIL (a subsidiary) is responsible for maintaining the beaches. This service reportedly does not extend to all of the communities in the DAoI however, for example Bakanta community reported they only use the roadsides/edge of the town for dumping of refuse.

Figure 8.13 Typical Designated Waste Disposal Sites on Outskirts of Settlements in the DAoI

Source : ERM Baseline Field Survey December, 2014

In communities where there is no allocated waste dump people also dispose of their waste in their yards, mainly by burning and in several places it was observed that both solid and liquid waste is disposed of into the sea, and along paths of streams and land drains. The use of non-bio degradable disposal materials and the haphazard means of disposal, particularly the litter of plastic waste remains a big threat to the environment and to public health.

<u>Housing</u>

Typically, cement blocks or sandcretes for the outer walls of dwelling units, followed by raffia and wooden slabs. The main materials used by households for roofing are corrugated aluminum or zinc sheets, covered by raffia leaves. An exception to this is the small settlement of Anwolakrom, where all structures are built entirely from raffia (walls) and thatch (roofs). This is reportedly due to the migrant nature of this community, who settled here with no real formal claim to the land and only built temporary structures in anticipation of needing to move. Floors of most dwelling units in the Project Area are made of cement or concrete.

It costs between approximately 50 GH¢ (USD 13) to rent a single room in the DAoI, and almost twice that for an additional room.

Figure 8.14 Typical Raffia House in the DAoI

Source : ERM Baseline Field Survey December, 2014

Energy

All the towns within the DAoI are connected to the national electricity grid and most households are also reportedly connected. In general, houses have meters and are billed monthly by the provider. Kerosene lanterns and battery-operated or rechargeable lanterns are used as alternative source for lighting when the electricity power is off. The majority of households use wood or firewood (harvested from farms) and charcoal for cooking. A few more affluent, households use gas for cooking. There was no record of any household using electricity as the main source of cooking.

8.8.10 Crime, Police and Emergency Services

Common crimes reported to occur in the area are break-ins and petty thievery. Most of the communities in the DAoI however, reported a low crime rate with the exception Atuabo The community agreed that the petty crime has increased there since the onset of the GNGC Gas Plant project. They cited examples like breaking of doors and stealing from people's rooms. This has been attributed to post-construction unemployed workers who have not returned to their homes or places of origin, and to the influx of new job seekers into the community. Many of those interviewed noted that there is no police station nor police presence at Atuabo to deal with the increasing crime rate. The community explained that there used to be a police presence at Atuabohowever, since the police station and staff housing became dilapidated the police left. The Awulae is presently renovating the police station with about 80% of the reportedly work completed. Crimes are mostly therefore reported at Bayin and Ainyinasie Police Stations. Conflict is managed at home by elders or at the Chief's Palace.

8.8.11 Education

School Infrastructure

All communities in the DAoI have a public primary school financed by the government. However, not all communities with public primary schools have Junior High Schools. For example, Bankanta does not have a JHS.

There are no SHS or tertiary educational facilities in the communities. JHS graduates are selected through a national exam into SHS in other communities nationwide based on a computerised placement system implemented by the Ghana Education Service. The nearest SHS is located at Nkroful, the capital of the Ellembelle District and the students wanting to pursue Secondary School education need to move to settle there.

The Atuabo community has an Information Communication Technology (ICT) centre for teaching ICT, which is staffed by a permanent trained ICT teacher. ICT is one of the national subjects required for gaining access to SHS. The centre was donated by the Member of Parliament of the area and caters for other neighbouring communities in the DAoI. A teacher emphasised that without the facilities to teach computer skills there was almost no chance that local students would find places in SHS. He also highlighted that students cannot travel to Atuabo regularly to learn ICT given the distance to walk between the two towns and due to their other responsibilities in school and at home.

Table 8.16 Schools Statistics in Project Communities

Community	Name of School	Departments	Boys	Girls	Total No. of Pupils
Eikwe	Determined I Shall Be School	Pre-school, Primary 1 & 2	31	25	56
	Oxford International School	Pre-school, Primary, JHS	115	108	223
	Eikwe Catholic Primary	Pre-school, Primary	239	168	383
	Eikwe Catholic JHS	JHS	33	50	83
	St. Luke Inclusive Catholic Vocational Institute	Levels 100 – 400	16	15	31
	St. Raphael Day Care	Pre-School/ KG	20	17	37
	Vocational School (for young people with physical disability)		Unknown	Unknown	Unknown
Sanzule	Sanzule Wisdom Academy	Pre-school, Primary, JHS	145	138	283
	Sanzule/Krisan DA JHS	JHS	58	70	128
	Sanzule/Krisan Primary	Primary	22	14	36
	Charlotte Dolphyne Training Institute	Year 1 – Year 4	228	116	344
	National Vocational Training School	Ages 16 and up	Unknown	Unknown	Unknown

Community	Name of School	Departments	Boys	Girls	Total No. of Pupils
Krisan	Peace Crèche	Pre-school	17	17	34
	Sanzule-Krisan DA Primary & JHS	Pre-school, Primary, JHS	219	280	490
Atuabo	Atuabo DA Primary	Pre-school and Primary	126	113	271
	Atuabo DA JHS	JHS	47	38	85

Figure 8.15 Examples of Education Facilities in the DAoI

Eikwe Catholic School

A Typical KG School Playground

Source : ERM Baseline Field Survey December, 2014

Finances and Staff

Kindergarten, primary schooling and the junior high schools in Ghana are free and funded by the government through a capitation grant. However, in reality parents are required to pay some nominal annual fees for certain aspects of the schooling. These include:

- Printing of examination materials (Gh¢8 (USD 2) for JHS and Gh¢3 (USD 0.80) for Primary student per term);
- Computer user fees (Gh¢2.5 (USD 0.70) for JHS and Gh¢1 (USD .030) for Primary student per term);
- Parent Teacher Association (PTA) levies (Gh¢2 (USD 0.60) per student per term); and
- Uniforms.

This may vary from a school to another and also between years. For example, an extra classes attracts an additional fees of Gh¢10.00 (USD 3) at Atuabo JHS.

The head teachers reported that the government's grants paid to schools are inadequate to run the school and that bureaucratic procedures can delay this payment to the school. This money is also sometimes spent on repair/maintenance works on school properties such as desks, infrastructure, as well as field trips, sport trips and other educational trips. Furthermore, parents do not always invest money in their children's education.

There are two types of teachers at the local schools: those trained and employed by GES; and untrained teachers (usually trainees who are completing their studies) whom the community employs. The trained teachers and the ICT instructor are employed and paid for by the GES and salaries vary depending on qualifications attained, and years of experience in the teaching field. Moreover, lack of qualified teachers has been cited as areason in communities for poor education performance.

Teachers at all of the schools reported issues with the condition of school buildings and infrastructure. Primary issues include, wall cracks, leaking roofs, poor sanitation facilities and limited administrative space. All also reported inadequate textbooks, furniture, teaching aids and materials, lack of sports facilities/equipment, lack of a library and teachers accommodation as common problems among the schools in the Project Area.

School attendance and retention

According to Key Informants, about 65 percent of the population is illiterate and is this is skewed against females. In addition, some children are not able to read and write in English after completing Junior High School. It is estimated that only 30 percent of male and 10 percent of female students would normally enroll into the Senior High School. Potential reasons include:

- Poor education at lower levels of schooling;
- Poverty;and
- Starting schooling late.

The teachers also noted that most children lack an educated and high achieving role model in the community. They explained that people who graduate from higher education in the cities do not return to their communities to serve as role models of educational attainment and career success for the other children. As as a result they feel children have little to strive for and do not see education as an important area worth investing their time.

The academic level in the area is perceived as very low. The main reasons given for this are the poor level of attainment in English language of the students, and the lack of teachers.

Approximately between 80-90 percent of children in the area attend school. However, there is a high rate of absenteeism, estimated at 50 percent mainly due to poverty, children working (at home or fishing) and to teenage pregnancy in girls. Absenteeism is higher in boys than in girls (40 percent boys and 20 percent girls), because they engage in fishing and other menial jobs to supplement family incomes.

In general, more girls enroll at the start of schooling than boys. However, as schooling progresses, the retention rate for boys exceeds those of girls. One reason for this trend as mentioned above is that girls tend to drop out from school due to teenage pregnancies and are unable to go back to school after having children. Teachers recommended that an awareness and public education campaign for both girls and parents should be organized to try and combat this problem.

Literacy

In the Western Region adults who have no formal education constitute 26 percent of the population (GSS, 2012). Similarly, in the Ellemeblle District, of the population who are 11 years and older, 73.8 percent are literate and 26.2 percent is not literate (Ghana Statistical Service, 2012). Approximately 22.1 percent of the population have never attended school while 43.8 percent are currently in school and 34.1 percent have attended school in the past (Ghana Statistical Service, 2012). Focus group discussions and key informant interviews with educators indicted literacy levels exceeding 50 percent in the communities within the DAoI, with most adults having attained at least a primary school level of education.

8.8.12 Community, Identity, and Relationships

The majority of the people living in the DAoI are Nzema. Like most Akans, the Nzema culture is manifest in its traditional rites and practices, music and dance, cuisine, religion, chieftaincy system, and livelihood activities.

Household and Family Structure

Like most Ghanaians, the Nzema people emphasize communal values such as family, respect for the elderly, honouring traditional rulers, and the importance of dignity and proper social conduct. The family is the primary source of identity, loyalty and responsibility, and family obligations take precedence over everything else in life. Individual conduct is seen as having impact on an entire family, social group and community and individuals achieve recognition and social standing through their extended family. The entire family shares any loss of honour, making the culture a collective one and people are expected to act with decorum to ensure they do not cause embarrassment to the family.

The composition and structure of the household in the DAoI are a general reflection of the social structure of the Ghanaian society. Most households in the DAoI follow the traditional household composition of a man, wife and children, along with extended family..

Hierarchy of Seniority

Nzema society is hierarchical. People are respected because of their age, experience, wealth and/or position. Young address their elders as mother or father. Older people are viewed as wise and are respected in the community. Senior people are also expected to make decisions that are in the best interest of the group.

Customs are often passed on through the extended family, and the customary leaders or chiefs, are given historical authority over social, family, and land-related matters.

Politeness, hospitality and formality are emphasized in the Nzema culture andshaking hands, inquiring after one another’s health (and the health of families) is expected practice. Visitors to a house are greeted with handshaking from each member, and are then seated and greeted in turn by everyone present. The left hand is considered rude; it is not used to take or offer an object or used to wave.

Religious belief and practices

Though Christianity and Islam are being practiced among majority of the Nzemas, African Traditional Religion is still actively practised. Deities in the form of trees, islands, water bodies are worshipped, and shrines, sacred groves and fetish priests are still patronised today.

There are elaborate ceremonies associated with birth, reaching adulthood, and death. Rites associated with childbirths and deaths are, however, the most ubiquitous. The birth rite can be separated into three major events; the birth of the baby, the naming of the baby, and taking the baby outdoors. The labour of childbirth is lleft to traditional midwives and other women who could also play a role in the naming of the baby. Often, babies are either named after relatives, both living and dead, or events surrounding their births. A baby is named eight days after their birth, to align their spirit with divine powers.

A funeral is seen asa rite of passage that marks the transition of elder to ancestor. The ancestor will maintain involvement in the family, lineage and community after death. Funerals tend to be an elaborate occasion, with mourners dressed in red or black while the corpse is usually dressed in white.

Land Ownership

Ownership of land is intricately linked with a membership of a lineage and it is through this lineage that people lay claim to land. Under the customary system, the land is viewed as a common heritage from God to the indigenes, through their ancestors. Land must be preserved and handed to successive descendants. Traditionally, land was in the "customary ownership" of chiefs, who dispensed and allocated it on behalf of their people. The mode and control of acquisition, use and transfer of land rights is through the customs and traditions of the indigenes. Plots of land are given out in exchange for one or few bottles of drinks and a token of money (usually in the form of thanks-giving) in the presence of witnesses. Under the statutory system, land ownership, boundaries and transfer of rights are to be determined, approved, documented and registered by the state through official procedures.

Dispute Resolution

Traditionally, disputes and conflicts are arbitrated or resolved by a complainant first going to the chief with some drinks and lodging acomplaint against the other party. The chief then informs his elders and sends his linguist with his staff to the defendant or the accused party. The linguist extends the staff to the accused party who then touches it to indicate that he accepts the invitation of the chief and his elders. They later fix a date on which the case should be called for hearing and settlement. Once the dispute is resolved, the two parties are asked to shake hands with each other and all the people at the arbitration. After this, they put their heads together to pacify the stool by sending food and drink to the room where the stool is kept (this is a symbolic gesture as the stool is not brought to the place where the arbitration is held).

8.8.13 Cultural Heritage

Within the District and DAoI cultural heritage extends to festivals and cultural resources, for example cemetaries, shrines, and churches. In addition, there are certain cultural taboos. For example, within the DAoI many fisherman are not permitted to fish on Tuesdays and goat rearing is prohibited in Sanzule.

Kundum Festival

The Kundum festival is celebrated by the Nzema people to give thanks for the abundance of food at the time of the harvest period of the area. The festival is believed to have first been celebrated in the 16th century. Bossman, a Dutch explorer who travelled to the Gold Coast in the 17th century and observed the festival, made the first record of the event. According to oral history, the festival began when a hunter, Akpoley, chanced upon some dwarves dancing in a circle during an expedition. After observing the dance, he returned to his town and introduced it to his people. The ritual dancing is associated with expelling the devil and evil spirits from towns and villages. During the festival, most inhabitants in all surrounding towns perform the dance. Kundum is both a harvest and religious festival. The start of the festival is based on the day that the fruit of a certain palm tree becomes ripe and usually occurs in October to coincide with the harvest. Originally, the festival lasted for four weeks but in recent years it has been reduced to eight days. The festivals occur separately in each town of the paramountcy and they each schedule the . Sunday on which their local festival will start. The celebration consists of three main components: dancing, drumming, and feasting.

Cultural Heritage Resources

In Ghana, the National Commission on Culture and the Museums and Monuments Board are responsible for administering cultural sites. The Cultural Policy of Ghana as prepared by the National Commission on Culture (NCC 2004) states:

"The National Commission on Culture shall preserve as monuments, all forts and castles, designated shrines, mosques, church buildings, old city walls and gates, cultural sites and palaces, public and private buildings of historical significance, and monumental sculptures. These shall be protected from neglect, desecration and/or destruction."

Communal and Religious Cemeteries as well as shrines are found across the DAoI. A characteristic feature of such cemeteries are numerous prominent tombstones some of which date back to more than half a century. Churches such Twelve Apostles, Catholic and Methodist have burial grounds reserved for their members. Other shrines found in the DAOI were Adualu shrine (Ngalikpole) and Ayera, Bodibodi, Amenzure, Atofokpolo and Adikefele (Bakanta).

Sacred sites identified, along with a brief description thereof, are listed in Table 8.17.

Table 8.17 Summary of Heritage Resources Inventory

Resource type and description	Community	Coordinates	
Branvien Shrine: This shrine housed in a small building located in the middle of Sanzule. The compound of the shrine is fenced with raffia palm. Oil palm and korkoma trees are found on the compound. A ritual feast is performed a week prior to every Kundum Festival. These include pouring libation, slaughtering sheep and fowls.	Sanzule	W002°27.140'	N04°57.643'
The Royal Cemetery. This is the burial ground of	Sanzule	W002°26.959'	N04°57.650'

Resource type and description	Community	Coordinates	
paramount chiefs is located at the eastern outskirt of Sanzule and covers an approximate land size of an acre. The site is characterized by heavy undergrowth, shrubs, and twines such as seregna, fuba, aloebo teke, and a handful of coconut trees. No felling of trees is allowed within the confines of the cemetery. Of all the cultural sites found in the DAoI, the royal cemetery is the closest to the project site. The cemetery needs to be clearly mapped out and protected			
Other shrines found were Ayera, Bodibodi, Amenzure, Atofokpolo and Adikefele (Bakanta).			

Source: Cultural heritage resources survey conducted in 2014

Approach for Preserving Cultural Heritage Resources

Cultural heritage resources are non-renewable resources and the primary goal of cultural resource management should be their physical preservation (i.e. to avoid direct or indirect impact where practicable). Where preservation at its original location is deemed impossible, "preservation by record" through systematic recording, and subsequent reinstatement of those sites affected is recommended.

Discussions with community elders and caretakers of shrines and sacred groves in the DAoI suggested that the general procedure for moving or preserving shrines and graves should consists of the following:

- Contacting the Chief on whose land the shrine occurs.
- The Chief in return informs the keeper of the shrine or grave and ask him about the required pacification and purification rights.
- Purification involves slaughtering of an animal, pouring of libation, prayers and a monetary payment to the shrine steward and/or traditional authorities.
- Finally, adequate demarcations and fencing is required to prevent accidental damage or disruptions to use of cultural resources found at the fringe of the Project footprint.

Figure 8.16 Typical Graves in the DAoI

Source : ERM Baseline Field Survey December, 2014

ESHIA for GHANA OCTP BLOCK Phase 2

ABSTRACT

Chapter 9 provides an overview of the current health conditions at the national, regional , district and local level.

July 2015	06	Final version	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

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26-01-2015	00	-	Cristina O.	Henry C.	Daniele S.
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

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9 HEALTH BASELINE

9.1 APPROACH

The following Section provides an overview of the current health conditions at the national, regional (Western Region), district (Ellembelle District) and local level (Area of Influence). The Area of Influence for the health baseline is the same as for the social baseline (see Chapters 4 and 8). The Area of Influence covers the communities where the project activities will be located including: Eikwe, Krisan, Sanzule, Anwolakrom, Bakanta and Atuabo. All of these communities are located in Ellembelle District.

This information provides a baseline for assessing any potential positive and/or negative impacts to the health of communities as result of the project and allows for the measurement and monitoring of any changes to health over time.

In order to develop the health baseline the following activities were undertaken:

1) A desktop review of information was performed. The review covered bibliographic resources and previous studies including review of monthly morbidity / mortality reports and annual reports together with relevant administrative documents available at each level of healthcare delivery.

2) A field survey was conducted to cover the Area of Influence including key informant interviews (KII) and focus group discussions (FGD) with communities and direct observations.

3) The information gathered was analysed.

The key sources of existing information used for the preparation of this Section are:

- Ghana Health Service, Health Sector Performance Review Western Region, 2013;
- Holistic Assessments of the Health Sector Program of Work years 2010-2013. Ministry of Health, Ghana;
- Environmental, Social and Health (ESH) Study Report conducted by eni Ghana in 2011. This study included field surveys at regional and district level to collect health data;
- Ghana Health Service (GHS) (2010). 2010 Half Year Report: Western Region (most updated report publicly available);
- Ghana Health Service (GHS) (2009). Health Sector in Ghana: Facts and Figures 2009 (most updated report publicly available);
- Health and Life Sciences in Ghana, March 2014. Embassy of the Kingdom of the Netherlands in Ghana.
- Ghana Health Service, Ellembelle District Profile, 2014;
- Ellembelle District Medium-Term Development Plan, 2010-2013 (the Medium-Term Development Plan, 2014-2017 was not publicly available at the time of writing this report), and
- Annual Health Service Report 2013. St. Martin de Porres Hospital, Eikwe, Ghana.

The field survey was undertaken from the 2nd to the 9th of December 2014. The survey including the following elements:

- KIIs were held with health professionals including the regional Director of health services in the Western Region; the District Director of health services in the Ellembelle District and key personnel at the District hospital including the medical Superintendent/Director, the health services Administrator, the public health Nurse and the health information Officer. At the community-based health planning and services (CHPS) compounds, Community Health Officers were interviewed.
- FGDs were held with targeted groups at the community level incorporating questions on relevant aspects of health. Data gathered from these sources were collated and cross-checked to establish consistency and accuracy.

9.2 INSTITUTIONAL FRAMEWORK

The Ghanaian healthcare system is governed by the Ministry of Health (MoH), which is divided in two units: The Ghana health service (GHS) and the teaching hospitals (TH). The MoH is responsible for policy formulation, monitoring and evaluation, resource mobilisation and regulation of health services delivery. The GHS oversees services and the TH oversees training of health professionals.

The MoH is responsible for policy formulation, monitoring and evaluation, resource mobilization and regulation of health services delivery. The GHS is the body within the MoH who are responsible for health service provision, including the administration and management of state owned-hospitals and health facilities (excluding teaching hospitals).

In addition there are a number of other service providers including:

- national blood transfusion services (NBTS);
- national ambulance services (NAS);
- mental health hospitals; and
- teaching hospitals.

Teaching hospitals provide the most specialized clinical and maternity care as well as providing academic and practical training and research in all related health fields.

Management of the health system organization is decentralized with 10 Regional health administrations and 110 District health administrations that act semi-autonomously, though their budgets and primary policies are approved by the MoH.

The regional health administrations are in charge of the coordination of the activities of the various districts by adapting the national mandates, guidelines and frameworks set by the MoH and GHS to the regional context. The regional administrations are also responsible for the management of regional hospitals.

The district health services constitute the major primary healthcare organization in Ghana. They are organized by sub-districts and communities, the latter based on village-based health units or compounds (the CHPS).

This public health sector is complemented by the private health sector, including both profit and non-profit organizations.

Further information about the healthcare system is presented in Section 9.7 below.

9.3 NATIONAL HEALTH ACCOUNTS

The health expenditure of Ghana between 2011 and 2012 (most recent data available) represented 5.3 to 5.2% of the GDP (WorldBank, health expenditure data by country).

The MOH recorded a total expenditure of GH¢ 2,709.4 million ($849.3MM[1]) in 2013 (Ministry of Health of Ghana, 2013). Out of this amount, 57.3% was for employee compensation as against 63.1% in 2012. Expenditure incurred for goods and services was 31.1% as compared to 34.8% in 2012 whilst that incurred for assets was 11.6% compared to 2.2% in 2012. Data for 2014 was not available at the time of writing this report.

The MoH Financial Report 2013, reported variations in funding and spending patterns relative to the same period in 2012. The contribution from donors was GH¢342.4 million ($107.3MM) in the reporting year whilst there was GH¢266.0 million ($83.4MM) contribution the previous year, an increase of 28.7%. Internally Generated Fund (IGF) increased by 28.7% from GH¢442.3 million ($138.6MM) in 2012 to GH¢569.19 ($178MM) million in 2013. Government of Ghana contribution decreased by 13.1% from GH¢1,750.0 ($548.6MM) million in 2012 to GH¢1,521.0 ($476.8MM) million in the current year.

National health expenditure is financed by many sources, including funds mobilized from primary sources (households and firms) and secondary sources (government and donors). The funds are accumulated in fund pools (health fund and National Health Insurance Fund) before being used to purchase health services and products.

The National Health Insurance Law, Act 650 of 2003, which has been replaced by Act 852 of 2012, introduced the national health insurance scheme (NHIS) with the object of the to attain universal health insurance coverage in relation to persons resident in Ghana, and non-residents visiting Ghana, and to provide access to healthcare services to persons covered by the Scheme. Around 60 to 70% of the population is registered to the NHIS. However, those that remain without insurance are some of the poorest and most in-need members of the population.

9.4 HEALTH POLICY AND PROGRAMMES

Ghana has developed a national overall medium term development framework namely: Ghana shared growth and development agenda (GSGDA) 2014-2017 to guide its development. In similar manner the health sector has consistently been developing its medium term health strategies since 1997, the current one being the health sector medium term development Plan (2014-2017). It should be noted that the medium term development Plan for the period 2014-2017 was not publicly available at the time of writing this report and therefore the Medium-Term Plan for the previous period 2010-2013 have been used as reference for this section.

The holistic assessment of the health sector program of work published every year by the MoH, review the overall sector performance for the past year. According to the 2013 Holistic Assessment Report, the health sector performance in 2013 was mixed with an overall assessment score of zero, i.e. minimal or no progress made during the year. For the years

(1) [1] Considering 1GH¢ = 0.31348 USD (http://www.xe.com/es/currencyconverter/convert/?Amount=1&From=GHS&To=USD#rates). Retrieved January 2015.

2010, 2011 and 2012 the performance ratio depends on the indicator. For instance, in 2012 the number of outpatients per capita doubled the 2006 figure. However, with the increase in Out-patient (OPD) visits across the regions, there has not been equally significant improvement in infrastructure of the most of the facilities to accommodate these increases. Other indicators that improved their performance in 2012 were the maternal mortality which dropped significantly from 2011, the contraceptive prevalence rate, the supervised delivery birth coverage and the Government of Ghana contribution in health. However indicators like total fertility rate, the under-five mortality inequality gap between richest and poorest children and exclusively breastfed has worsened in 2012.

Strategic Health Development Programs at the National Level

The MoH, working in partnership with its agencies and stakeholders has the aim to improve human capital and health under the theme "creating wealth through health". These policies are governed by the medium-term health strategy (2010-2013) which aimed to:

- improve individual lifestyle and health behaviours;
- implement high impact interventions and services targeting the poor, disadvantaged and vulnerable groups;
- strengthen health systems capacity; and
- promote governance, partnership and sustainable financing.

The strategy was closely linked with the poverty reduction strategies at a national level that are focused on bridging health inequality, including investments in the CHPS program and construction and equipping of health facilities in deprived regions.

The strategy is focused on the creation, expansion or upgrading of health system capabilities to fill capacity and service gaps, and improve clinical and organizational performance. In particular it aims to optimize services by creating specialized facilities with hospitals providing curative care while the CHPS provide preventive and primary services. Prior to the strategy mismanagement and poor planning resulted in the underuse of CHPS and overuse of hospitals.

According to MoH (2009), within these larger strategic areas, the medium term priorities in order to improve health, as defined in the health policy are:

- ensuring healthier mothers and children through scaling up implementation of high impact and rapid delivery health interventions;
- promoting good nutrition across the life span, food security and food safety;
- combating communicable diseases such as HIV/AIDS, malaria, tuberculosis, epidemic prone diseases and diseases that almost exclusively affect the poor such as buruli ulcer, Guinea worm, leishmaniasis, lymphatic filariasis, and schistosiamiasis;
- effectively collaborating with relevant MDAs and stakeholders to improve housing, personal hygiene, environmental sanitation and access to potable water;
- reducing risk factors such as tobacco and alcohol use, lack of exercise, poor eating habits, unsafe driving and stress associated with non-communicable diseases;
- strengthening referrals and clinical management of diseases as well as prevention and management of blindness and promotion of mental health;
- strengthening surveillance and response to epidemics and emergencies;

- strengthening the regulatory framework within the health sector; and
- forging stronger, integrated, effective, equitable and accountable health systems including strengthening financing, human resources management, information management and private sector.

In order to accomplish the strategic areas and objectives defined, the MoH also defined the following:

- Human Resources Development Strategy: to increase production and retention of trained professionals and equitable distribution of the health workforce. The impact of these strategies has been an increase in the health workforce and an improvement in staff/population ratio.
- Infrastructure Resources Development Strategy: to increase the existing health facilities, with special attention in deprived and peri-urban areas.
- Pharmaceutical Policy and Essential Drug Strategy: to ensure access to good quality drugs at affordable prices, enacting drug regulations, developing professional standards, and promoting the rational use of drugs.
- Health Management Information System Strategy: to improve the development and use of health related data for decision-making and coordination.
- Quality Services Assurance Strategy Protocols: to deliver clinical services that are client-cantered, of good technical quality and managed efficiently to achieve desired effect.
- Monitoring, Review and Evaluation Guidelines: to monitor the implementation of programs and the performance of the different health actors.

<u>Health Programs at Regional Level</u>

The Western Region benefited from the USAID-funded Ghana Focus Region Health Project (FRHP), 2009-2014. The FRHP was a 4.5-year integrated maternal, new-born, and child health, family planning and HIV&AIDS (MNCH/FP and HIV/AIDS) project which worked to improve the health status of communities in three regions of Ghana (Greater Accra, Central, and Western Regions). The project's efforts targeted 7.9 million people, encompassing 1/3 of Ghana's total population, through a budget of more than US$38 million. Fifteen percent of funding was channelled to GHS through performance-based grants.

In addition, the Regional Health Directorate had been implementing the high impact rapid delivery (HIRD), a strategy to reduce maternal and child mortality. The approach bundles core health and nutrition interventions and delivers many of them in the heart of communities where families tend to lack access to healthcare facilities and lack even the most basic knowledge on how to manage common childhood disease. It aims for rapid scale up to achieve universal coverage (at least 80%) in key priority and cost effective interventions by 2010 and 90% by 2015. The HIRD package includes: routine immunization, vitamin A supplementation, exclusive breastfeeding and complementary feeding, use of insecticide treated bed nets, treatment of diarrhoea, malaria and pneumonia, prevention of mother-to-child transmission of HIV.

Other health programs running within the Western Region are the national tuberculosis control program (NTP) implemented through the Ghana's national tuberculosis health sector strategic plan, 2009–2013 and the expanded program on immunisation (EPI) currently implemented by the immunisation programme comprehensive multi-year plan 2010-2014 (cMYP). The objective of the EPI in Ghana is to contribute to the overall poverty reduction goal of the government through the decrease in the magnitude of vaccine preventable diseases. Ghana launched the EPI in June 1978 with six antigens: BCG (meningitis and disseminated tuberculosis in children), measles, diphtheria-pertussis-tetanus (DPT) and oral polio for children under one year of age together with tetanus toxoid (TT) vaccination for pregnant women. In 1992, the government added yellow fever vaccination and the Polio in 1996. In January 2002, two new vaccines were added: Hepatitis B and the Haemophilus influenza type b. Furthermore, the current cMYP will be revised to accommodate the plans to introduce two new vaccines: pneumococcal and rotavirus.

Specific Health Programs in Ellembelle District and in the Area of Influence

Specific public health programs and activities currently on-going in the District include:

- Pregnancy educational sessions in Esiama, Ayinase, Eikwe and Nkroful sub-districts: series of health educational sessions held at community level for pregnant women and their husbands/male partners with the purpose of preparing them for antenatal care, labour, delivery and puerperium.
- Door-to-Door provision of Family Planning Services in Esiama and Nkroful sub-districts.
- Domiciliary midwifery in Esiama, Aiyinase and Eikwe sub-districts.
- Formation of youth clubs in schools in Aiyinase and Nkroful sub-districts.
- Establishment of schools clinics (run by community health nurses) in the second-cycle institutions (ie. senior high schools, and technical/vocational schools), currently in Nkroful agriculture secondary school.
- Ebola awareness and preparedness in schools and the community including talks about Ebola disease, how a case can be detected early and how its spread can be prevented.
- Maternal death prevention campaign involving educating the communities about how to prevent maternal deaths and helping them institute local measures that will reduce maternal deaths.
- Engagement and training of pharmaceuticals to support in the provision of Family Planning Services: under this program pharmaceuticals are being trained to provide family planning services such as sale of condom, and the family planning pill.
- Screening and management of diseases of public health concern (ie. Hepatitis B screening and breast cancer screening through breast examination). This program has recently started at Nkroful sub-District.

9.5 Health Related NGOs and Associations

The UN and its related agencies have established bilateral agreements to provide funding and technical support for the health sector and therefore have a strong influence on programs and the health agenda of the country. The most relevant agencies or associations include the United States agency for international Development (USAID), European Union (EU), World Health Organization (WHO), World Bank Group (including IFC), and UK department for International Development (DFID), Danish International Development Agency (DANIDA).

There are also a number of health non-governmental organizations (NGO), community based organizations (CBOs) and civil society organizations involved mainly in preventive health, and operating within the Western Region. They work with the various donor funded programs in the health sector to provide health services. These include SNV, Family Rescue Foundation, Nzema Development Association, which focus on HIV/AIDS prevention and education, African Women International, Friends of the Nation, Care International, Mercy Foundation, Centre for Aids Information Network among others. These NGOs and CBOs operate mainly in the education and health sectors. UNICEF and USAID are also supporting health programmes in the region.

Furthermore, Ghana receives funds annually from the Global Fund for the health activities linked to malaria and HIV/AIDS.

Health NGOs in the Area of Influence

According to the interviews conducted with health professionals, the following health related NGOs are currently supporting health programs in the District and the Area of Influence in collaboration with the District Health Administration:

- FOCOS is involved with the provision of health infrastructure.
- eni-foundation supports health infrastructure and health programs in the area.
- JHPIEGO supports capacity building through training of community health nurse (CHN) to become community health officers (CHO).
- Ghana AIDS Commission supports the training of peer educators and 'Models of Hope' for persons with HIV/AIDS.
- The Vitol Foundation supports livelihood, education and water and sanitation programmes across the country.

9.6 Health Information Systems

The GHS implemented a District health information management system (DHIMS II) developed with the University of Oslo in 2012 (holistic assessment report of the health sector programme, June 2014). The DHIMS II system enables health facilities to record summary reports directly into an electronic database with capacity to generate reports, map data and create graphics. With a unified reporting system, information consistency and reliability has also improved. This increases the quality and relevance of year-on-year comparisons.

9.7 Public Health Care System

In 2003, the GoG established the National Health Insurance Council (NHIS) to ensure equitable universal access for all residents of Ghana without out-of pocket payment being required at the point of service use.

The NHIS imposes a national minimum and maximum annual premium based on economic status (membership is free for the elderly). The premium is paid to the District Mutual Schemes. In order to enable transaction payment, the District mutual health schemes have District offices in the District capitals with outreaches into the communities where officers are deployed periodically to register new clients and renew the status of old clients by collecting premiums (in cash).

The public health Division of the Western Region has a key function of coordinating all public health and clinical activities in the region to ensure a steady improvement in the health status of the region. The public health Division in the region is divided within three main Departments: disease control, occupational health, and family health.

9.7.1 Health Care Facilities

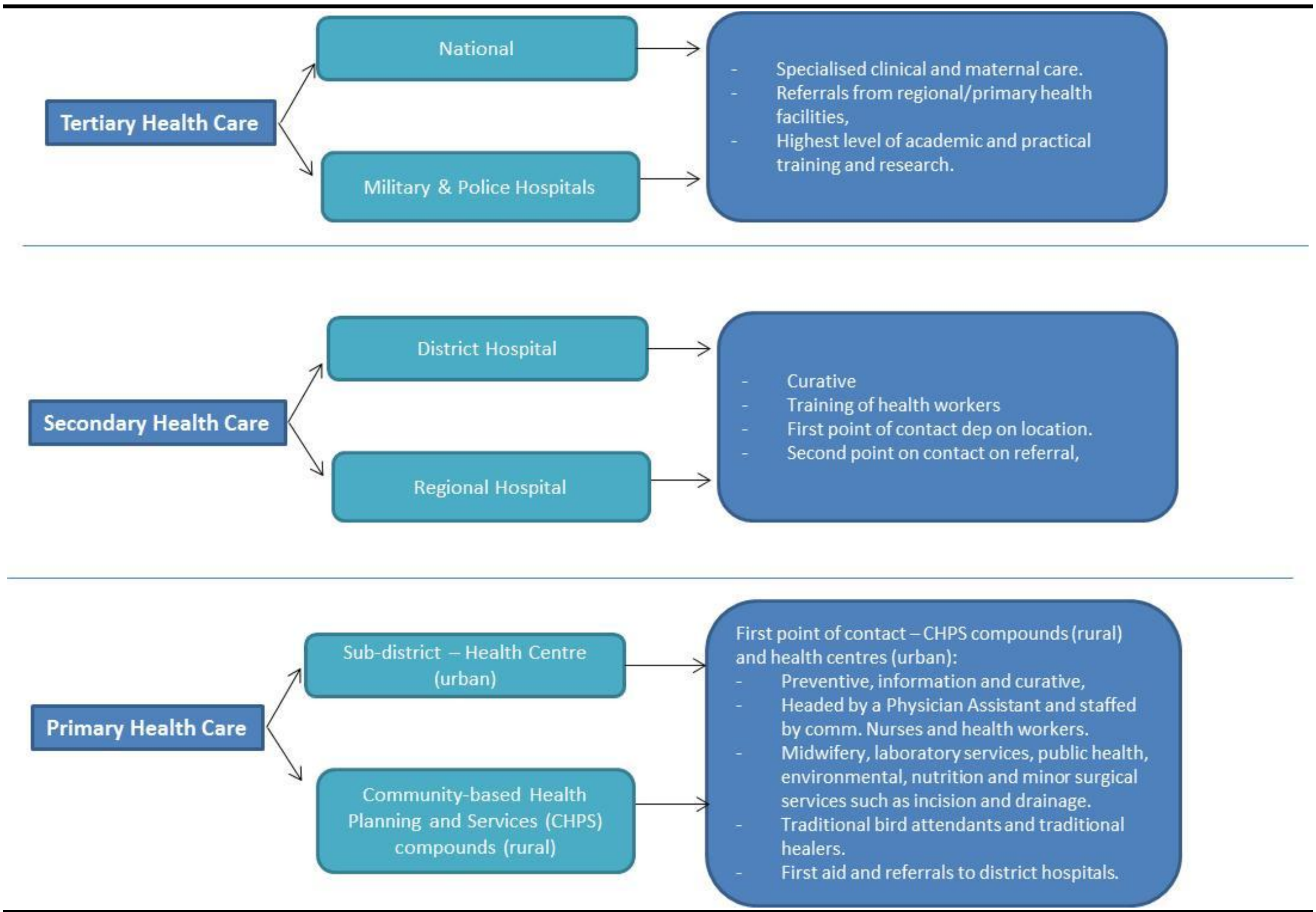
The public health service is offered through a hierarchy of hospitals, health centres, maternity homes and clinics including community-based health planning and services (CHPS) compounds.

Services are run on a three-tier system of care, from primary through secondary to tertiary services organized at five levels: community, sub-district, district, regional and national. Community and sub-District levels provide primary care with district and regional hospitals providing secondary health care (see Figure 9.1). The teaching hospitals provide tertiary services and are the most specialised.

The public sector is complemented by the private health sector, which provides about 42 per cent of Ghana's health care services (Arhinful, 2009).

Traditional healing centres and traditional healers including herbalists, spiritualists, homeopaths and other nonconventional health service providers form part of the primary health care services available as shown in Figure 9.1.

Figure 9.1 Health Care System in Ghana



Source: ERM, 2014

9.7.2 Traditional Medicine

The use of traditional healers is common in Ghana and is also recognized by the GHS as part of the CHPS. The Department of health offers basic training to interested traditional healers such as first aid, safe delivery of babies, identifying signs of anaemia and good hygiene practices for the mother and midwife (Traditional Healer, April 2012).

The usefulness of the traditional birth attendants (TBA) is also recognized and as such the GHS has incorporated TBAs into maternal health delivery outlets when uncomplicated deliveries are expected. Training programmes are freely arranged for registered TBAs on a regular basis. Training areas normally focus on identification of likely complications, first aid and other relevant services. Approximately the 6.1% of births in Ellembelle District are supervised by trained TBAs in 2009.

Traditional medicine in the Area of Influence is mainly practiced by spiritualist (also known as faith healers) and Herbalist. Healers use non-timber forest products as medicine to cure various ailments, including malaria, typhoid, fever, diarrhoea, arthritis, rheumatism, and snake bites.

The dominant faith healers operate under the 12 apostle Church locally called "Nakaba". These operate prayer camps where healing is sought from.

From the key informant interviews performed with health professionals and focus groups it emerged that the use of traditional medicine is high in the Area of Influence as there is a high tendency for people to associate certain illnesses to spirits. Thus, at the initial stage, people resort to traditional remedies from spiritualists and herbalists before seeking medical care at the CHPS or hospitals. Cases may therefore present late with potentially avoidable complications.

9.8 HEALTH INFRASTRUCTURE

For the purpose of effective and efficient delivery of health services, the District health administration has divided the District into 5 sub-Districts: Aiyinase, Esiama, Eikwe, Nkroful and New Aiyinase. The Area of Influence is mainly located within the Eikwe sub-district.

Health infrastructure in the Ellembelle District consists mainly of:

1. one mission hospital;
2. four (4) health centres;
3. seven (7) clinics, and
4. fourteen (14) CHPS compounds.

The highest referral facility in the region is Effia Nkwanta regional hospital which provides secondary health care. There are no tertiary health facilities in the Western Region.

Tables below present the breakdown of primary and secondary health facilities at National level, in the Western region and in Ellembelle District.

Table 9.1 Distribution of Health Facilities in Ghana (2014)

Ownership	Hospital	Health centre	Clinic	CHPS	Maternity home	Total
Public	352	785	918	1,710	-	**3,765**
Private*	119	-	474	-	241	**834**

Ownership	Hospital	Health centre	Clinic	CHPS	Maternity home	Total
Total	**471**	**785**	**1,392**	**1,710**	**241**	**4,599**

* Accredited private health facilities in Ghana by 12th May 2014. Information provided by the Health Facility Regulatory Agency.

Source: MOH-Ghana, 2014 extracted from Health and Life Sciences in Ghana, March 2014 (Embassy of the Kingdom of the Netherlands in Ghana).

Table 9.2 Health Facilities in the Western Region by Ownership and Type (2013)

Ownership	Hospital	Health centre	Clinic	CHPS	Maternity home	Total
Government	15	56	42	181	0	**294**
Mission	4	2	18	0	1	**25**
Quasi-gov't	3	0	2	0	0	**5**
Private	7	1	47	0	40	**95**
Industrial	2	0	0	0	0	**2**
Total	**31**	**59**	**109**	**181**	**41**	**421**

Source: Ghana health service, Western Region, 2013

Table 9.3 Health Facilities in Ellembele District by Ownership and Type (2014)

Ownership	Hospital	Health centre	Clinic	CHPS	Maternity home	Total
Government	0	4	2	14	-	20
Mission	1	0	0	0	0	1
Quasi-gov't	0	0	1	0	0	1
Private	0	0	3	0	0	3
Industrial	0	0	1	0	0	1
Total	**1**	**4**	**7**	**14**	**0**	**26**

Source: Ghana health service, Ellembelle District profile, 2014

As shown in Table 9.3 currently there are not maternity homes within the Ellembelle District, and most of the existing maternity homes available within the Western Region are private (Table 9.2). A maternity home is a privately owned health facility (often manned by a midwife) that primarily offers antenatal and delivery services.

9.8.1 Health facilities in the Area of Influence

The health facilities within the Area of Influence include:

- one hospital at Eikwe (St Martin de Porres hospital);
- one CHPS compound located at Atuabo serving Atuabo and Asemda-Suazo[1] communities; and
- one CHPS compound located at Sanzule serving Sanzule, Anwolakrom (also known as Ewe) and Bakanta communities.

In addition, Krisan Refugee Camp has a clinic which provides basic primary health care to the 1,700 refugees living in the camp.

(2) [1] Neighboring community to the Area of Influence.

There are six (6) active TBAs in the sub-district (Annual Health Service Report 2013 of St Martin de Porres hospital, Eikwe), they have been trained and work as maternal and child health volunteers assisting the communities (family planning, maternal and new-born, etc.).

In general, people within the Area of Influence go to St. Martin de Porres catholic hospital in Eikwe to seek medical attention. In Atuabo, participants in focus groups report that they also go to Kabaku Health Centre in nearby Jomoro District hospital, which is 2 km west and 6 km of Atuabo.

St. Martin de Porres Hospital, Eikwe

St. Martin de Porres Hospital, Eikwe is a catholic health facility which was established in 1959, and currently serves as the District hospital. The hospital serves a wide catchment area that extends beyond Ellembelle District, covering a population of over 100,000. Patients outside the Eikwe sub-district come to the Eikwe hospital mainly for maternity care.

The hospital is an obstetrics and gynaecology specialist hospital but also offers the following services:

- general outpatient services;
- general surgery and orthopaedics;
- reproductive and child health (RCH) services;
- HIV testing and counselling (HTC), prevention of mother-to-child transmission (PMTCT) and antiretroviral therapy (ART); and
- home –based care.

Other services include:

- diagnostic services (laboratory, blood bank, ultrasonography and X-ray);
- pharmacy: about 97% of essential drugs are stocked by the hospital and adequate medical supplies are also maintained for most part of the year. The hospital gets its supplies from the catholic medicine centre, the Western Regional medical stores and private suppliers (accredited companies); and
- a stand-by ambulance for transporting emergency cases to and from the hospital.

The hospital has 200 beds with an overall bed occupancy rate of 94% in 2013. The outpatient clinic has an average daily attendance of about 270 and average monthly admissions of about 1,230. The St. Martin de Porres Hospital contributes about 40% of the total outpatient department (OPD) attendance in the District. The number of OPD attendance and hospital admissions increased significantly with the introduction of the NHIS. On the average, insured clients form about 85% of all in and out patients. The hospital has a free treatment list for those patients not insured and that cannot afford consultations and medication. Health care is also free for all pregnant women and new borns up to 6 weeks post-partum.

The total number of staff is 218 with medical staff constituting about 40% of all staff (human resources strategic plan, St. Martin de Porres Hospital, 2013-2015). Currently the hospital has only 3 doctors in the hospital made up of one medical officer, one general surgeon and one obstetrician gynaecologist.

The two main sources of income for the hospital are the Government of Ghana through subventions and income generated as fees from patients. The largest spending areas are salaries, drugs and medicines and medical supplies.

In addition, donations of assorted equipment and medicines are received from organisations and individuals. For instance, in 2013 eni Foundation reconstructed the antenatal block for the hospital, provided a 4x4 vehicle for outreach programs and funds for various trainings and procurement of equipment for maternal and child health programs in the sub-district.

According to the key informant interviews with health professionals at the hospital conducted in December 2014, the main challenges faced by are:

- inadequate medical staff particularly doctors and midwives;
- lack of mortuary services;
- broken X-ray machine;
- fluctuations and interruptions in power supply; and
- delays in reimbursement from the NHIS.

Figure 9.2 shows some photographs of the St Martin de Porres hospital at Eikwe.

Figure 9.2 St Martin de Porres Hospital at Eikwe

Source: ERM-SRC, 2014

Atuabo CHPS Compound

The Atuabo CHPS Compound was established in November 2012 by the Ghana health service in collaboration with Atuabo and Asemda–Suazo communities which the CHPS serves. The estimated population of these communities are 15,484 and 689 respectively. The CHPS is manned by two community health officers and a healthcare assistant and has an average daily outpatient department (OPD) attendance of three.

Services offered by the CHPS Compound include:

- treatment of minor ailments;
- reproductive and child health services mainly:

  - family planning;
  - postnatal care; and
  - child welfare clinic consisting of immunisation, growth monitoring and Vitamin A Supplementation.
- school health services;
- health promotion; and
- integrated disease surveillance and response (IDSR).

Antenatal and delivery services are not offered as there is no midwife or labour ward.

The Atuabo CHPS Compound has basic medical equipment and supplies including Sphygmomanometer (BP Apparatus), thermometers, weighing scale, vaccine carriers, Malaria rapid diagnostic kits, needle, syringes and basic drugs. The facility gets its supply of drugs and equipment from the District health administration at Nkroful while the vaccines are obtained from Eikwe. The facility has no ambulance.

The health facility has electricity and regular supply of water. However, it does not have a refrigerator for vaccines. It therefore gets its supply of vaccines from St. Martin de Porres hospital at Eikwe.

The main source of revenue is from outpatient services, sale of drugs and family planning commodities. Most of the patients are insured and do not pay in cash for services rendered.

Figure 9.3 shows the CHPS in Atuabo community.

Figure 9.3 Atuabo CHPS Compound, 2014

Source: ERM-SRC, 2014

Sanzule CHPS Compound

The Sanzule CHPS Compound was established by the Ghana health service in collaboration with the Sanzule, Bakanta and Anwolakrom communities which the CHPS serves. The three communities in the CHPS zone have an estimated population of 1,295 and 760 and 600 respectively. The CHPS compound is manned by three Community Health Officers.

Services, equipment, supplies and funding sources at the the Sanzule CHPS Compound are the same as for Atuabo CHPS Compound outlined above. Antenatal and delivery services are not offered as there is no midwife or labour ward. The facility has no ambulance. Referred patients from the facility go by commercial vehicles.

Office accommodation for its operations is a rented privately owned apartment at Sanzule. eni foundation is funding the construction of a new building at the permanent site. Figure 9.4 shows the CHPS in Sanzule.

Figure 9.4 Sanzule CHPS Compound, 2014

Source: ERM-SRC, 2014

9.9 HEALTH HUMAN RESOURCES

The health workforce in Ghana grew from 26,502 in 2010 to 55,016 in 2014 according to the data provided by the Ghana Health Service (see Table 9.4 below). This represents an increase of the 51.8% mainly due to the significant increase of the number of nurses (from 20,046 in 2010 to 45,623 in 2014) and in particular Community Health Nurses. This could be attributed to an increase in the number of CHPS compounds, however this could not be confirmed due to the absence of available reliable data related to CHPS for the period 2010-2012.

According to the national data provided below, health worker/population density trends have improved from 1.07 health worker / 1,000 pop in 2010 to 2 health worker / 1,000 pop in 2014.

Table 9.4 National Health Human Resources (2010-2014)

	2010	2011	2012	2013	2014
Total Population	24,658,823	25,287,190	25,932,161	26,594,184	27,273,725
Nº Doctors	2,066	2,474	2,463	3,264	3,018
Nº of Medical assistants (Physician Assistants)	610	1,054	1,190	1,405	1,611
Nº of Nurses (all categories)	20,046	24,066	29,947	37,512	45,623
Nº of Community Health Nurses*	6,343	7,596	9,609	12,285	13,659
Nº of Midwives	3,780	4,034	3,863	4,185	4,764
Total Health Human Resources	**26,502**	**31,628**	**37,463**	**46,366**	**55,016**

Source: Data provided by the Monitoring and Evaluation Division and the Resource Development Directorate of the Ghana Health Service, 2014.

* Community Health Nurses are nurses trained to manage CHPS compounds. Community Health Nurses managing CHPS compounds are also called Community Health Officers.

The following table summarises the health human resources data in the Western Region for the period 2010-2013 included in the Regional Annual Report (2013). The data shows an increase of the 61% from 2010 to 2013. Similarly to the trend at National level, there has been a significant increase on the number of nurses. The health worker/population density trends have also improved from 0.8 health worker / 1,000 pop in 2010 to 1.9 health worker / 1,000 pop in 2013.

Table 9.5 Health Human Resources in Western Region (2010-2013)

	2010	2011	2012	2013
Total Population	2,376,021	2,423,541	2,472,021	2,521,455
Nº Doctors	60	107	89	87
Nº of Medical assistants (Physician Assistants)	59	83	90	114
Nº of Nurses (all categories)	1,452	3,371	3,892	4,315
Nº of Community Health Nurses	311	320	332	**
Nº of Midwives	316	336	344	409
Total Health Human Resources	**1,887**	**3,897**	**4,415**	**4,925**

Source: Regional Annual Report, Western Region, 2013.

* Community Health Nurses are nurses trained to manage CHPS compounds. Community Health Nurses managing CHPS compounds are also called Community Health Officers.

**Data not available in the Regional Annual Report.

Table 9.6 shows the health resources available at Eikwe sub-district (where Area of Influence is located) according to the data provided by the District Health Directorate for the period 2012-2014. As shown in the table, the total number of health human resources in the sub-district has slightly increased from 2012 to 2014 (from 92 to 97). The health worker/population density in 2014 is much higher than the national and regional ratio: 8.4

health worker / 1,000 pop at the Eikwe sub-district versus 1.9-2 health worker / 1,000 pop at Regional level and National levels respectively.

Table 9.6 Health Human Resources at Eikwe sub-district (2012-2014)

	2012	2013	2014
Total Population	11,315	11,537	11,541
Nº Doctors	5	6	4
Nº of Medical assistants (Physician Assistants)	2	3	3
Nº of Nurses (all categories)	70	70	75
Nº of Community Health Nurses	2	5	5
Nº of Midwives	15	15	15
Total Health Human Resources	**92**	**94**	**97**

Source: Data provided by the District Health Directorate, Nkroful, 2014.

* Community Health Nurses are nurses trained to manage CHPS compounds. Community Health Nurses managing CHPS compounds are also called Community Health Officers.

9.10 HEALTH PROFILE

This section provides a summary of the regional, district and local level health profile. Where regional information is not available, national level data has been presented. Regional health data were sourced from 2013 Ghana health service, Western Region Report. District specific health data were sourced from the annual district health report, Ellembelle District 2013 published by the Ghana Health Service and from the Annual Health Service Report 2013 St.Martin de Porres Hospital, in Eikwe. Local level information was sourced from the key informants interviews conducted at Atuabo and Sanzule CHPS compounds during the field survey performed in November-December 2014.

No data regarding life expectancy at regional, district or local level were available at the time of writing this report. However, life expectancy at birth for males at a national level is 61 years whilst that for females is 64 years (Ghana health profile WHO, 2015. Data from 2012, most updated data available).

9.10.1 Morbidity

<u>Regional Level</u>

The ten top causes of morbidity in the Western Region is presented in Table 9.7. Malaria is the number one cause of morbidity, contributing to the 37.50% to all new reported cases in 2013. The other main causes of morbidity were respiratory infections, skin diseases and diarrhoea.

Table 9.7 Top ten Causes of Morbidity in Western Region, 2011-2013

2011			2012			2013		
Disease Condition	**No. of Cases**	**%**	**Disease Condition**	**No. of Cases**	**%**	**Disease Condition**	**No. of Cases**	**%**
Malaria	1,206,510	40.7	Malaria	1,208,370	49.3	Malaria	1,384,255	37.50
Acute Respiratory Infection (ARI)	347,020	11.7	Acute Respiratory Infection (ARI)	337,019	13.8	Upper Respiratory Tract Infection	410,093	11.11
Skin Diseases & Ulcers	144,320	4.9	Skin Diseases & Ulcers	139,610	5.7	Diarrhoea	185,200	5.02
Diarrhoea	142,715	4.8	Diarrhoea	137,356	5.6	Skin Disease	163,347	4.43
Rheumatism and Joint	112,242	3.8	Rheumatism & Other Joint Pains	107,116	4.4	Rheumatism & Other Join Pains	157,780	4.27
Intestinal worms	59,698	2.0	Intestinal Worms	57,161	2.3	Intestinal worm	123,973	3.36
Acute Eye infection	57,972	2.0	Acute Eye Infection	57,014	2.3	Anaemia	109,533	2.97
Anaemia	56,727	1.9	Anaemia	54,565	2.2	Acute Eye Infection	55,460	1.50
Hypertension	41,548	1.4	Hypertension	39,994	1.6	Hypertension	50,656	1.37
Pregnancy and Related	35,918	1.2	Vaginal Discharge	39,406	1.6	Acute Urinary Tract Infection	46,804	1.27
All Other Diseases	756,505	25.5	All Other Diseases	271,379	11.1	All Others	1,004,196	27.20
TOTAL	**2,961,175**	**100**	**Total**	**2,448,990**	**100**	**Total**	**3,691,297**	**100.00**

Source: Ghana health service, Western Region, 2013

The top ten causes of hospital admissions in the Western Region for the period 2011-2013 reflects the morbidity data as shown in Table 9.8. In 2013, the top ten causes of admissions accounted for 63.9% of all admissions with malaria and gastroenteritis being the most common causes. Malaria contributed 39.3% which showed a decrease from 2012 (43.7%) but an increase from the 2011 (21.2%). According to the District Health Director, at Nkroful, the most recent bed nets distribution in Ellembelle district took place in 2012. However, it is worthy to note that possession does not necessarily translate into use.

Table 9.8 Top ten Causes of Admissions in Western Region, 2011-2013

2011			2012			2013		
Disease Condition	**No. of Cases**	**%**	**Disease Condition**	**No. of Cases**	**%**	**Disease Condition**	**No. of Cases**	**%**
Malaria	29,534	21.2	Malaria	16,355	43.7	Malaria	16,355	43.7
Diarrhoeal Disease	3,667	2.6	Gastroenteritis	2,145	5.7	Gastroenteritis	2,907	5.79
Anaemia	2,997	2.1	Hypertension	1,214	3.2	Anemia	2,269	4.52
Hypertension	1,815	1.3	Anaemia	1,203	3.2	Hypertension	1,902	3.79
Hernia	1,486	1.1	Abortion	1,02	2.7	Abortion	1,257	2.50
Abortion	1,464	1.0	False labour	783	2.1	Sepsis	1,128	2.25
Enteric Fever	1,263	0.9	Pneumonia	718	1.9	Pneumonia	841	1.67
Malaria Pregnancy	868	0.6	Typhoid fever	600	1.6	Hernia	774	1.54
Pneumonia	842	0.6	Cellulitis	409	1.1	Cellulitis	638	1.27
Fibroid	841	0.6	Sepsis	411	1.1	Typhoid Fever	635	1.26
All other Disease	94,67	67.9	All Other Disease	12,672	33.9	All Others	18,141	36.12
Total	**139,447**	**100**	**Total**	**37,423**	**100**	**Total**	**50,231**	**100.00**

Source: Ghana health service, Western Region, 2013

District Level

Similarly as for the regional level, malaria was the leading cause of ill health 2013 within the Ellembelle District, contributing 37% to all new reported cases in 2013. The second most common disease for the same period was acute respiratory tract infections.

Table 9.9 Top ten Causes of Morbidity in Ellembelle District, 2013

No.	Disease Condition	No. of cases	%
1	Malaria	132,984	37
2	Acute Respiratory Tract Infection	45,085	12
3	Rheumatism. & other Joint Pains	22,831	6
4	Skin Diseases & Ulcers	22,444	6
5	Diarrhoea Diseases	19,222	5
6	Intestinal Worms	12,710	4
7	Gynaecological conditions	10,735	3
8	Anaemia	6,220	2
9	Urinary Tract Infection	4,714	1
10	Acute Eye Infection	3,873	1
Others		79,903	22
Total		**360,721**	**100**

Source: Ghana health service, annual District health report, Ellembelle, 2013

The top ten causes of hospital admission in St Martin de Porres hospital in Eikwe sub-District (where people within the Area of Influence mostly seek medical attention) for 2013 are shown in Table 9.10. The data presents a similar health profile to the morbidity data and regional hospital admissions.

Table 9.10 Top ten Causes of Admissions in St Martin de Porres Hospital, 2013

No.	Disease Condition	No. of cases	% of total cases
1	Malaria	1,793	15.1
2	Anaemia	1,037	8.7
3	Diarrhoeal diseases	798	6.7
4	Abortion	636	5.4
5	Pregnancy and related Complication	396	3.3
6	Hernia	376	3.2
7	Hypertension	339	2.9
8	Neonatal Sepsis	254	2.1
9	Pneumonia	194	1.6
10	Enteric Fever	150	1.3
Total		**5,973**	**50.4**
Others		**5,885**	**49.6**
Grand Total		**11,858**	**100**

Source: St Martin de Porres hospital annual report, 2013

The main cause of disease in Ellembelle District is Malaria. Malaria is also the main cause of outpatient attendance in all the health facilities among all age groups. It also accounts for most of the admissions and deaths especially among children at the only hospital in the District, St Martin de Porres at Eikwe.

Tuberculosis (TB) and HIV are also commonly detected at the hospital. However, cases of Eikwe hospital are reported to be mainly attributable to patients from neighbouring districts and the Ivory Coast. Other diseases like yaws and schistosomiasis are found to be common among school children (Ellembele Development Plan, 2009).

Local Level

As shown in Table 9.11 and similar to the Western Region, the main causes of morbidity at the two CHPS Compounds in the Area of Influence are malaria, respiratory diseases and diarrhoea. However, malaria represented the 63.8% of the total cases while at regional and district levels this rate was significantly lower, 37.50 and 37% respectively. This can be explained because of the limited facilities available within the CHPS compared with the health centres and hospital at the District and regional levels. Within the CHPS, some specific conditions (ie. Hypertension, diabetes, cerebrovascular accidents, septicaemia, asthma, etc.), cannot be managed and are referred to the higher levels.

Table 9.11 Top five Causes of Outpatient Morbidity, Atuabo and Sanzule CHPS Compound, 2013

No.	Disease Condition	Atuabo CHPS		Sanzule CHPS	
		No. of cases	% of total cases	No. of cases	% of total cases
1	Malaria	831	63.8	831	63.8
2	Acute Respiratory Infection / Chest Infection	181	13.9	181	13.9
3	Diarrhoea	112	8.6	112	8.6
4	Musculoskeletal Disorders	95	7.3	95	7.3
5	Skin infection	83	6.4	83	6.4
Total		1,302	100	1,302	100

Source: Atuabo and Sanzule CHPS compounds, 2013. Fieldwork ERM-SRC, 2014

9.10.2 Mortality

Regional level

The top ten causes of hospital recorded deaths in the Western Region are shown in Table 9.12. During the period 2011-2013, the top ten causes of reported deaths accounted for between 42.3% in 2013 and 56.9% in 2012 of all causes of deaths. Malaria was the most common cause of death in 2013 and 2012 and the second most common cause in 2011. Anaemia was the main cause of death in 2011. The other main causes of deaths during this period were septicaemia, hypertension and sepsis.

Table 9.12 Causes of Deaths in the Western Region, 2011-2013

2011			**2012**			**2013**		
Condition	**No. of Cases**	**%**	**Condition**	**No. of Cases**	**%**	**Condition**	**No. of Cases**	**%**
Anaemia	336	10.2	Malaria	87	13.2	Malaria	65	8.21
Malaria	269	8.1	Hypertension	46	7.0	Septicemia	61	7.70
Sepsis	261	8.1	Sepsis	42	6.4	Cerebrovascular Accident	43	5.43
Cerebrovascular Accident	241	7.3	Anaemia	41	6.2	Anemia	39	4.92
HIV/AIDS	167	5.1	Stroke	37	5.6	Pneumonia	27	3.41
Pneumonia	158	4.8	Cardiovascular disease	30	4.5	HIV/AIDS	26	3.28
Hypertension	106	3.2	HIV/AIDS	30	4.5	Diabetes Mellitus	20	2.53
Gastroenteritis	98	3	Pneumonia	29	4.4	Hypertension	20	2.53
Cirrhosis of Liver	81	2.5	Gastroenteritis	19	2.9	Cardiovascular Accident	17	2.15
Cerebrovascular Accident	78	2.4	Meningitis	15	2.3	Hypoglycemia	17	2.15
All Other Disease	1,503	45.6	All Others	285	43.1	All Others	457	57.70
Total	**3,298**	**100**	**Total**	**661***	**100**	**Total**	**792***	**100.00**

* According to the Annual Health Report for the Western Region dated 2013, the number of admission cases recorded in the in-patient mortality were not entered in DHIMS at the time of writing the report (18/02/2014). This would explain the difference in the total number of deaths registered in 2011 and the subsequent years (i.e 2012 and 2013). Annex 21 Sectorwide Indicators of the same report indicates a total number of deaths for 2012 and 2013 of 3,276 and 3,579 respectively, numbers aligned with the trend of the previous years.

Source: Ghana health service, Western Region, 2013

District level

At district level, the only updated information publicly available regarding mortality are the figures recorded at St Martin de Porres hospital (2013). The top ten causes of mortality in St Martin de Porres hospital for 2013 are shown in Table 9.13 and reflect the data for the Western Region, with the main causes of mortality being asphyxia, malaria and septicaemia. According to the medical Director of the hospital, the major contribution factor to the number of deaths due to asphyxia is the lack of a paediatrician to manage perinatal and neonatal conditions effectively.

Table 9.13 Top ten Causes of Mortality in St Martin de Porres Hospital, 2013

No.	Disease Condition	No. of cases	% of total cases
1	Asphyxia	28	6.5
2	Malaria	27	6.3
3	Septicemia	26	6.1
4	Diarrhoeal Diseases	25	5.8
5	Cerebrovascular Accident (CVA)	21	4.9
6	Pneumonia	21	4.9
7	Anaemia	20	4.7
8	Neonatal Sepsis	20	4.7
9	Premature baby	16	3.7
10	Congestive Cardiac Failure (CCF)	14	3.3
	Total	**218**	**50.9**
	Others	**210**	**49.1**
Grand Total		**428**	**100.0**

Source: St Martin de Porres hospital annual report, 2013

9.11 COMMUNICABLE DISEASES

Tuberculosis

Tuberculosis (TB) diagnosis and treatment are offered to clients free of charge under the National tuberculosis control program (NTP). This program is responsible for designing and implementing policies, programs and interventions for the effective and efficient detection management and prevention of TB in the country. It operates in almost all public and private health facilities involved with the management of TB.

The St Martin de Porres hospital at Eikwe, implemented a policy to register only TB patients in the catchment of the hospital (ie. the Eikwe sub-District were the Area of Influence is located), for whom treatment is also initiated, has effectively reduced the registered TB patient numbers from over 100 to 31, in the last 5 years. Other confirmed cases in the hospital are referred to health units closer to patients address. In 2013, of the 31 total registered patients, 11 were positive. This policy aims to improve the effectiveness and efficiency of follow-up and monitoring of patients on TB treatment by the DOTS1 strategy.

These numbers translate into a case notification rate of 278/100,000 population. This is much higher than the overall case notification rate in Ghana (63/100,000 population) for all forms of TB (National tuberculosis control program, 2011).

(3) [1] DOTS stands for *Directly observed treatment, short-course,* is the name given to the tuberculosis control strategy recommended by the World Health Organization (WHO).

Table 9.14 Tuberculosis Cases, 2009-2013

Year			**2009**	**2010**	**2011**	**2012**	**2013**
PULMONARY TB	Smear Positive	Total Pulm	90	67	75	29	29
		Total Smear +ve	63	41	34	15	14
		New Cases	54	34	33	13	11
		Relapse	9	7	1	2	3
	Smear Negative		27	46	41	14	14
	Extra Pulm.		12	12	13	0	3
	Total TB		**102**	**99**	**88**	**29**	**31**

Source: St Martin de Porres hospital annual report, 2013

Pneumonia and other Acute Respiratory Infections

Pneumonia and other Acute Respiratory Infections constitute 4.2 % of morbidities seen at St. Martin de Porres hospital (2013). In both CHPS zones, Atuabo and Sanzule, it is second to malaria among the top five causes of morbidity. This is consistent with the Regional disease pattern within the period, 2011-2013; Acute Respiratory Infections have placed second to Malaria among the top ten causes of morbidity in the Region.

Vaccine Preventable Diseases

Vaccine-preventable diseases under the expanded program on immunisation include poliomyelitis, tuberculosis, diphtheria, whooping cough, tetanus, hepatitis b, hemophilus influenza type b yellow fever and measles. This program aims to ensuring safe, effective and timely immunization of the population against vaccine preventable diseases with special emphasis on children under five years of age. For over 6 years there has been no confirmed case of measles, Acute Flaccid Paralysis (used for poliomyelitis surveillance), or yellow fever in the Area of Influence.

According to the St Martin de Porres hospital annual report, 2013, the immunization coverage was attained high levels for all the antigens. The Hospital received support from the District and regional health Directorates with the provision of logistics, training and direct supervision. The following table provide the immunization coverage for the period 2009-2013 at the St Martin the Porres hospital.

Table 9.15 Immunization Coverage, St Martin de Porres Hospital, 2009 -2013

Year			2009	2010	2011	2012	2013
Target Pop. [0-11 months]	Antigen		501	517	561	491	334
Antigen [% Target Pop]	BCG	Nº. Immnunized	2,342	1,947	1,876	1,998	1,900
		Coverage	467	377	334	407	569
	Measles	Nº. Immnunized	603	457	513	481	305
		Coverage	120	88	91	98	91
	DPT3 Hip/Heb	Nº. Immnunized	548	491	514	503	303
		Coverage	109	95	92	102	91
	OPV3	Nº. Immnunized	548	447	514	503	303
		Coverage	109	86	92	102	91
	TT2/3	Nº. Immnunized	599	1,311	2,815	2,321	2,242
		Coverage	120	254	502	534	671
	Yellow Fever	Nº. Immnunized	603	457	513	477	332
		Coverage	120	88	91	97	99

Source: Ghana health service, Western Region, 2013. Data from: 2012 annual report and DHIMS 2, 13th February, 2014.

9.12 Non-Communicable Diseases

Admissions and deaths from non-communicable diseases in the Western Region are presented in Table 9.16 and Table 9.17 for the period 2009-2013. Hypertension is the main non-communicable disease in the region but diabetes, asthma are also common. Cardiovascular diseases also occur and are one of the leading causes of mortality from non-communicable diseases.

Table 9.16 Trend of OPD Admissions due to Non-Communicable Diseases Recorded at OPD in the Western Region, 2009 -2013

Condition	2009	2010	2011	2012	2013
Hypertension	40,772	45,377	41,071	52,698	50,656
CVA	No cases at OPD				5,241
Diabetes Mellitus	9,801	15,820	12,813	16,932	18,329
Rheumatism & Other Joint Pains	57,160	73,607	112,242	141,944	
Asthma	6,114	7,043	7,700	14,943	10,483
Sickle Cell Disease	1,890	3,773	2,105	2,974	2,828
Accidents & Injuries	19,331	17,739	35,873	37,991	25,778
Cancers	No cases at OPD				

Source: Ghana health service, Western Region, 2013. Data from: 2012 annual report and DHIMS 2, 13th February, 2014.

Table 9.17 Trend of Deaths from Non-Communicable Diseases (2009 - 2013)

Trend of Deaths from Non-Communicable Diseases (2009 - 2013)					
Condition	**2009**	**2010**	**2011**	**2012**	**2013**
Hypertension	90	71	77	46	20
Diabetes	43	69	50	9	20
Asthma	19	13	9	3	1
Sickle Cell Disease	9	10	21	6	3
Cardiovascular	27	40	46	30	17
Cancers	16	12	25	No data	6
Accidents & Injuries	8	24	41	4	7

Source: Ghana health service, Western Region, 2013

Diabetes, hypertension and other cardiovascular diseases are major causes of mortality in the area. To manage these conditions, clinic days for diabetes and hypertension have been established at the OPD of St Martin de Porres hospital at Eikwe.

There is a lack of health facilities in the Area of Influence with capacity to manage cancers. Such cases are referred to the regional hospital (in Takoradi) or the teaching hospital (the closer ones located at Cape Coast and Accra).

Data related to psychiatric conditions is not available, either because they are not common diseases in the Area of Influence or because it is being under-diagnosed. According to the District health Director, the condition is underdiagnosed due to inadequate expertise.

With regards to accidents & injuries, reliable data at district or sub-district level was not publicly available at the time of writing this report. During the community meetings, the potential increase of traffic associated to the project was identified as one of the concerns of the population

9.13 VECTOR RELATED DISEASES

Malaria is the commonest vector related disease present at Regional, District and Local levels. It is the commonest cause of morbidity in the Area of Influence and constitutes about 37% of OPD morbidities at Ellembelle District (2013) and over 60% at the two CHPS Compounds in the Area of Influence. In addition, as reflected in Table 9.10 and Table 9.13 it is the most common cause of admissions to the St Martin de Porres hospital and the second most common cause of death. Efforts at malaria control in the District include early diagnosis by confirmation with rapid diagnostic testing (RDT), effective case management with artemisinin-based combination therapy, intermittent-preventive treatment (IPT) among pregnant women, bed net distribution among households and Indoor Residual Spraying. According to the data available, there have been no confirmed cases of Dengue Fever recorded in the past 5 years and no new case of lymphatic filariasis was recorded in 2013. The Lymphatic filariasis is a disease targeted for elimination, the Lymphatic filariasis treatment coverage was of 71.9% in 2012 (District Health Directorate, Ellembelle, 2013*).*

9.14 SEXUALLY TRANSMITTED INFECTIONS AND HIGH RISK SEXUAL BEHAVIOUR

HIV/AIDS

According to the 2013 HIV sentinel survey report in Ghana, the national HIV prevalence in 2013 is 1.3%. An estimated 224,488 Persons made up of 189,931 adults and 34,557 Children (15%) are living with HIV in Ghana. HIV prevalence amongst pregnant women attending Antenatal clinic for 2013 is 1.9% a drop from 2.1% in 2012. It is the first recording below 2% in two decades. Regarding the HIV prevalence by age group at national level, the higher prevalence was recorded within the 45-49 group at 3.3%, followed by 35-39 at 3.2% and with 15-19 being the lowest at 0.8%. There has been a decrease from the previous year in all age groups except for 15-19 and 45-49. In general, HIV prevalence is higher in urban areas while Syphilis is higher in rural areas.

The prevalence in the Western Region in 2013 was 2.4% whilst the higher HIV prevalence rate was registered in the Eastern Region with 3.7% and the lowest prevalence in the Northern and Upper West Regions with 0.8% in both.

According to the KII performed in the area, HIV /AIDS are relatively common in the Area of Influence. One of the reasons for this is its proximity to Ivory Coast which has a higher prevalence of HIV/AIDS.

During the community meetings and KIIs it emerged that there is a concern between the population for a potential increase of the prevalence of HIV/AIDS and other Sexually Transmitted Infections (STIs) related to increased influx of people associated to the current and future developments in the area.

HIV/AIDS testing and counselling (HTC), prevention of mother to child transmission (PMTCT) and antiretroviral therapy (ART) are all offered at the St Martin de Porres hospital at Eikwe. ART started in the Hospital in 2006. None of these services is currently being offered by the any of the two CHPS compounds in the Area of Influence.

Table 9.18 presents the HIV Screening and Outcome in 2013 recorded at St Martin de Porres Hospital.

Table 9.18 HIV Screening and Outcome, 2013

Source	Sex	Screening & Outcome	0-11 months	1-4 yrs	5-9 yrs	10-14 yrs	15-19 yrs	20-34 yrs	35-44 yrs	45-59 yrs	60+ yrs	Grand total
Blood Donors	Male	Total	0	0	0	0	47	1538	395	47	13	2040
		+ve	0	0	0	0	2	90	22	1	0	115
	Female	Total	0	0	0	0	0	3	0	0	0	3
		+ve	0	0	0	0	0	0	0	0	0	0
	Subtotal	Total	0	0	0	0	0	1541	395	47	13	2043
	+ve	+ve	0	0	0	0	0	90	22	1	0	115
Patients	Male	Total	0	6	26	14	14	234	182	188	34	698
		+ve	0	0	3	2	0	40	45	42	6	138
	Female	Total	0	2	30	19	59	606	313	205	33	1267
		+ve	0	1	2	4	6	160	88	57	7	325
	Subtotal	Total	0	8	56	33	73	840	495	393	67	1965
	+ve	+ve	0	1	5	6	6	200	133	99	13	463
[V]CT*	Male	Total	0	0	1	0	0	1	1	0	0	3
		+ve	0	0	0	0	0	0	0	0	0	3
	Female	Total	0	2	0	2	0	3	0	2	0	9
		+ve	0	0	0	0	0	0	0	0	0	0
	Subtotal	Total	0	0	1	2	0	4	1	2	0	12
	+ve	+ve	0	0	0	0	0	0	0	0	0	0
PMTCT	Female	Total	0	0	0	8	202	1403	428	28	2	2071
		+ve	0	0	0	0	4	33	17	1	0	55
Grand Total	Total	Screening	0	10	57	43	322	3788	1319	470	82	6091
	Total	Positive	0	1	5	6	12	323	172	101	13	633

Source: St Martin de Porres hospital annual report, 2013
Note*: [V]CT* = Voluntary testing and counselling, also known as; HIV counselling and testing (HCT)

Interventions to minimise transmission of HIV include awareness campaigns through health talks at community durbars1, in churches, and among organised groups with a (ie. professional associations, religious societies, etc.). These talks are organized through collaborative effort between the District Health Directorate and the opinion leaders in the community concerned.

St. Martin de Porres hospital provides monthly sessions to people living with HIV/AIDS (PLWA). During these sessions, PLWA discuss issues relating to their care and wellbeing. This platform also serves for sharing experiences and knowledge on the disease. Condoms are also provided at designated outlets such as chemical shops and from community-based surveillance volunteers (CBSV) for sale or distribution. According to key informants interviewed, awareness about the disease and its mode of transmission is high among the reproductive age groups as a result of these efforts.

Data on contraception is lacking in the sub-district as the St Martin de Porres hospital does not provide any family planning methods apart from the natural method for religious reasons. However data from the District Annual Report shows that Family planning acceptor rate in Ellembelle District is about 30% (District health Directorate, Ellembelle, annual report, 2013) as against 21.2% for the whole Region (Ghana health service, Western Region, 2013).

According to key informant interviewed, prostitution is not common in the Area of Influence. However, during some of the focus groups conducted in the Area of Influence, stakeholders (ie. women, elders, leaders, fishermen) confirmed the presence of transactional sex workers in the area, mainly in Esiama sub-District. They also confirmed that they are aware of the HIV/AIDs risks. Stakeholders raised concerns about the construction workforce increasing the transmission of STDs and using transactional sex workers based on their previous experiences of other projects.

Figure 9.5 Focus Group Discussions at Krisan, 2014

Source: ERM-SRC, 2014.

9.15 Soil, Water Borne and Waste Related Diseases

Residential areas in the Area of Influence are highly concentrated towards the coast as the main occupation of the population is associated to fishing activities and fish mongering. Most

(1) [1] Public meetings which involves the community, opinion leaders and public officials. The purpose is often to educate and/or deliberate on issues affecting the community and how they are to be addressed.

of the houses are made of raffia roofed with thatch or corrugated iron sheets but others have concrete walls and the new settlements are mainly made of cement blocks (further information regarding housing in the Area of Influence can be found in Chapter 7 Socio-economic Baseline.

Figure 9.6 Examples of Houses in the Area of Influence, 2014

Rafia houses in Anwolakrom community (close to Sanzule, also known as Ewe)

Houses with concrete walls in Sanzule

Source: ERM-SRC, 2014

The provision of sanitation facilities is poor in all the communities within the Area of Influence. All the communities have access to shared toilet facilities but only a very few of households has their own improved sanitation facility[1]. From the KII interviews and community meetings performed during the fieldwork it emerged that the public toilet facility in Eikwe was in a deplorable state and so poorly patronised by the community (see Figure 9.7) Open defecation (in the bush and on the beach) was reported in focus groups within all the communities surveyed. Some community members commented on the health risks of people using the beach or the bush as a toilet as well as the risk of groundwater pollution from the existing sanitation system. During the focus group discussions some communities raised that the number of toilet facilities available were insufficient and/or in poor condition (ie. Krisan, Anokyi and Asemda Suazo[2]).

(2) [1] An improved sanitation facility is defined by WHO/UNICEF Joint Monitoring Programme for Water and Sanitation, as one that hygienically separates human excreta from human contact. Examples of improved sanitation facilities are flush or pour-flush to piped sewer system, piped sewer system and pit latrine; flush or pour-flush to elsewhere; ventilated improved pit latrine (VIP); and composting toilet. However, shared facilities of any type are not considered as improved sanitation facility.

(3) [2] The communities of Anokyi and Asemda Suazo are out of the Direct Area of Influence but within the Extended Area of Influence. These communities were included in the Public Consultation performed in November-December, 2014..See Chapter 4 – Project Description for further details on the Direct and Extended Area of Influence.

Figure 9.7 Examples of Community Toilets in the Area of Influence, Sanzule (left) and Eikwe (right), 2014

Toilet facility built by eni Ghana in Sanzule (the community toilets were operational at the time of the field survey).

Community toilets in Eikwe.

Source: ERM-SRC, 2014

Most households in the Area of Influence obtain drinking water from boreholes or purchase processed water from private providers (water packaged in rubber sachets). Some communities reported their concerns regarding the number and conditions of the existing boreholes, for example in Krisan where the boreholes are old and/or out of order. Groundwater availability was also reported to be limited during the months of November, to January.

There is no public waste collection or formal disposal waste system, instead waste is dumped either at specified sites (ie. in Atuabo, Bakanta and Krisan) or indiscriminately. The allocated waste sites are informal in structure and unmarked. It was observed that dumping of refuse along the beach is the main mode of waste disposal in Eikwe whilst in Sanzule the dumping sites are located close to a stream that flows through the village posing a potential health hazard to people downstream who use the water for drinking.

Figure 9.8 Examples of Indiscriminate Waste Dumping in Sanzule (left) and Eikwe (right), 2014

Source: ERM-SRC, 2014

Regarding diseases associated with poor environmental sanitation, it is worth noticing that malaria and diarrhoeal disease are among the top ten causes of admissions to St Martin the Porres hospital and among the top five causes of morbidity in the two CHPS zones (Atuabo and Sanzule). However, no confirmed cases of cholera have been recorded in the past six years. In 2013, intestinal worm infestation ranked third among the top ten causes of morbidity recorded in the Hospital and in 2014 it occurs among the top five causes of morbidity recorded in Sanzule CHPS zone.

Figure 9.9 Examples of Boreholes in the Area of Influence, 2014

Borehole working with solar system in Sanzule

Borehole in Krisan

Storage of water collected from a public borehole in Krisan

Storage of package drinking water for sell in Sanzule

Source: ERM-SRC, 2014

9.16 LIFE STYLE BEHAVIOURS

Alcohol and cigarette consumption are prominent risk factors for onset and acceleration of some chronic diseases. Evidence from the field survey indicated that smoking cigarettes is not common. However, from Health KIIs interviews it emerged that smoking marijuana is becoming common among the young men in the communities within the Area of Influence.

This is in line with the results of the survey conducted by eni Ghana in 2011 (ESH study report, eni Ghana 2011). According to this study only a 3.7% of the 83 respondents in the Ellembelle District reported to smoke cigarettes. However, 4.1% of the respondents who did not smoke cigarette smoked other kinds of tobacco.

Alcoholism was reported to be very common among men but illicit drug use is not common. Similarly the survey conducted by eni Ghana in 2011, reported that 32.1% of the respondents in Ellembelle District consume alcohol, and 73.1% had consumed alcohol in the last week.

No official regional, district or local data are available.

9.17 MATERNAL AND CHILD HEALTH

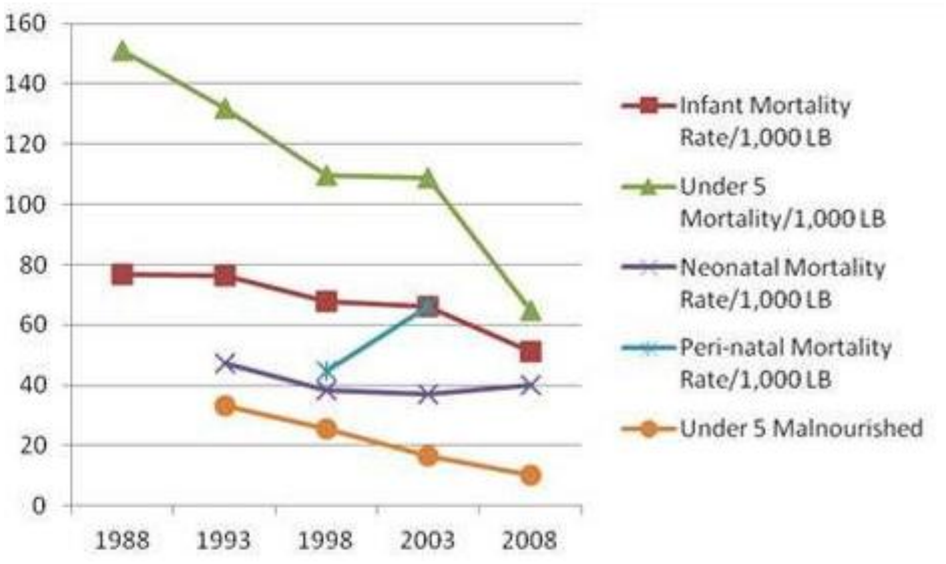
Infant mortality rate is one of the measures of development of a country and it is of prime importance to every nation, of which Ghana is no exception. The millennium development goal 4 (MDG4) demands governments to reduce by two-thirds the under-five mortality rate by 2015 (i.e. less than 50 deaths per 1,000 births). According to the State of The World's Children 2015 Country Statistical (Unicef, 2013), the under-five mortality rate in Ghana reduced from 128 deaths per 1,000 births in 1990 to of 78 in 2013 (most recent data available). Although evidence shows that there has been a significant reduction in under-five mortality rates in recent times, it is unlikely that the 2015 target of reducing the child mortality rates (MDG4) will be achieved, unless there is an effort to scale-up and sustain the recent child survival interventions which have brought about the current improvement[1] (UNDP in Ghana, Millennium Development Goals, 2015).

Figure 9.10 displays the regional trend in: Under 5 mortality, neonatal mortality, and peri-natal mortality and rates of under-5 malnourished and shows that:

- Infant mortality rate in the region fell from 76.9 in 1988 to 51 in 2008.
- Under-5 mortality rate also fell sharply from 151.2 to 60 within the same twenty-year period in the region.
- Neonatal mortality rate fell initially from 47 in 1993 to 38.3 and 37 in 1998 and 2003 respectively. However, in 2008, the records show that it has started to rise from 37 to 40.
- Peri-natal Mortality Rate in contrast has increased dramatically between 1998 and 2003; from 44.7 to 66.0.
- The Under 5 Malnourished situation also shows signs of some improvement from 33.1 in 1993 to only 10.3 as at 2008.

(4) [1] Data retrieved on 18th March from: http://www.gh.undp.org/content/ghana/en/home/mdgoverview/overview/mdg4.html

Figure 9.10 Trend of Western Region Performance in some key Child Health Indicators



Source: Ghana Health Service (GHS) 2009

The Western Region of Ghana has recorded high maternal deaths in the past few years. The records show that over 57% of the deaths were due to haemorrhage and eclampsia.

According to a Ghana health service 2009 report, the national death rate among infants was 51.8 for 2008 and 45.2 in 2009, showing a decrease of 6.6. The under 5 death rate was lower than that of the infants, 31.9 and 24.2 for 2008 and 2009 respectively. This also shows a decrease of 7.7. Lastly, those above five years had the overall lowest mortality rate of 25.9 and 23.1 for the two referral years.

Reproductive and Child Health Indicators in the District and the Area of Influence

The only data available on reproductive and child health in the Area of Influence are the indicators provided by the Eikwe sub-District hospital, St Martin de Porres. The % under five years who are underweight in 2013 was of 2.9% and the percentage of under-five deaths following admission to the Hospital was 4.8% in 2013. Antenatal care, delivery, postnatal care, immunisations, growth monitoring and nutritional indicators are summarised in the Table 9.19 below.

Table 9.19 Reproductive and Child Health Indicators for Eikwe Sub-District, 2011-2013 (St Martin de Porres Hospital)

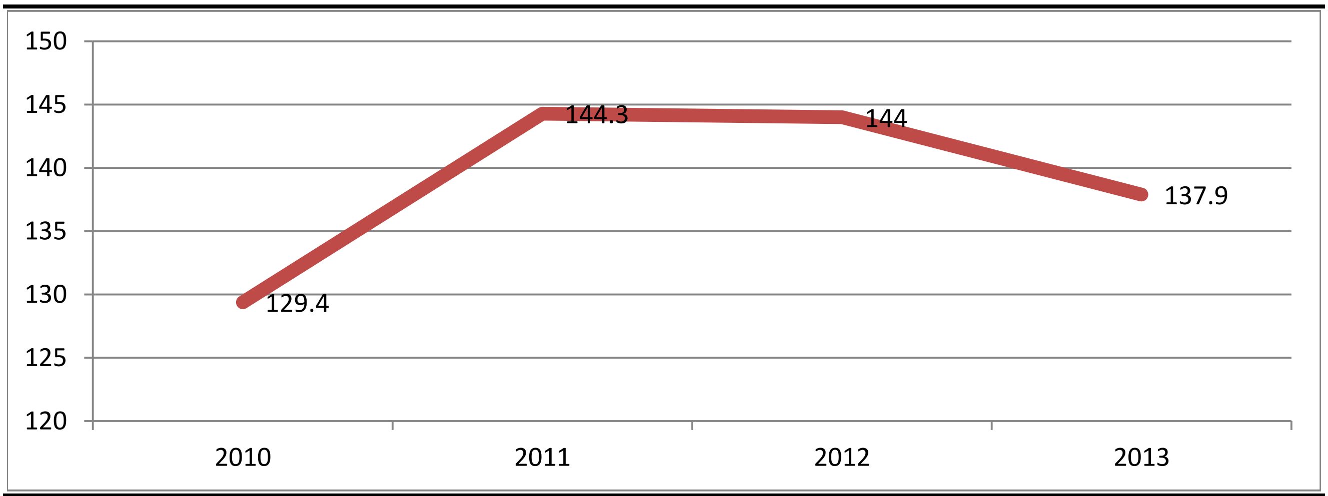
Indicators	**2011**	**2012**	**2013**
		Actual	**Actual**
Population	14,034	10,924	11,143
Number of outpatient visits	83,223	95,997	119,176
Outpatient visits per capita	7.5	8.5	10.3
Number of admissions	14,583	14,832	14931
Reproductive & Child Health & Safe Motherhood			
Number of ANC registrants	1,484	1,308	1354
% ANC coverage	265	266	405
% ANC registrants given IPT2	46.2	63.5	77.2
Number of PNC registrants	1033	1,533	2036

Indicators	**2011**	**2012 Actual**	**2013 Actual**
% PNC coverage	184	312	610
Number of Supervised Deliveries (excludes deliveries by TBAs)	2925	3,336	3173
% of Supervised Deliveries	521	679	950
Number of deliveries by skilled attendants (TBA)	40	66	45
% of Deliveries by Skilled Personnel	17.2	14.1	4.9
Total maternal deaths	3	5	8
% maternal deaths audited	100.0	100.0	100.0
Maternal Mortality ratio – (per 100,000 LBs)	108.7	157.2	262.6
Live births	2761	3164	3048
Still birth + IUD	164	172	125
Still birth rate	1.1	1.3	0.8
Child Survival			
Number of Infants deaths – Institutional	71	81	126
Number of Infants admissions – Institutional	1148	1,320	1557
Number of under five deaths	114	122	163
Number of under-five admissions – Institutional	3411	3,227	3396
% Under five years who are underweight – Institutional	2.1	1.5	2.9
Vitamin A supplementation	1916	1273	1191
EPI coverage BCG (%)	334.0	407.0	569.0
EPI coverage Penta 3 (%)	92.0	102.0	91.0
EPI coverage Measles (%)	91.0	98.0	91.0
EPI coverage Yellow Fever	91.0	97.0	99.0
EPI coverage TT2/3	502.0	534.0	671

Source: District health Directorate, Ellembelle, 2013

From the table above, coverages for antenatal care (ANC) supervised delivery and postnatal care (PNC) show increasing trends over the period (2011-2013) in Ellembelle District. The trend of ANC (see Figure 9.11 below) contrasts the decreasing trend for Region within the same period (Ghana health service annual report, Western Region, 2013).

Figure 9.11 Trend of ANC Coverage from 2010 to 2013



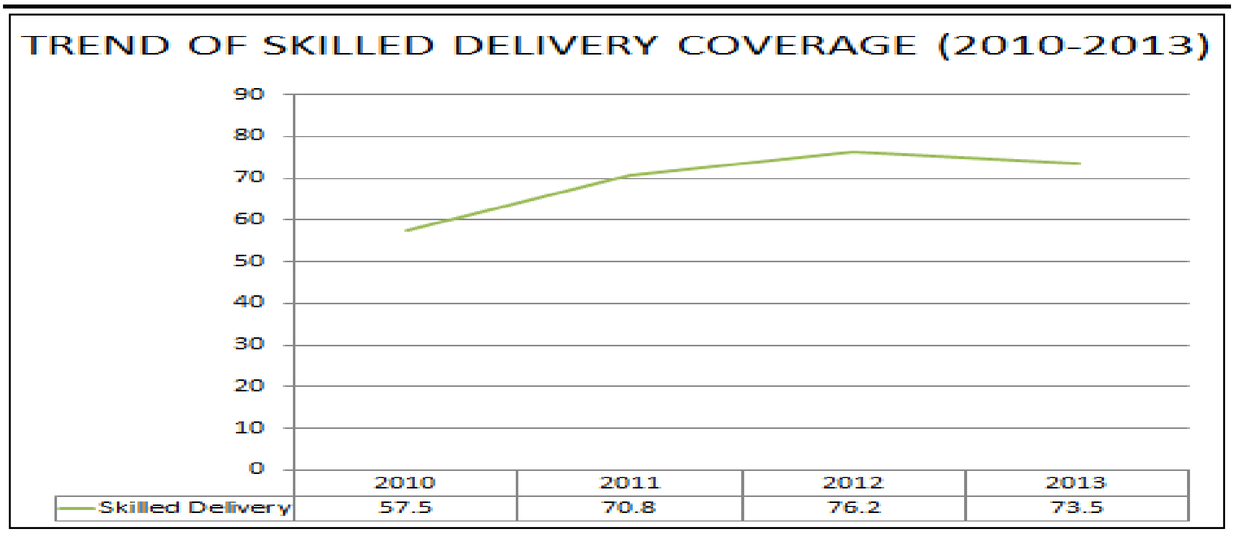
Source: Ghana health service annual report, Western Region, 2013

This could be attributed to the client – friendly programs in maternal health instituted in the district (ie. the pregnancy school, domiciliary midwifery, use of TBA's as maternal Health Volunteers).

The trend in coverage for postnatal care (PNC) in the Region showed a marginal decline from 84.7% in 2012 to 84.5% in 2013, in contrast to the observed trend in the District (Table 9.19).

The coverage for skilled delivery also declined from 76.2% in 2012 to 73.5% in 2013 (see Figure 9.12 below).

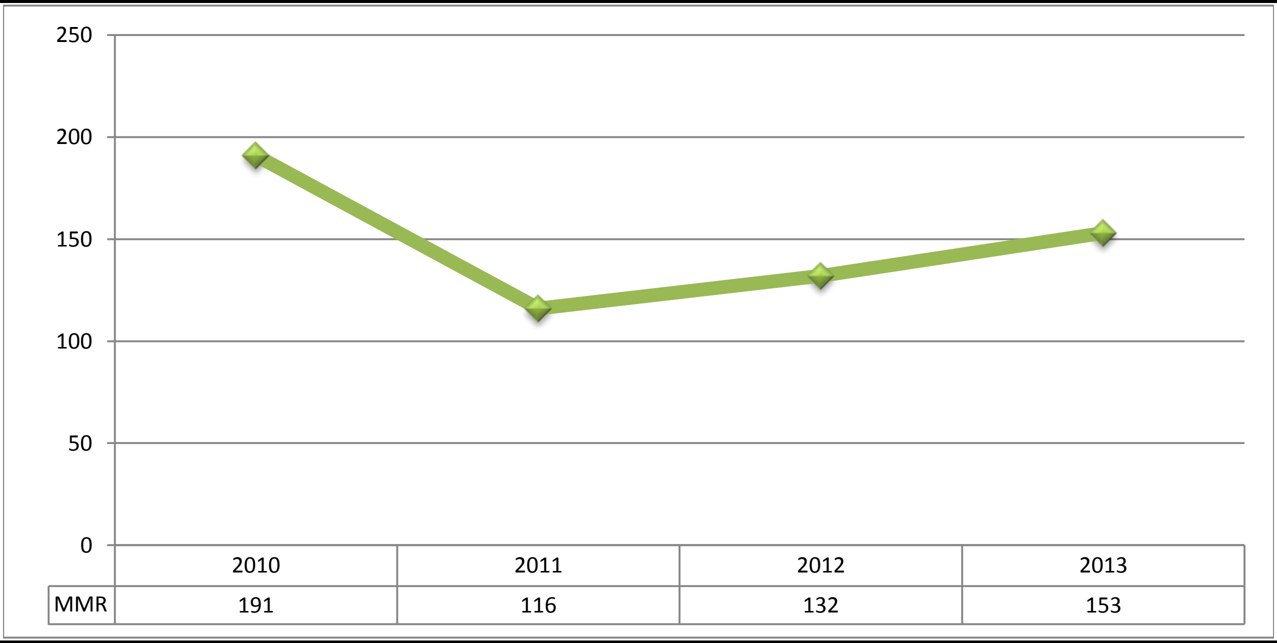
Figure 9.12 Coverage for Skilled Delivery, Western Region, 2010-2013



Source: Ghana Health Service Annual Report, Western Region,2013

However, the trend in maternal mortality ratio is consistent with the increasing regional trend (See Figure 9.13). This emerged as a concern during the KII with the District Director According to her; one major factor accounting for the rise in maternal deaths in spite of all interventions in place in the District is the lack of adequate capacity in the peripheral facilities to manage complications of labour. By policy, the community health officers (CHO) who manages the CHPS compound supposed to serve the deprived communities are not permitted to manage labour. All women in labour have to be referred to the hospital or health centres to be managed by midwives and other highly skilled professionals as the situation may require. The only exception is pregnant women who report to the CHPS compound in their second stage of labour. Under this circumstance the CHO is permitted to manage the labour and afterwards refer to the Hospital. The District Director is vehemently advocating for a review of this policy that seems to undermine their effort at preventing maternal deaths in Ellembelle District and the Region at large. An alternative would be to strengthen the referral system by providing easy access to ambulance services in all communities within a CHPS zone. However, this intervention would need to be piloted in a few CHPS zones before scale-up if proven effective.

Figure 9.13 Maternal Mortality Ratio, Western Region, 2010-2013



Source: Ghana health service annual report, Western Region, 2013

Child undernutrition / malnutrition

A child's birth weight or size at birth is an important indicator of the child's vulnerability to the risk of childhood illnesses and the chances of survival. Children whose birth weight is less than 2.5 kilograms, or children reported to be "very small" or "smaller than average" are considered to have a higher than average risk of early childhood death. According to the State of The World's Children 2015 Country Statistical (Unicef, 2013), the low birthweight ratio (less than 2.5 kg) within the period 2009-2013[1] was of 11%.

Information on this issue was not available at the GHS in Western Region at the time of writing this report.

However, evidence from 2008 GDHS show that 17% of new-borns were under-weight. It is worth noting that only 42% of birth weights were reported in 2008 in the Western region. Therefore these births are unlikely to be representative of all births because births in urban areas and births to mothers in higher wealth quintiles are over-represented, and the pattern of birth weights by background characteristics is likely to be biased.

Child stunting and underweight can expose such children severe anaemia and high risk of death from infectious diseases such as malaria, measles and respiratory tract infections. Results from the 2003 Ghana demographic and health survey shows that height-for-age, weight-for-height and weight-for-age makers had experienced some improvements in almost all the indicators between 2003 and 2008. For instance, extremely stunted children moved from 8% in 2003 to 11% in 2008 (Data from DHS, 2003-2008 extracted from the ESH Study Report, eni Ghana 2011).

(5) [1] Data refer to the most recent year available during the period specified.

EIS for GHANA OCTP BLOCK Phase 2

ABSTRACT

Chapter 10 presents a summary of the identification and assessment of the Project's environmental, social and health impacts.

July 2015	06	Final version	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

Summary of Revisions

Date	Revision	Revision Description	Prepared	Checked	Approved
July 2015	05	Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
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27-01-2015	01	Issued for comments	ERM	eni SEQS/SAL	G. Nicotra
20-01-2015	00	-	Cristina O.	Henry C.	Daniele S.

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10 ASSESSMENT OF IMPACTS AND MITIGATION

10.1 INTRODUCTION

This Chapter provides a summary of the assessment of the potential residual impacts that may result from the Project, after the implementation of the mitigation measures and management actions aimed to avoid, reduce, remedy or compensate for significant adverse effects and, where practicable, to maximise potential positive benefits and opportunities from the project. The impact assessment covers all phases of the Project - construction, operations and decommissioning - as well as unplanned events

A more exahustive discussion about impacts and mitigation measures connected to the project can be found in Annex G, where a detailed description of the impact assessment methodology implementation is reported. Annex H, I, J and K reports the outcomes of technical assessment based on the implementation of modelling activities.

Potential impacts from project activities are described for the following receptors or resources.

In the onshore environment:

- air quality;
- GHG emissions;
- noise and vibration;
- surface water;
- groundwater
- terrestrial soils, geology and geomorphology;
- terrestrial flora;
- terrestrial fauna;
- ecosystem services; and
- landscape.

In the offshore environment:

- seawater quality;
- seabed;
- air quality (including GHG);
- underwater noise;
- marine fauna and flora;
- coastal processes.

In the socio-economic and health environment:

- fisheries;
- economy and employment;

- land, fisheries and livelihood;
- socio-cultural changes;
- cultural heritage resources;
- social infrastructure and public services;
- worker management and rights, and worker health and safety;
- community health, safety and security.

In addition, Project activities have the potential for impacts from:

- unplanned events;
- cumulative effects; and
- transboundary effects.

10.2 Assessment Methodology

The impact assessment approach follows Ghana regulations as well as international best practice. Potential impacts are indentified by predicting the effects of Project activities on environmental and social receptors and resources. The significance of each impact (positive or negative) is assessed through the evaluation of the following criteria:

- temporal scale of the impact (i.e. temporary, short-term, long-term, permanent);
- spatial scale of the impact (i.e. local, regional, national, international, trans-boundary);
- sensitivity, resilience and/or importance of the receptor/resource that is being impacted;
- number of elements (including individuals, households, enterprises, species and habitats) that could be affected by the impact.

Each criterion is scored as defined in the following Table 10.1 to determine the significance (equal to the sum of the scores).

The significance of an impact heavily relies on

- values of the affected society;
- site-specific human and natural environment;
- nature of the Project; and
- specific conditions of the Area of Influence.

Consequently, in the impact assessment, weights are adjusted in some instances due to the actual possibility of occurrence of the impact. Any change in weighting and the reason for change is described.

Based on the impact significance, appropriate control and management measures are defined (see Table 10.2).

Table 10.1 Impact Ranking and Evaluation Criteria

Ranking	Evaluation Criteria: Duration	Evaluation Criteria: Extent	Evaluation Criteria: Importance / Resilience of Receptor/ Resource	Evaluation Criteria: No. of elements involved	Significance
1 - Low	Less than 1 year / Temporary	Local scale: the proposed operating site and its immediate environs	Low value/ sensitivity of receptors or resources, able to recover or adapt to the change without interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	Ranging from 4 to 16
2 - Medium	Between 1 and 5 years	Regional scale: as determined by country's administrative boundaries	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	
3 - High	Between 5 and 10 years	National scale: Entire country	High value/ sensitivity of receptors or resources, poorly able to adapt to changes with strong interventions	Affecting great no. of individuals, households and /or medium/large enterprises and/or habitats and ecosystems	
4 - Critical	Over 10 years / Irreversible	International scale: trans-boundary	Extreme value/ sensitivity of receptors or resources, resulting in permanent changes	Affecting huge no. of individuals, households and /or large enterprises and/or habitats structure and ecosystems functions	
Score	*1,2,3 or 4*	*1,2,3 or 4*	*1,2,3 or 4*	*1,2,3 or 4*	

Table 10.2 Impact Significance, Control and Management Actions

Ranking	Impact Level		Control and Management Action
4-6	LOW	Actions in the short term	Ensure that policy and control measures are adequate to control the impact
		Actions in the long term	Verify that monitoring and reporting activities are properly established to guarantee the correct application of policy and ensure that control measures remain adequate.
7-9	MEDIUM	Actions in the short term	Check if current policy and control measures are adequate, and revise them accordingly to set appropriate objectives for improvement.
		Actions in the long term	Develop adequate plans and activities for control measures, ensuring that are approved and implemented with timescales set and resources (budget and personnel) allocated.
10-12	HIGH	Actions in the short term	Plans and activities are implemented to mitigate the impact as soon as possible. Interim reduction measures are established.
		Actions in the long term	Long-term plans and activities are developed. Parameters and KPIs are set and properly measured, monitored, reported and verified. Targets are set for improvement and feedback used for corrective actions.
13-16	CRITICAL	Actions in the short term	Immediate emergency measures to reduce the impact. Align the current level of control and implemented measures to best available practices to address the issue. Parameters and KPIs are measured, monitored, reported and verified. Targets are set for improvement and feedback used for continuous improvement.
		Actions in the long term	The Company demonstrates the delivery of continuously improved performance through Research and Development, technology innovation, training of the personnel, strategic partnerships and input and feedback from internal and external stakeholders.

As shown in Table 10.1, impacts continuing over 10 years receive a "critical" score which automatically raises impacts significance to "Medium". As an outcome, the impacts that are continous across the operations phase of the project are all classified (at least) as Medium.

This is a reflection of the methodology's conservative approach, where eni wants to ensure that adequate monitoring, management and control measures are applied in a timely manner to any possible impacts whose duration would be more than 10 years (see Table 10.2 for Medium impacts long term control measures).

The specific management, monitoring and control measures to be applied for these imapcts will be fully developed at the Environmental, Social and health Management Plan, where measures will be tailored to the specific impacts and its main driver (duration, extent, sensitivity, or affected individuals).

In order to faciliate the understanding of the impact described in the document (and fully detailed in Annex G, H, I, J, K in term of assessment of impact magnitude and significance) in the Summary Table of Impacts shown in Section 10.12 the main driver of the impact are identified together with the definition if the selected impact is inducted by the occurrence of accidental events. Moreover in the next Section whereas specialists studies (as the air quality, noise and drilling cut dispersion modelling enclosed in Annex I, H, K) identified the impact magnitude as Negligible a comment has been added along the document.

Section 10.13 summary impacts identified and their significance.

10.3 GENERAL MITIGATION MEASURES

An objective of the impact assessment process is to reduce the negative effects and enhance the benefits associated with Project activities. Once potential impacts are identified and evaluated, mitigations are applied to avoid or reduce the effects according to the following hierarchy:

Table 10.3 Mitigation Hierarchy for Planned Project Activities

Avoid at Source; Reduce at Source
Avoiding or reducing at source is essentially 'designing' the project so that a feature causing an impact is designed out (or altered Often called minimisation). Example e.g. re-routing a pipeline, relocating facilities, etc.
Reduction on Site
This involves adding design control system to the basic design to abate the impact - pollution controls fall within this category. Often called "*end-of-pipe*". Example wastewater treatment, NOx reduction technology
Reduce off Site
If an impact cannot be abated on-site then measures can be implemented off-site. Example soundproof equipment at a nearby residences, visual screening by planting of hedges.
Repair or Remedy
Some impacts involve unavoidable damage to a resource, e.g. vegetation disturbance. Repair essentially involves restoration and reinstatement type measures.
Compensate in Kind
Where other mitigation approaches are not possible or fully effective, then compensation, in some measure, for loss, damage and general intrusion might be appropriate. Example is a like-for-like biological offset attaining ecological no net loss.
Net Positive Outcomes
Make a positive contribution to Biodiversity conservation and/or improvement of Ecosystem Services and communities' development.

10.4 ONSHORE ENVIRONMENTAL IMPACTS

10.4.1 Air Quality

Construction Phase

The potential residual impact significance on air quality associated with the construction phase is summarised in Table 10.4.

Table 10.4 Ranking of residual impacts and risks on air quality during construction phase

Impacts	Duration	Extent	Importance / Resilience of Receptor / Resource	No. of Elements Involved	Impact Rank
Air Quality–Onshore Construction Phase					
Increased dust emissions from earth movement, excavation works, stockpiles, vehicle movement on unpaved surfaces Increased atmospheric pollutant concentrations due to exhaust emissions from vehicles involved in construction activities, engine-driven machinery and power generators.	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Air Quality–Onshore Precommissioning Phase					
Increased atmospheric pollutant concentrations due to exhaust emissions from hydrostatic testing.	Less than 1 year / Temporary	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**5 - Low**
Score	*1*	*1*	*2*	*1*	

Note: Impact classified according to methodology introduced in Annex G. However, it has to be noted that, as clearly apparent from the Air Quality Modelling Study results (Annex H), predicted pollutant concentrations widely comply with AQS.

Operational Phase

The residual impact significance on air quality associated with the operational phase is summarised in Table 10.5.

Table 10.5 Ranking of *residual impacts and risks* on air quality during operational phase

Impacts	Duration	Extent	Importance / Resilience of Receptor / Resource	No. of Elements Involved	Impact Rank
Air Quality–Onshore Operational Phase					
Increased atmospheric pollutant concentrations mainly due to continuous exhaust emissions released by the ORF facilities	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	

Note: Impact classified according to methodology introduced in Annex G. However, it has to be noted that, as clearly apparent from the Air Quality Modelling Study results (Annex H), predicted pollutant concentrations widely comply with AQS.

Decommissioning

The residual impact significance on air quality associated with the decommissioning phase is summarised in Table 10.6.

Table 10.6 *Ranking of residual impacts and risks on* air quality during decommissioning

Impacts	Duration	Extent	Importance / Resilience of Receptor / Resource	No. of Elements Involved	Impact Rank
Air Quality–Onshore Decommissioning					
Increased dust emissions from earthworks and vehicle movement and increased atmospheric pollutant concentrations due to exhaust emissions from vehicles	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	

Note: Impact classified according to methodology introduced in Annex G. However, it has to be noted that, as clearly apparent from the Air Quality Modelling Study results (Annex H), predicted pollutant concentrations widely comply with AQS.

10.4.2 GHG Emissions

The Greenhouse Gas (GHG) emissions associated with the onshore planned activities, presented in Table 10.7, are not expected to be significant.

Table 10.7 GHG emission sources from onshore Project activities

Project Phase	GHG Emissions
Construction	• CO_2 emissions from machinery and vehicles for facilities installations and for personnel and material transport. • CO_2 emissions from power generators to supply energy for construction activities. • CO_2 emissions from compressors used during hydrostatic testing. • CH4 emissions from combustion sources.
Operation	• CO_2 emissions from power generation unit and compression system. • CO_2 and CH_4 emissions from flaring limited to the process upsets. • Fugitive emissions (CH4) from emergency flaring.
Decommissioning	• CO_2 emissions from vehicles for facilities dismantling and for personnel and material transport.

10.4.3 Noise and Vibration

Construction Phase

The residual impacts significance on the ambient acoustic conditions associated with the construction phase is summarised in Table 10.8.

Table 10.8 Ranking of residual impacts and risks on ambient noise levels during construction phase

Impacts	Duration	Extent	Importance / Resilience of Receptor / Resource	No. of Elements Involved	Impact Rank
Ambient Acoustic Conditions –Onshore Construction Phase					
Increased noise emissions from equipment involved in the construction of the ORF, pipeline installation	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Ambient Acoustic Conditions –Onshore Pre-commissioning Phase (Hydrostatic testing)					
Increased noise emissions from hydrostatic testing	Less than 1 year / Temporary	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**5 - Low**
Score	*1*	*1*	*2*	*1*	

Note: Impact classified according to methodology introduced in Annex G. However, it has to be noted that, as described in the Noise Modelling Study results (Annex I), predicted noise emission levels are in compliance with both WBG/IFC and Ghana EPA standards.

<u>Operational Phase</u>

The residual impacts significance on the ambient acoustic conditions associated with the operational phase is summarised in Table 10.9

Table 10.9 Ranking of residual impacts and risks on ambient noise levels during operational phase

Impacts	**Duration**	**Extent**	**Importance / Resilience of Receptor / Resource**	**No. of Elements Involved**	**Impact Rank**
Ambient Acoustic Conditions –Onshore Operational Phase					
Increased noise emissions from power generators and compressors of the ORF and vehicles for maintenance operations	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	

Note: Impact classified according to methodology introduced in Annex G. However, it has to be noted that, as described in the Noise Modelling Study results (Annex I), predicted noise emission levels are in compliance with both WBG/IFC and Ghana EPA standards.

<u>Decommissioning</u>

The residual impacts significance on the ambient acoustic conditions associated with the decommissioning is summarised in Table 10.10.

Table 10.10 Ranking of residual impacts and risks on ambient noise levels during decommissioning

Impacts	**Duration**	**Extent**	**Importance / Resilience of Receptor / Resource**	**No. of Elements Involved**	**Impact Rank**
Ambient Acoustic Conditions –Onshore Decommissioning					
Increased noise emissions from equipment involved in pipeline and ORF decommissioning	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	

10.4.4 Surface water

<u>Construction Phase</u>

The residual impacts on surface water resources associated with the construction phase are summarised in Table 10.11.

Table 10.11 Ranking of Impacts on Surface Water Resources during Construction Phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Surface Water Resources – Construction Phase					
Removal of ephemeral water bodies	Over 10 years / Irreversible	Local scale	High value/ sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**9 - Medium**
Score	4	*1*	*3*	*1*	
Degradation of surface water quality due to increased sediment load	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Degradation of surface water quality due to potential contamination from improper handling of waste	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Degradation of surface water quality due to spillages of the fuels and chemicals	Between 1 and 5 years	Local scale	High value/ sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8- Medium**
Score	*2*	*2*	*3*	*1*	
Changes in hydrology and hydrological regime caused by reduced flows and/or changes in flow direction	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8- Medium**
Score	*4*	*1*	*2*	*1*	

Operations and Maintenance Phase

The residual impacts on freshwater resources associated with the operation phase are summarized in Table 10.12.

Table 10.12 Ranking of Impacts on Surface Water Resources during Operation Phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Freshwater Resources – Operation Phase					
Degradation of surface water quality due to potential contamination from improper handling of waste	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**6 - Low**
Score	2	1	2	1	
Degradation of surface water quality due to spillages of the fuels and chemicals	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	2	1	2	1	

Decommissioning Phase

For ORF facilities decommissioning, apart from the impact associated with the removal of ephemeral and permanent ponds within the Project site, the potential impacts and the mitigation measures will be the same as the construction phase for the ORF area (foreseen as **Medium** to **Low**). For pipeline decommissioning, considering that the pipes will remain underground and related impacts on freshwater resources will be **Not significant**.

10.4.5 Groundwater

Construction Phase

The residual impacts on groundwater resources associated with the construction phase are summarised in Table 10.13.

Table 10.13 Ranking of impacts and risks on groundwater during construction phase

Impacts	*Duration*	*Extent*	*Importance / Resilience of Receptor / Resource*	*No. of Elements Involved*	*Impact Rank*
Freshwater Resources – Construction Phase					
Reduction in groundwater resources due to water consumption	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**7 - Medium**
Score	2	1	2	2	
Surface sealing and infilling leading to lowering of groundwater levels and drawdown	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	2	1	2	1	
Degradation of groundwater quality due to seepage from discharge of wastewater and improper waste storage and handling	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	2	1	2	1	
Degradation of groundwater quality due to spillages of fuels and chemicals	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**8 - Medium**
Score	4	1	2	1	

Operations and Maintenance Phase

The residual impacts on groundwater resources associated with the operation phase are summarised in Table 10.14.

Table 10.14 Ranking of impacts and risks on groundwater during operation and maintenance phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Groundwater Resources – Operation Phase					
Reduction in groundwater resources due to water consumption	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**9 - Medium**
Score	*4*	*1*	*2*	*2*	
Degradation of groundwater quality due to seepage from discharge of wastewater and improper waste storage and handling	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	
Degradation of groundwater quality due to spillages of fuels and chemicals (unplanned event)	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**9 - Medium**
Score	*4*	*1*	*2*	*2*	

<u>Decommissioning Phase</u>

For ORF facilites decommisioning the potential impacts and the mitigation measures will be the same as for the construction phase for the ORF area (foreseen as **Medium** to **Low**). For pipeline decommissioning, considering that the pipes will remain underground and they will be only filled with a suitable material, the related impacts on groundwater resources will be **Not significant**.

10.4.6 Terrestrial Soils, Geology and Geomorphology

<u>Construction Phase</u>

The residual impacts on soils associated with the construction phase are summarised in Table 10.15.

Table 10.15 Residual Impacts on Soil during Construction Phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Geology, Geomorphology and Soil – Construction Phase					
Potential contamination of the soil	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Potential disturbance and degradation during construction	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Soil removal/ land take	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*2*	*1*	*2*	*1*	

<u>Operations and Maintenance Phase</u>

The residual impacts on soil component associated with the operation phase are summarised in Table 10.16.

Table 10.16 Residual Impacts and Impacts on Soil during Operation Phase

Impacts	*Duration*	*Extent*	*Importance/ Resilience of Receptor/ Resource*	*No. of Elements Involved*	*Impact Rank*
Geology, Geomorphology and Soil – Operation Phase					
Potential contamination of the soil	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	
Soil compaction and erosion	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	

Decommissioning Phase

The residual impacts on soil component associated with the operation phase are summarized in Table 10.17.

Table 10.17 Residual Impacts on Soil during Decommissioning Phase

Impacts	*Duration*	*Extent*	*Importance/ Resilience of Receptor/ Resource*	*No. of Elements Involved*	*Impact Rank*
Geology, Geomorphology and Soil – Decommissioning Phase					
Potential contamination of the soil	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Soil compaction and erosion	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	

10.4.7 Terrestrial Flora

<u>Construction and Precommissioning phase.</u>

The residual impacts on the terrestrial flora associated with the construction phase are summarised in Table 10.18.

Table 10.18 Ranking of residual impacts and risks on flora during construction and pre-commissioning phase

Impacts	*Duration*	*Extent*	*Importance / Resilience of Receptor / Resource*	*No. of Elements Involved*	*Impact Rank*
Flora– Construction Phase					
Loss of natural vegetation	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**9 - Medium**
Score	*4*	*1*	*2*	*2*	
Loss of habitat/ habitat fragmentation	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**9 - Medium**
Score	*4*	*1*	*2*	*1*	
Impacts on flora due to degradation of abiotic components of ecosystems	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Introduction of alien species	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	

<u>Operational Phase</u>

The residual impacts on the flora associated with the operational phase are summarised in Table 10.19.

Table 10.19 Ranking of residual impacts and risks on flora during operational phase

Impacts	*Duration*	*Extent*	*Importance / Resilience of Receptor / Resource*	*No. of Elements Involved*	*Impact Rank*
Flora – Operation Phase					
Impacts on flora due to degradation of abiotic components of ecosystems	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	

Decommissioning

Considering the mitigation measures described, the potential impacts on the flora associated with the construction phase are summarised in Table 10.20

Table 10.20 Ranking of residual impacts and risks on flora during decommissioning phase

Impacts	*Duration*	*Extent*	*Importance / Resilience of Receptor / Resource*	*No. of Elements Involved*	*Impact Rank*
Flora– Decommissioning Phase					
Impacts due to emissions	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Introduction of alien species	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6- Low**
Score	*2*	*1*	*2*	*1*	

10.4.8 Terrestrial Fauna

Construction Phase

The residual impacts on fauna associated with the construction phase are summarised in Table 10.21.

Table 10.21 Ranking of residual impacts and risks on fauna during construction phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Fauna – Construction Phase					
Habitat reduction/ fragmentation and isolation	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	
Disturbance and/or displacement of fauna due to pollution	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Increased mortality of wildlife	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	

Operational Phase

The residual impacts on fauna associated with the operation phase are summarised in Table 10.22.

Table 10.22 Residual Impacts on Fauna during Operations Phase

Impacts	*Duration*	*Extent*	*Importance / Resilience of Receptor / Resource*	*No. of Elements Involved*	*Impact Rank*
Fauna – Operations Phase					
Disturbance and/or displacement of fauna due to pollution	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	
Increased mortality of wildlife	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**9 - Medium**
Score	*4*	*1*	*2*	*2*	

Decommissioning Phase

The residual impacts on fauna associated with the decommissioning phase are summarised in Table 10.23.

Table 10.23 Residual Impacts on Fauna during Decommissioning Phase

Impacts	*Duration*	*Extent*	*Importance / Resilience of Receptor / Resource*	*No. of Elements Involved*	*Impact Rank*
Fauna – Decommissioning Phase					
Disturbance and/or displacement of fauna due to pollution	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Increased mortality of wildlife	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**7 - Medium**
Score	*2*	*1*	*2*	*2*	

10.4.9 Landscape

Construction phase

The residual impacts on landscape associated with the construction phase are summarized in Table 10.24.

Table 10.24 Ranking of residual impacts and risks on landscape during the construction phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Landscape and Visual – Construction Phase					
Landscape changes and visual impacts due to installation of the pipeline	Less than 1 year / Temporary	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**5 - Low**
Score	*1*	*1*	*2*	*1*	
Landscape changes and visual impacts due to construction of ORF and associated infrastructure	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8-Medium**
Score	*4*	*1*	*2*	*1*	

Operation and Maintenance Phase

The residual visual and landscape impacts associated with the operation phase are summarised in Table 10.25.

Table 10.25 Residual visual and landscape impacts during operational phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Landscape and Visual Impacts – Operation Phase					
Visual impacts due to presence of the ORF and associated infrastructure	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8- Medium**
Score	*4*	*1*	*2*	*1*	

Decommissioning Phase

Potential impacts during Project decommissioning are likely to be similar to impacts during the construction phase for onshore and offshore facilities (**Low** impact). For the pipeline decommissioning, considering that the pipeline will remain underground ant they will be only filled with a suitable material, the related impacts on landscape are considered **Not significant**.

10.5 OFFSHORE ENVIRONMENTAL IMPACTS

10.5.1 Seawater Quality

Installation/Construction Phase

The residual impacts on seawater resources associated with the installation/construction phase are summarised in Table 10.26.

Table 10.26 Ranking of residual impacts and risks on seawater during installation/construction phase

Impacts	*Duration*	*Extent*	*Importance / Resilience of Receptor / Resource*	*No. of Elements Involved*	*Impact Rank*
Seawater Resources – Installation/Construction Phase					
Increase in Turbidity	Between 1 and 5 years	Local scale	Moderate value/ sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6- Low**
Score	*2*	*1*	*2*	*1*	
Release of contaminants and nutrients	Between 1 and 5 years	Local scale	Moderate value/ sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Potential contamination from routine discharges of vessel operations and occasional spills	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Drilling waste (mud and cuttings) and cement discharges	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Seawater Resources – Installation/Construction Phase					
Use and discharge of treated seawater resources	Less than 1 year / Temporary	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**5 - Low**
Score	*1*	*1*	*2*	*1*	

Note: Impact related to drilling mud and cuttings discharge have been classified according to methodology introduced in Annex G. However, it has to be noted that, as described in the Drill Cutting Modelling Study results (Annex K), this Project activity will lead to minor effects on marine environment.

Operations and Maintenance Phase

The residual impacts on seawater resources associated with the operational phase are summarised in Table 10.27.

Table 10.27 Ranking of impacts on seawater during operational phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Seawater Resources – Operational Phase					
Potential contamination due to FPSO operations	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 – Medium**
Score	*4*	*1*	*2*	*1*	
Contamination from routine discharge from vessel operations	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 – Medium**
Score	*4*	*1*	*2*	*1*	
Potential contamination from pipeline anti corrosion anodes	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 – Medium**
Score	*4*	*1*	*2*	*1*	

Decommissioning Phase

In the decomissioning phase impacts will be similar to installation/construction phase as there will be several vessels involved in the process, however the duration and intensity of works will be reduced and therefore impact expected will also be reduced. As the wells will not be removed but permanently abandoned by setting cement plugs on top of the openhole of each well, no adiditional discharges are expected.

Main difference with the construction phase is the pipeline that will not ve removed removed from the seabed once the project life is finished, but cleaned up through pigging process and flushing seawater. The seawater used to clean it shall be properly treated before discharge; finally the two ends of the pipeline will be plugged and the pipeline left there offering hard substrate to benthic organisms.

The related impacts as a result of the decomissioning of the Project on seawater quality will be **Not significant**.

10.5.2 Seabed

Installation/Construction Phase

The residual impacts on seabed component associated with the installation/construction phase are summarised in Table 10.28.

Table 10.28 Ranking of impacts and risks on seabed during installation/construction phase

Impacts	*Duration*	*Extent*	*Importance / Resilience of Receptor / Resource*	*No. of Elements Involved*	*Impact Rank*
Seabed Quality – Installation/Construction Phase					
Physical alterations to the seabed	Between 1 and 5 years	Local scale	High value/ sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**7 -Medium**
Score	*2*	*1*	*3*	*1*	
Sediment contamination due to use of cementing/ drilling chemicals	Between 1 and 5 years	Local scale	High value/ sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**7 -Medium**
Score	*2*	*1*	*3*	*1*	

Operations and Maintenance Phase

The residual impacts on seabed component associated with the operational phase are summarised in Table 10.29.

Table 10.29 Residual impacts and risks on seabed during operational and maintenance phase

Impacts	*Duration*	*Extent*	*Importance/ Resilience of Receptor/ Resource*	*No. of Elements Involved*	*Impact Rank*
Seabed Quality – Operational Phase					
Potential seabed contamination	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	
Sediment accumulation and/or scouring/ erosion	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	

Decommissioning Phase

No impacts on seabed quality are expected for the decommissioning phase as the pipeline will remain laid in the subsea (no further changes to it after 20 years of use) and wells will be permanently abandoned by setting cement plugs on top of the openhole of each well with no intervention on the seabed. The related impacts on seabed will therefore be **Not significant**.

10.5.3 Air Quality

Construction Phase

The residual impact significance on air quality associated with the construction phase is summarised in Table 10.30.

Table 10.30 Ranking of Residual Impacts on Air Quality during Offshore Construction Phase

Impacts	**Duration**	**Extent**	**Importance / Resilience of Receptor / Resource**	**No. of Elements Involved**	**Impact Rank**
Air Quality–Offshore Construction Phase					
Increased atmospheric pollutant concentrations due to emissions from vessels' involved in the wells drilling and completion	Between 1 and 5 years	Local scale	Low value/ sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**5 – Low**
Score	*2*	*1*	*1*	*1*	
Increased atmospheric pollutant concentrations due to emissions from vessels' involved in the FPSO installation	Less than 1 year / Temporary	Local scale	Low value/ sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**4 – Low**
Score	*1*	*1*	*1*	*1*	
Increased atmospheric pollutant concentrations due to emissions from vessels' involved in the Pipe laying and Installation	Less than 1 year / Temporary	Local scale	Low value/ sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**4 – Low**
Score	*1*	*1*	*1*	*1*	

Operational Phase

The residual impact significance on air quality associated with the operational phase is summarised in Table 10.31.

Table 10.31 Ranking of Residual Impacts on Air Quality during Offshore Operational Phase

Impacts	Duration	Extent	Importance / Resilience of Receptor / Resource	No. of Elements Involved	Impact Rank
Air Quality–Offshore Operational Phase					
Increased atmospheric pollutant concentrations due to exhaust emissions released by the FPSO operation	Over 10 years / Irreversible	Local scale	Low value/ sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**7 - Medium**
Score	*4*	*1*	*1*	*1*	

Decommissioning

The residual impact significance on air quality associated with decommissioning is summarised in Table 10.32

Table 10.32 Ranking of Residual Impacts on Air Quality during Offshore Decommissioning

Impacts	Duration	Extent	Importance / Resilience of Receptor / Resource	No. of Elements Involved	Impact Rank
Air Quality–Offshore Decommissioning					
Vessels exhausts	Between 1 and 5 years	Local scale	Low value/ sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**5 - Low**
Score	*2*	*1*	*1*	*1*	

10.5.4 GHG Emissions

The Greenhouse Gas (GHG) emissions associated with the offshore planned activities are reported in Table 10.33.

Table 10.33 GHG Emission Sources from Offshore Project Activities

Project Phase	GHG Emissions
Construction	• CO_2 and CH_4 emissions from vessels' engines, power units, drilling rigs well testing and vent/flaring.
Operation	• CO_2 emissions from power generation; • CO_2 and CH_4 emissions from FPSO processes and from flaring limited to the drilling process upsets, maintenance, fugitive. • CO_2 and CH_4 emissions from vessels involved in maintenance works and helicopter flights.

Project Phase	GHG Emissions
Decommissioning	• CO_2 and CH_4 emissions from vessels for facilities dismantle and for personnel and material transport.

10.5.5 Noise

Installation/ Construction Phase

The residual impacts on noise environment associated with the construction phase are summarised in Table 10.34.

Table 10.34 Ranking of residual impacts on underwater noise during installation/ construction phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Underwater Noise – Installation/ Construction Phase					
Increased underwater noise emissions as a result of pipeline laying, trench excavation and shipping activities	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Increased underwater noise emissions as a result of drilling activities	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 – Low**
Score	*2*	*1*	*2*	*1*	

Operational Phase

The residual impacts on freshwater resources associated with the installation/construction phase are summarised in Table 10.35.

Table 10.35 Ranking of residual impacts on noise and underwater noise during operational phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Noise and Underwater Noise – Operational Phase					
Increased underwater noise emissions due to general shipping activities and FPSO operation	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	

<u>Decommissioning Phase</u>

In this phase potential impacts on underwater noise will be generated mainly by vessels operational for offshore installations decommissioning. The associated impacts are expected to be similiar though of reduced intensity and duration than during installation/construction phase. For pipeline decommissioning, considering that the pipeline will remain underground and they will be only filled with a suitable material, the related impacts due to underwater noise generation on decommissioning phase will be **Not significant**.

10.5.6 Marine Fauna and Flora

<u>Installation/ Construction Phase</u>

The residual impacts on marine fauna associated with the installation/construction phase are summarised in Table 10.36.

Table 10.36 Ranking of residual impacts and risks on marine fauna during installation/construction phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Marine Fauna – Installation/ Construction Phase					
Potential disturbance of marine fauna due to increased underwater noise emissions	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Potential disturbance of marine fauna due to physical presence (collision risk, light emissions, physical presence)	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Potential disturbance of marine fauna due to cuttings deposition on seabed, decreased marine water quality and increase of suspended solids	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Potential disturbance to ecosysym due to the introduction of alien species due to the discharge of ballast water	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	

Note: Impact related to drilling mud and cuttings discharge have been classified according to methodology introduced in Annex G. However, it has to be noted that, as described in the Drill Cutting Modelling Study results (Annex K), this Project activity will lead to minor effects on marine organisms.

Operational Phase

The residual impacts on marine fauna associated with the operational phase are summarised in Table 10.37.

Table 10.37 Ranking of residual risks and impacts on marine fauna during operational phase

Impacts	*Duration*	*Extent*	*Importance / Resilience of Receptor / Resource*	*No. of Elements Involved*	*Impact Rank*
Marine Fauna – Operational Phase					
Potential disturbance of marine fauna due to increased underwater noise emissions	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	
Potential disturbance of marine fauna due to physical presence	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or	**8 - Medium**
Score	*4*	*1*	*2*	*1*	
Potential disturbance of marine fauna due physical disturbance of the seabed	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	
Potential disturbance to ecosysym due to the introduction of alien species due to the discharge of ballast water	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	

Decommissioning Phase

For the pipeline decommissioning, considering that the pipes will remain underground/on the sea bed, the related impacts on marine biota will be **Not significant** as no changes and almost no intervention is envisaged. Wells will be permanently abandoned, setting cement plugs on top of the openhole of each well. FPSO and drill rig will be towed and scrapped. Potential impacts will therefore be limited to the physical presence and movements of the vessels as well as to the noise they generate. These impacts will be similar to those on the installation/construction phase though of reduced intensity and duration. Impacts will be direct and temporary.

10.5.7 Coastal Processes

Installation/ Construction Phase

The residual impacts on coastal processes associated with the installation/construction phase are summarised in Table 10.38.

Table 10.38 Ranking of impacts on marine fauna during installation/construction phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Marine Fauna – Installation/ construction Phase					
Impacts due to the Installation of the Pipeline in the Nearshore	Less than 1 year / Temporary	Local scale	Low value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**4 - Low**
Score	*1*	*1*	*1*	*1*	

Operational Phase

The impacts that will arise throughout the operational phase are anticipated to result from physical presence of the nearshore pipeline. The permanent presence of the nearshore pipeline could result in an alteration of sedimentation transport and deposition patterns along the coast of Sanzule. However, considering that the pipeline will remain buried, apart from small mounds generated during installation/construction phase no artificial infrastructure will remain to disrupt the normal sediment flow. As a result impact on coastal processes from operational phase are considered as **Not significant**.

Decommissioning Phase

For the pipeline decommissioning, considering that the nearshore pipeline will remain underground, the related impacts on coastal processes will be **Not significant** as no changes and almost no intervention is envisaged.

10.6 Fisheries Impact Assessment

10.6.1 Construction Phase

The following table presents a summary of the residual impact associated with the impacts identified.

Table 10.39 Residual Impacts on Commercially exploited species during Construction Phase

Impacts	**Duration**	**Extent**	***Importance / Resilience of Receptor /Resource***	***No. of Elements Involved***	**Impact Rank**
Impact derived from FPSO, drilling rig and vessel discharges.	Between 1 and 5 years	Local scale	Low value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**5-Low**
Score	2	1	1	1	
Impact derived from discharge of ballast waters	Less than 1 year / Temporary	Local scale	Low value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**4-Low**
Score	1	1	1	1	
Impact derived from the physical presence and light emissions on commercially exploited species.	Between 1 and 5 years	Local scale	Low value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**5-Low**
Score	2	1	1	1	
Potential impact of underwater noise commercially exploited species	Between 1 and 5 years	Local scale	Low value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**5-Low**
Score	2	1	1	1	
Pipeline underwater noise activities potentially affecting commercially exploited species	Between 1 and 5 years	Local scale	Moderate value/ sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6-Low**
Score	2	1	2	1	

10.6.2 Operation and Maintenance Phase

The following table presents a summary of the residual impact associated with the impacts identified.

Table 10.40 Residual Impacts on Commercially exploited species during Operation Phase

Impacts	Duration	Extent	*Importance / Resilience of Receptor /Resource*	*No. of Elements Involved*	Impact Rank
Impact derived from FPSO, and vessel discharges	Over 10 years / Irreversible	Local scale	Low value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**7-Medium**
Score	*4*	1	1	1	
Impact derived from the physical presence and light emissions on commercially exploited species.	Over 10 years / Irreversible	Local scale	Low value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**7-Medium**
Score	*4*	1	1	1	
Potential impact of underwater noise commercially exploited species	Over 10 years / Irreversible	Local scale	Low value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**7-Medium**
Score	*4*	1	1	1	

10.6.3 Decommissioning Phase

The residual impacts are likely to be similar to construction that is of low significance.

10.7 IMPACTS ON THE SOCIO-ECONOMIC AND HEALTH ENVIRONMENT

10.7.1 Economy and Employment

Construction Phase

The residual impacts on economy and employment associated with the construction phase are summarized in Table 10.41.

Table 10.41 Residual Impacts on Economy and Employment during Construction Phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor /Resource***	***No. of Elements Involved***	***Impact Rank***
Economy and Employment – Construction Phase					
Increased Government Revenue	Between 1 and 5 years	National scale	Moderate value/sensitivity of receptors or resources	Affecting a great no. of individuals, households and/or medium/large enterprises.	**10-High Positive**
Score	2	3	2	3	
Employment opportunities and skills enhancement	Between 1 and 5 years	Regional scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**8-Medium-Positive**
Score	2	2	2	2	
Increased procurement	Between 1 and 5 years	International scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**10-High Positive**
Score	2	4	2	2	
Enhanced hospitality and tourism business development	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6-Low Positive**
Score	2	1	2	1	
increased price inflation and economic vulnerability	Between 1 and 5 years	Local scale	High value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**8-Medium**
Score	2	1	3	2	
Workforce demobilisation	Project duration/Between 1 and 5 years	Local scale	High value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**8-Medium**
	2	1	3	2	

Operation Phase

The residual impacts on economy and employment associated with the operation phase are summarized in Table 10.42.

Table 10.42 Residual Impacts on Economy and Employment during Operation Phase

Impacts	*Duration*	*Extent*	*Importance / Resilience of Receptor /Resource*	*No. of Elements Involved*	*Impact Rank*
Economy and Employment – Construction Phase					
Increased government revenue	Over 10 years / Irreversible	National scale	Moderate value/sensitivity of receptors or resources	Affecting a great no. of individuals, households and/or medium/large enterprises.	**13-Critical Positive**
Score	4	3	2	3	
Employment opportunities and skills enhancement	Over 10 years / Irreversible	Regional scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**10- High Positive**
Score	4	2	2	2	
Increased procurement	Over 10 years / Irreversible	Regional scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**10- High Positive**
Score	4	2	2	2	
Enhanced hospitality and tourism business development	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8- Medium Positive**
Score	4	1	2	1	
Increased price inflation and economic vulnerability	Between 1 and 5 years	Local scale	Low value/ sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**5- Low**
Score	2	1	1	1	

Decommissioning Phase

The residual impacts are likely to be similar to construction, with the benefit of the implementation of improved mitigations based on lessons learned. However, residual impacts depend on the outcome of potential impacts during construction and the effectiveness of mitigation measures. As such, the impacts have not been rated at this stage.

10.7.2 Land, Fisheries and Livelihoods

Construction Phase

The residual impacts on Land and Livelihood resources associated with the construction phase are summarized in Table 10.43.

Table 10.43 Residual Impacts on Land and Livelihoods during Construction Phase

Impacts	**Duration**	**Extent**	***Importance / Resilience of Receptor /Resource***	***No. of Elements Involved***	**Impact Rank**
Land and Livelihood – Construction Phase					
Economic Displacement of Land-Based Livelihoods					
Economic displacement of farming in land acquisition area	Over 10 years / Irreversible	Local scale	High value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats of species	**10-High**
Score	4	1	3	2	
Disruption/Displacement of Fisheries-based livelihoods					
Restricted access to offshore fishing grounds due to exclusion zones	Between 1 and 5 years	Local scale	Low value/ sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**6-Low**
Score	2	1	1	2	
Disruption of onshore and near-shore fishing activities	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**7-Medium**
Score	2	1	2	2	
Damage to fishing gear	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**7-Medium**
Score	2	1	2	2	
Lighting	Between 1 and 5 years	Local scale	Low value/ sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**6-Low**
Score	2	1	1	2	

Operation Phase

The residual impacts on Land and Livelihood resources associated with the operation phase are summarized in Table 10.44.

Table 10.44 Residual Impacts on Land and Livelihoods during Operation Phase

Impacts	**Duration**	**Extent**	***Importance / Resilience of Receptor /Resource***	***No. of Elements Involved***	**Impact Rank**
Land and Livelihood – Construction Phase					
Economic Displacement of Land-Based Livelihoods					
Economic Displacement of Farming in Land Acquisition Area	Over 10 years / Irreversible	Local scale	High value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats of species	**10-High**
Score	4	1	3	2	
Disruption/Displacement of Marine Fishing-based livelihoods					
Restricted Access to Offshore Fishing Grounds due to Exclusion Zones	Over 10 years / Irreversible	Local scale	Low value/ sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**8-Medium**
Score	4	1	1	2	
Disruption of near-shore Fishing activities	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**9-Medium**
Score	4	1	2	2	
Damage to Fishing Gear	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**9-Medium**
Score	4	1	2	2	
Lighting	Over 10 years / Irreversible	Local scale	Low value/ sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**8-Medium**
Score	4	1	1	2	

Decommissioning Phase

The residual impacts at decommissioning are likely to be similar to those felt during construction, with the benefit of being improved mitigations based on lessons learned during construction. However, residual impacts depend on the outcome of potential impacts during construction and the effectiveness of mitigation measures. As such, the impacts have not been rated at this stage.

10.7.3 Socio-cultural Changes

Construction Phase

The residual impacts on socio-cultural changes associated with the construction phase are summarized in Table 10.45.

Table 10.45 Residual Impacts on Socio-cultural Impacts

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor /Resource***	***No. of Elements Involved***	***Impact Rank***
Socio-Cultural Change – Construction Phase					
Changes to cultural and Social Norms	Between 1 and 5 years	Local scale	High value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**7-Medium**
Score	2	1	3	1	
Increased anti-social behaviour	Between 1 and 5 years	Local scale	High value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**7-Medium**
Score	2	1	3	1	
Tension and Conflict between Villages	Between 1 and 5 years	Local scale	High value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**7-Medium**
Score	2	1	3	1	

Operation Phase

The residual impacts on socio-cultural changes associated with the construction phase are summarized in Table 10.46.

Table 10.46 Residual Impacts on Socio-cultural Impacts

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor /Resource***	***No. of Elements Involved***	***Impact Rank***
Socio-Cultural Change – Operation Phase					

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor /Resource***	***No. of Elements Involved***	***Impact Rank***
Socio-Cultural Change – Operation Phase					
Changes to cultural and social norms	Over 10 years / Irreversible	Local scale	Low value/ sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**7-Medium**
Score	4	1	1	1	
Increased anti-social behaviour	Over 10 years / Irreversible	Local scale	Low value/ sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**7-Medium**
Score	4	1	1	1	
Tension and conflict between villages	Over 10 years / Irreversible	Local scale	Low value/ sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**7-Medium**
Score	4	1	1	1	

Decommissioning Phase

The residual impacts are likely to be similar to construction, with the benefit of improved mitigations based on lessons learned during construction. However, residual impacts depend on the outcome of potential impacts during construction and the effectiveness of mitigation measures. As such, the impacts have not been rated at this stage.

10.7.4 Cultural heritage resources

Construction Phase

The residual impacts on cultural heritage resources associated with the construction phase are summarized in Table 10.47.

Table 10.47 Residual Impacts on Cultural Heritage during Construction Phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor /Resource***	***No. of Elements Involved***	***Impact Rank***
Economy and Employment – Construction Phase					
Cultural heritage resources	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**6 Low**
	2	1	2	1	

Impacts	*Duration*	*Extent*	*Importance / Resilience of Receptor /Resource*	*No. of Elements Involved*	*Impact Rank*
Economy and Employment – Construction Phase					
Sense of place	Between 1 and 5 years	Local scale	High value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**7 Medium**
	2	1	3	1	

Operation Phase

The residual impacts on cultural heritage resources associated with the operation phase are summarized in Table 10.48.

Table 10.48 Residual Impacts on Cultural Heritage during Operation Phase

Impacts	*Duration*	*Extent*	*Importance / Resilience of Receptor /Resource*	*No. of Elements Involved*	*Impact Rank*
Economy and Employment – Construction Phase					
Cultural heritage resources	Over 10 years / Irreversible	Local scale	Low value/ sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**7 Medium**
Score	4	1	1	1	
Sense of place	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**8 Medium**
Score	4	1	2	1	

Decommissioning Phase

The residual impacts are likely to be similar to construction, with the benefit of improved mitigations based on lessons learned during construction. However, residual impacts depend on the outcome of potential impacts during construction and the effectiveness of mitigation measures. As such, the impacts have not been rated at this stage.

10.7.5 Social and Health infrastructure and Public Services

Construction Phase

The residual impacts on social infrastructure and marine traffic associated with the construction phase are summarized in Table 10.49.

Table 10.49 Residual Impacts on Infrastructure and Public Services during the Construction Phase

Impact	Duration	Extent	Importance / Resilience of Receptor /Resource	No. of Elements Involved	Impact Rank
Infrastructure and public services – Construction Phase					
Social infrastructure	Between 1 and 5 years	Local scale	High value/ sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**8-Medium**
Score	2	1	3	2	
Road infrastructure	Between 1 and 5 years	Regional scale	High value/ sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**9-Medium**
Score	2	2	3	2	
Health infrastructure	Between 1 and 5 years	Regional scale	High value/ sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**9-Medium**
Score	2	2	3	2	
Marine traffic and infrastructure	Between 1 and 5 years	International Scale	Low value/ sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**9-Medium**
Score	2	4	1	2	

Operation Phase

The residual impacts on social infrastructure and marine traffic associated with the operation phase are summarized in Table 10.50.

Table 10.50 Residual Impacts on Infrastructure and Public Services during Operation Phase

Impact	Duration	Extent	Importance / Resilience of Receptor /Resource	No. of Elements Involved	Impact Rank
Infrastructure and public services – Operation Phase					
Social infrastructure	Over 10 years / Irreversible	Local scale	Low value/ sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**7-Medium**
Score	4	1	1	1	

Impact	Duration	Extent	Importance / Resilience of Receptor /Resource	No. of Elements Involved	Impact Rank
Road infrastructure	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8-Medium**
Score	4	1	2	1	
Health infrastructure	Over 10 years / Irreversible	Local scale	Low value/ sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**7-Medium**
Score	4	1	1	1	
Marine traffic and infrastructure	Over 10 years / Irreversible	Regional scale	Low value/ sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8-Medium**
Score	4	2	1	1	

Decommissioning Phase

The residual impacts are likely to be similar to construction, with the benefit of improved mitigations based on lessons learned during construction. However, residual impacts depend on the outcome of potential impacts during construction and the effectiveness of mitigation measures. As such, the impacts have not been rated at this stage.

10.7.6 Workers management and rights, and workers health and safety

Construction Phase

The residual impacts on worker management and rights associated with the construction phase are summarized in Table 10.51.

Table 10.51 Residual Impacts on Worker Management and Rights during Construction Phase

Impacts	Duration	Extent	Importance / Resilience of Receptor /Resource	No. of Elements Involved	Impact Rank
Worker health and safety	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6-Low**
Score	2	1	2	1	
Workers' rights, retrenchment and accommodation	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or	**6-Low**

Impacts	Duration	Extent	*Importance / Resilience of Receptor /Resource*	*No. of Elements Involved*	Impact Rank
				small no. of species	
Score	2	1	2	1	
Forced labour	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6-Low**
Score	2	1	2	1	
Child labour	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6-Low**
Score	2	1	2	1	

Operation and Maintenance Phase

The residual impacts on worker management and rights associated with the construction phase are summarized in Table 10.52.

Table 10.52 Residual Impacts on Worker Management and Rights during Operation Phase

Impacts	Duration	Extent	*Importance / Resilience of Receptor /Resource*	*No. of Elements Involved*	Impact Rank
Worker health and safety	Over 10 years*	Local scale	Low value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**7-Medium**
Score	4	1	1	1	
Workers' rights and accommodation	Over 10 years*	Local scale	Low value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**7-Medium**
Score	4	1	1	1	

**Although the impact will last for over 10 years in fact it may be intermittent over that time period.*

Decommissioning Phase

The residual impacts are likely to be similar to construction, with the benefit of being improved mitigations based on lessons learned during construction. However, residual impacts depend on the outcome of potential impacts during construction and the effectiveness of mitigation measures. As such, residual impacts could be rated differently approaching the time period of Project decommissioning.

10.7.7 Community Health, Safety and Security

Construction Phase

The residual impacts on community health, safety and security associated with the construction phase are summarized in Table 10.53.

Table 10.53 Residual Impacts on Health, Safety and Security during Construction Phase

Impacts	Duration	Extent	*Importance / Resilience of Receptor /Resource*	*No. of Elements Involved*	Impact Rank
Increased prevalence of Sexually Transmitted Infections including HIV/AIDS	Between 1 and 5 years	Regional scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**8-Medium**
Score	2	2	2	2	
Increased prevalence of Communicable diseases	Between 1 and 5 years	Regional scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**8-Medium**
Score	2	2	2	2	
Increased prevalence of malaria	Between 1 and 5 years	Local scale	Low value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**6-Low**
Score	2	1	1	2	
Traffic accidents from increased traffic and presence of heavy vehicles in local roads	Between 1 and 5 years	Regional scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**7-Medium**
Score	2	2	2	1	

Impacts	Duration	Extent	*Importance / Resilience of Receptor /Resource*	*No. of Elements Involved*	Impact Rank
Increased pressure on health care resources.	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**7-Medium**
Score	2	1	2	2	
Site trespass and injury	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**6-Low**
Score	2	1	2	1	
Environmental health	Between 1 and 5 years	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**6-Low**
Score	2	1	2	1	
Public security	Between 1 and 5 years	Local scale	Low value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**5-Low**
Score	2	1	1	1	

Operation and Maintenance Phase

The residual impacts on community health, safety and security associated with the operation phase are summarized Table 10.54.

Table 10.54 Residual Impacts on Health, Safety and Security during Operation Phase

Impacts	Duration	Extent	*Importance / Resilience of Receptor /Resource*	*No. of Elements Involved*	Impact Rank
Increased prevalence of sexually transmitted infections, HIV/AIDS	Over 10 years / Irreversible	Local scale	Moderate value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 -Medium**
Score	4	1	2	1	
Increased prevalence of communicable diseases	Over 10 years / Irreversible	Local scale	Low value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8-Medium**
Score	4	1	1	1	
Increased transmission of malaria	Over 10 years / Irreversible	Local scale	Low value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**7-Medium**
Score	4	1	1	1	
Traffic accidents from increased traffic and presence of heavy vehicles in local roads	Over 10 years / Irreversible	Local scale	Low value/sensitivity of receptors or resources	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**7-Medium**
Score	4	1	1	1	
Public security	Over 10 years / Irreversible	Local scale	Low value/sensitivity of receptors or resources	Affecting small no. of individuals, communities or administrative and/or higher no. of species and habitats	**7-Medium**
Score	4	1	1	1	

Decommissioning Phase

The residual impacts are likely to be similar to construction, with the benefit of being improved mitigations based on lessons learned during construction. However, residual impacts depend on the outcome of potential impacts during construction and the effectiveness of mitigation measures. As such, residual impacts could be rated differently approaching the time period of Project decommissioning.

10.8 ECOSYSTEM SERVICES

10.8.1 Construction Phase

This Section identifies the possible impacts on ecosystem services during the installation/construction and pre-commissioning phase, including onshore and offshore activities. Four tables are presented, each for one ecosytem (forest, wetlands, deepsea and nearshore), where the different sources of impacts and potential impacts on ecosystem services are identified and discussed.

Table 10.55 Identification of impacts and risks to ecosystem services (Forest habitat) - construction phase

Sub-activity Issue	Potential Impact	Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	**Regulating**	**Cultural**
Facility footprint	Modification, fragmentation and loss of habitats and agricultural land. Terrain modification.	Reduction of the habitat could reduce the ability to hunt and gather wild foods.	Loss of carbon sequestration services from clearing vegetation. Reduction in flood and erosion control and water purification by clearing vegetation.	Reduction of species.
Exclusion zones	Reduced human access to an area.	Temporary reduction in local people's ability to gather wild products. Increase in key species due to protection from overuse.	n/a	Temporary loss of access to cultural, livelihood and recreation features. Protection of habitats and species from misuse and overuse by people.
Workforce and ancillary camps	Disposal and pollution from wastes and wastewater. Vegetation clearance. Introduction of alien-invasive species.	Loss of carbon sequestration services from clearing vegetation. Reduction in flood and erosion control and water purification by clearing vegetation.	Loss of carbon sequestration services from clearing vegetation. Reduction in flood and erosion control and water purification by clearing vegetation.	
Site preparation	Modification, fragmentation and removal of habitats. Modification to drainage and hydrology regimes. Soil erosion. Water runoff and sedimentation.	Reduction of the habitat could reduce the ability to hunt and gather wild foods.	Loss of carbon sequestration services from clearing vegetation. Reduction in flood and erosion control and water purification by clearing vegetation.	Loss of access to recreation features
Provisioning workforce	Depletion of water and local food resources. Reduction in flora and fauna.	New local market but increased pressure on use of water, wild meat and fruit as a result of increased procurement.	n/a	Reduction in species from increased hunting.
Construction work	Noise, light, vibrations and dust from construction works affecting flora and fauna. Depletion of natural resources for buildings	Disturbance and loss of animals	Interference with natural water supplies downstream.	n/a
Landscape alteration	Visual impacts. Import of non-local species.	n/a	n/a	Visual and aesthetic impact on enjoyment of locals and visitors.
Accidental events	Water, soil and air contamination. Mortality and morbidity to flora and fauna. Noise, fire and smoke.	Reduction in provisioning foods and water through contamination by chemicals.	Reduction of regulating services from loss of habitat extent and quality.	Reduction in local livelihoods, recreation and species through chemical contamination.

Table 10.56 Identification of impacts and risks to ecosystem services (wetlands) - construction phase

Sub-activity Issue	Potential Impact	Impacts and risks on Ecosystem Services		
		Provisioning	Regulating	Cultural
Chemical handling and use	Water quality contamination associated with permitted releases.	Reduction in artisanal or commercial fisheries.	n/a	n/a
Accidental events	Water and air contamination. Mortality and morbidity to flora and fauna. Noise, fire and smoke.	Reduction in provisioning foods through contamination by chemicals.	n/a	Reduction in local livelihoods and species through oil and chemical contamination.

Table 10.57 Identification of impacts and risks to ecosystem services (deepwater habitats) - construction phase

Sub-activity Issue	Potential Impact	Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	Regulating	Cultural
Vessels	Noise and light. Physical presence of ships leading to disturbance to fauna. Visual presence.	Reduction in commercial fisheries. Impacts on fisheries due to disturbance.	n/a	Disturbance (visual, auditory and physical) of species.
Exclusion zones	Reduced human access to an area. Protection of habitats and species.	Temporary reduction in artisanal or commercial fishing. Local increase in key species due to protection from overuse.	n/a	n/a
Seabed interaction	Turbidity, noise and direct physical impacts to seabed habitats, species, spawning areas and fishing grounds.	Loss of habitat could result in loss of associated provisioning services such as fisheries.	Loss of habitat could result in loss of associated regulating services such as assimilative services.	Loss of habitat could result in loss of associated cultural services such as aesthetic and non-use values.
Chemical handling and use	Water quality contamination.	Reduction in commercial or artisanal fisheries.	n/a	n/a
Accidental events	Water and air contamination. Mortality and morbidity to flora and fauna. Noise, fire and smoke.	Reduction in provisioning foods and fisheries through contamination by chemicals.	n/a	n/a
Facility/ equipment footprint	Artificial reef effect (positive impacts for species, fish and fisheries)	Increase commercial or artisanal fisheries.	n/a	n/a

Table 10.58 Identification of impacts and risks to ecosystem services (nearshore, transition zone) - construction phase

Sub-activity Issue	Potential Impact	Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	**Regulating**	**Cultural**
Offshore				
Vessels	Noise and light. Physical presence of ships leading to disturbance to fauna. Visual presence.	Reduction in artisanal or commercial fisheries and fish or shellfish for consumption.	n/a	Disturbance (visual, auditory and physical) of species
Exclusion zones	Reduced human access to an area. Protection of habitats and species.	Temporary reduction in local people's ability to fish.	n/a	Loss of access to cultural, livelihood. Protection of habitats and species from overuse.
Seabed interaction	Turbidity, noise and direct physical impacts to seabed habitats, species, spawning areas and fishing grounds.	Loss of habitat could result in a reduction in fish or shellfish for consumption.	Loss of habitat could result in loss of associated regulating services such as assimilative services.	Loss of habitat could result in loss of associated cultural services.
Chemical handling and use	Water quality contamination associated with permitted releases.	Reduction in commercial or artisanal fisheries.	n/a	Negative impacts for marine recreation
Accidental events	Water and air contamination. Mortality and morbidity to flora and fauna. Noise, fire and smoke.	Reduction in provisioning foods through contamination by chemicals.	n/a	Reduction in local livelihoods, recreation and species through oil and chemical contamination.
Facility / quipment footprint	Artificial reef effect (positive impacts for various species, fish and fisheries)	Increase commercial or artisanal fisheries. Alternatively, reduction in fish or shellfish due to disturbance.	n/a	n/a
Onshore				
Facility footprint and Site preparation	Modification, fragmentation and loss of habitats and agricultural land. Modification to drainage and hydrology regimes. Soil erosion. Water runoff and sedimentation.	Reduction of habitat could reduce the ability to hunt and gather wild foods and to harvest timber and agricultural outputs.	Loss of carbon sequestration services from clearing vegetation. Reduction in flood and erosion control and water purification by clearing vegetation.	Reduction in access to cultural or recreation features
Exclusion zones	Reduced human access to an area. Protection and maintenance of habitats and species.	Temporary reduction in local people's ability to gather wild products. Increase in key species due to protection.	n/a	Loss of access to cultural, livelihood and recreation features. Protection from overuse.
Construction work	Noise, light, vibrations and dust. Depletion of natural resources.	Disturbance and loss of animals	Interference with natural water supplies downstream.	n/a
Landscape alteration	Visual impacts to the local landscape. Import of non-local species.	n/a	n/a	Visual and aesthetic impact on enjoyment of locals.
Accidental events	Water, soil and air contamination. Mortality and morbidity to flora and fauna. Noise, fire and smoke.	Reduction in provisioning foods and water through contamination by oil and chemicals.	Reduction of regulating services from loss of habitat extent and quality.	Reduction in local livelihoods, recreation and species through chemical contamination.

10.8.2 Operational phase impacts

This Section identifies the possible impacts on ecosystem services during the operation phase, including onshore and offshore activities.

Four tables are presented, each for one ecosytem, where the different sources of impacts and potential impacts on ecosystem services provided are identified and discussed.

Table 10.59 Identification of impacts and risks to ecosystem services (forest habitat) - operational phase

Sub-activity Issue	Potential Impact	Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	Regulating	Cultural
Facility footprint	Fragmentation of habitats. Noise. Light. Atmospheric emissions.	Reduction of habitat could reduce the ability to hunt and gather wild foods and to harvest timber and agricultural outputs.	Loss of carbon sequestration services from clearing vegetation. Reduction in flood and erosion control and water purification by clearing vegetation.	n/a
Workforce and work camps	Disposal and pollution from wastes and wastewater, having visual, physical, biological and chemical impacts. Cutting down of trees. Introduction of alien-invasive species.	Pollution of water supply. Changes to supply of wild foods through introduction of alien species.	Loss of carbon sequestration services from clearing vegetation. Reduction in water purification by clearing vegetation.	Visual and aesthetic impact of camp and waste.
Provisioning workforce	Depletion of water and local food resources. Reduction in flora and fauna.	New local market but increased pressure on use of water and wild meat, fruit, nuts, etc. gathered due to increased procurement.	n/a	Reduction in species from increased hunting.
General operation	Depletion of water resources. Support of local economies. Depletion of fuel, aggregates and timber.	Reduction of water supply. Restriction in energy supply	n/a	n/a
Management of waste materials and wastewater	Contamination of air, soil, water and groundwater resources potentially causing smothering and poisoning of flora and fauna.	Pollution of water supplies and impacts to fisheries. Useful products in waste materials.	n/a	Visual and aesthetic impact to locals. Threats to species for degradation of environment.
Visual presence	Impacts to local landscape. Visual impacts to local communities and amenity users.	Pollution of water supply.	n/a	Visual and aesthetic impact on enjoyment of locals.
Accidental events	Water, soil and air contamination. Mortality and morbidity to flora and fauna. Noise.	Reduction in provisioning foods and water through contamination by chemicals.	Reduction of regulating services from loss of habitat extent and quality.	Reduction in local livelihoods, recreation and species through chemical contamination.

Table 10.60 Identification of impacts and risks to ecosystem services (wetlands) - operational phase

Sub-activity Issue	Potential Impact	Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	**Regulating**	**Cultural**
Chemical handling and use	Water quality contamination associated with permitted releases.	Reduction in artisanal or commercial fisheries.		
Accidental events	Water and air contamination. Mortality and morbidity to flora and fauna. Noise, fire and smoke.	Reduction in provisioning foods through contamination by chemicals.		Reduction in local livelihoods and species through chemical contamination.

Table 10.61 Identification of impacts and risks to ecosystem services (deepwater habitat) - operational phase

Sub-activity Issue	Potential Impact	Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	**Regulating**	**Cultural**
FPSO and vessels	Noise and light. Physical presence of ships leading to disturbance to fauna. Visual presence. Alien-invasive species associated with water and sediment ballast.	Increase in commercial fisheries resulting from the rig acting as habitat. Impacts on fisheries due to disturbance and alien-invasive species.		Disturbance (visual, auditory and physical) of species
Buffer zones	Reduced human access to an area. Protection of habitats and species.	Reduction in commercial or artisanal fisheries. Local increase in key species due to protection from overuse.		
Footprint/ physical presence of equipment	Artificial reef effect (positive impacts for various species, fish and fisheries). Noise from subsea valves leading to disturbance of fauna.	Increase commercial or artisanal fisheries.		
Chemical handling and use	Water quality contamination associated with permitted releases.	Reduction in commercial or artisanal fisheries.		
Accidental events	Water and air contamination. Mortality and morbidity to flora and fauna. Noise, fire and smoke.	Reduction in provisioning foods and fisheries through contamination by chemicals.		Reduction in local livelihoods, recreation and species through chemical contamination.

Table 10.62 Identification of impacts and risks to ecosystem services (nearshore/ transition zone habitat) - operational phase

Sub-activity Issue	Potential Impact	Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	Regulating	Cultural
Offshore				
FPSO and vessels	Noise and light. Physical presence of ships leading to disturbance to fauna. Visual presence. Alien-invasive species associated with water and sediment ballast.	Increase in commercial or artisanal fisheries resulting from the rig acting as habitat. Impacts on fisheries due to disturbance and alien-invasive species.	n/a	Disturbance of species. Impacts on marine recreation (visual presence).
Buffer zones	Reduced human access to an area. Protection of habitats and species.	Reduction in local people's ability to fish. Increase in key species due to protection from overuse.	n/a	Loss of access to cultural, livelihood and recreation features. Protection of habitats and species from misuse and overuse by people.
Footprint / physical presence of equipment	Artificial reef effect (positive impacts for various species, fish and fisheries). Noise from subsea valves leading to disturbance of fauna	Increase commercial or artisanal fisheries. Alternatively, reduction in fish or shellfish due to disturbance.	n/a	n/a
Chemical handling and use	Water quality contamination associated with permitted releases.	Reduction in commercial or artisanal fisheries.	n/a	Negative impacts for marine recreation.
Accidental events	Water and air contamination. Mortality and morbidity to flora and fauna. Noise, fire and smoke.	Reduction in provisioning foods through contamination by chemicals.	n/a	Reduction in local livelihoods, recreation and species through chemical contamination.
Onshore				
Facility footprint	Fragmentation of habitats. Noise. Light. Atmospheric emissions.	Reduction in local people's ability to gather wild products.	Loss of carbon sequestration services from clearing vegetation. Reduction in flood and erosion control and water purification by clearing vegetation.	Reduction in access to cultural or recreation features. Disturb tranquillity for local communities and species.
Management of waste materials and wasterwater	Contamination of air, soil, water and groundwater resources potentially causing smothering and poisoning of flora and fauna.	Pollution of water supplies and impacts to fisheries and damage to mangroves habitats. Useful products in the waste materials.	n/a	Visual and aesthetic impact to locals and visitors. Threats to species due to environmental degradation.
Visual presence	Impacts to local landscape. Visual impacts to local communities and amenity users.	Pollution of water supply.	n/a	Visual and aesthetic impact on enjoyment of locals.
Accidental events	Water, soil and air contamination. Mortality and morbidity to flora and	Reduction in provisioning foods and water through contamination by oil and	Reduction of regulating services from loss of habitat extent and quality.	Reduction in local livelihoods, recreation and species through

Sub-activity Issue	Potential Impact	Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	**Regulating**	**Cultural**
Offshore				
	fauna. Noise, fire and smoke.	chemicals.		chemical contamination.

10.8.3 Decommissioning phase impacts

Potential impacts during Project decommissioning are likely to be similar to impacts during construction but less significant than during the Construction Phase due to the smaller affected area.

10.9 UNPLANNED EVENTS

Several types of unplanned events with potential consequences to humans and the environment could occur during the different phases of the project. In this early stage of engineering and design, the Project has performed preliminary assessments of risks. More detailed assessments will be conducted at later stages of the Project design including studies to identify risks and methods to assess and mitigate risks (e.g., HAZOP, QRA).

10.9.1 Offshore component

Preliminary assessments undertaken allow an identification and asessment of the events with the most significant consequences. These events in the case of the OCT project are:

- Well blow out;
- Rupture/failure of pipes/flow lines at different sections:
- Spills of hazardous materials (including oil spill and diesel spill from FPSO).

These impacts from these events are described in the following Sections.

Seabirds and Coastal Birds

Direct mortality of birds in the event of an oil spill is often the most widely perceived risk. While impacts to birds can occur offshore in the marine environment, the more pronounced impacts are often experienced if oil reaches coastal waters. Spills affecting coastal waters near major bird colonies during the breeding season can be particularly severe since birds are feeding intensively and often dive through the surface oil to feed on fish.

Main bird areas potentially affected by the spills according to the model are the coastal Important Bird Areas, namely the Amasuri wetland, Densu Delta, Keta Lagoon Complex, Muni-Pomadze, Sakumo and Songor. According to the model, these areas would be affected with more than the 90% probability in the most severe and most probable scenarios derived from oil wells, while in the scenario of the diesel spill the probability of each area to be affected would be less than 30%.

Marine Mammals

Marine mammals are generally less sensitive to oil spills than seabirds as they will tend to avoid and move away from affected areas and avoid any breaching or feeding behaviors, thus reducing direct physiological impacts, and returning as the environment recovers. However, marine mammals are still sensitive to impacts from the hydrocarbons and chemicals that evaporate from the oil, particularly in the first few days following a spill event.

According to the modelled results, most of the area affected by the spill in the most probable and most severe scenarios is expected to present dissolved aromatic hydrocarbons (DAH) concentrations above the acute toxicological threshold (5 ppb). An oil spill as those modelled would result in avoidance of the area by the marine mammals and an increase in mortality and probably a reduction in reproduction success due to potential chronic problems for the individuals affected.

Marine turtles

Turtles are sensitive to the effects of oil spills at all life stages: eggs, post hatchlings, juveniles and adults. Potential direct impacts from oil spills to sea turtles include:

- increased egg mortality and developmental defects;
- direct mortality due to oiling in hatchlings, juveniles and adults; and
- negative impacts to skin, blood, immune systems and salt glands.

In addition, sea turtles are sensitive to potential secondary and longer term impacts, which include:

- behavioral effects (eg disorientation) resulting from loss of smell sensors;
- contamination of food supply and reduction in available food levels; and
- influence on sea turtle development and behaviour caused by subtle changes in sand temperature colour and when spills impact the shoreline (eg because sex determination in turtles is temperature dependent, shifts in sand temperature caused by oiling could potentially change hatchlings sex ratios).

Fish Stocks

Typically, adult fish are not considered highly sensitive to impacts from oil spills. In open waters, fish have the ability to move away from an area of pollution, and therefore it is unlikely that fish are significantly affected by oil in open water. Fish kills may occur, however, as a result of high exposure to emulsified oil / freshly spilled diesel in shallow waters (such as in lagoons) and oil pollution may clog fish gills causing asphyxiation.

In all the oil spill scenarios modelled, the top few meters of the water column beneath the slick in the first days after release, before many hydrocarbon compounds evaporate or degrade, are likely to present high levels of aromatic compounds which may cause acute toxicological effects due to narcosis. Fish exposed to elevated concentrations of hydrocarbons absorb contaminants through their gills, accumulating it within their internal organs which can lead also to long-term, sub-lethal effects. In addition, spilled oil reaching confined and shallow waters, such as lagoons or mangrove areas, poses a threat to fish eggs and larvae which cannot actively avoid oil.

Fisheries

In the event of an oil spill reaching either coastal waters, fisheries are usually temporarily banned by the regulatory authorities to prevent the introduction of polluted fish into markets. The fishermen might for a period be forced to stop or temporarily move to other fishing grounds free of oil slicks. Fishing communities along the coastline will therefore be affected on their livelihood during the closure, resulting in a reduction in both food and economic resources. Given the importance of artisanal fishing along the Ghanaian coast, fisheries are considered highly sensitive to impacts resulting from an oil spill that reaches coastal waters.

Coastal Habitats

According to the model performed there are more than 1,000 km of coastal areas at risk of being directly affected by oiling as a result of an oil spill. The probability of oiling however varies depending on the site, and even in a worst case scenario it is unlikely that all of these areas are finally affected at the same time. The model shows that the four major habitat types found along the shores of Ghana are at risk:

- Sandy marine shore ecosystem and beaches;
- Rocky marine shores;
- Coastal lagoons;
- Mangrove/ tidal forests.

Each type of coastal habitat is considered sensitive to oil spills, however, lagoons and mangrove habitats are considered particularly sensitive as they tend to support higher levels of biodiversity, and be the place of fish nurseries that allow the stocks to be replaced. They are also usually bird feeding areas.

10.9.2 Onshore Component

A formal risk assessment report is not yet available for the ORF at this stage of engineering design. These processes and documents are planned to be developed for the next stage of engineering design, in the form of HAZID, HAZOPS and QRAs for the different components of the onshore facilities. The objective of these will be to guarantee the safety of the facility in terms of risks to the nearest human habitation, which in case of the ORF will be the permanent accommodation camp located immediately south-west of the ORF facility.

At this stage of the project design and with very preliminary calculations, the need for potential further mitigation measures to guarantee the safety of the nearest buildings at Awonakrom cannot be discarded. Specific mitigations (if necessary) shall be designed when further steps of engineering and more formal risk assessment processes are developed.

10.10 CUMULATIVE IMPACTS

Cumulative impacts are generally considered to be impacts that act with impacts from other projects such that:

- the sum of the impacts is greater than the parts; or
- the sum of the impacts reaches a threshold level such that the impact becomes significant.

10.10.1 Cumulative Onshore Environmental Impacts

Air Quality

The cumulative impact on Air Quality for the construction phase are identified as **Not significant** unless construction phases are concurrent when these would be **Low**; and for operation as **Not significant**.

GHG Emissions

The cumulative impacts on GHG identified as **Not significant** construction phase are and as **High** for the operational phase in relation to the lifetime of impacts.

Noise and Vibration

In relation to the physical propagation of noise related to project activities and due to the location of the projects, the cumulative impacts on noise and vibration are expected to be **Not significant** during both construction and operation phases.

Surface Water

The cumulative impacts, taking the most conservative approach for the purpose of the impact assessment, on the surface water system are considered to be **Medium** during both construction and operation phases in relation to the sensitivity of the receptors.

Groundwater

Taking the most conservative approach for the purpose of the impact assessment, the cumulative impacts on the groundwater are considered to be **medium** during both construction and operation phases.

Terrestrial Soils, Geology and Geomorphology

The cumulative impacts on soils and geology are considered to be **Low** during construction (if the construction phases are concurrent) and **Not significant** during operation phase.

Terrestrial Flora

The cumulative impacts on terrestrial flora is considered to be **Medium** during construction phase, whilst has been assessed as **Not significant** during operation phase since the described risk is not related to this phase.

Terrestrial Fauna

Due to the largely modified habitat present over the planned development sites the cumulative impacts on terrestrial flora are considered to be **Low** during construction phase and **Not significant** during operation phase.

Landscape

The cumulative impacts on Landscape are considered to be **low** both during construction and operation phase.

10.10.2 Cumulative Offshore Environmental Impacts

Seawater Quality

The cumulative impacts on seawater quality (discharges and small-scale spills) is considered to be **Low** during construction and operation, and cumulative impacts of increased turbidity are considered **Not significant** for construction or operation

Deterioration in marine water quality could impact biodiversity, fisheries and local communities. Contaminants within the water column are likely to settle out and accumulate within the marine sediments, and negatively affect the benthic habitat and fauna as described in the following Sections.

Seabed

The cumulative impacts during construction and operation phases on seabed are considered **Not significant**.

Air Quality and GHG

The cumulative impacts on air quality during construction and operation are considered **Not significant**.

Underwater Noise

The cumulative impact from noise is therefore assessed as of **Low** significance during construction and operation phases.

Marine Fauna and Flora

Given the extension of suitable nesting habitats , the cumulative impacts on marine fauna and flora during construction and operation are considered **Low**.

Coastal Processes

It is considered that there will be **Not significant** cumulative impact on coastal processes derived from the presence of such structures and nearshore works during operation and construction.

Unplanned Events

In terms of cumulative impacts from offshore facilities unplanned events, the ones related to fire and explosions and environmental effects related to gas blow outs and pipeline ruptures depend heavily on the safety measures undertaken by other operators. Given the distances of between the different gas bearing faciltiies and infastructures it is not expected to have cumulative impacts from unplanned events from this source.

The most significant unplanned event from an offshore facility with environmental consequences is a hydrocarbon spill. In this respect the cumulative effects of OCTP Phases I and II have in fact been analysed jointly in this ESIA already, as well as the necessary mitigation measures.

The risk of collision and accidents related to vessel traffic may increase with the traffic increases related to Lornho Port, and that should be managed with the already mentioned Marine Traffic Management Plan.

10.10.3 Cumulative Impacts of the Socio-economic and Health Environment

Economy and Employment

The significance of this positive cumulative impact is considered to be **Low** during operation and construction given the low levels of literacy, available skills and lack of technical training of the local population, which limit the extent to which they are able to access and benefit employment opportunities available, particularly during the operation phase of the O&G projects.

Considering inflation, although this is expected to temper the inflationary action, the overall cumulative impact on price inflation is considered to be **Medium** during construction and operation.

Considering tourism, the significance of this cumulative impact is considered to be **Low** during construction and operation.

Lands and Livelihoods

The accelerated influx of people to the area as a result of other O&G developments in the will be associated increased pressure on land, natural resources and ecosystem services. The cumulative impact on fisheries based livelihoods, also considering the baseline context of already historically declining fish catch, is considered to be of **High** significance during construction and operations.

In terms of pressure on farming activity, multiple projects in the area, all with their own land requirements could lead to a significant loss of agricultural land and associated economic displacement and loss of livelihoods. The cumulative impact on farming is considered to be of **High** significance during construction and operation.

Considering the increased human pressure on natural resources and development of new transportation infrastructures may lead people accessing previously undisturbed land and therefore an increase of the potential for habitat degradation/land use change. This impact is considered to be of **Medium** significance during construction and operation.

Post Decommissioning and Livelihoods

The result of post-decommissioning job losses could have a negative economic and psychological impact on members of the local population, in particular those who have come to rely solely on the O&G sector for their source of livelihood. The significance of this cumulative impact is considered as **Medium** during decommissioning.

Socio-cultural Changes

The introduction of large scale developments in relatively remote and rural environments can bring about substantial social and cultural change as a result of the increasing number of project workers and job-seekers from outside the area or the country, that move into the area. These cumulative impacts are assessed to be of **Medium** significance.

Social Infrastructure and Public Services

In order to mitigate the negative impacts of increased pressure on social infrastructure and service delivery, the Project should, in conjunction with other projects in the area and local government, develop an influx management plan. The effective implementation of such a plan will mean significance of this cumulative impact is considered to be **Medium** during construction and operation**.**

Community Health, Safety and Security

Appropriate maintenance of roads by relevant parties (projects and government) and mitigation such as development of project health and safety plans and support of government and NHO programmes would ensure that the impacts would remain **Medium** during construction and operation.

10.11 TRANS-BOUNDARY IMPACTS

In line with best practices, particular attention is paid in this EIS to potential trans-boundary impacts, which are those that may affect receptors in different countries.

10.11.1 Economy and Employment

During the construction phase, the Project will require the purchase of equipment and other goods and services, generating business for suppliers. Due to the small size of the project when considering an international scale, the transboundary impact on the economy and employment (positive impact) is considered **Low** during construction and operation.

Project construction activities will also lead to an increase in vessel traffic on offshore routes connecting the Project, the Takoradi Port and the countries from where the supplies will come from. Due the reduced number of project vessels/trips involved internationally, the potential transboundary impact has been also considered as **Low** during construction and operation

10.11.2 Unplanned Events (Major Spills)

No significant transboundary impacts are expected to occur as a result of normal operations. However, modelling simulations of a large oil spill into the marine environment showed oil being transported throughout the Gulf of Guinea, with oil making landfall in Ghana, Côte d’Ivoire, Togo, Benin, Nigeria, Cameroon, Equatorial Guinea and Gabon. Due to the high sensitivity of resources, the probability of a crude oil spill due to a blow out and receptors and the prevention measures defined the impact is assessed as being of **Medium** significance during operations (see at Chapter 10.9 Unplanned Events for further details).

10.12 SUMMARY TABLES

Table 10.63 Summary Table of Impacts - Construction phase

Impacts	Duration	Extent	Importance / Resilience of Receptor / Resource	No. of Elements Involved	Impact Rank	Impact Main Driver	Accidental Event (Y/N)
Onshore Air Quality							
Increased dust emissions and increased atmospheric pollutant concentrations during ORF and pipeline construction	*2*	*1*	*2*	*1*	**6 - Low**		
Increased atmospheric pollutant concentrations during hydrostatic testing	*1*	*1*	*2*	*1*	**5 - Low**		
Onshore Ambient Acoustic Conditions							
Increased noise emissions during ORF and pipeline construction	*2*	*1*	*2*	*1*	**6 - Low**		
Increased noise emissions during hydrostatic testing	*1*	*1*	*2*	*1*	**5 - Low**		
Surface Water Resources							
Removal of ephemeral within the Project site	***4***	*1*	*3*	*1*	**9 - Medium**	**Duration**	**N**
Degradation of surface water quality due to increased sediment load	*2*	*1*	*2*	*1*	**6 - Low**		
Degradation of surface water quality due to improper handling waste	*2*	*1*	*2*	*1*	**6 - Low**		
Degradation of surface water quality due to spillages of the fuels and chemicals	*2*	*2*	***3***	*1*	**8- Medium**	**Sensitivity**	**Y**
Changes in hydrology and/or the hydrological regime caused by reduced flows and/or changes in flow direction caused by projected related work	***4***	*1*	*2*	*1*	**8- Medium**	**Duration**	**N**
Groundwater Resources							
Reduction in Groundwater Resources due to Water Consumption	*2*	*1*	*2*	*2*	**7 – Medium**	**-**	**N**
Surface sealing and infilling leading to lowering of groundwater levels and drawdown	*2*	*1*	*2*	*1*	**6 - Low**		
Degradation of groundwater quality due to seepage from discharge of wastewater and improper waste storage and handling	*2*	*1*	*2*	*1*	**6 - Low**		

Impacts	**Duration**	**Extent**	**Importance / Resilience of Receptor / Resource**	**No. of Elements Involved**	**Impact Rank**	**Impact Main Driver**	**Accidental Event (Y/N)**
Degradation of groundwater quality due to spillages of fuels and chemicals	*4*	*1*	*2*	*1*	**8 - Medium**	**Duration**	**Y**
Geology, Geomorphology and Soil							
Potential contamination of the Soil	*2*	*1*	*2*	*1*	**6 - Low**		
Potential Disturbance and Degradation During Construction	*2*	*1*	*2*	*1*	**6 - Low**		
Soil Removal/ Land Take	*2*	*1*	*2*	*1*	**8 - Medium**	**-**	**N**
Flora							
Loss of natural vegetation	*4*	*1*	*2*	*2*	**9 - Medium**	**Duration**	**N**
Loss of habitat/ habitat fragmentation	*4*	*1*	*2*	*1*	**9 - Medium**	**Duration**	**N**
Impacts on flora due to degradation of abiotic components of ecosystems	*2*	*1*	*2*	*1*	**6 - Low**		
Introduction of alien species	*2*	*1*	*2*	*1*	**6 - Low**		
Fauna							
Habitat Reduction/ Fragmentation and Isolation	*4*	*1*	*2*	*1*	**8 - Medium**	**Duration**	**N**
Disturbance and/or Displacement of Fauna due to Pollution	*2*	*1*	*2*	*1*	**6 - Low**		
Increased Mortality of Wildlife	*2*	*1*	*2*	*1*	**6 - Low**		
Landscape and Visual							
Landscape changes and visual impacts due to installation of the pipeline	*1*	*1*	*2*	*1*	**5 - Low**		
Landscape changes and visual impacts due to construction of ORF and infrastructure	*4*	*1*	*2*	*1*	**8-Medium**	**Duration**	**N**
Visual impacts due to well installations, presence of the FPSO and vessel movement	*1*	*1*	*2*	*1*	**5 - Low**		
Seawater Resources							
Increase in Turbidity	*2*	*1*	*2*	*1*	**6- Low**		

Impacts	Duration	Extent	Importance / Resilience of Receptor / Resource	No. of Elements Involved	Impact Rank	Impact Main Driver	Accidental Event (Y/N)
Release of Contaminants and Nutrients	2	1	2	1	**6 - Low**		
Contamination from routine discharges of Vessel Operations and occasional spills	2	1	2	1	**6 - Low**		
Drilling waste (mud and cuttings) and cement discharges	2	1	2	1	**6 - Low**		
Use and discharge of Treated Seawater Resources	1	1	2	1	**5 - Low**		
Physical alterations to the seabed (including smothering of habitat)	2	1	3	1	**7 -Medium**	**Sensitivity**	**N**
Sediment contamination due to use of cementing/ drilling chemicals	2	1	3	1	**7 -Medium**	**Sensitivity**	**N**
Drill rig and vessels exhausts for production wells drilling	2	1	1	1	**5 - Low**		
Vessels exhausts for pipeline installation	1	1	1	1	**4 - Low**		
Increased underwater noise emissions	2	1	2	1	**6 - Low**		
Increased underwater noise emissions as a result of drilling activities	2	1	2	1	**6 – Low**		
Potential disturbance of marine fauna due to increased underwater noise emissions	2	1	2	1	**6 - Low**		
Potential disturbance of marine fauna due to physical presence	2	1	2	1	**6 - Low**		
Potential disturbance of marine fauna (benthos and nekton) due to cuttings deposition on seabed, decreased marine water quality and increase of suspended solids	2	1	2	1	**6 - Low**		
Potential disturbance to ecosystem due to the introduction of alien species due to the discharge of ballast water	2	1	2	1	**6 - Low**		
Marine Fauna							
Impacts due to the Installation of the Pipeline in the Nearshore	1	1	1	1	**4 - Low**		
Fisheries							
Impact derived from FPSO, drilling rig and vessel discharges.	2	1	1	1	**5-Low**		

Impacts	**Duration**	**Extent**	**Importance / Resilience of Receptor / Resource**	**No. of Elements Involved**	**Impact Rank**	**Impact Main Driver**	**Accidental Event (Y/N)**
Impact derived from discharge of ballast waters	*1*	*1*	*1*	*1*	**4-Low**		
Impact derived from the physical presence and light emissions	*2*	*1*	*1*	*1*	**5-Low**		
Potential impact of underwater noise commercially exploited species	*2*	*1*	*1*	*1*	**5-Low**		
Pipeline underwater noise activities potentially affecting commercially exploited species	*2*	*1*	*2*	*1*	**6-Low**		
Economy and Employment							
Increased Government Revenue	*2*	*3*	*2*	*3*	**10-High Positive**	**Magnitude**	**N**
Employment opportunities and Skills Enhancement	*2*	*2*	*2*	*2*	**8-Medium-Positive**	**-**	**N**
Increased Procurement	*2*	*4*	*2*	*2*	**10-High Positive**	**Magnitude**	**N**
Enhanced Tourism Potential	*2*	*1*	*2*	*1*	**6-Low Positive**		
Increased Price Inflation and Economic Vulnerability	*2*	*1*	*3*	*2*	**8-Medium**	**Sensitivity**	**N**
Workforce Demobilisation	*2*	*1*	*3*	*2*	**8-Medium**	**Sensitivity**	**N**
Land and Livelihood							
Economic Displacement of Land-Based Livelihoods							
Economic Displacement of Farming in Land Acquisition Area	*4*	*1*	*3*	*2*	**10-High**	**Duration**	**N**
Disruption/Displacement of Fisheries-based livelihoods							
Restricted Access to Offshore Fishing Grounds due to Exclusion Zones	*2*	*1*	*1*	*2*	**6-Low**		
Disruption of Onshore and near-shore Fishing activities	*2*	*1*	*2*	*2*	**7-Medium**	**-**	**N**
Damage to Fishing Gear	*2*	*1*	*2*	*2*	**7-Medium**	**-**	**Y**
Lighting	*2*	*1*	*1*	*2*	**6-Low**		

Socio-Cultural Change							
Changes to cultural and Social Norms	*2*	*1*	*3*	*1*	**7-Medium**	**Sensitivity**	**N**
Increased anti-social behaviour	*2*	*1*	*3*	*1*	**7-Medium**	**Sensitivity**	**Y**
Tension and Conflict between Villages	*2*	*1*	*3*	*1*	**7-Medium**	**Sensitivity**	**Y**
Economy and Employment							
Cultural Heritage Resources	*2*	*1*	*2*	*1*	**6 Low**		
Sense of Place	*2*	*1*	*3*	*1*	**7 Medium**	**Sensitivity**	**N**
Infrastructure and public services							
Social Infrastructure	2	1	3	2	**8-Medium**	**Sensitivity**	**N**
Road Infrastructure	2	2	3	2	**9-Medium**	**Sensitivity**	**N**
Health Infrastructure	2	2	3	2	**9-Medium**	**Sensitivity**	**N**
Marine Traffic and Infrastructure	2	4	1	2	**9-Medium**	**Magnitude**	**N**
Workers management and rights, and workers health and safety							
Worker health and Safety	2	1	2	1	**6-Low**		
Workers' Rights, retrenchment and accommodation	2	1	2	1	**6-Low**		
Forced Labour	2	1	2	1	**6-Low**		
Child Labour	2	1	2	1	**6-Low**		
Community Health, Safety and Security							
Increased prevalence of Sexually Transmitted Infections including HIV/AIDS	2	2	2	2	**8-Medium**	**-**	**Y**
Increased prevalence of Communicable diseases	2	2	2	2	**8-Medium**	**-**	**Y**
Increased prevalence of malaria	2	1	1	2	**6-Low**		
Traffic accidents from increased traffic and presence of heavy vehicles in local roads	2	2	2	1	**7-Medium**	**-**	**Y**
Increased pressure on health care resources	2	1	2	2	**7-Medium**	**-**	**N**
Site trespass and injury	2	1	2	1	**6 - Low**		
Environmental health	2	1	2	1	**6-Low**		
Public security	2	1	1	1	**5-Low**		

Note 1: Impacts on ecosystem services have been assessed using a different methodology and so results re not shown in this table.
Note 2: Impacts related to unplanned events and cumulative impacts have not been included in this table.

Table 10.64 Summary Table of Impacts - Operation phase

Impacts	**Duration**	**Extent**	**Importance / Resilience of Receptor / Resource**	**No. of Elements Involved**	**Impact Rank**	**Impact Main Driver**	**Accidental Event**
Onshore Air Quality							
Increased atmospheric pollutant concentrations	*4*	*1*	*2*	*1*	**8 - Medium**	**Duration**	**N**
Ambient Acoustic Conditions							
Increased noise emissions	*4*	*1*	*2*	*1*	**8 - Medium**	**Duration**	**N**
Freshwater Resources							
Degradation of surface water quality due to improper handling of waste	*2*	*1*	*2*	*1*	**6 - Low**		
Degradation of surface water quality due to spillages of the fuels and chemicals	*2*	*1*	*2*	*1*	**6 - Low**		
Groundwater Resources							
Reduction in groundwater resources due to water consumption	*4*	*1*	*2*	*2*	**9 - Medium**	**Duration**	**N**
Degradation of groundwater quality due to seepage from discharge of wastewater and improper waste storage and handling	*4*	*1*	*2*	*1*	**8 - Medium**	**Duration**	**Y**
Degradation of groundwater quality due to spillages of fuels/chemicals (unplanned event)	*4*	*1*	*2*	*2*	**9 - Medium**	**Duration**	**Y**
Geology, Geomorphology and Soil							
Potential contamination of the Soil	*4*	*1*	*2*	*1*	**8 - Medium**	**Duration**	**Y**
Soil compaction and erosion	*4*	*1*	*2*	*1*	**8 - Medium**	**Duration**	**Y**
Flora							
Impacts on flora due to degradation of abiotic components of ecosystems	*4*	*1*	*2*	*1*	**8 - Medium**	**Duration**	**N**
Fauna							
Disturbance and/or Displacement of Fauna due to Pollution	*4*	*1*	*2*	*1*	**8 - Medium**	**Duration**	**Y**

Impacts	Duration	Extent	Importance / Resilience of Receptor / Resource	No. of Elements Involved	Impact Rank	Impact Main Driver	Accidental Event
Increased Mortality of Wildlife	*4*	*1*	*2*	*2*	**9 - Medium**	**Duration**	**Y**
Landscape and Visual Impacts							
Visual impacts due to presence of the ORF and associated infrastructure	*4*	*1*	*2*	*1*	**8- Medium**	**Duration**	**N**
Visual impacts due to the presence of the FPSO and vessel movement	*1*	*1*	*2*	*1*	**5 - Low**		
Seawater Resources							
Potential Contamination due to FPSO operations	*4*	*1*	*2*	*1*	**8 – Medium**	**Duration**	**Y**
Contamination from routine discharge from Vessel Operations	*4*	*1*	*2*	*1*	**8 – Medium**	**Duration**	**N**
Potential Contamination from pipeline anti corrosion anodes	*4*	*1*	*2*	*1*	**8 – Medium**	**Duration**	**N**
Seabed Quality							
Potential seabed contamination	*4*	*1*	*2*	*1*	**8 - Medium**	**Duration**	**Y**
Sediment accumulation and/or scouring/ erosion	*4*	*1*	*2*	*1*	**8 - Medium**	**Duration**	**N**
Offshore Air Quality							
Vessels (and FPSO) exhausts for maintenance works	*4*	*1*	*1*	*1*	**7 - Medium**	**Duration**	**N**
Noise and Underwater Noise							
Increased underwater noise emissions due to shipping activities and FPSO operation	*4*	*1*	*2*	*1*	**8 - Medium**	**Duration**	**N**
Marine Fauna							
Potential disturbance of marine fauna due to increased underwater noise emissions	*4*	*1*	*2*	*1*	**8 - Medium**	**Duration**	**N**
Potential disturbance of marine fauna due to physical presence	*4*	*1*	*2*	*1*	**8 - Medium**	**Duration**	**N**
Disturbance of marine fauna (benthos and nekton) due physical disturbance of seabed	*4*	*1*	*2*	*1*	**8 - Medium**	**Duration**	**N**

Impacts	Duration	Extent	Importance / Resilience of Receptor / Resource	No. of Elements Involved	Impact Rank	Impact Main Driver	Accidental Event
Disturbance to ecosystem due to introduction of alien species due to the discharge of ballast water	*2*	*1*	*2*	*1*	**6 - Low**		
Fisheries							
Impact derived from FPSO, and vessel discharges	*4*	*1*	*1*	*1*	**7-Medium**	**Duration**	**N**
Impact derived from the physical presence and light emissions	*4*	*1*	*1*	*1*	**7-Medium**	**Duration**	**N**
Potential impact of underwater noise commercially exploited species	*4*	*1*	*1*	*1*	**7-Medium**	**Duration**	**N**
Economy and Employment							
Increased Government Revenue	*4*	*3*	*2*	*3*	**13-Critical Positive**	**Duration**	**N**
Employment opportunities and Skills Enhancement	*4*	*2*	*2*	*2*	**10- High Positive**	**Duration**	**N**
Increased Procurement	*4*	*2*	*2*	*2*	**10- High Positive**	**Duration**	**N**
Tourism Development	*4*	*1*	*2*	*1*	**8- Medium Positive**	**Duration**	**N**
Increased Price Inflation and Economic Vulnerability	*2*	*1*	*1*	*1*	**5- Low**		
Land and Livelihood							
Economic Displacement of Land-Based Livelihoods							
Economic Displacement of Farming in Land Acquisition Area	*4*	*1*	*3*	*2*	**10-High**	**Duration**	**N**
Disruption/Displacement of Marine Fishing-based livelihoods							
Restricted Access to Offshore Fishing Grounds due to Exclusion Zones	*4*	*1*	*1*	*2*	**8-Medium**	**Duration**	**N**
Disruption of near-shore Fishing activities	*4*	*1*	*2*	*2*	**9-Medium**	**Duration**	**N**
Damage to Fishing Gear	*4*	*1*	*2*	*2*	**9-Medium**	**Duration**	**Y**
Lighting	*4*	*1*	*1*	*2*	**8-Medium**	**Duration**	**N**

Impacts	Duration	Extent	Importance / Resilience of Receptor / Resource	No. of Elements Involved	Impact Rank	Impact Main Driver	Accidental Event
Socio-Cultural Change							
Changes to cultural and Social Norms	*4*	*1*	*1*	*1*	**7-Medium**	**Duration**	**Y**
Increased anti-social behaviour	*4*	*1*	*1*	*1*	**7-Medium**	**Duration**	**Y**
Tension and Conflict between Villages	*4*	*1*	*1*	*1*	**7-Medium**	**Duration**	**Y**
Economy and Employment							
Cultural Heritage Resources	*4*	*1*	*1*	*1*	**7 Medium**	**Duration**	**Y**
Sense of Place	*4*	*1*	*2*	*1*	**8 Medium**	**Duration**	**Y**
Infrastructure and public services							
Social Infrastructure	*4*	*1*	*1*	*1*	**7-Medium**	**Duration**	**N**
Road Infrastructure	*4*	*1*	*2*	*1*	**8-Medium**	**Duration**	**N**
Health Infrastructure	*4*	*1*	*1*	*1*	**7-Medium**	**Duration**	**N**
Marine Traffic and Infrastructure	*4*	*2*	*1*	*1*	**8-Medium**	**Duration**	**N**
Workers management and rights, and workers health and safety							
Worker health and Safety	4	1	1	1	**7-Medium**	**Duration**	**N**
Workers' Rights and accommodation	4	1	1	1	**7-Medium**	**Duration**	**N**
Community Health, Safety and Security							
Increased prevalence of sexually transmitted infections, HIV/AIDS	4	1	2	1	**8 -Medium**	**Duration**	**Y**
Increased prevalence of Communicable diseases	4	1	1	1	**8-Medium**	**Duration**	**Y**
Increased transmission of Malaria	4	1	1	1	**7-Medium**	**Duration**	**Y**
Traffic accidents from increased traffic and presence of heavy vehicles in local roads	4	1	1	1	**7-Medium**	**Duration**	**Y**
Public security	4	1	1	1	**7-Medium**	**Duration**	**Y**

Note 1: Impacts on ecosystem services have been assessed using a different methodology and so results re not shown in this table.
Note 2: Impacts related to unplanned events and cumulative impacts have not been included in this table.

Note 3: impacts that are continous across the operations phase of the project are classified (at least) as Medium due to impact duration. This is a reflection of the methodology's conservative approach, where eni wants to ensure that adequate monitoring and control measures are applied. .

Table 10.65 Summary Table of Impacts - Decommissioning phase

Impacts	Duration	Extent	Importance / Resilience of Receptor / Resource	No. of Elements Involved	Impact Rank	Impact Main Driver	Accidental Event
Onshore Air Quality							
Increased dust emissions and increased atmospheric pollutant concentrations	*2*	*1*	*2*	*1*	**6 - Low**		
Ambient Acoustic Conditions –Onshore Decommissioning							
Increased noise emissions from equipment	*2*	*1*	*2*	*1*	**6 - Low**		
Geology, Geomorphology and Soil							
Potential contamination of the Soil	*2*	*1*	*2*	*1*	**6 - Low**		
Soil Compaction and Erosion	*2*	*1*	*2*	*1*	**6 - Low**		
Flora							
Impacts due to emissions	*2*	*1*	*2*	*1*	**6 - Low**		
Introduction of alien species	*2*	*1*	*2*	*1*	**6- Low**		
Fauna							
Disturbance and/or Displacement of Fauna due to Pollution	*2*	*1*	*2*	*1*	**6 - Low**		
Increased Mortality of Wildlife	*2*	*1*	*2*	*2*	**7 - Medium**	**-**	
Offshore Air Quality							
Vessels exhausts for decommissioning activities	*2*	*1*	*1*	*1*	**5 - Low**		

Note: additional impacts related to the decommissioning phase, where considered not significant and a formal rating was not produced.

10.13 CONCLUSIONS

Previous Section 10.12 presents summary tables showing the temporal and spatial scale of each impact, the sensitivity, resilience and/or importance of the receptor and the number of elements that could be affected by the impact. They also present the final rating and associated significance of the impact according to the Impact Assessment methodology applied for the purpose of this ESHIA. In this Section, the potential impacts resulting from the Project, whose significance has been evaluated as Critical, High or Medium (only impacts with a ranking equal to 9 have been considered) have been summarized for each Project phase with the aim of addressing the attention to the most critical ones. This Section of the ESHIa, and generally this entire Chapter, should be read (for completeness of analysis) with Annex G.

The Study identifies some positive impacts, on economy and employment, and a number of negative impacts, on various environmental and social components.

<u>Construction Phase</u>

The Construction Phase will generate potential *positive impacts* on economy and employment component, as follow:

- **High positive** impacts due to increased government revenue and to increased procurement.

Along the Construction Phase the potential *negative impacts* will include:

- economic displacement of farming in land acquisition area, considered to be of **High** significance;
- impacts on surface water resources, due to removal of ephemeral within the project site, considered to be **Medium**;
- impacts on flora, due to loss of natural vegetation and habitat, and habitat fragmentation, considered to be **Medium**; and
- impacts on infrastructure and public services, particularly on road infrastructure, health infrastructure and marine traffic and infrastructure, considered to be **Medium**.

<u>Operation Phase</u>

The Operation Phase will generate potential *positive impacts* on economy and employment component, as follow:

- **Critical positive** impacts due to increased government revenue; and
- **High positive** impacts due to employment opportunities and skills enhancement, and increased procurement.

Along the Operation Phase the potential *negative impacts* will include:

- economic displacement of farming in land acquisition area, considered to be of **High** significance;

- reduction in groundwater resources due to water consumption and degradation of groundwater quality due to spillages of fuels and chemicals, both of them considered to be **Medium**; and

- increased mortality of wildlife, considered to be **Medium**; and

- disruption of near-shore fishing activities and damage to fishing gear, both of them considered to be **Medium**.

<u>Decommissioning Phase</u>

The most significative impact associated with the decommissioning phase is related to the increased mortality of onshore wildlife; this impact has been evaluated as of **Medium** significance.

ESHIA for GHANA OCTP BLOCK Phase 2

ABSTRACT

Chapter 11 provides a description of the decommissioning and abandonment phase, including applicable regulations and planned methodology.

July 2015	06	Final version	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

Summary of Revisions

July 2015	05	Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
April 2015	04	Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
March 2015	02	Interim Draft Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
27-02-2015	01	Issued for submission to Authorities	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
28-01-15	00	-	Cristina O.	Henry C.	Daniele S.
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

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11 DECOMMISSIONING AND ABANDONMENT

11.1 INTRODUCTION

At the end of the economic life of the OCTP Phase 1 and Phase 2 Development Project, the project will be decommissioned to restore the site to a safe condition that minimises potential residual environmental impacts and permits reinstatement of activities such as fishing, unimpeded navigation at the offshore site, and agriculture onshore. The decommissioning activities are planned to be completed in two years.

11.2 REGULATIONS AND AUTHORITY

The main current legislation covering oil and gas developments within Ghana is the Petroleum (Exploration and Production) Law (Act 84 of 1984). In relation to decommissioning, operators are required to remove infrastructure no longer required for petroleum production, including the decommissioning and abandonment of all wells at the end of the field's life. The Act further states that all decommissioning works must meet good international practices in comparable circumstances (i.e. similar deepwater FPSO projects).

The Act also requires that a Plan of Development (PoD) for proposed development be submitted and approved by the Petroleum Commission (PC) and the Ministry of Petroleum prior to field development and that this must include decommissioning requirements. The OCTP Phase 2 PoD containing decommissioning requirements has been submitted to the PC and approved on 30th December 2014.

eni Ghana will adhere to Ghana environmental and marine laws and regulations that are in place at the time of decommissioning including those concerned with environmental protection, pollution prevention, waste disposal and navigational safety at sea. These could include the following:

- Environmental Assessment Regulations (LI 1652, 1999); and
- Oil in Navigable Waters Act (Act No. 235 of 1964).

In addition the requirements of emerging legislation, including the Petroleum (Exploration and Production) Act and the Health Safety and Environment Regulations for the oil and gas industry will be adhered to.

11.2.1 International Conventions and Guidelines

There are a number of International Conventions pertaining to the decommissioning of oil and gas projects which cover both the removal of installations (i.e. to remove navigation and fishery hazards) and disposal of wastes (i.e. to prevent pollution).

These are summarised in Chapter 3 and include the following.

- the United Nations Convention on the Law of the Sea (UNCLOS), 1982, to which Ghana is a signatory, permits the partial removal of structures provided that IMO criteria are met;
- the IMO Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf in the Exclusive Economic Zone, 1989, stipulate that structures in deep waters can be partially removed as long as there is a minimum of 55 m of clear water for the safety of navigation. Structures weighing less than 4,000 tonnes located in water depths of 100 m or less are required to be removed completely;
- the requirements of the OSPAR Decision 98/3 supersede a number of the 1989 IMO guidelines, requiring that decommissioning will normally remove the whole of the installation with possible exceptions for large structures. Although Ghana is not a signatory to OSPAR, the requirements do provide guidance on good international practices in comparable circumstances as required by the Petroleum (Exploration and Production) Law.

The dismantling and reinstatement plan will comply with the IMO recommendations and with the necessary measures for the protection of the marine and terrestrial environment. Where entire removal is not technically feasible or would involve extreme cost, or an unacceptable risk to personnel or marine environment, this standard IMO consider the possibility of partial removal of the structure.

There are currently no specific international guidelines on the decommissioning of pipelines. However, the IFC EHS Guidelines for Offshore Oil and Gas Development establishes general guidelines for decommissioning of offshore O&G infrastructures, based on guidelines and standards issued by the IMO and decisions issued by OSPAR.

This includes that installations or structures of less than 4,000 tonnes, excluding the deck and superstructure, and in less than 75 meters of water will be removed entirely at decommissioning. An OSPAR decision recognizes the entire removal of the facility from the offshore locations for re-use, recycling, or final disposal on land as the preferred option for the decommissioning of offshore facilities.

IFC EHS Guidelines establishes that a preliminary decommissioning plan for offshore facilities should be developed.

11.3 APPROVAL PROCESS

eni Ghana will develop a project-specific Decommissioning and Abandonment Plan (DAP) early in the operational life of the project. The plan will be based on national regulations, licence requirements and international standards prevailing at the time. These currently include:

- Government of Ghana, including PC and EPA requirements;
- OCTP Phase 1 and Phase 2 PoD requirements;
- international laws and conventions to which Ghana is a signatory; and
- industry good practice standards and procedures such as OSPAR decommissioning requirements.

The DAP will include decommissioning methods and procedures for individual components of the OCTP Phase 1 and Phase 2 facilities and infrastructure and waste management requirements. The plan will address potential environmental and social impacts, as well as health and safety issues identified by a risk assessment. It will also include details on a post-decommissioning survey and monitoring programme (see Section 11.5).

In addition, the DAP will include a description of eni Ghana's exit strategy, addressing how social and economic benefits that project-affected people and project employees may have received can be sustainable or, if not sustainable, how the impact of losing them will be mitigated.

Planning for decommissioning will be an on-going activity through the life of the OCTP Phase 1 and Phase 2 Project and will be periodically reviewed.

The DAP will be updated to incorporate any changes in the field development (e.g. additional wells), changes to regulatory requirements, and/or new decommissioning techniques developed by the industry.

The GMA and Fisheries Commission will also be consulted by eni Ghana in developing the plan. Any updates over the life of the OCTP Phase 1 and Phase 2 Project will be provided to these authorities. The final plan will be submitted to the PC, Ministry of Petroleum and EPA for review and approval two years before closure and prior to commencement of decommissioning activities.

When production at the OCTP oil and gas fields becomes uneconomic and any other opportunities to increase production levels (e.g. introduction of new sources of hydrocarbon production) are not viable, a Cessation of Production (CoP) consent and approval to begin decommissioning will be sought from the PC. The request will include all relevant data required to demonstrate that practical and economic extraction of oil from the field has been achieved.

Once the CoP consent has been received and approval to commence with decommission has been granted, eni Ghana will implement the DAP.

11.4 Stakeholder Engagement

eni Ghana will perform appropriate community consultation and engagement before, during and at the end of the decommissioning process.

This will include the organization of an outreach program for community sensitization prior to any decommissioning activities, to minimize any potential impact to the population.

11.5 Decommissioning Methodology

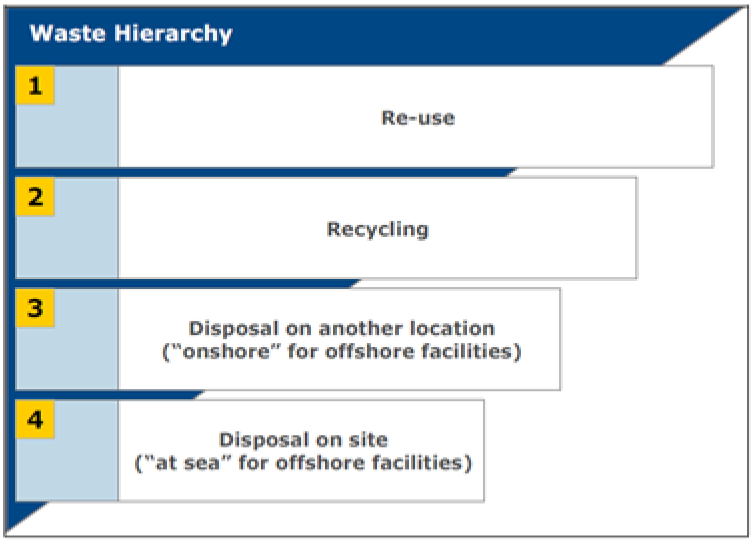
11.5.1 General Approach

Decommissioning activities will be performed based on the following criteria:

- The prime purpose of decommissioning is to render the area free from hazards for navigation and human activities in general (fishing, etc...) and to restore the environment to the original conditions, in agreement with applicable Regulations and Company expectations.

- Field decommissioning is a longitudinal process occurring at different stages of asset lifecycle which can be considered a Company Business Process, as it is characterised by a Company-wide relevance. Decommissioning may pose a threat to a company's reputation, and therefore need to be managed in a unitary manner throughout all Company Subsidiaries according to relevant regulatory requirements.
- eni Ghana's approach is based on an international Waste Hierarchy Policy (Figure 11.1) and on clear Strategy Pointers addressing how to deal successfully with key issues such as Stakeholder management, health, safety and environment and cost. The Waste Hierarchy stipules that, re-use of the decommissioned facilities is a preferred choice to recycle and re-use in current location is preferred to re-use in new location; recycle of the decommissioned facilities is a preferred choice to disposal.

Figure 11.1 Waste Hierarchy Policy



Source: eni, 2014

The selection of appropriate decommissioning methods and procedures for individual components of the OCTP Phase 1 and phase 2 facilities and infrastructure will take into account a variety of factors including: safety; environmental impacts; technical feasibility, complexity and technical risks; cost and economics; impacts to other sea/land users; and legal compliance.

11.5.2 Preparatory Works

The decommissioning project is to be considered as all other projects of the plant's life; therefore it will be deeply engineered, taking also into consideration that the equipment are close to the end of their life and they have to be carefully handled to avoid injuries to people and to environment.

The main steps of a typical decommissioning project are the following:

- Preparation and approval of a Preliminary Project Decommissioning Plan;
- Obtaining Authorities approval;
- Search and qualification of a contractor to carry out the job.

Further, the main steps of the project execution phase are the following:

- Development of the detailed Decommissioning Project;
- Detailed site survey visit and relevant report;
- Engineering and Project Management (Preparation of project documentation, drawing, etc.);
- Onsite activities;
- End of works authorities' approval.

11.5.3 Decommissioning of the Onshore Facilities

The main hypothesis and assumptions considered for the decommissioning and abandonment of Onshore facilities can be summarized as follows:

- All underground pipelines have to be flushed to remove fluids and sludge, plugged and then they can be left in place (when possible);
- All aboveground flowlines, pipelines, piping and equipment have to be flushed to remove fluids and sludge then they have to be totally removed;
- All onshore areas have to be cleaned; all materials removed and properly disposed;
- All paved areas and equipment foundations have to be totally demolished, removed and relevant debris properly disposed;
- After a HSE assessment of the risks and potential impacts associated, facilities and infrastructures specifically built for the project could be decided to be kept left in place after a mutual agreement with the authorities and handed over to local authorities/communities roads;
- After an E&S assessment of the risks and impacts, roads, bridges and power plant and other infrastructures built for the project could be decided to be kept in place and handed to local authorities/communities;
- Operator has to performed tanks reclamation and cleaning prior or immediately after plant shut down;
- All removed items will be disposed as scrap.
- All sites have to be restored as they were before starting the transportation and installation activities as per eni HSE policy requirement;

11.5.4 Decommissioning of the Offshore Facilities

For FPSO, subsea facilities and wells following decommissioning hypothesis and assumptions have been taken into account:

- Wells will be properly plugged and abandoned. Well-specific decommissioning requirements will be identified in the DAP. The general well decommissioning and abandonment approach is outlined below:
    - Downhole equipment such as tubing in the wells will be removed.
    - Residual hydrocarbons in production wells will be displaced with a high density fluid (ie weighted brine).
    - Wells will be mechanically and/or cement plugged to prevent fluid migration within the wellbore to the overlying formations or seabed.
    - Each well will be individually abandoned using a drilling vessel or well service vessel depending on requirements. Well abandonment will take approximately 16 days for each well including two days to flush any residual hydrocarbons back to the FPSO.
- Subsea FLETs will be flushed and then abandoned in sea bottom during the well P&A;
- Risers and main umbilicals dynamic sections will be disconnected from the FPSO and will be recovered to the surface;
- Depending on the final breakdown of materials, risers and main umbilicals will be disconnected from the FPSO and recovered to the surface, or flushed, cleaned and filled with seawater before being plugged and abandoned on seabed;
- Flow lines, umbilicals network static sections and relevant templates will be left in place. Lines will be flushed and cleaned, filled with seawater, plugged and abandoned on the seabed properly secured. Top termination of lines will be disconnected, sealed and will not extend above mud line in a snagging position;
- All subsea facilities will be flushed to FPSO topside;
- Waste water produced during cleanup operations is treated on FPSO facilities in order to reach the requested hydrocarbon residual and re-injected in a designated injection well;
- Mooring lines (12) will be disconnected from FPSO and abandoned on the seabed;
- Suction piles will be abandoned in situ;
- Dumped items will not cause interference with other Contractors, operating in the nearby OCTP Development & Production Areas, and will not have potential effects on safety of navigation and environment;
- The decommissioning and removal of the FPSO will be completed by the FPSO contractor. Mooring lines will be disconnected from FPSO and recovered. FPSO topside equipment and storage tanks will be flushed and drained;
- Once the decontamination activities have been completed, wastes will be properly collected and transported to shore for final disposal;
- FPSO topside equipment dismantling will be performed in dry dock;
- Decommissioning of FPSO hull is not considered;
- FPSO will be towed to an Onshore Yard from Accra to Singapore (8570 km); the ultimate decommissioning of the FPSO will depend on its condition at the end of the production life and options available for further use.
- Gas export line will be abandoned on seabed;

- Gas export line will be flushed to ORF and waste water produced during gas line clean-up operations is disposed in a final onshore area.

11.5.5 Discharges and Waste

Discharges that occur during the decommissioning phase will meet the same discharge criteria that applied to the operational phase of the project. Unused chemicals will be returned to suppliers.

eni Ghana's WMP will be updated to include specific requirements for managing decommissioning waste. Solid hazardous and non-hazardous waste generated during the decommissioning phase will be managed in accordance with eni Ghana's WMP. Although the FPSO contractor will be responsible for decommissioning of the FPSO, eni Ghana will ultimately remain responsible for ensuring that wastes generated from the decommissioning activities are managed in compliance with Ghanaian waste legislation.

11.6 POST-DECOMMISSIONING SURVEYS AND REPORTING

11.6.1 Post-Decommissioning Surveys

A post-decommissioning survey and monitoring programme will be developed and implemented by eni Ghana to verify that decommissioning requirements were followed. This programme will include geophysical and environmental surveys both onshore and offshore.

The geophysical survey will confirm the state of the seabed /soil once all activities have been finalised. A final layout plan will be developed indicating where infrastructure was located and what infrastructure remains on the seabed /soil post decommissioning.

The environmental survey will verify the state of the environment once all decommissioning activities have been completed. The following will be surveyed: sediment and water quality offshore; soil, ecology, surface and groundwater onshore. The results of the survey will be assessed against data collected during the baseline and operational phase. Unless a particular issue is identified during the surveys, the post-decommissioning sampling programme will only occur once.

11.6.2 Reporting

eni Ghana will submit a report to the relevant authorities describing what activities occurred during the decommissioning process and the state of the environment once all activities have ceased.

ESHIA for GHANA OCTP BLOCK Phase 2

ABSTRACT

Chapter 12 Chapter describes the provisional Environmental, Social and Health Management Plan for the OCTP Phase 2 Development Project.

July 2015	06	Final version	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

Summary of Revisions

July 2015	05	Final Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
April 2015	04	Final Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
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26-02-2015	00	-	Cristina O.	Henry C.	Daniele S.
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

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12 ENVIRONMENTAL, SOCIAL AND HEALTH MANAGEMENT PLAN

12.1 OVERVIEW, SCOPE AND REQUIREMENTS

12.1.1 Overview

This Chapter describes the framework Environmental, Social and Health Management Plan (ESHMP) for the OCTP Phase 2 Development Project.

With respect to the significant impacts identified by this EIS, this framework ESHMP for Phase 2 provides the linkage between each significant impact, the relevant mitigation measure, and the monitoring approach (see Chapter 10).

The elements of this framework plan and of the framework plan already developed for the OCTP Phase 1 Development project will be taken forward and incorporated into two integrated development ESHMP for both Phase 1 and Phase 2: one for the construction phase and one for the operations phase. This will be done, in order to deliver the project's environmental, social/health regulatory compliance objectives and commitments.

The eni Ghana Development ESHMPs are a component of eni Ghana's overall Health, Safety and Environmental, Integrated Management System (HSE IMS). The HSE IMS is an enduring and live system applicable to the full lifecycle of eni Ghana activities from exploration, through development and production including decommissioning. The HSE IMS applies to all activities performed by or on behalf of eni Ghana, including those undertaken in Ghana and contractors work locations overseas. On behalf of the JV partners, eni Ghana has been appointed as the OCTP Development Project Operator and is ultimately responsible for the management and supervision of all project activities. The HSE IMS describes the processes that eni Ghana will implement to manage the risks to people and the environment, caused as a result of its operations and activities, to a level that is compliant with legal requirements, tolerable to the company's shareholders, and assessed by the company management to be As Low As Reasonably Practicable (ALARP). See Chapter 4 for additional details on the HSE IMS.

The Development ESHMPs for construction and operation phases will be used to monitor compliance with statutory requirements and corporate environmental, social and health policies. Within the framework ESHMP, eni will develop the integrated construction phase ESHMP and operations phase ESHMP (and all relevant management plans) and require contractors to develop the relevant implementation plans which would need to be approved by Eni before mobilization.

Contractors, and in particular major contractors, will have their own management plans and systems that will be aligned with eni HSE policy, eni Ghana guidelines and procedures within the HSE IMS. Adequate bridging documents will be developed before contractor mobilization.

Contracting parties to eni Ghana will be monitored on the implementation of Project's environmental, social and health requirements in their activities. This framework ESHMP describes the structure and processes that will be applied to activities to check and monitor compliance and effectiveness of the mitigation measures to which eni Ghana has committed.

12.1.2 Objectives

The main objective of the present Chapter is to provide guidelines for the implementation of environmental, social and health impacts management at every stage of the Project, where the predicted negative impacts can be controlled and mitigated. The objectives of this framework ESHMP are as follows:

- Define strategies, methods and control approaches to ensure implementation of measures to mitigate potentially adverse environmental or social/health impacts.
- Define strategies to ensure that workers, subcontractors and other parties involved in the Project meet legal and other requirements with regards to environmental and social/health management is adopted during all phases of the Project (engineering, construction, operation and maintenance, and decommissioning).
- Provide a framework for mitigating impacts that may be unforeseen or unidentified until construction is underway.
- Address concerns and issues raised in the EIS's stakeholder consultation process and those that may arise during the project's lifetime.
- Provide a framework for implementing project environmental and social/health commitments (i.e. mitigation measures identified in the EIS).
- Prepare and maintain records of project environmental and social/health performance (i.e. monitoring, audits and non-compliance tracking).

12.1.3 Scope

The framework ESHMP is intended to cover those the OCTP Phase 2 Development activities described in this EIS. It covers onshore and offshore Project activities during drilling, completions, installation, hook-up and commissioning, operations and decommissioning.

The framework ESHMP relates to the significant environmental, social and health impacts associated with the OCTP Project. Whilst social mitigation is included within this framework ESHMP, they will also be implemented through a separate set of plans (e.g. Stakeholder Engagement Plan, Livelihood Restoration Plan), that complement the framework ESHMP.

The framework ESMHP does not cover activities/impacts outside of Ghana (e.g. FPSO fabrication activities). However, it should be noted that the equipment and facility will be aligned with the project design criteria based on the outcome of this EIS. In addition, contractual clauses and auditing procedures will be put in place by eni to ensure compliance with labour laws and OHS laws by the contractors and subcontractors even outside Ghana.

12.1.4 Requirements

Requirements for an ESHMP and guidance on scope and application are given in the Ghana environmental regulations. In particular, they are contained in the Environmental

Assessment Regulations of 1999 (Part II, Section 9), where a 'provisional environmental management plan' is a required element of an EIS.

International standards such as those outlined in the IFC/WB Performance Standards provide further guidance on the ESHMP scope and application. In particular, IFC/WB Performance Standard 1 requires that the environmental and social management system be part of the client's overall management system for the project. It should include the organisational structure, responsibilities, policies, procedures and practices, and resources. Performance Standard 1 underscores the importance of on-going management of environmental and social performance to achieve continuous improvement. The IFC/WB require that a management system be in place at the level where their investment is utilised. In this case, it is at the level of the project. It requires a plan for implementing the project-specific management programme developed through the environmental and social assessment.

The IFC Performance Standards considered relevant to this Project are:

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

The IFC's EHS Guidelines serves as a technical reference document to support the implementation of the IFC PS particularly those relating to PS3 (Resource Efficiency and Pollution Prevention), IFC PS 6 (Biodiversity Conservation and Sustainable Management of Living Resources), as well as certain aspects of Occupation and Community Health and Safety (IFC PS 4).

Finally, this ESHMP is intended to be consistent with the elements and expectations of the eni Ghana HSE IMS. Appropriate plans (including this ESHMP), procedures and programs will be implemented during the course of the project to ensure that the key elements of the HSE IMS expectations are met. These will be based on industry best practice and eni Ghana's HSE policies and standards, such as the eni Ghana HSE and Sustainability Guidelines.

The main elements of the eni Ghana HSE-IMS are shown in the following figure.

Figure 12.1 Main elements of the eni Ghana HSE-IMS

Source: eni Ghana, 2013

12.2 IMPACT ASSESSMENT AND PROJECT COMMITMENTS

12.2.1 Impact Assessment

As part of the HSE IMS, the Project utilises impact assessment as a part of the planning process. Impact assessment has been conducted for drilling activities as well as for the onshore and offshore development. The Project will continue to use impact assessment as a planning tool for any future development activities including significant changes, additional development phases, expansions, or ancillary projects.

12.2.2 Project Commitments

Through the project development and the EIS process, the project has made commitments to actions to manage or improve environmental, health and social performance. These commitments are not recommendations; they are binding commitments on the part of the project.

The commitments take a number of forms as summarised in Box 12.1 with the specific actions intended to address a particular environmental, social or health issue. The commitments are detailed in tabular form in Chapter 10. The commitments are organised by development stage and reference to the EIS, as applicable.

Box 12-1 Types of Commitments

Avoidance
Avoiding or reducing at source is essentially 'designing' the project so that a feature causing an impact is designed out or altered. Example: re-routing a pipeline, relocating facilities, etc.

Reduction on/off Site
This involves adding design control system to the basic design to abate the impact - pollution controls fall within this category. It is often called "end-of-pipe". Examples: wastewater treatment, NOx reduction technology.
If an impact cannot be abated on-site then measures can be implemented off-site.
Examples: soundproof equipment at nearby residences, visual screening by planting of hedges.

Repair or Remedy
Some impacts involve unavoidable damage to a resource, e.g. vegetation disturbance. Repair essentially involves restoration and reinstatement type measures.

Compensate in Kind
Where other mitigation approaches are not possible or fully effective, then compensation, in some measure, for loss, damage and general intrusion might be appropriate. Example in a like-for-like biological offset attaining ecological no net loss.

Management
Management commitments include development of plans and procedures for ensuring that measures to protect the environment actually take place and are of the desired standard of practice. Training is another commitment in this category.

Monitoring
Commitments to monitoring are primarily to ensure the above measures are working properly and delivering the desired (and anticipated) results.

Net Positive Outcomes
This involves actions and contributions which are designed to provide a positive benefit. Examples include maximising Ghanaian content in employment, or making a positive contribution to Biodiversity conservation.

12.2.3 Management Plans

<u>Framework Environmental, Social and Health Management Plan</u>

The goal of the framework ESHMP is to ensure full compliance with the project's policies and with mitigation, monitoring and other commitments made in the EIS. It outlines the actions necessary to attain this goal, and describes the means, and designation of responsibility required for compliance and conformance. The framework ESHMP provides the link for implementation of mitigation and monitoring actions described in Chapter 10.

<u>Development Environmental, Social and Health Management Plan</u>

Eni Ghana will develop two separate OCTP Phase 2 Project ESHMPs (for the construction and operation phase) following the guidance of this framework ESHMP and will integrate the two project phases (oil and gas). The OCTP Phase 2 Project ESHMPs will become parts of eni Ghana's overall HSE IMS. They will also be subject to annual review and re-issue, or as required, such as in the event of any significant changes to the project's environmental and social/health impacts occur. The key elements of the OCTP Phase 2 Project ESHMPs will be a series of Environmental, Social and Health Management and Monitoring Tables.

The construction ESHMP will be produced before the commencement of construction activities. The operations ESHMP will be submitted to Ghana EPA within 18 months of commencement of operations, to be renewed every three years thereafter as required by the Environmental Assessment Regulations (EPA, 1999, 24(1).

Related Management Plans

The eni Ghana HSE IMS also comprises a number of related management plans and procedures that lay out the specifications for compliance with specific environmental and social/health elements and describes the plans and processes required for carrying out the necessary activities. These plans will be reviewed and updated as appropriate, to ensure they are tailored to meet the specific project needs. Additional management plans have been recommended in Chapter 10 as mitigation measures to project impacts. The development of these additional plans and their inclusion in the HSE IMS is a commitment of the project. Project management plans are outlined in section 12.4.

Subcontractor Environmental and Social/Health Implementation Plans

In performing its business eni Ghana procures the services of contractors. The performance of many of these services, such as drilling operations, civil construction, warehousing and the transport of people and materials, pose significant HSE risks.

The contractors are responsible for performing all work:

- in compliance with relevant national and international EHS legislation and regulations, and with other requirements to which the project subscribes;
- in conformance with the OCTP Phase 2 Development ESHMPs and the overall eni Ghana HSE IMS; and
- in accordance with contractual technical and quality specifications.

As such the OCTP Phase 2 Development Project ESHMPs and related eni Ghana HSE IMS are the overarching contractual documents to which subcontractor environmental and social/health implementation documentation will be bridged to. Each subcontractor will be required to develop its own specific management plans in a manner that is aligned with the philosophy, ambitions, and requirements of the HSE Policy, demonstrating how they intend to comply with the stipulated requirements. Subcontractor plans will be reviewed and approved by eni Ghana.

12.3 PROJECT ESHMP MITIGATION TABLE

The impact assessment along with identifying potential impacts arising from the different project phases on environmental, social and health components, outlined mitigation measures to be implemented in order to minimise the likelihood of potential impacts and their magnitude. In the following section mitigation measures are summarised in a tabular format for each project phase.

12.3.1 Construction phase

Table 12.1 summarises potential impacts and related mitigation measures identified for the offshore construction phase of the Project [1]. And Table 12.2 summaries the onshore's.

(1) [1] Mitigation measures for unplanned events and cumulative impacts are not discussed in this section.

Table 12.1 Construction Phase - Mitigation measures Offshore

Potential Impacts	Mitigations	Type of Commitments	Relevant Management Plan
Biophysical environment			
Air Quality (for details, refer to Section G.5.3.3)			
Exhausts emissions from production wells drilling, vessels for pipeline installation.	• General mitigation measures will be applied, such as the selection of vessels and equipment (i.e. use of low sulphur fuels, proper maintenance activities, etc.) according to the best available technologies in terms of minimization of air pollutant emissions. • Project will comply with Marpol Annex VI requirements on air pollution from ships.	• Avoidance and reduction	• Pollution Prevention and Control Plan
Underwater Noise (Section G.5.5.3)			
Increased underwater noise emissions as a result of drilling activities, pipeline laying, trench excavation, general shipping activities.	• Vessels will not be allowed to intentionally approach marine mammals and, where practicable, will alter course or reduce speed to further limit the potential for disturbance.	• Avoidance	• Pollution Prevention and Control Plan • Marine Mammals Observation Program • Marine Traffic Management Plan
	• The Project will ensure that vessel engines are not left to idle unnecessarily. Vessels will be powered down to safe operational levels.	• Reduction on/off site	
Seawater Quality (Section G.5.1.3)			

Potential Impacts	**Mitigations**	**Type of Commitments**	**Relevant Management Plan**
Increase in Turbidity and Release of Contaminants and Nutrients	• Dredging equipment will be selected appropriately to the depths and material types to be dredged to reduce the resuspension of sediments and minimise turbidity.	• Avoidance	• Water Management Plan • Pollution Prevention and Control Plan • Waste Management Plan
Contamination from Routine Discharges from Vessel Operations and Occasional Spills	• Chemical, fuels and oil storage will be kept or stored in bunded areas on board the vessels to contain leaks and spills. Other sources will have drip trays to contain accidental spills or leaks. • During the refuelling processes, the fuel will be pumped into the ships´ tanks via the tanker and all precautions will be taken to prevent spills. No refuelling will take place in bad weather conditions so as to limit the risk. • Spill drills will take place frequently on the vessels involved in the Project, to ensure an efficient response in case such an event occurs.	• Avoidance	
	• All facilities and vessels will comply with MARPOL standards, and will be equipped with waste water treatment Unit/STU for the treatment of civil wastewater. • Vessels will include oil/water separators to treat drainage and bilge water and ensure the water discharges contains less than 15 ppm of oil content.	• Reduction on/off site	
	• Alarm systems are expected to be fitted to fuel tanks so they can warn of high levels and avoid spills due to excess fuel transfer.	• Management	

<table>
<tr><th>Potential Impacts</th><th>Mitigations</th><th>Type of Commitments</th><th>Relevant Management Plan</th></tr>
<tr><td rowspan="3">Drilling Waste Discharges</td><td>• Additives to be used in the WBM will be inert and eco-friendly.
• Use the lowest feasible chemical contents in the NADF, prioritising those included in the PLONOR list and those with lowest hazard according to the CHARM methodology developed by OSPAR.
• According to IFC recommendations, for NADF cuttings, whenever applicable, cleaned cuttings will be discharged via a caisson at least 15 m below water surface. For lower depths, good dispersion shall be demonstrated.</td><td>• Reduction on/off site</td><td rowspan="5">• Water Management Plan
• Pollution Prevention and Control Plan
• Waste Management Plan</td></tr>
<tr><td>• Optimise the operation of solids control system to maximise the useful life of drilling fluids by effective liquid/ solids separation and to minimise the quantity of fluid “lost” overboard with the cuttings.
• Additional modelling of the fate of the cuttings discharged and the associated turbidity plume generated will be carried out.</td><td>• Management</td></tr>
<tr><td>• The NADF cuttings to be discharged overboard will be monitored to ensure compliance with Ghanaian regulations</td><td>• Monitoring</td></tr>
<tr><td rowspan="2">Cement Discharge</td><td>• Cement will be prepared on board of the drill rig in marginally greater quantity than is expected to be required.
• The vast bulk of the cement mixture will be comprised of cement and barite; chemical additives will be in very small proportion and preference will be given to additives included in the PLONOR list.</td><td>• Reduction on/off site</td></tr>
<tr><td>• For top hole any excess cement is discharged at seabed as per standard international practice. Thereafter no cement returns are expected to surface as the casings will not be cemented to seabed.</td><td>• Management</td></tr>
</table>

Potential Impacts	**Mitigations**	**Type of Commitments**	**Relevant Management Plan**
Use and Discharge of Treated Seawater Resources	• The seawater used during the hydrotesting activities of the offshore pipeline will be discharged from ORF to the pipeline end termination or the sub-sea isolation valve.	• Reduction on/off site	
	• Chemicals used for pre-commissioning activities will be compliant to international standards and industrial best practice for oil and gas. • A hydrotest water discharge protocol will be prepared prior to hydrotesting, to ensure safe concentration levels of additives are not exceeded (concentrations of additives remain below toxic levels).	• Management	
Seabed (Section G.5.2.3)			

Potential Impacts	Mitigations	Type of Commitments	Relevant Management Plan
Physical alterations to the seabed (including smothering of habitat) and Sediment contamination due to use of cementing/ drilling chemicals.	• No discharge of NADF cuttings will take place, with the exception of a maximum 2 % of OC in weight associated to the cuttings after treatment on-board. • Additives to be used will be inert and eco-friendly, preferably included in the PLONOR list to the extent possible.	• Avoidance	• Pollution Prevention and Control • Waste Management Plan
	• Limit the use of additives in the cement mixture to the extent possible and ensure this chemicals conform to OSPAR HOCNF standards.	• Reduction on/off site	
	• Optimise operation of solids control system to maximise the useful life of drilling fluids by effective liquid/ solids separation and to minimise the quantity of fluid "lost" overboard with the cuttings. • Additional modelling is required to predict the final surface affected by the deposition of the cuttings.	• Management	
	• Monitor and limit the rate of WBM and cuttings discharge to the sea to 1,000 bbls / hr. • Monitor the content of Hg and Cd of the bentonite used to ensure compliance with Ghana EPA requirements and be consistent with WB/IFC guidelines.. • Monitor the oil content in cuttings to be discharged overboard.	• Monitoring	
Marine Fauna and Flora (Section G.5.6.3)			

Potential Impacts	Mitigations	Type of Commitments	Relevant Management Plan
Potential disturbance of Marine Fauna including Seabirds, Cetaceans and Turtles due to Physical presence	• Small boat movements in the vicinity of cetaceans will be strictly forbidden unless absolutely necessary for personnel safety. • Project vessels to avoid sailing through areas with large aggregations of seabirds where possible. • Control and reduce overall light intensity to the extent practicable, without adversely affecting maritime or operational safety. • Flaring will be avoided on foggy weather to the extent possible. • Laying of the pipeline within the nearshore area will be avoided during peak nesting season between October and February if possible.	• Avoidance	• Biodiversity Management Plan
	• Use of designated navigation channels, where applicable, and compliance with vessel speed and wake restrictions. • Maintain a record of cetaceans observed during the exploration activities to gain a better understanding of presence in the area. • A Biodiversity Management Plan (BMP) with special attention on marine turtles shall be developed and implemented.	• Management	
	• The BMP focused on turtles will include that prior to any construction activities, a pre-work inspection of the area will be performed to determine whether there are turtles nesting. If sea turtle nesting activity is discovered in the work area, Project will consult with an ecology specialist to determine the appropriate course of action (i.e. removal of eggs to a hatchery, relocation of the turtle nest to a safe area).	• Monitoring / Repair and remedy	

Potential Impacts	Mitigations	Type of Commitments	Relevant Management Plan
Potential Disturbance of Marine Fauna including Benthos and Nekton Community due to Discharge of Drilling Wastes and Decreased Water Quality	• No discharge of NADF cuttings will take place, with the exception of a maximum 2 % of OC in weight associated to the cuttings after treatment on-board. • Additives to be used will be inert and eco-friendly, preferably included in the PLONOR list.	• Avoidance	• Biodiversity Management Plan
	• Limit the use of additives in the cement mixture to the extent possible and ensure these chemicals conform to OSPAR HOCNF standards.	• Reduction on/off site	
	• Optimise operation of solids control system to maximise the useful life of drilling fluids by effective liquid/ solids separation and to minimise the quantity of fluid "lost" overboard with the cuttings. • Additional modelling is required to predict the final surface affected by the deposition of the cuttings.	• Management	
	• Monitor and limit the rate of WBM and cuttings discharge to the sea to 1,000 bbls / hr. • Monitor the content of Hg and Cd of the bentonite used to ensure lower levels possible. • Monitor the oil content in cuttings to be discharged overboard.	• Monitoring	
Coastal Processes (Section G.5.7.3)			
Impacts due to the Installation of the Pipeline in the Nearshore	• Implementation of sand pumping/redistribution from the western to the eastern side of the pipeline during installation. • The final design of the pipeline and installation methodologies will minimise potential scouring.	• Reduction on/off site	•
Fisheries (Section G.6.1.3)			

Potential Impacts	Mitigations	Type of Commitments	Relevant Management Plan
Routine Operational Discharges	• Separated oil will be contained in dedicated tanks and then sent to shore for disposal at licensed facilities. • The disposal of food wastes into the sea from support vessels will only be allowed if previously macerated to pass through a 25 mm mesh, and in areas located more than 12 nautical miles from land. • The support vessels will not discharge comminuted food waste within 500 m of the FPSO location. • In addition, no refuelling will take place in bad weather conditions so as to limit the risk of occasional spills	• Avoidance	• Fisheries Management Plan • Water Management Plan • Pollution Prevention and Control Plan
	• The decks on the FPSO will be equipped with a drainage system to collect run off water into a holding tank for treatment prior to discharge overboard. • A bilge pump and a bilge water separator will be installed for draining the bilge water tank, which discharges to sea. • Water collected from the bilge, engine spaces and drainage will be treated to MARPOL Annex I requirements, that is to a level lower than 15 ppm oil content in water. • Any food waste from support vessels to be discharged will be previously macerated to pass through a 25 mm mesh.	• Reduction on/off site	
	• All the wastewater effluents from FPSO and Project vessels will be discharged only after treatment. • Wastewater treatment and disposal is designed to meet national and international requirements.	• Management	

Potential Impacts	**Mitigations**	**Type of Commitments**	**Relevant Management Plan**
Discharge of ballast water	• In order to reduce the risk of introduction of alien species due to ballast water discharge IMO Guidelines for the Control and Management of Ship's Ballast Waste and Sediments (Ballast Water Management Convention) will be implemented. • All vessels involved in the Project, including the FPSO, will carry a Ballast Water Record Book where all ballasting operation will be registered.	• Reduction on/off site	
Physical Presence and Light Emissions	• The Project will control and reduce overall light intensity to the extent practicable, without adversely affecting maritime or operational safety.	• Avoidance • Management	
Underwater Noise	• The Project will ensure that vessel engines are not left to idle unnecessarily. Vessels will be powered down to safe operational levels.	• Avoidance	
Socio-Economic Environment			
Economic Displacement of Marine Fishing-Based Livelihoods (Section G.7.2.3)			
Economic displacement of marine fishing-based livelihoods due offshore pipeline construction and reduced access to fishing grounds as result of exclusion zones around offshore Project infrastructure	• The Project will limit exclusion zones around Project infrastructure as far as possible. It is estimated that a 500 m buffer zone will be established around the FPSO.	• Avoidance	• Fisheries Management Plan • Security Management Plan
	• Agree vessel transit route with the Ghana Maritime Authority and communicate to fishermen and other marine users through the CLO/FLO. • Develop and implement a Fisheries Management Plan. • If possible, employ a Fisheries Liaison Officer (FLO) to liaise between fishermen and eni. • Develop and implement a Security Management Plan.	• Management	

Potential Impacts	Mitigations	Type of Commitments	Relevant Management Plan
	• Monitor the exclusion zone with the assistance of the agencies of the Government of Ghana, for the safety of the facility and other users of the area (e.g. fishermen). • Monitor interaction with fishermen and other users through the CLO/FLO and the Project's grievance procedure.	• Monitoring	
Social/Health Infrastructure and Public Services (Section G.7.5.3)			
Disruption to marine traffic	• The vessels involved in dredging and other construction-related activities must be equipped with navigation equipment and suitable aids to minimize interference with other vessels and to maintain high visibility. • Ensure that all its service and construction vessels are equipped with functional radar equipment.	• Reduction on/off site	• Marine Traffic Management Plan • Security Management Plan
	• Engage with the Maritime Authority to maintain awareness of the Project among relevant stakeholders.	• Management	
	• Safety exclusion zones shall be clearly noted and/or monitored, and appropriate pilot vessels, coastguards and maritime support agreed between the Project and Maritime Authorities.	• Monitoring	
Offshore Security and Piracy (Section G.7.8.2)			

Potential Impacts	**Mitigations**	**Type of Commitments**	**Relevant Management Plan**
Risk of attacks on drilling vessels and supply vessels	• eni will upgrade the obligatory Code 1 International Ship and Port Facility Security (part of SOLAS convention) of all Project related vessels to Code 2, which implies conducting regular security and anti-piracy exercises and drills on all Project related vessels, increase situational awareness both at day and night periods, perform operational planning suited to mitigate risk and increase lookouts. • Monitor advisories from the National Port Authority and when piracy risks are deemed high, initiate protocols such as additional lookout and increased situational awareness both day and night. • eni will support the national government and other oil and gas companies in regional counter-piracy efforts.	• Avoidance	• Marine Traffic Management Plan • Security Management Plan

Note: there is a general commitment to comply with all measures specified in the OSCP (Annex F) and well control strategy

Table 12.2 Construction Phase - Mitigation measures Onshore

Potential Impacts	Mitigations	Type of Commitment	Relevant Management Plan
	Biophysical environment		
	Air Quality (Section G.4.1.3)		
Increased Dust Emissions	• Cover/spray materials during transport. • Use of compacted natural materials in parking areas, if available. • Allow vehicles travel only along designated transport corridors. • Limit vehicle's speed. • Use water for dust suppression, to control of loose materials on stockpile and working strip. • Use of dust arrestment equipment (e.g., particle traps for vehicles' engine) where practicable.	• Reduction on/off site	• Pollution Prevention and Control Plan • Traffic Management Plan
Increased Vehicle and Equipment Emissions	• Apply BAT, air emission specifications and energy efficiency principles in the selection and procurement of equipment.	• Avoidance	
	• Power generators: use of NOx catalytic reduction/ CO catalytic oxidation; apply WHO recommended emission levels; to be located downwind at a min distance of 100 m from work areas and air conditioning intakes. • Speed limits will be implemented along transport corridors.	• Reduction on/off site	
	• Implement a Traffic Management Plan. • Planning of activities to minimise the use of vehicles and machinery. • A register of trained drivers will be maintained. • A defensive driving training awareness campaign to be carried out and specific training on traffic management to be given to all project drivers.	• Management	

Potential Impacts	Mitigations	Type of Commitment	Relevant Management Plan
	• Keep an inventory of air emission sources (measured or estimated).	• Monitoring	
Emissions from Hydrostatic Testing	• Apply BAT in the selection and procurement of equipment.	• Avoidance	
	• Regular and periodic maintenance of the equipment.	• Management	
Noise (Section G.4.3.3)			
Increased ambient noise levels due to noise emissions from equipment/vehicles involved in construction activities and hydrostatic testing	• On noise sources/equipment: apply BAT to select equipment. • On operations: limit noisy construction activities to the least noise-sensitive times of day, avoiding night activities.	• Avoidance	• Pollution Prevention and Control Plan • Traffic Management Plan
	• On noise sources/equipment: switch off equipment when not in use; keep audible warning devices to minimum volume. • On operations: limit vehicle' speed; maintenance of to reduce traffic noise. • On propagation path: locate and orient stationary equipment far from nearby receptors; use on-site structures and terrain as screen.	• Reduction on/off site	
	• On noise sources/equipment: regular maintenance; keep audible warning devices to minimum volume.	• Management	
Surface Water (Section G.4.4.3)			
Removal of Ephemeral and Permanent Surfacewater Bodies	• The footprint of the site will be minimised, storage and laydown areas, vehicle parking areas and workers' facilities need to be clearly specified, and activities will be restricted to these areas. • The outer limits of wetland buffers in the vicinity of planned developments will be surveyed, clearly defined on the ground and marked as no-go areas prior to the onset of construction activities.	• Avoidance	• Water Management Plan

Potential Impacts	Mitigations	Type of Commitment	Relevant Management Plan
	• The deposition of material onshore will be restricted to the areas to be infilled.	• Reduction on/off site	
	• Disturbed areas will be re-vegetated with a diversity of naturally occurring tree species, including locally endemic species.	• Repair or remedy	
	• Construction staff and contractors will be informed of the importance of minimising their footprint and restricting activities to these areas.	• Management	
Degradation of Surface Water Quality due to Increased Sediment Load (Resulting from Increased Erosion and Dust)	• Topsoil will be stripped and stored away from watercourses in designated topsoil stockpile areas. • The runoff from bare areas would need to be collected and conveyed by adequate side drains. • Intercepting channels will be provided to prevent stormwater run-off from washing across exposed soil surfaces. • Surface water management structures within the construction areas must include stream diversion channels, internal run-off capture and diversion channels, to control sedimentation wherever necessary. • Where required, drainage channels will be provided on-site to direct stormwater to sand/silt traps for the removal of soil particles.	• Reduction on/off site	
	• All exposed areas will be stabilised once the covering vegetation has been removed. • After being removed, excavated topsoil and subsoil stockpiled in the proximity of the trenching will be irrigated periodically, in order to reduce its dispersion towards surface water by the action of the wind.	• Repair or remedy	

Potential Impacts	**Mitigations**	**Type of Commitment**	**Relevant Management Plan**
	• Adequate dust control strategies will be applied to minimise dust deposition and reduce sedimentation in the wetland systems	• Management	
	• The quality of runoff in watercourses will be monitored on a regular basis depending on flow and corrective actions taken as appropriate. • Monitor stockpiles for erosion and implement erosion control measures if required. • Monitor the turbidity and suspended solids, to ensure that levels do not increase or decrease by more than 10 to 15 percent of recorded baseline levels.	• Monitoring	
Degradation of Surfacewater Quality due to Potential Contamination from Improper Handling of Hazardous and Non-hazardous Waste	• A waste inventory of potential wastes will be generated prior to construction. A plan for waste management will be developed based on the waste inventory and in line with national and international requirements.	• Management	• Water Management Plan • Pollution Prevention and Control

Potential Impacts	Mitigations	Type of Commitment	Relevant Management Plan
Degradation of Surface Water Quality due to Accidental Spillages of the Fuels and Chemicals	• Fuels and other hazardous chemicals will be stored according to industry best practice including bunds that can accommodate 150 % of the total storage volume and covered to prevent rainfall entering the bund. • Refuelling of equipment and vehicles will be carried out in designated areas on hard standing ground to prevent seepage of any spillages to ground. • Collection systems will be installed in these areas to manage any spills, fuels will be collected and either reused, treated by incineration or removed by an approved local contractor. • Vehicles, vessels and equipment working onshore near the estuaries or in the near shore will be serviced regularly. • Temporary fuel stored along the pipeline working strip and access roads will be correctly bunded during construction.	• Reduction on/off site	• Water Management Plan • Pollution Prevention and Control
	• Spills to ground (soil) will be remediated immediately by an appropriately qualified person and the remediation verified	• Repair or remedy	
	• Handling, storage and disposal of excess or containers of potentially hazardous materials will be in accordance with the requirements of the relevant legislation. • An Emergency Response and/or spill contingency plan will be in place for any accidental spillage. Spill containment and clean-up kits will be available on-site, and clean-up from any spill must be in place and executed at the time of a spillage, with appropriate disposal as necessary.	• Management	

Potential Impacts	Mitigations	Type of Commitment	Relevant Management Plan
Changes in Hydrology by Reduced Flows and/or Changes in Flow Direction	• No effluent will be discharged into the fresh-water or seasonal wetlands. • No water will be pumped from wetlands (for Project need). • No impoundments or ponds will be constructed within any of the wetlands or within the 150 m buffer zone around streams and wetlands	• Avoidance	• Water Management Plan • Waste Management Plan
	• Wherever possible, existing roads will be upgraded rather than building new ones. • If structures (e.g. overpasses) are required to cross streams, construction will, wherever possible, minimise in-stream supporting structures to ensure minimal impact on the in-stream habitat.	• Reduction on/off site	
	• After the restoration of topsoil, vegetation will be reinstated in the project area and the drainage from the working areas will be granted, potential erosion/flood events due to rainfall runoff will be minimized.	• Repair or remedy	
Groundwater (Section G.4.5.3)			
Reduction in Groundwater Resources due to Water Consumption	• The use of water on-site will be optimised by minimisation of water use, re-use and recycling to reduce the demand for groundwater extraction. • All wells installed for water supply will be installed at sufficient depths to access the deep freshwater aquifer in line with outcomes of the current pump testing results which will help to quantify effects of abstraction on the aquifer.	• Reduction on/off site	• Water Management Plan • Waste Management Plan

Potential Impacts	Mitigations	Type of Commitment	Relevant Management Plan
	• Within the water management plan and on the basis of further investigations, thresholds for the amount of groundwater that can be extracted by the Project will be established.	• Management	
Surface Sealing and Infilling Leading to Lowering of Groundwater Levels and Drawdown	• Groundwater levels will be monitored on a regular basis throughout the construction phase. • Within the water management plan and on the basis of further investigations, thresholds for the amount of groundwater that can be extracted by the Project will be established.	• Monitoring	
Degradation of Groundwater Quality due to Seepage from Discharge of Wastewater and Improper Waste Storage and Handling	• The permanent facilities will be equipped with a sewage treatment system to treat civil water from toilets, showers, lavatories, kitchen and laundry. An Imhoff tank will be installed. • Treated water will be discharged through an underground infiltration network, while sewage sludge will be disposed as waste offsite. • All wastewater generated during construction will be collected in a saver pit and treated and disposed of in conformity with legal requirements. There will be no direct discharge of wastewater to water receptors.	• Reduction on/off site	
	• A waste inventory of potential wastes will be generated prior to construction. A plan for waste management will be developed based on the waste inventory. • Project staff will not be permitted to utilize any water sources (stream, river, or other water bodies) for the purposes of bathing, washing of clothing or for any other construction or related activities.	• Management	

Potential Impacts	Mitigations	Type of Commitment	Relevant Management Plan
	• Within the water management plan and on the basis of further investigations, thresholds for quality of groundwater that cannot be exceeded as a result of seepage will be established.	• Monitoring	
Degradation of Groundwater Quality Due to Spillages of Fuels and Chemicals (Unplanned Event)	• Vehicles, vessels and equipment working onshore near the estuaries or in the near shore will be serviced regularly. • Temporary fuel stored along the pipeline working strip and access roads will be correctly bounded during construction. • Fuels and other hazardous chemicals will be stored according to industry best practice including bunds that can accommodate 150% of the total storage volume and covered to prevent rainfall entering the bund. • Refuelling of equipment and vehicles will be carried out in designated areas on hard standing ground to prevent seepage of any spillages to ground. • Spill containment and clean up kits will be available on-site and clean-up from any spill will be appropriately contained and disposed of at a registered landfill site.	• Reduction on/off site	• Water Management Plan • Pollution Prevention and Control • Emergency Response Plan
	• Spills to ground (soil) will be remediated immediately by an appropriately qualified person and the remediation verified.	• Repair or remedy	
	• Handling, storage and disposal or containers of potentially hazardous materials will be in accordance with the requirements of the relevant legislation. • An Emergency Response and/or Spill Contingency Plan will be in place for any accidental spillage.	• Management	
Terrestrial Soils, Geology and Geomorphology (Section G.4.6.3)			

Potential Impacts	**Mitigations**	**Type of Commitment**	**Relevant Management Plan**
Potential soil contamination (unplanned event, by accidental spills of hazardous and non-hazardous materials and by improper handling of hazardous and non-hazardous waste, compaction of the soil surface and potential degradation, collapse and sinkhole formation.	• Waste will be collected, stored and transported in appropriate and approved bins and containers. • Facilities will be built with systems to contain hazardous materials in case of an accidental release. Control systems will be properly maintained proper operation.	• Reduction on/off site	• Waste Management Plan • Pollution Prevention and Control • Emergency Response Plan
	• Implementation of a Waste Management Plan and Hazardous Materials Management to address waste handling, storage and disposal. • Waste and Hazardous materials will be managed in accordance with Ghana laws and regulations and in line with best practice principles. • Implementation of an Emergency Response Plan to address accidental spills or release of hazardous materials. • Spills of hazardous materials will be cleaned up in accordance with Ghana laws and regulations, safely for human health and the environment.	• Management	
Potential disturbance and degradation of soil during the construction, including loss of productivity (erosion, soil compaction, soil removal modification of morphology, collapse and sinkhole formation).	• Topsoil will be removed from the working strip and stockpiled in the form of a continuous ridge along the edge of the RoW. The topsoil stockpile should be formed as is suitable for the soil specific types in the area of excavation and be protected to reduce the possibility of physical damage and compaction. Topsoil will be deposited on one side of the working corridor where it will be stored in such a way that it is not mixed with other trenched materials or driven over by vehicles • Once stockpiles have been established they will not be moved around to other areas but directly used for rehabilitation to avoid creating more compacted areas.	• Avoidance	

Potential Impacts	Mitigations	Type of Commitment	Relevant Management Plan
	• Soil stockpiles must be sampled, ameliorated (if necessary) and re-vegetated with indigenous species to reduce exposure to rainfall and wind, as well as to slow and trap runoff to reduce soil erosion. • A shallow tillage of the soil will be realised through mechanical agitation with the aim of aerating the top layer of soil compacted by machinery. • No machinery will be allowed to leave the working strip or access roadways.	• Reduction on/off site	
	• Topsoil used to fill nursery bags and to re-establish indigenous vegetation in a proposed nursery at the mine to ensure micro-organisms associated with indigenous plants remain active in the soil. • Topsoil will be removed from the Working Strip and stockpiled in the form of a continuous ridge along the edge of the RoW, and protected to reduce the possibility of physical damage and compaction. • The removed topsoil will be finally placed back on the working corridor. The original contours of the land will be restored as closely as possible.	• Repair or remedy	

Potential Impacts	Mitigations	Type of Commitment	Relevant Management Plan
	• Before starting any construction work, topographic and photographic records will be made of the existing condition to be used as the standards against which the quality of site restoration will be evaluated. • An erosion monitoring programme will be implemented biannually to determine seasonal variations and thereafter, annually to include observations of evidence of erosion, degradation, condition of access roads, cleared areas, perimeter drains and settlement ponds, verify the compliance with standards.	• Monitoring	• Waste Management Plan • Pollution Prevention and Control Emergency Response Plan
Removal of soils (landtake) during earthworks and land clearance.	• No machinery will be allowed to leave the access roadways or the working strip. • Land clearance must be kept to a minimum and must only be cleared for areas that will be developed.	• Avoidance	
Terrestrial Flora (Section G.4.7.3)			
Loss of Natural Vegetation and Loss of Habitat/Habitat Fragmentation	• Collection and/ or selling of plant specimens by employees of the Company is forbidden. • Vehicles will use only demarcated areas and not drive off the roads which can have significant impacts on the natural habitats and vegetation.	• Avoidance	• Biodiversity Management Plan
	• Priority important species directly affected will be transplanted to a new area at the end of the growing season. If this is not possible a conservation plan on the species will be required to grow a nearly equivalent number of plants.	• Repair or remedy	

Potential Impacts	**Mitigations**	**Type of Commitment**	**Relevant Management Plan**
	• To avoid the loss of vegetation especially for species of priority importance, a monitoring plan will be prepared. • A floral surveys will be planned during the flowering season. The monitoring plan will include activities to ensure the control of alien & pioneer species.	• Monitoring	
Impacts on Flora due to Degradation of Abiotic Components in Ecosystems	• Mitigation measures for Surface Water, Air Quality and Soils will be put in place. • Vehicles will be restricted to specific areas when driving outside the ORF and only use demarcated areas and not drive off the roads. • Where required roads and working areas will be wet (or similar) to prevent dust generation. • Hazardous substances will be stored within sealed containers and bunded to prevent unplanned spills. • Top soil will be stripped and temporarily stored on one side of the working strip. • Non-fertile "subsoil" obtained from the pipeline trench excavation will be stored on the opposite side of the working strip.	• Reduction on/off site	• Biodiversity Management Plan
	• Fertile top soil must be promptly re-deposited on top of the non-fertile soil to ensure adequate crop or vegetation growth.	• Repair or remedy	
Introduction of Alien Species	• No planting of alien species will occur in the camps or any areas within the AoI, including landscaping of re-vegetated areas.	• Avoidance	• Biodiversity Management Plan
	• Re-vegetation will be undertaken as soon as possible after clearance and construction.	• Repair or remedy	

Potential Impacts	**Mitigations**	**Type of Commitment**	**Relevant Management Plan**
	• A monitoring plan will be carried out for the most rigorous invasive species, to record their populations in the AoI. These results can then be used to define an Alien Species Eradication plan aimed at removing new populations and preventing them from spreading throughout the AoI.	• Monitoring	
	Terrestrial Fauna (Section G.4.8.3)		
Habitat Reduction/ Fragmentation and Isolation	• Mitigation measures foreseen for terrestrial flora will be implemented. • The project will consider undertaking the clearing of vegetation during construction in phases. In this way, the change will be gradual which will give fauna the chance to identify new suitable areas and migrate.	• Reduction on/off site	• Biodiversity Management Plan • Pollution Prevention and Control • Emergency Response Plan • Traffic Management Plan

Potential Impacts	Mitigations	Type of Commitment	Relevant Management Plan
Disturbance and/or Displacement of Fauna due to Pollution	• Mitigation measures foreseen for Surface Water, Groundwater, Soils and Air Quality, Noise will be implemented. • Facilities will be built with systems to contain hazardous materials in case of an accidental release (e.g., interceptor drain downslope of storage area). Control systems will be properly maintained proper operation. • Lighting will, where possible, be aimed directly at the areas where it is required, minimising light pollution outside of the ORF and other working areas. • Construction activities, will as far as possible, be limited to daytime hours. • Machinery and vehicles will be in good working order and regularly maintained to prevent unnecessary noise.	• Reduction on/off site	• Biodiversity Management Plan • Pollution Prevention and Control • Emergency Response Plan • Traffic Management Plan

Potential Impacts	Mitigations	Type of Commitment	Relevant Management Plan
	• The Project will develop and implement a Waste Management Plan to address waste handling, storage and disposal. Waste will be managed in accordance with Ghana laws and regulations and in line with best practice principles. Waste will be collected, stored and transported in appropriate and approved bins and containers. • A Hazardous Materials Management Plan will be implemented to address hazardous material handling and storage. • Hazardous materials will be managed in accordance with Ghana laws and regulations and in line with best practice principles. • An Emergency Response Plan to address accidental spills or release of hazardous materials will be implemented. Spills of hazardous materials will be cleaned up in accordance with Ghana laws and regulations. • A pre-construction survey will be undertaken to identify sensitive avian species that may be present during times outside of those surveyed previously (April and November) and particularly during the boreal winter.	• Management	
Increased Mortality of Wildlife	• The hunting for bush meat needs to be strictly controlled. • Design and implementation of embedded bush meat action plans to prevent all activities of staff and contractors related to the trade in animal protein and live specimens.	• Reduction on/off site	• Biodiversity Management Plan • Pollution

Potential Impacts	Mitigations	Type of Commitment	Relevant Management Plan
	• Implementation of a BAP which will include detailed mitigation to address possible impacts on fauna including mitigation to avoid mortality of local faunal species. • Possible additional conservation actions in collaboration with Ankasa National Park or Birdlife International with regards to the Amansuri Wetlands IBA	• Management	Prevention and Control • Emergency Response Plan • Traffic Management Plan
Ecosystem Services (Section G.8.1.3)			

Potential Impacts	Mitigations	Type of Commitment	Relevant Management Plan
Modification, fragmentation and loss of habitats and agricultural land and the associated services. Reduction in access to ecosystem services. Disturbance to fauna and flora from air emissions, noise and light and depletion of natural resources (e.g. water, wood) for construction activities resulting in a reduction or loss of associated ecosystem services. Potential pollution of soils and water with the associated loss on ecosystem services provided.	• Priority ecosystem services will be identified in consultation with the affected communities during the livelihood restoration baseline data collection. Results will be reflected in the LRP. • Provisioning services: mitigation measures applicable will be mostly related to those identified for Terrestrial/Aquatic Flora and Fauna and Habitats. • Regulating services: Mitigation measures identified are those related to terrestrial flora, such as flora monitoring and re-vegetation. • Cultural services: mitigation measures for fauna consider the restoration of vegetative cover and limits to project emissions which may limit disturbance, and at the same time have an effect on the surrounding landscape.	• Reduction on/off site; • Management	• All plans apply to Ecosystem Services
Landscape (Section G.4.9.3)			

Potential Impacts	Mitigations	Type of Commitment	Relevant Management Plan
Landscape changes and visual impacts due to installation of the pipeline, construction of ORF and associated infrastructure..	• Worksite facilities to be constructed at a minimal height to avoid unnecessary impacts on the landscape. • Use of directed downward lighting sufficient to enhance the night time visibility. • Use specifically designed lighting equipment that minimises the upward spread of light near to and above the horizontal.	• Avoidance	• --
	• Worksites will only be temporary as machinery and construction equipment will be dismantled and removed. In addition, there will be a reduction in workers on site as construction is completed and restoration activities will be undertaken.	• Reduction on/off site	
	• Soil stockpiles must be sampled, ameliorated (if necessary) and re-vegetated with indigenous species as soon after construction as possible to reduce exposure to rainfall and wind, to trap runoff to reduce soil erosion. • The original contours of the land will be restored as closely as possible.	• Repair or remedy	
Socio-Economic Environment			
Economy and Employment (Section G.7.1.3)			
Increased Government Revenue Employment opportunities and Skills Enhancement Increased Procurement	• eni will collaborate with the Government of Ghana to make payments of taxes and royalties in a transparent, accurate, and timely manner, utilising sound financial principles and accounting processes in alignment with EITI requirements. • Where possible, and as part of it Social and Environmental Investment Plan eni will work with Local Government to encourage use of revenues to promote economic diversification, thereby minimising dependence on the oil and gas sector. • Engage with local authorities to ensure that Project Social and Environmental Investment programmes are aligned with local	• Management	• Recruitment, Employment and Training Plan • Project Procurement Plan • Workers Management

Potential Impacts	Mitigations	Type of Commitment	Relevant Management Plan
Enhanced Tourism Potential Increased Price Inflation and Economic Vulnerability	development plans and programmes. • Make available information on the workforce requirements of the Project. • Comply with the local content requirements outlined in the Ghana Local Content Policy Framework (2010). • Ensure that recruitment procedures are transparent and monitored. No children will be employed. • Where possible, give priority to vulnerable groups most directly impacted by the Project. • Advertise employment requirements at a national level, and specify that Ghanaians from DAoI will be given priority. • All contractors will be required to provide details of their own national employment and training plans. • Identify the existing skills in the DAoI to identify skills gaps and initiate training mechanisms. • Prioritize development opportunities for employees who are Ghanaian nationals, particularly vulnerable groups. • Build the capacity of employees through development plans, technical, health and safety training. • eni will comply with the minimum local content requirements for supplies and services prescribed in the Ghana Local Content Policy Framework (2010). • Identify potential partnerships with NGOs and other education organisations for training and skills acquisitions. • Disseminate information regarding procurement opportunities and requirements as early as possible. • Make available quality standards required by the Project for provision of goods and services to the Project.		Plan • Local content Development Plan • Influx Management Plan • Stakeholder Engagement Plan

Potential Impacts	Mitigations	Type of Commitment	Relevant Management Plan
	• Encourage small businesses to provide goods and services. • Definition of Corporate Social Investment activities that promote sustainable projects, training and education. • Commit to Corporate Social Investment activities, through the Social and Environmental Investment Plan. • Undertake a demographic survey and rapid appraisal to reflect on the perceived challenges and changes to quality of life.		
Economic Displacement of Land-Based Livelihoods (Section G.7.2.3)			
Economic Displacement of Farming in Concession Area (crop cultivation, animal rearing, and aqua-culture).	• Develop a Livelihoods Restoration Plan (and later CDP) which will focus on key elements of compensation and livelihood restoration.	• Management	• Livelihoods Restoration Plan

Potential Impacts	**Mitigations**	**Type of Commitment**	**Relevant Management Plan**
Socio-Cultural Changes (Section G.7.3.3)			

Potential Impacts	Mitigations	Type of Commitment	Relevant Management Plan
• Changes to cultural and Social Norms. • Increased anti-social behaviour. • Tension and Conflict between Villages. • Social Unrest resulting in violence towards the Project, Communities or Migrant	• Implement the Grievance Mechanism described in the OCTP OCTP EIS SEP, Annex A in compliance with IFC PS6. • Stakeholder consultation to conserve and preserve and or document local cultural artefacts and traditional practices of particular value and significance. • Perform stakeholder consultation with the communities through the relevant administrative and traditional authorities. • A Workers Management Plan including a Code of Conduct will be developed to minimise the risk of anti-social behaviours. • All Project Personnel will be provided with induction training that will include communication of the Code of Conduct, associated disciplinary procedures, and awareness raising on cultural sensitivities. • Induction training will also include procedures to ensure appropriate management of grievances. • Work teams will be accompanied by the CLO when interaction with communities is required. • Development of an Influx Management Plan and adding measures within the Stakeholder Management Plan including a Grievance Procedure to ensure proper management of aspects related to socio-cultural changes and potential for community tension or social unrest. • Development of a Security Management Plan containing measures to protect the project facilities and personnel against potential violent protest or social unrest and to train Security personnel in safeguarding of community human rights.	• Management	• Workers Management Plan • Recruitment, Employment and Training Plan • Local content Development Plan • Influx Management Plan • Stakeholder Engagement Plan • Security Management Plan

Potential Impacts	Mitigations	Type of Commitment	Relevant Management Plan
Cultural heritage resources (Section 10.7.4.3)			
Disturbance or destruction of cultural heritage resources Loss of sense of place	• Protect the Royal cemetery to prevent accidental damage while allowing access to local people. • Minimising Project land take and footprint for construction, to avoid disturbance to and loss of cultural and natural resources of value to the affected communities.	• Avoidance	• Local content Development Plan • Recruitment, Employment and Training Plan • Cultural Heritage Management and Monitoring Plan
	• Adopt a participatory approach with communities directly impacted by Project activities to agree how archaeological and cultural heritage sites will be identified and protected. • A Chance Finds Procedure will be developed and implemented to ensure appropriate treatment of a chance find • Training and awareness material in the identification of archaeological material; and • Developing procedures for contractors to report chance finds to the Project. • Cultural Sensitivity Training for Project workforce during induction in order to increase worker awareness of local community sensitivity to changes to their natural and cultural environment.	• Management	
Social Infrastructure and Public Services (Section G.7.5.3)			

Potential Impacts	**Mitigations**	**Type of Commitment**	**Relevant Management Plan**
Pressures on local infrastructure and public services (e.g. electricity, waste sanitation) Pressure on road infrastructure. Pressure on health infrastructure	• Eni will build and operate Project support infrastructure, such as access roads, accommodation camps, and wastewater systems and waste storage/treatment facilities related to the project facilities. • In coordination with the Recruitment, Employment and Training Plan and Procurement plan, manage regional expectations and detract work-seeking migration through the communication of Project labour needs and clear Project policies and procedures for recruitment. • Formalise local recruitment procedures. • Support government initiatives that address local capacity to meet increased pressure on schools in the area. • Promote the implementation of joint planning approaches with government and other key stakeholders. • Implement the Project Waste Management Plan. • Develop and implement an Social and Environmental Investment Plan, which will include a community education/awareness campaign around responsible and safe disposal of waste. • Develop and implement a Traffic Management Plan. • Capacity and needs assessment of equipment and personnel of hospitals in the project area. • Develop Emergency Response Plans (ERPs) for the Project taking into account access to health care, major incidences, multiple casualty events and pandemics to avoid draw-down of community health resources in the event of an incident. • Workers will be provided with primary health care and basic first aid at construction camps / worksites.	• Management	• Waste Management Plan • Emergency Response Plan • Recruitment, Employment and Training Plan • Procurement plan • Traffic Management Plan • Influx Management Plan

Potential Impacts	Mitigations	Type of Commitment	Relevant Management Plan
Workers Management and Rights (Section G.7.6.3)			

Potential Impacts	Mitigations	Type of Commitment	Relevant Management Plan
	• Develop policies and strategies outlining its commitment to ensuring the health and safety of its workers. • As part of HSE IMS, undertake socioeconomic compliance monitoring to inform its internal auditing and monitoring process. • In all contractor contracts, make explicit reference to the need to abide by Ghana law, international standards and eni's policies in relation to health and safety, labour and welfare standards. • Consider performance with regard to worker management, worker rights, health and safety as outlined in Ghana law, international standards and eni's policies. • Support contractors and subcontractors to ensure that labour and working conditions are in line with Ghana law through gap analysis and capacity building. • Workers will be provided with primary health care and basic first aid at construction camps /worksites. • Facilities and operations will be developed, planned and maintained such that robust barriers are in place to prevent accidents. • Employee will not be under the influence of intoxicants. • Surveillance programs for health status shall be established and implemented. • Support contractors to ensure that labour and working conditions are in line with Ghana laws and regulations. • All workers will receive induction training on worker rights. • All contracts for workers will clearly state the terms and conditions of their employment (and their legal rights). • No employee or job applicant will be discriminated against on the basis of his or her gender, marital status, nationality, age, religion or sexual orientation. • All workers will receive training on worker rights in line with Ghana legislation. • Eni will require all contractors and subcontractors to comply with	• Management	• Workers Management Plan • Recruitment, Employment and Training Plan

Potential Impacts	Mitigations	Type of Commitment	Relevant Management Plan
	• Review and monitor the outcomes of community engagement, media coverage and its workforce and community grievance mechanism. • Contractor contracts will specify monitoring to be undertaken by the contractor, establish the right for eni monitoring and auditing of all contractors and subcontractors and the consequences for the contractor if they are found to be breaching requirements or clauses in the contract.	• Monitoring	
	Community health, safety and security **(Section G.7.7.3)**		
Increased prevalence of sexually transmitted infections including HIV/AIDS. Increased prevalence of communicable diseases due to worker-community interaction. Increased prevalence of malaria due to worker-community interaction. Traffic accidents from increased traffic and presence of heavy vehicles in local roads. Increased pressure on health care resources	• Provide workers with primary health care and basic first aid at construction camps / worksites. • Provide access to free condoms at all worker sites and project site and accommodation. • Take measures to reduce the presence of standing water during construction. • Take measure such as the installation of screens or nets on windows and at doors to reduce the potential for mosquito-human interactions. • Plan traffic routes to limit road use by the Project during high traffic periods. • Assess local road conditions and be responsible for road maintenance during Project construction. • Erect signs around work fronts and construction sites warning of risks associated with trespassing. • Erect fencing around pipe yards and other similar facilities to minimise the risk of trespassing. • When work areas are within 100 m of an inhabited site,	• Reduction on/off site	• Security Management Plan • Community Health Management Plan • Traffic Management Plan • Emergency Response Plan • Recruitment, Employment and Training Plan • Procurement plan • Influx Management

Potential Impacts	**Mitigations**	**Type of Commitment**	**Relevant Management Plan**
Environmental changes due to nuisance and air emissions. Site trespass and injury. Use of security forces.	equipment will be parked overnight in a restricted area. • Plan traffic routes to limit road use by the Project during high traffic periods.		Plan
	• All employees will be trained and required to follow the Worker Code of Conduct. • Employees will be trained and educated to improve awareness of transmission routes and methods of prevention of sexually transmitted infections, communicable diseases (such as TB) and vector borne diseases. • Develop and implement Emergency Response Plans (ERPs) for the Project taking into account access to health care, major incidences, multiple casualty events and pandemics to avoid draw-down of community health resources in the event of an incident. • Continue to implement a programme of stakeholder engagement including a grievance mechanism, in compliance with IFC PS1 and PS4 • Work with relevant health authorities and NGOs to provide awareness training regarding the transmission of communicable diseases and STIs, preventative measures and the importance of seeking appropriate treatment. • Provide education and communication campaigns on malaria diseases with the workforce; • Work with relevant partners in the community health sector to implement malaria awareness raising campaigns. • Implement procedures to identify specific prophylaxis needs for Project personnel.	• Management	• Management Plan • Community Health Management Plan • Traffic Management Plan • Emergency Response Plan • Recruitment, Employment and Training Plan • Procurement plan

Potential Impacts	Mitigations	Type of Commitment	Relevant Management Plan
	• Implement journey management planning, driving codes of conduct and enhanced driver safety awareness. • Provide driver training to promote safe and responsible driving behaviour. • Require mandatory training on safe driving, worker code of conduct and health awareness training for all drivers. • Develop and implement a Traffic Management Plan to ensure compliance with procedures and rules. • Engage with local communities and authorities to inform about plans and procedures • Develop and implement an education program to promote awareness and understanding of personal safety risks associated with the Project. • Undertake a programme of stakeholder engagement and consultation to educate local communities of the risks of trespassing, the meaning of signs, dangers of playing on or near equipment or entering fenced areas. • Eni will implement a Grievance Mechanism. • A security management plan together with a specific patrolling procedure will be developed. • Project security systems will comply with Ghana laws and regulations as well as the requirements of the UN Voluntary Principles for Security and Human Rights. • Be particularly attentive to ensuring that their security arrangements respect human rights, with constructive outreach to police and the navy through consultation, as well as training on human rights.		

Potential Impacts	Mitigations	Type of Commitment	Relevant Management Plan
	• Conduct pre-employment screening protocols for all employees. • Conduct regular health screening for all employees. • Monitor health trends during Project construction (and operations). • Monitor the emergence of major pandemics/ epidemics through WHO alerts. • Monitor the incidence of malaria in the workforce.	• Monitoring	•

12.3.2 Operation phase

The following Table 12.3 summarises potential impacts and related mitigation measures identified for the offshore operation phase of the Project, whereas Table 12.4 presents potential impacts and related mitigation measures identified for the onshore operation phase of the Project.

For a number of impacts, the commitment in this framework ESHMP is that the mitigation measures defined for the construction phase will continue to be implemented during the operation phase.

However, it should be noted that when the operations ESHMP is developed, eni Ghana will update and adapt the mitigation measures as needed, and with the assurance that they will be at least as stringent and protective of the environment as the ones defined in the framework ESHMP. This will be done based on result of monitoring and additional, refined design information (including updated modelling or air quality and noise). According to current plan, the operations ESMHP will be developed at least 18 months prior to the commencement of project operations.

Table 12.3 Operation Phase - Mitigation measures Offshore

Potential Impacts Offshore	Mitigations Offshore - Operations	Type of Commitments	Relevant Management Plan
	Biophysical environment		
	Air Quality (Section G.5.3.4)		
Vessels exhausts for maintenance works	• All offshore facilities and support vessels will be compliant with the air pollution criteria set in Marpol Annex VI with the only exceptions of the treatment, handling, or storage of sea-bed minerals, and the emissions from diesel engines that are solely dedicated to the exploration, exploitation and associated offshore processing of sea-bed mineral resources. • Gas turbine emissions will be compliant with EHS Guideline for Thermal Power Plants (above 50 MWth). • VOCs emissions will be limited by tank blanketing. • Flare, vent and blowdown system will be designed to satisfy the zero flaring philosophy adopted for the entire Project.	• Reduction on/off site	• Pollution Prevention and Control Plan
	GHG (Section G.5.4)		
GHG emissions	• Implementation of best available techniques related to: efficiency of power generation; optimisation of overall energy efficiency; reduction in flaring; and reduction in venting.	• Reduction on/off site	• Pollution Prevention and Control Plan
	• Regular monitoring and recording as part of a continuous improvement programme specifically for GHG.	• Monitoring	
	Underwater Noise (Section G.5.5.4)		
Increased underwater noise emissions due to general shipping activities and FPSO operation	• The mitigation measures defined for the construction phase will continue to be implemented during the operation phase.	See Table 12.1 (Construction phase)	• Pollution Prevention and Control Plan

Potential Impacts Offshore	Mitigations Offshore - Operations	Type of Commitments	Relevant Management Plan
	Seawater Quality (Section G.5.1.4)		
Potential Contamination of Seawater from FPSO and	• No refuelling will take place in bad weather conditions so as to limit the risk of occasional spills	• Avoidance	• Water Management

Potential Impacts Offshore	Mitigations Offshore - Operations	Type of Commitments	Relevant Management Plan
Support Vessel Operations	• All the wastewater effluents from FPSO will be discharged only after treatment. Wastewater treatment and disposal is designed to meet national and international requirements. • The decks on the FPSO will be equipped with a drainage system to collect run off water into a holding tank for treatment prior to discharge overboard. • A bilge pump and a bilge water separator will be installed for draining the bilge water tank, which discharges to sea. • Separated oil will be contained in dedicated tanks and then sent to shore for disposal at licensed facilities. • Sewage from support vessels and FSPO will be treated in an approved sewage treatment unit in compliance with MARPOL Annex IV requirements prior to discharge. • Water collected from the bilge, engine spaces and drainage will be treated to MARPOL Annex I requirements, Water will be treated in an oil/water separator and continuously monitored by an automatic oil content meter. • Produced water will be reinjected. However, if needed treated produced water will only be discharged to the sea if it meets WB/IFC guidelines. For this effect, sampling points will be made available to sample and test eventual produced water discharges. • As per Ghanaian Pollution Prevention and Control regulations the discharge of garbage, with the exception of food waste, is prohibited from any vessel involved in the Project and the FPSO. • Any food waste from support vessels to be discharged will be previously macerated to pass through a 25 mm mesh and discharged in areas located more than 12 nautical miles from land. The support vessels shall not discharge comminuted food waste within 500 m of the FPSO location.	• Reduction on/off site	Plan • Pollution Prevention and Control Plan • Waste Management Plan

Potential Impacts Offshore	**Mitigations Offshore - Operations**	**Type of Commitments**	**Relevant Management Plan**
Potential Contamination of Seawater from Pipeline's Anti-Corrosion Anodes	• The composition of the anti-corrosion anodes to be used will not include toxic metals such as mercury or cadmium to avoid their introduction in the environment.	• Avoidance	
Seabed (Section G.5.2.4)			
Contamination of sediment by deposition of pollutants discharged from vessels and the FPSO	• All discharges will be compliant with MARPOL Annex I and IV requirements	• Management	• Water Management Plan • Pollution Prevention and Control Plan • Waste Management Plan
Marine Flora and Fauna (Section G.5.5.4)			
Disturbance due to vessel presence, collision risk and light emissions	• The mitigation measures defined for the construction phase will continue to be implemented during the operation phase.	See Table 12.1 (Construction phase)	• Biodiversity Management Plan
Fisheries (Section G.6.1.5)			

Potential Impacts Offshore	**Mitigations Offshore - Operations**	**Type of Commitments**	**Relevant Management Plan**
Routine operational discharges, Disturbance due to physical presence of installations, light emissions and underwater noise	• The mitigation measures defined for the construction phase will continue to be implemented during the operation phase.	See Table 12.1 (Construction phase)	• Fisheries Management Plan • Water Management Plan • Pollution Prevention and Control Plan
Socio-Economic Environment			
Economy and Employment (Section G.7.1.4)			
Increased Government Revenue Employment opportunities and Skills Enhancement Increased Procurement Enhanced Tourism Potential Increased Price Inflation and Economic Vulnerability	• The mitigation measures defined for the construction phase will continue to be implemented during the operation phase.	• See Table 12.1 (Construction phase)	• Project Recruitment, Employment and Training Plan • Project Procurement Plan • Local Content Development Plan • Influx Management Plan • Stakeholder Engagement Plan

Potential Impacts Offshore	Mitigations Offshore - Operations	Type of Commitments	Relevant Management Plan
Economic Displacement of Fisheries-Based Livelihoods (Section G.7.2.4)			
Restricted access to fishing grounds. Disruption of near shore fishing activities. Damages to fishing gears.	• The mitigation measures defined for the construction phase will continue to be implemented during the operation phase. In addition: • Ongoing mitigation and stakeholder engagement to monitor that those affected are able to adapt to the changes brought about by the Project. • The offshore facilities, the gas export pipeline and the associated exclusion areas will be clearly marked on navigation charts as cautionary advice to all sea-users. • The presence of vessels and other marine operations will be notified to mariners.	• See Table 12.1 (Construction phase) • Monitoring	• Stakeholder Engagement Plan
Social Infrastructure and Public Services (Section G.7.5.3)			
Disruption to marine traffic	• The mitigation measures defined for the construction phase will continue to be implemented during the operation phase.	• See Table 12.1 (Construction phase)	• Marine Traffic Management Plan • Security Management Plan
Community health, safety and security (Section G.7.7.4)			

Potential Impacts Offshore	Mitigations Offshore - Operations	Type of Commitments	Relevant Management Plan
Increased prevalence of sexually transmitted infections including HIV/AIDS. Increased prevalence of communicable diseases due to worker-community interaction. Increased prevalence of malaria due to worker-community interaction. Increased pressure on health care resources Environmental changes due to nuisance and air emissions. Site trespass and injury. Use of security forces.	• Quantified Risk Assessments (QRAs) will be developed for the operation of the FPSO to prevent occupational risks due to emissions, flaring, gas leakages, etc. at the FSPO. • Mitigation measures to be adopted will be updated according to the results of the QRAs to be developed for the FPSO facility. • The mitigation measures defined for the construction phase will continue to be implemented during the operation phase. In Addition: • Undertake stakeholder engagement regarding the operation of the drilling areas, the FPSO and associated facilities, and the offshore pipeline. This will be undertaken prior to the commencement of the operation phase. • Maintain the grievance mechanism throughout the operation of the Project. • Undertake a community education programme on pipeline safety to alleviate concerns. • Have the FPSO permanently guarded, while the offshore pipeline routes will be regularly patrolled to deter deliberate damage or vandalism and assure the operational safety of the Project is not compromised.	• See construction phase	• Security Management Plan • Community Health Management Plan • Traffic Management Plan • Emergency Response Plan • Recruitment, Employment and Training Plan • Procurement plan
Offshore Security and Piracy (Section G.7.8.3)			
Risk of attacks on drilling vessels and supply vessels	• The mitigation measures defined for the construction phase will continue to be implemented during the operation phase.	• See Table 12.1 (Construction phase)	• Marine Traffic Management Plan • Security Management Plan

Note: there is a general commitment to comply with all measures specified in the OSCP (Annex F)

Table 12.4 Operation Phase - Mitigation measures Onshore

Potential Impacts	Mitigations	Type of Commitments	Relevant Management Plan
Biophysical environment			
Air Quality (Section G.4.1)			
Increased atmospheric pollutant concentrations (CO, NOx) due to exhaust emissions from ORF facilities operation and vehicles involved in maintenance.	• Consider BATs in selection of operational equipment.	• Avoidance	• Pollution Prevention and Control Plan • Traffic Management Plan
	• Equipment and vehicle maintenance.	• Reduction on/off site	
	• Implementation of a Traffic Management Plan. • Repeat the air quality modelling study once final Project design information is available by means of modelling tools (i.e. CALMET-CALPUFF) in order to improve the efficiency of the mitigation measures designed as a result of the current air quality model (see Annex H).	• Management	
GHG (Section G.4.2)			
GHG emissions	• Implementation of best available techniques related to: efficiency of power generation; optimisation of overall energy efficiency; reduction in flaring; and reduction in venting.	• Reduction on/off site	• Pollution Prevention and Control Plan
	• Regular monitoring and recording as part of a continuous improvement programme specifically for GHG.	• Monitoring	
Noise (Section G.4.3.4)			
Increased ambient noise levels	• BATs will be considered in selection of operational equipment.	• Avoidance	• Pollution

Potential Impacts	Mitigations	Type of Commitments	Relevant Management Plan
due to noise emissions from ORF operation and vehicles involved in maintenance.	• Regular maintenance of equipment and vehicles. • Limitation of vehicle's speed and maintenance of road surfaces to avoid increases in noise from vehicles travelling. • Keep the noise level of audible warning devices to the minimum necessary for health and safety.	• Reduction on/off site	Prevention and Control Plan
	• The noise modelling study will be repeated once final Project design is available by means of modelling tools (i.e., SoundPLAN) in order to improve the efficiency of the mitigation measures designed as a result of the current noise model (see Annex I). • Considering noise performance in the selection of equipment and vehicles in accordance with the best available technique (selection of lower noise equipment). • Optimization of the ORF layout, locating the emission sources as far as possible from the sensitive receptors. • If feasible, planning the installation of noise barriers, equipment enclosures and silencers to reduce noise emissions.	• Management	
	Surface Water (Section G.4.4.4)		
Degradation of Surfacewater Quality due to Potential Contamination from Improper Handling of Hazardous and Non-hazardous Waste	• A waste inventory of potential wastes will be generated prior to construction. A plan for waste management will be developed based on the waste inventory, in line with national and international requirements	• Management	• Water Management Plan • Pollution Prevention and Control • Waste Management
Degradation of Surface Water Quality due to Accidental Spillages of the Fuels and	• Procedures for vehicle/equipment refuelling will be implemented to prevent spillage and will prohibit construction vehicles and equipment to be refuelled near water courses.	• Avoidance	

Potential Impacts	**Mitigations**	**Type of Commitments**	**Relevant Management Plan**
Chemicals used	• Appropriate spill containment equipment will be available at refuelling sites. • Any storage facilities containing hazardous substances will be lined, bunded or otherwise designed to prevent seepage and impact to surface or groundwaters. • Vehicles, vessels and equipment working onshore near the estuaries or in the near shore will be serviced regularly. • Spill containment and clean-up kits will be available on-site, and clean-up from any spill must be in place and executed at the time of a spillage, with appropriate disposal as necessary. • Project staff will not be permitted to utilise any water sources (stream, river, or other water bodies) for the purposes of bathing, washing of clothing or for any other construction or related activities.	• Reduction on/off site	Plan • Emergency Response Plan
	• All drivers will be trained in emergency spill response procedures. • Oil spill prevention and response plans will be put in place. Temporary fuel stored along the pipeline working strip and access roads for maintenance purposes will be correctly bunded. • An Emergency Response and/or spill contingency plan will be in place for any accidental spillage.	• Management	
Groundwater (Section G.4.5.4)			

Potential Impacts	**Mitigations**	**Type of Commitments**	**Relevant Management Plan**
Reduction in Groundwater Resources due to Water Consumption	• The use of water on-site will be optimised by minimisation of water use, re-use and recycling to reduce the demand for groundwater extraction. • All wells installed for water supply will be installed at sufficient depths to access the deep freshwater aquifer to avoid impacts on groundwater resources used by local communities.	• Reduction on/off site	• Water Management Plan • Pollution Prevention and Control • Waste Management Plan • Emergency Response Plan
Degradation of Groundwater Quality due to Seepage from Discharge of Wastewater and Improper Waste Storage and Handling	• Should a landfill be constructed in the future, this will be designed to industry best standards for wastes generated at the Project site. • Project staff will not be permitted to utilise any water sources (stream, river, or other water bodies) for the purposes of bathing, washing of clothing or for any other construction or related activities.	• Avoidance	
	• The permanent facilities will be equipped with a sewage treatment system to treat civil water from toilets, showers, lavatories, kitchen and laundry. An Imhoff tank will be installed. Treated water will be discharged through an underground infiltration network, while sewage sludge will be disposed as waste offsite.	• Reduction on/off site	
	• A waste inventory of potential wastes will be generated prior to construction. A plan for waste management (including disposal) will be developed based on the waste inventory.	• Management	• Waste Management Plan

Potential Impacts	Mitigations	Type of Commitments	Relevant Management Plan
Degradation of Groundwater Quality Due to Spillages of Fuels and Chemicals (Unplanned Event)	• Fuels and other hazardous chemicals will be stored according to industry best practice including bunds that can accommodate 150% of the total storage volume and covered to prevent rainfall entering the bund. • Refuelling of equipment and vehicles will be carried out in designated areas on hard standing ground to prevent seepage of any spillages to ground. Collection systems will be installed in these areas to manage any spills. • Handling, storage and disposal of excess or containers of potentially hazardous materials will be in accordance with the requirements of the relevant legislation. • Spill containment and clean up kits will be available on-site and clean-up from any spill will be appropriately contained and disposed of at a registered landfill site. • Vehicles, vessels and equipment working onshore near the estuaries or in the near shore will be serviced regularly.	• Reduction on/off site	• Emergency Response Plan • Waste Management Plan
	• Spills to ground (soil) will be remediated immediately by an appropriately qualified person and the remediation verified.	• Repair or remedy	
	• An Emergency Response and/or spill contingency plan will be in place for any accidental spillage. Spill containment and clean-up kits will be available on-site, and clean-up from any spill must be in place and executed.	• Reduction on/off site	
Terrestrial Soils, Geology and Geomorphology (Section G.4.6.4)			

Potential Impacts	**Mitigations**	**Type of Commitments**	**Relevant Management Plan**
Potential soil contamination (unplanned event, by accidental spills of hazardous and non-hazardous materials and by improper handling of hazardous and non-hazardous waste).	• All the effluents will be treated as liquid waste, and construction mitigation measures will be applied, where applicable. • Waste water will be collected in sewage tanks and treated as waste. • Any spills must immediately be collected using booms, pads and absorbent mops and correctly disposed on site before being removed for final disposal at a licensed hazardous waste site (to be identified).	• Management	• Emergency Response Plan • Waste Management Plan • Pollution Prevention and Control
	• Any solid waste generated on site will be stored and removed in accordance with the Waste Management Plan.	• Management	
Potential for compaction of soils in heavily used areas and erosion along roads and around other hardstanding areas.	• Topography will be restored and soil stockpiles revegetated.	• Repair or remedy	
	• Any rehabilitated areas must be regularly maintained and monitored in order to maintain a high basal cover and limit soil erosion due to both water (runoff) and wind (dust) erosion.	• Management	
Landtake	• Land will continuously be remediated during operations, where possible.	• Repair or remedy	
Terrestrial Flora (Section G.4.7.4)			

Potential Impacts	Mitigations	Type of Commitments	Relevant Management Plan
Impacts on flora due to degradation of Abiotic Components of Ecosystems	• The mitigation measures foreseen for Surface Water, Air Quality and Soils will be implemented. • Vehicles will be restricted to specific areas when driving outside the ORF and only use demarcated areas and not drive off the roads. • Hazardous substances will be stored within sealed containers and bunded to prevent unplanned spills. • The power generation unit will include abatement technologies as per the best available techniques to minimize NO_x emissions.	• Reduction on/off site	• Biodiversity Management Plan
	• According to international best practice, a survey with a regular frequency must be performed in order to verify the status and the implementation of the vegetation recovery process in the AoI.	• Monitoring	
Terrestrial Fauna (Section G.4.8.4)			
Disturbance and/or Displacement of Fauna due to Pollution	• The mitigation measures foreseen for Air Quality, Noise and Landscape and Visual will be implemented.	• See Air Quality, Noise and Landscape and visual	• Biodiversity Management Plan • Traffic Management Plan • Pollution Prevention and Control

Potential Impacts	Mitigations	Type of Commitments	Relevant Management Plan
Increased Mortality of Wildlife	• Maintenance of the areas planted with native species during the construction phase will be undertaken on a regular basis. • The hunting for bush meat needs to be strictly controlled. Design and implementation of embedded bushmeat action plans to prevent all activities of staff and contractors related to the trade in animal protein and live specimens. • Roads must be clearly marked with speed limits and all staff and contractors must obey these regulations.	• Management	• Biodiversity Management Plan • Traffic Management Plan • Pollution Prevention and Control
	• Monitoring programs on target wildlife species (i.e. amphibians, reptiles, small mammals and birds) will be implemented.	• Monitoring	
Ecosystem Services (Section G.8.1.8)			

Potential Impacts	Mitigations	Type of Commitments	Relevant Management Plan
Modification, fragmentation and loss of habitats and agricultural land and the associated services. Reduction in access to ecosystem services. Disturbance to fauna and flora from air emissions, noise and light and depletion of natural resources (eg water, wood) for operation activities resulting in a reduction or loss of associated ecosystem services. Potential pollution of soils and water with the associated loss on ecosystem services provided.	• Priority ecosystem services will be identified in consultation with the affected communities during the livelihood restoration baseline data collection. Results will be reflected in the LRP. • The mitigation measures required to minimise impacts on ecosystem services are in line with each of the impacts identified for the Physical, Biological and Social environmental components identified in the Project baseline. • Mitigation measures included for the operation phase on its different components will also apply for the ecosystem services. • Mitigation measures set forth during the construction phases will be implemented also during operation.	• See mitigation measures for Physical, Biological and Social environmental components	• All management plans can be applied to Ecosystem Services
	Landscape (Section G.4.9.4)		
Visual impacts due to presence of the ORF and associated infrastructure.	• Use vegetation planted for restoration as a partial mitigation for visual and light spill of the ORF and as screen for viewers. • Use, where feasible, a lower level of lighting; enhance the night time visibility required for safety and security. • Use specifically designed lighting equipment that minimises the upward spread of light near to and above the horizontal.	• Reduction on/off site	• NA

Potential Impacts	Mitigations	Type of Commitments	Relevant Management Plan
Socio-Economic Environment			
Economy and Employment (Section G.7.1.4)			
Increased Government Revenue Employment opportunities and Skills Enhancement Increased Procurement Enhanced Tourism Potential Increased Price Inflation and Economic Vulnerability	• The mitigation measures defined for the construction phase will continue to be implemented during the operation phase.	• See construction phase	• Recruitment, Employment and Training Plan • Project Procurement Plan • Workers Management Plan • Local content Development Plan • Stakeholder Engagement Plan
Economic Displacement of Land-Based Livelihoods in the Land Acquisition Area (Section G.7.2.4)			
Economic Displacement of Farming in Concession Area (crop cultivation, animal rearing, and aqua-culture).	• The mitigation measures defined for the construction phase will continue to be implemented during the operation phase.	• See construction phase	• Livelihoods Restoration Plan • Stakeholder Management Plan
	• Ongoing mitigation and stakeholder engagement to monitor that those affected are able to adapt to the changes brought about by the Project.	• Monitoring	

Potential Impacts	Mitigations	Type of Commitments	Relevant Management Plan
Socio-Cultural Changes (Section G.7.3 .4)			
• Changes to cultural and Social Norms. • Increased anti-social behaviour. • Tension and Conflict between Villages. • Social Unrest resulting in violence towards the Project, Communities or Migrants.	• The mitigation measures defined for the construction phase will continue to be implemented during the operation phase.	• See construction phase	• Workers Management Plan • Recruitment, Employment and Training Plan • Local content Development Plan • Stakeholder Engagement Plan • Security Management Plan. • Influx Management Plan
Cultural heritage resources (Section G.7.4.4)			
Disturbance or destruction of cultural heritage resources Loss of sense of place	• Ensure that people continue to have access to the cemetery located near the acquisition area. • Implement all mitigation measure defined for Noise, Vibrations and Emissions.	• Reduction on/off site • Mitigation measure for Noise, Vibrations and Emissions	• Local content Development Plan • Recruitment, Employment and Training Plan • Stakeholder Engagement Plan
	• Continue to train operations workforce to uphold the code of conduct and respect the cultural and natural environment.	• Management	

Potential Impacts	Mitigations	Type of Commitments	Relevant Management Plan
Social/Health Infrastructure and Public Services (Section G.7.5.4)			
Pressures on local infrastructure and public services (e.g. electricity, waste sanitation) Pressure on road infrastructure. Pressure on health infrastructure Disruption to marine traffic	• The mitigation measures defined for the construction phase will continue to be implemented during the operation phase.	• See construction phase	• Waste Management Plan • Emergency Response Plan • Recruitment, Employment and Training Plan • Procurement plan • Traffic Management Plan • Stakeholder Engagement Plan
Workers Management and Rights (Section G.7.6.4)			
Worker Health and Safety Worker Rights Forced and child Labour	• The mitigation measures defined for the construction phase will continue to be implemented during the operation phase.	• See construction phase	• Workers Management Plan • Recruitment, Employment and Training Plan
Community health, safety and security (Section G.7.7.4)			
Increased prevalence of sexually transmitted infections	• The mitigation measures defined for the construction phase will continue to be implemented during the operation phase. In Addition:	• See construction phase	• Security Management Plan

Potential Impacts	Mitigations	Type of Commitments	Relevant Management Plan
including HIV/AIDS. Increased prevalence of communicable diseases due to worker-community interaction. Increased prevalence of malaria due to worker-community interaction. Traffic accidents from increased traffic and presence of heavy vehicles in local roads. Increased pressure on health care resources* Environmental changes due to nuisance and air emissions. Site trespass and injury. Use of security forces.	• Undertake stakeholder engagement regarding the operation of the drilling areas, the ORF and associated facilities, and the pipeline. This will be undertaken prior to the commencement of the operation phase. • Maintain the grievance mechanism throughout the operation of the Project. • Undertake a community education programme on pipeline safety to alleviate concerns. • Have the ORF permanently guarded, while the pipeline routes will be regularly patrolled to deter deliberate damage or vandalism and assure the operational safety of the Project is not compromised.	• Management	• Community Health Management Plan • Traffic Management Plan • Emergency Response Plan • Recruitment, Employment and Training Plan • Procurement plan

12.3.3 Decommissioning phase

Potential impacts and related mitigation measures for the decommissioning phase of the Project will be similar to those expected for the construction phase. Appropriate mitigation, both for onshore and offshore section of the Project will be addressed by a decommissioning plan.

12.3.4 Unplanned events

The following *Table 12.5* summarises the mitigation measures related to the offshore and onshore unplanned events within the different phases of the Project.

It must be noted that due to the recent changes in the design philosophy of the project, a formal risk assessment report is not yet available for some components of such as the ORF at this stage of engineering design. These processes and documents are planned to be developed for the next stage of engineering design, in the form of HAZID, HAZOPS and QRAs for the different components of the Project.

As a result mitigation measures required to address the risks identified will be revised and updated according to the final results of such studies.

Table 12.5 Unplanned events - Mitigation measures

Potential Unplanned Event	**Mitigation of Unplanned Events**	**Type of Commitments**	**Relevant Management Plan**
	Offshore Component (Section G.9.2)		
Well Blow Out	• Adopt formal and systematic hazard identification practices and procedures. • The Project will incorporate an Integrated Control and Safety System (ICSS) providing an integrated monitoring, control, protection and safety system for the entire offshore facilities. • Use of appropriate drilling fluids for hydrostatic control in the event of sudden or unexpected changes in well bore pressure; • Installation and regular testing of industry standard safety valves (blowout preventers) on the subsea well head. • Preventive maintenance on all rig equipment. • Crew will be trained and certified in well management and well control procedures. • Routine operator inspections, maintenance inspections and internal and external audits. • Adoption of standard procedures of well monitoring and control, including a peer-reviewed / independent expert reviewed well control plan for each well, before drilling. • Emergency Shut Down (ESD) valves at every well head and platform and secondary and emergency controls systems installed and tested. • Emergency drills will be regularly scheduled and performed.	• Avoidance	• Pollution Prevention and Control Plan • Well Control Plan • Oil Spill Contingency Plan • Emergency Response Plan

Potential Unplanned Event	Mitigation of Unplanned Events	Type of Commitments	Relevant Management Plan
	• Inclusion in the well procedures of the kill option • Implementation of the Emergency Response Plan in case of a blow out.	• Reduction on/off site	
Rupture / Failure of pipes or flowlines	• Subsea Safety Isolation Valve (SSIV) will be installed on long lines, and is strongly reccomended for the gas injection line. • Electro-hydraulic activation on wellheads. • Flame detection systems will be installed on each in order to have quick leak detection times • The hull of the FPSO will be filled with water in order to protect the bulkhead in case of flame impingement. • Remotely operated firewater monitors in the corners of the balcony to assure a longer resistance of the hull to flame impingement.	• Reduction on/off site	• Pollution Prevention and Control Plan • Well Control Plan • Oil Spill Contingency Plan • Emergency Response Plan

Potential Unplanned Event	Mitigation of Unplanned Events	Type of Commitments	Relevant Management Plan
Spills of Hazardous Materials	• Adopt formal and systematic hazard identification practices and procedures. • Use of appropriate drilling fluids for hydrostatic control in the event of sudden or unexpected changes in well bore pressure; • Installation and regular testing of industry standard safety valves (blowout preventers) on the subsea well head. • preventive maintenance on all rig equipment; • Crew will be trained and certified in well management and well control procedures. • Routine operator inspections, maintenance inspections and internal and external audits. • Adoption of standard procedures of well monitoring and control, including a peer-reviewed / independent expert reviewed well control plan for each well, before drilling. • Emergency Shut Down (ESD) valves at every well head and platform and secondary and emergency controls systems installed and tested. • Secondary and emergency controls systems installed and tested; • Procedures will be followed on all occasions and will not be circumvented. • Regular emergency drills will be scheduled and performed. • Procedures for bunker transfer will be stablished to minimise the risk of spillage. • Bulk handling methods and non-return valves for diesel transfer will be implemented.	• Avoidance	• Pollution Prevention and Control Plan • Well Control Plan • Oil Spill Contingency Plan • Emergency Response Plan

Potential Unplanned Event	Mitigation of Unplanned Events	Type of Commitments	Relevant Management Plan
	• Implementation of the Oil Spill Contingency Plan (OSCP), including access to subsea containment solutions and to Tier 1, 2 and 3 spill management resources.	• Reduction on/off site	
Onshore Component (Section G.9.2.4)			

Potential Unplanned Event	Mitigation of Unplanned Events	Type of Commitments	Relevant Management Plan
Risks derived from the ORF facility and the onshore pipeline	• Development of a Hazard Identification Study (HAZID) for the ORF, pipeline and other onshore facilities once final design is available. • Development of a Hazard and Operability Study (HAZOP) for the ORF, pipeline and other onshore facilities once final design is available. • Development of a Quantified Risk Assessment (QRA) for the ORF, pipeline and other onshore facilities once final design is available. • Apply the minimum distances recommended by the previously mentioned studies between any of the facilities and the accommodation camp. • Engineering design measures to decrease probability and/or consequences of an accident at the sensitive segment of pipeline (the closest to human settlements at Awonakrom), such as increasing pipe thickness or burial depth and installing concrete slab atop the pipeline. • Depending on the results of the QRAs on the pipeline landfall, a shift of the landfall location and pipeline route 70 m westward will be considered in order to keep safe distances both to Awonakrom and Sanzule settlements. • Depending on the results of the QRAs and Hazid/Hazop, an increase in the service/safety corridor to the final safety distance indicated by them after implementation of engineering design measures will be adopted. • Efficient measures to keep the pipeline safety corridor width to prevent encroachment and to keep the safety radius around the ORF as per the studies will be agreed with Government.	• Avoidance	• Emergency Response Plan • Pollution Prevention and Control Plan

Potential Unplanned Event	Mitigation of Unplanned Events	Type of Commitments	Relevant Management Plan
	• Preparation of an Emergency Plan for dealing with potential accidents	• Reduction on/off site	

12.3.5 Cumulative impacts

Main mitigation measures related to cumulative impacts are those adopted by the Project to address the significant impacts identified in order to reduce to the extent possible the remaining residual impacts.

However solutions to address properly the cumulative effect derived from the development of several projects in a given area are beyond any individual project sponsor. In this context, the approach adopted by eni to mitigate the cumulative impacts will be to to use their best efforts to engage other developers, governments, and other stakeholders by acknowledging the cumulative impacts and risks and suggesting coherent management strategies to mitigate them.

As a result, eni will do his best endeavours for the establishment of a technical and management committee involving the operators in the area (at least those related to the Jubilee field development, Lornho Oil Service Port, GNGC Gas Plant and TEN Development) the national and local government and institutions, including the Environmental Protection Agency of Ghana (EPA) and financing institutions. Participative monitoring of the affected communities and adequate stakeholder engagement on cumulative effects will also be considered.

In this context, eni will promote the following actions so as to ensure proper coordination with relevant authorities and Project sponsors to minimizer cumulative impacts:

- Liaison with other O&G operators to promote residual gas inclusion into the commercial circuit and avoid burning it so as to reduce the total amount of GHG emissions.
- For the cumulative impacts on livelihoods and ecosystem services, eni will work with local and regional governments to develop effective measures and procedures to encourage sustainable resource management, spatial planning and land development as well as efficient land administration by relevant authorities.
- eni will also do their best endeavours to develop a sustainable social investment and exit strategy in collaboration with local authorities and other Project sponsors, focused on addressing how social investments can benefit project affected people and project employees in a sustainable manner. The exit strategy will also define actions to mitigate the potential residual impact of withdrawing these benefits post-decommissioning
- Regarding the expected cumulative pressure on social infrastructure and service delivery, the Project will, in conjunction with other projects in the area and local government, develop an influx management plan.
- eni will do his best endeavours to strengthen the coordination between O&G operators and other Projects (such as the Lornho Port) under the Abidjan Convention, focused on the protection and conservation of marine areas and its resources in West Africa by reducing and controlling all sources of pollution likely affecting marine ecosystems, wetlands, mangroves barriers and lagoons.
- eni will work together with other oil operators and with the public authorities, as possible, with the objective of designing a national or regional OSCP, including the port, which would result in benefits for all parties from coordinated plans and actions to manage any accidents and by the sharing of oil spill equipment and

management procedures. The development of such a plan will benefit from the Regional Contingency Plans and other means of preventing and combatting pollution incidents developed by the Abidjan Convention in 2011.

12.4 MANAGEMENT PLANS

The management plans included as mitigation measures in this EIS provide the basis and guidelines for the implementation of the environmental, social and health impacts management at every stage of the activity, where the predicted negative impacts can be prevented, controlled and mitigated. Moreover management plans represent a source of information for public to understand the environmental, social and health management of the Project which will be implemented with the principles of environmentally sound, so that people can also prevent and/or avoid the negative impacts that may occur, and to develop or take advantage of the positive effects that arise. Lastly, the management plans can be useful for the government as guidance in the implementation and supervision of environmental, social and health management.

The following table presents a summary of the management plans to be developed by eni Ghana for the OCTP Phase 2 Development Project and that will be applicable for all project phases[1]:

Table 12.6 Management Plans required for all the phases of the OCTP Phase 2 Development Project

Already included in the eni Ghana HSE IMS	To be developed and integrated in the HSE IMS
• HSE Plan (see Annex E) • Emergency Response Plan • Waste Management Plan (see Annex E) • Oil Spill Contingency Plan (see Annex E) • Medical Emergency Response Plan	• Worker's Management Plan • Influx Management Plan • Community Health Management Plan • Security Management Plan • Project Procurement Plan • Project Recruitment, Employment and Training Plan • Livelihood Restoration Plan • Stakeholder Engagement Plan (see Annex A) • Cultural Heritage Management Plan • Fisheries Management Plan • Pollution Prevention and Control Plan • Biodiversity Management Plan • Water Management Plan • Local Content Development Plan

(2) [1] These plans will be developed for all project phases. However, some plans might contain different measures/procedures for construction and operation.

	• Social and Environmental Investment Plan • Traffic Management Plan • Marine Traffic Management Plan • Decommissioning Plan • Well Control Plans for each well.

The abovementioned management plans to be developed and integrated in the HSE IMS are briefly described in the following subsections. Moreover a brief description of the existing Emergency Response Plan and Medical Emergency Response Plan has been included for reference.

Existing Plans already integrated in the HSE IMS will be reviewed and updated if necessary to address the specific impacts of this project. For instance, the Waste Management Plan will be updated in order to include project specific measures such as a procedure for land clearing waste disposal management (e.g. wood from trees and brush) including a no burning policy.

12.4.1 Emergency Response Plan

An Emergency Response Plan (ERP) has been already developed and implemented by eni Ghana and is integrated within the eni Ghana HSE IMS. The ERP covers all stages and phases of the emergency response, from initiation until the emergency is over and the normalisation phase has started. The ERP is applicable to all operations carried out by eni Ghana both onshore and offshore and except indicated otherwise, it applies to all employees including secondees and direct-hire personnel.

It defines the organisational structure, the communication channels, the main actions to be taken by the designated eni Ghana personnel and the resources that should be available to handle an emergency situation during its operations. It provides also, guidance to line management and contractors regarding the ERP related processes, organization, roles and facilities.

Contractor companies must develop their own ERP (covering their employees), which shall be sent to eni Ghana to assess the compatibility with this plan and for approval.

The ERP is regularly revised as the eni Ghana activities evolve. In fact, the ERP will be updated to include a response procedure to address gas-related hazards to communities and other unplanned events (eg. fire and explosion at the ORF, sea-line / pipeline rupture).

12.4.2 Medical Emergency Response Plan

A Medical Emergency Response Plan (MERP) has been already developed by eni Ghana and is integrated within the eni Ghana HSE IMS. The MERP applies to all operative areas, including projects and operations and involves the entire organization structure.

MERP is a functional part of the ERP (see Section 12.4.1) and it describes the response to various medical emergency scenarios. The plan also describes the procedure for arranging the International medical evacuation of expatriate Company personnel or their

dependents. Moreover, the MERP contains specific information required to activate early and efficiently the response to an emergency.
This plan defines also the organizational structure, the information channels, the main actions to be undertaken by the designated personnel and the available resources to be activated in case of emergency.

The MERP is intended to be a "live" document and shall be updated as follows:

- Every suggestion coming out from operative experiences aimed at improving the emergency response process shall come to the relevant Department Manager. He will ensure, through Health Manager its incorporation into the document; HSE & CI Manager and HR & Training Manager are responsible for the reviewing, issuing and distribution of the Plan.
- All possible variations shall be communicated to the HSE & CI Manager, in order to assure the relevant updating in the ERP. This includes variations of: names (i.e. changes in positions), internal telephone numbers (i.e. office, fax, home, mobile phone and radio), telephone numbers of Local Authorities and hospitals, telephone numbers of Partners, Service Companies and Contractors (i.e. office, fax and mobile phone), apparatus and equipment.

As a fundamental principle, it is required that any installation, operated or contracted by eni Ghana (e.g. drilling activity), shall have in place a specific MERP as well as the Duty Card which identifies the responsibilities of the personnel in emergency situations. To guarantee that Medical Emergency Response Plan is applied properly, regular practices are carried out for all eni Ghana health services.

Contractor companies must develop their own ERP (covering their employees), which shall be sent to the eni Ghana to assess the compatibility with this plan.

12.4.3 Workers Management Plan

The Worker Management Plan (Workers MP) will be developed to address potential risks to worker rights, health and safety by summarizing expectations and procedures to maintain quality working conditions, activities and conduct.

The following items underpin the Workers MP:

- Ghanaian legal framework related to worker H&S and rights and IFC standards (in particular Performance Standard [PS] 2).
- eni Management Systems related to worker H&S and rights: The plan will follow eni management systems that include regular training of workforce and monitoring as well as ongoing safety checks and safety audits; development of KPIs about worker rights, discrimination, management of workforce grievance mechanism and associated monitoring.
- Contractor Management: The plan shall provide an overview of how eni Ghana considers H&S performance, workers' rights and legal compliance as part of the contractor and supplier selection process. It will also include how eni Ghana supports contractors and subcontractors to ensure that labour and working conditions are in line with Ghanaian law, international standards and eni policies. It will also indicate the monitoring and auditing process of all contractors and

subcontractors, including the consequences and escalation process if contractors are found to be breaching Ghanaian law, international standards, eni policies or contract clauses.

- Worker Grievance Mechanism: the plan will set the approach and procedures for a worker grievance mechanism that is accessible to all workers (including contractor and subcontractor workers). It will therefore indicate how to submit grievances, the process to review and respond to grievances, corrective actions, appeals procedure and grievance documentation and monitoring.
- Monitoring: the plan will set the approach to monitor worker H&S and rights performance and worker grievance trends as well as response performance to grievance so as to evaluate and continuously improve on management activities.

12.4.4 Influx Management Plan

The Influx Management Plan would be designed to avoid or minimise potential impacts associated with local and regional population influx to villages within the Area of Influence (Sanzule, Bakanta, Anwolakrom, Krisan, Eikwe and Atuabo) and other adjacent populations that may occur as a result of the OCTP Phase 2 Project. The Project would benefit from sustainable economic development both at the local and regional scale is important, thus eni Ghana is recommended to develop specific measures to:

- Minimise and manage a potential influx;
- Ensure the sustainable development of settlements within the Direct and Extended Area of Influence (see Chapter 4 Project Description for further details on the Area of Influence) through close collaboration with other operators and government authorities;
- Avoid, minimise or mitigate potential negative environmental economic or social/health impacts which might result from Project-induced population influx; and
- Optimise opportunities for future economic development presented by the development.

12.4.5 Community Health Management Plan

The Community Health Management Plan (Community Health MP) will be developed to avoid or minimise the risks and adverse impacts to community health that may arise from project activities (i.e. risk of increase of communicable diseases transmission rate, potential increase of pressure in existing health facilities, risk of creating mosquito breeding ground that could contribute to the transmission of malaria etc.).

The Community Health Plan will be developed following the mitigation measures defined in this EIS (in particular in Chapter 10), the relevant Ghanaian legal framework and IFC standards (in particular PS 4 on Community Health, Safety and Security).

12.4.6 Security Management Plan

A Security Management Plan (SMP) will be developed for both onshore and offshore activities to ensure that the safeguarding of project, related personnel and property is carried out in a legitimate manner that avoids or minimises risks to the community's safety and security. The SMP will have special focus on the interaction with fishing boats and compliance with IFC PS 4 on Community Health, Safety and Security.

Onshore security (facilities, construction sites, camp) will be assured by a private company with unarmed personnel. An exclusion area around the FPSO will be established for safety and security reasons. Eni will provide an unarmed dedicated patrol vessel to monitor and patrol offshore buffer zones. Ghana Navy, if required, will support eni's patrol vessel to assure the buffer zones to be respected. Additional Ghana Navy representatives can be deployed on eni's patrol vessel for extra support (in this case, they will be unarmed).

This plan will be developed following the mitigation measures defined in this EIS (in particular in Chapter 10) and in compliance with the policies of the project, relevant Ghanaian legislation, best practice (i.e. UN Voluntary Principles for Security and Human Rights) and IFC standards (PS 4 on Community, Health and Security). The SMP will include the following elements:

- Definition of safety buffers around the facilities and description of detailed security and fishermen safety measures.
- Procedure for the selection of personnel based on a careful background screening, and training with regards to human rights requirements.
- Definition of training to be provided to private security providers near FPSO and the ORP in Voluntary Principles on Security and Human Rights
- Procedure for a constructive outreach to police and the navy (public security providers) through consultation, as well as training on human rights.
- Communication procedure between the Navy and eni for rapid response in case of piracy or terrorist attack on offshore facilities and ships loading at the FPSO.
- Community safety grievances as part of the Stakeholder Engagement Plan (see Annex A) a grievance mechanism will be developed which will apply across the Project's life. This grievance mechanism will cover all the potential grievances related to the project. The SMP will highlight the security related grievance management mechanisms to be implemented based on the Stakeholder Engagement Plan (SEP).
- Monitoring: the plan will set the approach to monitor community safety and rights performance and community grievance trends as well as response performance to grievance so as to evaluate and continuously improve on management activities.

It should be noted that the existing ERP will include a procedure to address gas-related hazards to communities and other unplanned events (eg. fire and explosion at the ORF, sealine / pipeline rupture) (see Section 12.4.1).

12.4.7 Project Procurement Plan

The Project Procurement Plan will be developed in compliance with the minimum local content requirements for supplies and services prescribed in the Ghana Local Content Policy Framework (refer to Chapter 3 for further details on this policy), and will implement requirements of applicable laws and regulations for local content and procurement.

The Project Procurement Plan will be developed with the objective to maximize local procurement as much as possible without affecting local prices (i.e. increases in prices resulting from limiting available supply) by monitoring local and national inflation indicator statistics and developing appropriate interventions where inflation or limited food supply could cause negative pressure on local communities and be linked directly or indirectly to project activities.

Key principles of the plan should include:

- Maximize local procurement as much as possible without affecting local prices (i.e. increases in prices resulting from limiting available supply) by monitoring
- Dissemination of information regarding procurement opportunities and requirements as early as possible.
- Definition of quality standards required by the Project for provision of goods and services to the Project.
- Development of a supplier training programme to enhance the capacity of existing suppliers.
- Encourage unbundling of certain contracts to allow a number of small businesses to provide goods and services rather than the supply being monopolised by one large (foreign) contractor.
- Corporate Social Investment activities that promote sustainable projects should be considered by eni Ghana as well as, training and education to help communities to develop alternative livelihoods and ensure that economic dependence on the Project is limited.

12.4.8 Project Recruitment, Employment and Training Plan

A Recruitment, Employment and Training Plan will be developed for the project in order to maximise benefits of employment and skills enhancement by the project, manage expectations and minimise negative impacts. All recruitment, training and development of national staff shall be undertaken in accordance to this plan.

The plan will be developed following the mitigation measures defined in this EIS (in particular in Chapter 10) and in compliance with relevant Ghanaian legislation (i.e. Local Content Policy Framework) and IFC standards (PS 2 Labour and Working Conditions). Key principles of the plan should include:

- Definition of Employment Strategy – fair, transparent, clear and accessible recruitment process for all openings.
- Establish a procedure to identify the existing skills in the Direct Area of Influence to identify skill gaps.
- Define Training Plan Strategy and Capacity Building Program with the authorities.
- The training plan should have strong female focused component and will lay the groundwork for implementation by commissioning a Training Needs Assessment. The Training Plan will focus on particular needs of the youth, based on feedback from stakeholders and give them priority for training programs and opportunities.

- Opportunities for development, promotions and fast tracking will be prioritised for employees who are Ghanaian nationals, and who display sufficient capacity to develop their skills and deliver high performance. Such opportunities will have a priority focus on the youth and women.
- Define the procedure to disclose information on the workforce requirements of the project.
- Define a method to ensure that employment opportunities are allocated fairly to the different communities within the direct area of influence.
- Define the means for managing expectations of job seekers.
- Establish the means to ensure that children (under 18 years old) are not hired.
- Establish the means to ensure non-discrimination and equal opportunity.
- Establish a monitoring procedure to assess implementation performance.
- Require that all the contractors (national and international) provide details of their own national employment and training plans.
- The plan will consider potential partnerships with NGOs and other education organisations, particularly those focusing on the empowerment of women and youth, as well as supporting NGOs and the Regional Education management board to expand and improve school and skills training facilities in the Direct Area of Influence.

12.4.9 Livelihoods Restoration Plan

A Livelihood Restoration Plan (LRP) is being developed by eni Ghana to address potential economic displacement (loss of assets, leading to loss of income or means of livelihood) of stakeholders from project land acquisition and mitigate adverse socioeconomic impacts. The LRP will be produced according to Ghanaian legislation requirements, WB/IFC PS 5 on Land Acquisition and Involuntary Resettlement.

The LRP will establish the entitlements of affected persons or communities and ensures that compensation is provided in a transparent, consistent, and equitable manner in line with WB/IFC requirements. It will be in line with the Stakeholder Engagement Plan.
Key elements to be included in the LRP are:

- Provide compensation for loss of assets at replacement cost.
- Ensure that the LRP is implemented with appropriate disclosure of information, consultation, and the informed participation of those affected.
- Pay particular attention to the needs of vulnerable groups.
- Disclosure of LRP and monitoring reports at local level in a manner that is accessible, understandable and culturally appropriate to ensure that affected stakeholders understand the compensation procedures and know what to expect at various stages of the project.
- Grievance Mechanism: Description of mechanisms for addressing grievances, complaints and appeals taking into account the availability of judicial recourse as well as traditional conflict resolution mechanisms to solve grievances and address complaints in a timely, impartial and transparent manner.

- LRP completion report: Evaluation of the quality, outcomes and stakeholder satisfaction of LRP activities. Completion reports will include an evaluation of the degree of stakeholder participation in the decision making process, the number of households that agreed to the eni Ghana offer and the livelihoods of affected people in relation to the baseline situation and the living conditions of similar populations nearby, whether the policy objectives have been achievement and – if needed – corrective actions to address outstanding issues.
- LRP monitoring: Outline of the monitoring, which will be conducted by eni Ghana as well as by independent evaluators to ensure that complete and objective formation are available for the participatory performance monitoring system.

A section focused on fishermen will be included in the LRP which will be aligned with the Fisheries Management Plan and the Fisheries Monitoring Program.

12.4.10 Stakeholder Engagement plan

The Stakeholder Engagement Plan is intended to build and maintain positive relationships between the Project and relevant stakeholders. It establishes procedures for constructive engagement and continuous dialogue that are essential to good business practice and corporate citizenship, as well as Project risk management and performance improvement. It has been developed in compliance with IFC PS1 Assessment and Management of Environmental and Social Risks and Impacts and is presented in Annex A to this Report.

12.4.11 Cultural Heritage Management Plan

A Cultural Heritage Management Plan (CHMP) will be developed to avoid and minimise risks to existing cultural heritage resources and in compliance with the relevant Ghanaian legislation and IFC PS 8 on Cultural Heritage. This PS will be triggered by the cultural heritage site (Royal family cemetery and deity) in close proximity to the concession area that has been avoided, but needs to be protected during construction and maintenance activities.

The following elements will be included in the CHMP:

- A Chance Finds Procedure to define the processes aligned with relevant national laws and regulations, local customs and traditional norms that must be followed to ensure appropriate treatment of a chance find, and to minimise disruption to construction activities, including:
    - Definition of the training and awareness material to educate Project staff and contractors in the identification of archaeological material.
    - The procedures for reporting chance finds to the Project.
- Definition of measures to be adopted to prevent accidental damage to the existing cultural heritage sites (i.e. the Royal cemetery) during the full project life cycle.
- The procedure to monitor protection/disturbance avoidance performance.

12.4.12 Fisheries Management Plan

The Fisheries Management Plan (FMP) will be developed to ensure that undue or reasonably avoidable adverse impacts on fisheries of the Project phases are prevented, and that positive benefits of the Project are enhanced. The FMP will be designed to cover impacts on fisheries on the following three components: biodiversity conservation, fishermen livelihood restoration and ecosystem services. The Plan will also consider the the requirements of WB/IFC Performance Standards 5" Land Acquisition and Involuntary Resettlement, WB/IFC Performance Standards 6 " Biodiversity Conservation and Sustainable Management of Living Natural Resources", and IFC Good Practice Handbook: Baseline Assessment and Development of a Fisheries Livelihoods Restoration Plan.

The FMP will comprise of a number of components project activity, potential impact, each with an overall associated management policy, mechanism of policy implementation, proposed monitoring programs, potential corrective actions and responsibility. Typically a Fisheries Management Plan covers the following elements:

- Project Aspect: Aspect of the project with direct impact on the Fisheries.
- Potential Impacts: Adverse and beneficial impacts on the fisheries.
- Policy: The guiding operational policy that applies to the element.
- Policy Implementation: The actions plans through which the policy will be achieved.
- Performance Indicators: The criteria by which the success of the implementation of the policy will be determined.
- Monitoring and Reporting: The Measurement of Actual Performance of the policy and auditing of monitoring results.
- Corrective Action: In case where a performance requirement is not met, action to be taken.
- Responsibility: Personnel responsible for policy.

The three main fisheries resources/receptor to be considered in the Fisheries Management Plan are:

- Fish, arine mammals & Birds.
- Fishing Activity.
- Socio-Economic-Cultural Aspect.

12.4.13 Pollution Prevention and Control Plan

The Pollution Prevention and Control Plan will be developed to cover all project phases and will be aligned with the ERP and the Oil Spill Contingency Plan. The plan will be produced following relevant Ghanaian legal requirements and best practices and will include provisions for the training of all workers and procedures related to communications to stakeholders and community improvement opportunities like workers and public awareness plans regarding pollution prevention and environment protection.

Typically a Pollution Prevention and Control Plan covers the following elements:

- General measures to be followed on site during the construction phase. General measures will include housekeeping, good material handling practices and inspection procedures.
- Prevention of accidental spills will be achieved through the application of a series of actions and measures to prevent leakages and spills and to enable effective response to unplanned releases of liquids, such as fuels, oils and chemicals.
- Product Specific Practices will be adopted for the following:
  - Petroleum products: vehicles and construction equipment will be monitored for leaks and receive regular preventive maintenance to reduce the potential for leakage. Petroleum products will be stored in tightly sealed containers that are clearly labelled;
  - Fertilizers: during re-vegetation works they will be applied in the minimum amounts recommended by the manufacturers. The contents of any partially used bags of fertilizer will be transferred to a sealable plastic bin to avoid spills;
  - Paints: containers will be tightly sealed and properly stored when not required for use. All excess paint materials will be properly disposed of according to manufacturer's instructions.
- Isolation of Potentially Hazardous Materials: supply of drums will be available for use in the event of spills or if potentially hazardous materials are found during project construction. The contaminated material will be placed in the drums, sealed and placed in the storage area to await proper characterization and disposal. In the event that a larger amount of material needs to be isolated, it will be placed directly into a lined roll-off container from a licensed hazardous waste transporter. The roll-off container will be placed out of the flow of construction traffic and equipment, in a bermed area to contain and isolate possible leaks and rainwater.
- Product Substitution: a policy of using environmental friendly products will be adopted. In particular, when feasible, non-chlorinated solvents, paints with low volatile organic compound content, and non lead-based paints will be used. Organic biocides will replace chlorine in cooling water systems, if feasible, and assessment will be developed to determine the availability of less harmful substances.
- Prohibited Materials: The following materials or chemicals are prohibited from purchase due to their extreme hazardous or toxic nature: PCBs, leaded paints, chromium-based cooling water treatment and mercury-filled meters.
- Air Emission Management Plan: an air emissions management plan for onshore and offshore activities will be implemented, including the definition of the Project air pollutant emission sources and the management measures to be applied for the control, and if feasible, the reduction of emissions.
- Noise Emission Management Plan: a noise emissions management plan for onshore and offshore activities will be implemented, including the definition of the Project noise emission sources and the management measures to be applied for the control, and if feasible, the reduction of noise emissions.

In addition, the Pollution Prevention and Control Plan will establish the management procedures (collection, storage, treatment and disposal) for those wastewater streams not addressed in the Waste Management Plan, including:

- Ballast water: ballast tanks will be separated from any hydrocarbon storage areas on board the vessels and no potentially contaminated drain systems will be routed to the ballast tanks. De-ballasting shall be undertaken offshore in accordance with IMO guidelines and away from sensitive environmental areas to prevent introducing marine organisms from outside the project location.
- Bilge water discharge: All Project vessels will be equipped with oil-water separation systems in accordance with MARPOL requirements.
- Deck run-off water: Any spills on deck will be contained and controlled using absorbing materials. This will be collected in dedicated drums to avoid contamination of deck run-off water before being discharged overboard.
- Sewage discharge: Project vessels and FPSO will be equipped with a sewage treatment system according to IMO regulations. If a vessel does not have a sewage treatment system it will have a suitable holding tank to collect and store waste water. These tanks will be taken ashore for its proper treatment and disposal by a licensed contractor.
- ORF Plant: wastewater effluents in onshore facilities will be collected, removed and disposed of in appropriate treatment plants (owned by Zeal or Zoil local waste management companies).
- Hydrotest water disposal: hydrotest effluent will be collected and analysed before disposal. Hydrotesting discharged water will be free of any chemicals or oxidizers.

12.4.14 Biodiversity Management Plan

The Biodiversity Management Plan (BMP) will be developed on the basis of the impacts and mitigation measures identified in this EIS and in compliance with the relevant Ghanaian legislation, eni's best practices and IFC PS 6 on Biodiversity Conservation and Sustainable Management of Living Natural Resources.

The BMP will summarise all on-site biodiversity-related mitigation measures included in the EIS and to be implemented during the entire project life. The plan will specify the responsible for the implementation of each mitigation measure (i.e operator or the contractor).

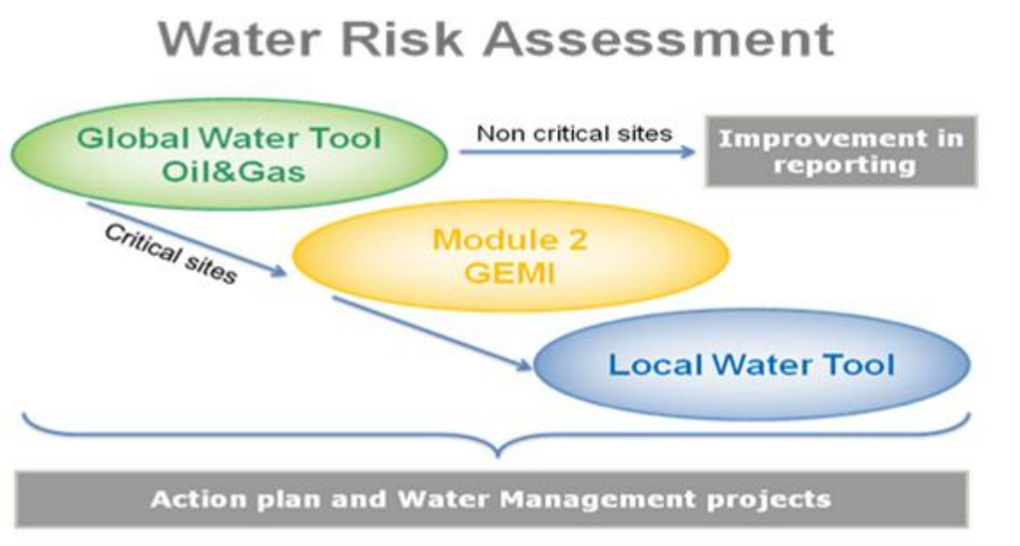
In addition to the BMP, specific Biodiversity Action Plans will be developed to cover potential gaps identified during this EIS and during project development. For instance, a Biodiversity Action Plan (BAP) is recommended to be developed for marine turtles. The BAP will be developed in line with PS 6 (Annex A).

12.4.15 Water Management Plan

At the time of writing this EIS, eni Ghana was undertaking a Water Risk Assessment to define the most suitable water sources to be used for the Project activities.

The Water Risk Assessment represents the basis to take into account, since the preliminary phase of the project, the water related potential impacts in order to set a short and long-term water strategies and set up adequate targets to minimize water risk. The methodological approach for the identification, evaluation and mitigation of impacts on water resources was developed by eni as a result of eni's active participation in international organizations (like IPIECA) on water resource management and also use of specific knowledge management tools. The used approach is reported in Figure 12.2.

Figure 12.2 Water Risk Assessment



Source: eni, 2015

The Water Management Plan (WMP) will be developed based on the results of the Water Risk Assessment and according to criteria of diligence, transparency, correctness and in compliance with all applicable laws.

The Water Management Plan (Water MP) to be developed will have the following objectives:

- Compliance with Ghanaian legislation/permitting regulation on water use, eni HSE standards and policies and all the relevant IFC requirements and industry best standards.
- Define an appropriate Water Management Strategy.
- Define objectives and targets, which should be continuously revised and updated in order to better match water saving concerned goals.
- Identification of appropriate activities and indicators to monitor water performances for controlling each water flow used or produced during project lifecycle and for rainfall managed at well site.

- Define the human resources and the expenditure required to ensure the achievement of each objectives.
- Set the operative control procedures with customized actions for each phase of the project.

The Water MP will be developed taking into account the outcomes of the Water Risk Assessment, that eni Ghana was carrying out and the mitigation measures identified in the impact assessment.

Regarding water supply, the Water MP will be addressed to:

- Report water sources and extraction locations: water sources to be used will be pre-agreed with the relevant local authorities. Water sources will be identified and registered in the plan, together with the GPS coordinates and the maximum water volumes allowed from the source. Each selected water supply and discharge location should be maintained accessible for periodic sampling.
- Identification and recording of water flows for offshore and onshore facilities divided by type and volumes.
- Opportunities for water saving: the plan will provide a series of measures to be considered for minimising the use of water, including training of Project staff.
- Water measurements (quantity and quality measures).

12.4.16 Local Content Development Plan

The Local Content Development Plan (LCDP) will define the project strategy that maximises Ghanaian goods and services on the project. The LCDP will be developed to contribute to the competitiveness of local employment and procurement opportunities and enhance opportunities to optimise costs, quality, flexibility, networks, local knowledge and other considerations in the value chain.

This plan will be developed in compliance with the Ghanaian "Policy on Local Content and Local Participation in the Petroleum Industry" (refer to Chapter 3 for further details) and other relevant Ghanaian legislation in force at the time of developing the plan.

12.4.17 Social and Environmental Investment Plan

The Social and Environmental Investment Plan (SEIP) to be developed will have the objective to enhance living conditions in communities neighbouring the Project, to foster sustainable natural resource management and enhance biodiversity in and around critical habitats. This plan will therefore include activities aiming to provide additional benefits from the project to the communities and is independent from the mitigation measures included to avoid/reduce negative impacts and enhance positive impacts.

This plan will set out how investment opportunities will be identified, assessed, selected, planned, implemented and supported over the entire lifespan of Project as a long term commitment.

The SEIP will integrate other management plans previously discussed (e.g. the BAP, Fisheries Management Plan, Livelihood Management Plan) to facilitate the synergies between them.

The guiding principles of this Plan will mainly follow IFC's Good Practice Principles for Strategic Community Investment into a set of clear guiding principles including the following:

- *Strategic*: SEIP shall address short and long-term objectives, focus on key areas where eni Ghana can effectively leverage its role/competencies and evolve different approaches along the project cycle. The investment program will therefore focus on projects that enhance peoples' livelihoods, the local economy, local environment and the capacity of local government and local residents to participate effectively in the changing environment.
- *Aligned*: The SEIP shall be aligned with communities, civil society & government to create "shared value" by coordinating SEIP with EIS results, stakeholder engagement and local content development and promoting cross-functional coordination and responsibilities. As a result, all projects financed (in part or wholly) by eni Ghana will be identified through some type of consultative process to ensure that they address priorities identified by the intended beneficiaries
- *Sustainable*: Avoids dependency and encourages self-reliance and the creation of long-term benefits, all activities require a viable exit or handover strategy and reinforces, rather than replaces local institutions and processes where feasible. As a result, the emphasis will be on collaborating with local organizations (including NGOs, community organizations, government, businesses, etc.) in developing and implementing projects.
- *Measurable*: SEIP shall measure returns to eni Ghana, local communities and the environment by using outcome/impact indicators to measure quantity and quality of change, track changes, use participatory methods to build trust and local ownership and proactively communicate the generated value to internal and external audiences.

It is critical that any investment activities are supported by robust stakeholder engagement so as to clearly identify the correct opportunities for investment, and as a result

12.4.18 Traffic Management Plan

A Traffic Management Plan (TMP) will be developed to manage construction traffic generated by the Project, minimise impacts on traffic disruption and road user delay and provide for the on-going safety of terrestrial fauna and road users, including pedestrians.

All of the traffic related impacts described in the EIS previously can be mitigated very effectively by the implementation of standard best practices in terms of environmental controls and management practices during construction. These measures will be detailed in the TMP, which will describe in detail the measures to be implemented, in particular during the Project construction phase, when traffic intensity will be higher.

Additionally, the TMP will consider the accumulated increase in traffic and road use derived from the potential development of nearby projects at the same period of time, enhancing the development of a common TMP for the different projects involved.

The TMP is intended to be a 'live' document and therefore shall be regularly updated as the construction evolves and movement requirements are known therefore in more detail.

The construction contractor will also consult with the principal representative of any communities that will suffer a significant increase in traffic in order to develop awareness of the mitigation measures within the TMP.

As a result the TMP will include the following minimum requirements:

- Identification of access to construction areas;
- Routing of construction traffic ;
- Prevention of road user delay;
- Temporary traffic control and management;
- Preventing and remedying pavement degradation; and
- Parking facilities;
- Project driver training requirements with respect to road safety and environment;
- Roles and responsibilities for implementation of the TMP;
- Measures to prohibit "off-route" driving;
- Speed limits and methods of enforcement;
- Means to inform the community of traffic risks;
- Vehicle equipment;
- Vehicle maintenance and refuelling locations;
- Inspection, auditing and reporting; and
- Driver competency.

12.4.19 Marine Traffic Management Plan

A Marine Traffic Management Plan (Marine Traffic MP) will be developed to manage all shipping vessel movements within the offshore Area of Influence and ensure the safe passage of local fishing boats along the coast. The Marine Traffic MP will be developed taking into consideration the mitigation measures included in this EIS and in compliance with Ghanaian statutory requirements, best practices and in coordination of the Ghana navy.

The Marine Traffic MP should include the following elements:

- Consultation with local fishing communities on the Marine Traffic MP and fishermen will be provide with up-to-date information on marine logistics.
- Definition of speed restriction and exclusion areas.
- Coordinated 24-hour monitoring of vessel movements.
- Marine safety awareness campaign, targeting fishing communities, to reduce the risks of marine traffic accidents for all types of fishing vessels.
- Procedure for a constructive outreach to the navy through consultation, as well as training on human rights (in line with the Security Management Plan).

- Community engagement and grievance mechanism to ensure that any concerns on Project Marine Traffic can be raised and managed promptly using a transparent process.
- Database of local fishing vessels, including smaller craft to identify the fishing boats who regularly use the area.
- Minimise marine accidents though high levels of vessel maintenance, driver awareness, training and awareness raising amongst vulnerable water users.
- Marine contractors will submit suitable HSE plans which will include a marine safety risk assessment. This includes qualifications of marine vessel captains and crew, training conducted and compliance auditing.

12.4.20 Decommissioning Plan

Eni Ghana will develop a Decommissioning Plan which will describe how all project assets (including wells, facilities, flowlines/risers, onshore and offshore pipelines, etc.) which have reached the end of their useful life span, shall be decommissioned and either dismantled and removed or abandoned. The objective of developing this plan is to return the sites to as close to their former state as possible.

The plan will be produced in accordance with statutory requirements and best industry practices (e.g. guidelines from OGP, API, IMO, refer to Chapter 3 for further information on these guidelines).

The Decommissioning Plan will include at a minimum: risk assessments, environmental impacts, medical aspects, waste destinations, transportation issues, methodologies, restoration and landscaping, legislative issues and monitoring methodology for assurance of correct abandonment procedures. The Decommissioning Plan will be applicable to all phases of the project including construction activities.

After decommissioning, eni Ghana will prepare a final report on condition of all assets abandoned prior to relinquishment. The abandonment report will include as a minimum:

- Operating and technical data (data on the asset thorough its operating life; e.g., location, repairs, etc.);
- Financial data and the abandoned asset; and,
- Final Abandoned Condition.

12.4.21 Well Control Plan

A peer-reviewed / independent expert reviewed Well Control Plan will be developed for each well before drilling activities commence. The plans will be in alignment with the OCTP OSCP (Annex F).

12.4.22 Roles and Responsibility

The implementation of the Project Management Plans will be achieved through the management structure described in section 12.7.

12.5 Monitoring Plans

The environmental, social and health baseline defined background environmental, social and health conditions highlighting critical issues and sensitive components; whereas the impact assessment identified the components likely to experience fundamental negative changes due to project stressors. Based on the baseline and impact assessment outcomes, environmental, social and health monitoring activities to be carried out during the whole life of the Project have been identified.

Monitoring will have the following purposes:

- Provide the basis and guidelines for eni Ghana in carrying out environmental and social/health monitoring at every stage of the activities.
- Provide reference to evaluate the effectiveness and to improve the implementation of environmental management plans in an effort to minimize the significant negative impacts.

The following sections briefly outline the monitoring plans which will be implemented for the eni Ghana Project, both offshore and onshore.

12.5.1 Offshore

In general, the following monitoring plans will be implemented:

- **Ecological Monitoring Program**.

  This program will include a Marine mammal observation monitoring program and a sea turtle monitoring program.

- **Participatory Fisheries Monitoring Program** that evaluates fishing activities in the Area of Influence (AoI) to determine potential impacts of Project activities on fishing. The evaluation included a determination of current fishing practices from desktop-based research, stakeholder engagement, and a catch assessment programme. Fishermen will be highly involved in the program in particular in characterising the losses incurred and the definition of compensation and livelihood restoration measures. In addition and as far as feasible, a technical/management committee involving eni and other Operators in the AoI as well as national and local government and financiers will be created in order to assess the potential cumulative impacts on fisheries.

  The Project will develop and implement a Fisheries Management Plan (FMP) so that undue or reasonably avoidable adverse impacts of the project phases are prevented and positive benefits of the project are enhanced. The FMP will incorporate the findings, mitigations and management actions arising from the Fisheries Impact Assessment (FIA) so that they are clearly defined and implemented through all phases of the Project.

  A programme of monitoring will be implemented in order to determine that mitigations and management actions are effective. The monitoring will include the following elements:

- Catch Surveys
- Water Quality Measurements
- Plankton Measurements
- Stakeholder Engagement

Catch Surveys

The Project will conduct catch surveys every six month during the construction and commissioning phase and every six months for two years following the commencement of operations. The survey will be conducted over a single day for each event at each location. The survey will be conducted at the two locations where the surveys were conducted during the baseline studies for the Project's Environmental Impact Assessment, namely at the communities of Sanzule and Bakanta. The survey will focus on beach seine fishing activities.

The following basic information will be collected for each survey:

- Physical conditions such as weather and tides;
- Gear type used and description including size
- Time spent fishing
- Number of people involved in fishing effort

A detailed catch assessment will also be conducted to evaluate fishing production. The following information will be collected for each fish catch:

- Total catch by weight
- Types (species name, common name) and distribution of fish
- Average size of each fish species
- Total weight of each species

The catch survey will be done by a qualified specialist in consultation with community leadership and representative.

The information and data collected will be documented in report form and submitted to the Ghana EPA no more than two months after each survey event. The report will include analysis of the data collected with respect to historic data including trends.

Water Quality Measurements

Water quality measurements will be taken at of Sanzule and Bakanta and at the location of the pipeline landing four times per year during the construction period. Samples will be taken at the same location each time.

During each monitoring event, sea water samples will be collected at a water depth of about 1 metre. Samples will be analysed for e. coli bacteria and physical measurements of pH, salinity and turbidity.

The information and data collected will be documented in report form and submitted to the Ghana EPA no more than two months after each survey event. The report will include analysis of the data collected with respect to historic data including trends.

Plankton Measurements

The Project will conduct a survey to measure phyto- and zooplankton conducted every six months during the construction and commissioning phase and every six months for two years following the commencement of operations. The survey will be conducted over a single day for each event at each location. The plankton measurements should be taken near the same time as the catch surveys.

The survey should focus on the near shore environment cover near fishing grounds.

The survey approach details will be developed and conducted by a qualified specialist.

Stakeholder Engagement

The Project's stakeholder engagement programme will include a process to engage fishing stakeholders in Sanzule and Bakanta as well as in the wider area of interest. The stakeholder engagement programme will include the following.

Monthly direct engagements with fishing leaders in Sanzule and Bakanta. Bi-annual engagements with fishing authorities including the Fishing Commission

The project's grievance mechanism will include provisions specific for grievances associated with fishing. The grievance mechanism will be widely disclosed and communicated, especially in Sanzule and Bakanta. Grievances will be monitored to determine patterns or trends and corrective actions taken as required.

- **Environmental Monitoring Plan**, including sub-plans for each topic (sea water quality, marine fauna, FPSO air emissions, seabed monitoring, routine effluent and discharge monitoring).

  This will be in line with Ghanaian law, International best practices and eni's best practices. During the operation phase decrease in water quality will be monitored periodically by sampling the output of the produced water treatment in the FPSO, of open drain at the FPSO and of the outlet of sanitary wastes water at the FPSO; samples will be analysed in order to identify the content of pollutants such as oil, grease and chlorine and results will be compared against in force Ghanaian standards.

During the operation phase decrease in water quality in the surrounding of the produced water discharge will be monitored periodically by sampling sea water around the FPSO platform; water samples will be then analysed in the laboratory. Typical parameters to be analysed include: physical-chemical parameters (temperature, pH, redox potential, conductivity and salinity, dissolved oxygen, turbidity, suspended matters and chlorophyll a); water quality (hydrocarbons [BTEX, PAH, THC, aliphatic hydrocarbons], metals, nutrients [nitrites, nitrates, Phosphorus/Orthophosphates], chemical oxygen demand, biochemical oxygen demand and total organic carbon). Results will be compared against in force standard set by the Ghanaian legislation.

Sediments analysis will be based on the following parameters: visual and granulometric analysis, total organic carbon, metals (Pb, Cr, Cu, Hg, Cd, Zn, Ni, Ba, Fe, As, V, Al), hydrocarbons (BTEX, PAH, THC, aliphatic hydrocarbons), sediment oxygen demand and specific biological analyses on living species.

Every disposal activity during the operation phase the disturbance to plankton will be monitored, by taking plankton samples in the vicinity of produced water disposal in the FPSO. Samples will be compared with the measuring standard of Shannon diversity index - Wiener.

Monitoring of NO2 concentration in atmospheric emissions generated by the combustion engine and by the gas turbine located on the FPSO will be carried out. Air samples will be periodically collected directly at the emission stacks and sent to a certified laboratory to be analysed. Results will be compared against in force emissions limits for NO2 concentrations in combustion engine and gas turbine flue gas respectively set by the Ghanaian regulations.

12.5.2 Onshore

For the onshore part of the Project, the main interferences are expected during the construction phase and will involve cultural heritage, local vegetation and fauna, local air quality and noise.

A Cultural Heritage Monitoring Plan will be implemented, and its procedure will be defined within the CHMP. This monitoring plan will include the review and audit of mitigation activities to ensure their satisfactory implementation and periodic inspection of known archaeological sites/cultural sites in the Area of Influence (i.e. the Royal Cemetery). The parameters to be measured include: completion of required reporting (i.e. chance finds), the completion of induction training and toolbox talks, the implementation of signage and fencing measures and the correct management of grievances and cultural heritage issues raised through community consultation.

An Environmental Monitoring Plan will be implemented. This Environmental Monitoring Plan will include sub-plans for each topic (emissions and ambient noise, ORF air emissions and ambient air quality, vegetation and alien species, Biodiversity and Ecosystem Services, water quality/quantity).

Both vegetation and fauna monitoring activities will be conducted according to the monitoring measures defined within the Biodiversity Management Plan.

Noise monitoring activities will be conducted during both construction and operation phases at emission sources and sensitive receptors. The noise monitoring activity will ensure that noise levels comply with in force standards in particular during the hydrotesting activities and that no receptors are adversely impacted during the Project construction and operation.

Air emissions and air quality monitoring activities will be conducted during the project operation Phase. Air emissions will be monitored at the emission sources while air ambient quality will be monitored at receptors (communities and ecological sensitive spots). Atmospheric emissions during the operation of the onshore part of the project will be released by the ORF facilities, including compressors, gas turbines, diesel power generators providing energy to the onshore facilities and mainly to the ORF. Fugitive emissions and temporary air emissions may be also released by emergency flaring. Therefore air emissions monitoring locations will be located in the area surrounding the ORF, and downwind to the emission sources.

A noise and air quality modelling specific for the project have been undertaken (see Annexes H and I). A final model will be undertaken once the design of the final ORF design is completed.. The details of both monitoring campaigns (locations, frequency and parameters to be measured in the case of the air quality) will be defined based on the results of these modelling studies.

Water quantity/quality monitoring activities will be conducted during construction and operation phases in offshore and onshore facilities. The water monitoring activities will ensure that the discharge effluents comply with in force standards and that the receiving bodies are not adversely impacted. In addition, this monitoring plan will set a procedure for estimating water used by the project, identifying activities that use this resource and following a reporting procedure for registering used volumes of water.

12.6 EIS Action Plan

Aim of the present section is to highlight recommendations/actions to be undertaken within the Project development in order to close gaps and to ensure Project compliance with EPA and with IFC/WB Standards.

Particular focus of this Paragraph is to highlight those actions that are not included in the mitigation and monitoring section presented above and that are believed as necessary in order to define more precisely some aspects that remain unexplored or need more specific information in relation to the location and activities of the Project. Action Plans are reported in Table 12.7.

Table 12.7 Summary of EIS Action Plan

Items	Gap	Action	When
#1 – Noise impact assessment	The final design of the ORF is currently not available to allow for noise modelling to be undertaken.	Modelling studies have been undertaken based on preliminary design data, to provide quantitative information on the noise	May 2015

Items	Gap	Action	When
		emissions at the construction and operations of the ORF. Modelled noise emissions have been used to assess the noise impacts on the local communities and natural environment, and develop mitigation measures and monitoring plans. However, new modelling studies will be undertaken again once final project design is available. Mitigation measures and monitoring plans will be updated (as necessary) according to the results	
#2 – Air Quality impact assessment	The final design of the ORF is currently not available to allow for air emission modelling to be undertaken.	Atmospheric emissions modelling has been undertaken based on preliminary design data to show the changes in air quality as a result of the emissions from the operation of the ORF and FPSO. Modelled atmospheric emissions have been used to assess the air impacts on the local communities and natural environment, and develop mitigation measures and monitoring plans. However, new modelling studies will be undertaken again once final project design is available. Mitigation measures and monitoring plans will be updated (as necessary) according to the results	May 2015
#3 – Unplanned Events	Due to the recent changes in the design philosophy of the onshore components of the project, a formal risk assessment report is not yet available for the ORF at this stage of	These processes and documents are planned to be developed for the next stage of engineering design, in the form of HAZID, HAZOPS and QRAs for the different components of the onshore facilities.	May-June 2015

Items	**Gap**	**Action**	**When**
	engineering design.	As a result mitigation measures required to address the risks identified will be revised and updated according to the final results of such studies	
#4 – Fisheries baseline	Availability of long-term and consistent baseline dataset.	Develop and implement a participatory fisheries monitoring program.	Post-ESHIA
#5 – Social	Availability of sufficient baseline data to assess the proportional scale of livelihood losses to Sanzule, along with information on the availability of alternative agricultural land in the direct area of influence to allow for like-for-like replacement of acquired farmland.	Supplementary baseline livelihoods survey work to be conducted by ERM in parallel with the resettlement planning process.	March - May 2015
#6 – Social	Ecosystem services in the Sanzule area are not fully classified by priority.	Priority ecosystem services will be identified in consultation with the affected communities during the livelihood restoration baseline data collection. Results will be reflected in the LRP	March - May 2015
#7 – Social	Livelihood Restoration	Develop a Livelihood Restoration Plan and a Fishermen Management Plan	June 2015

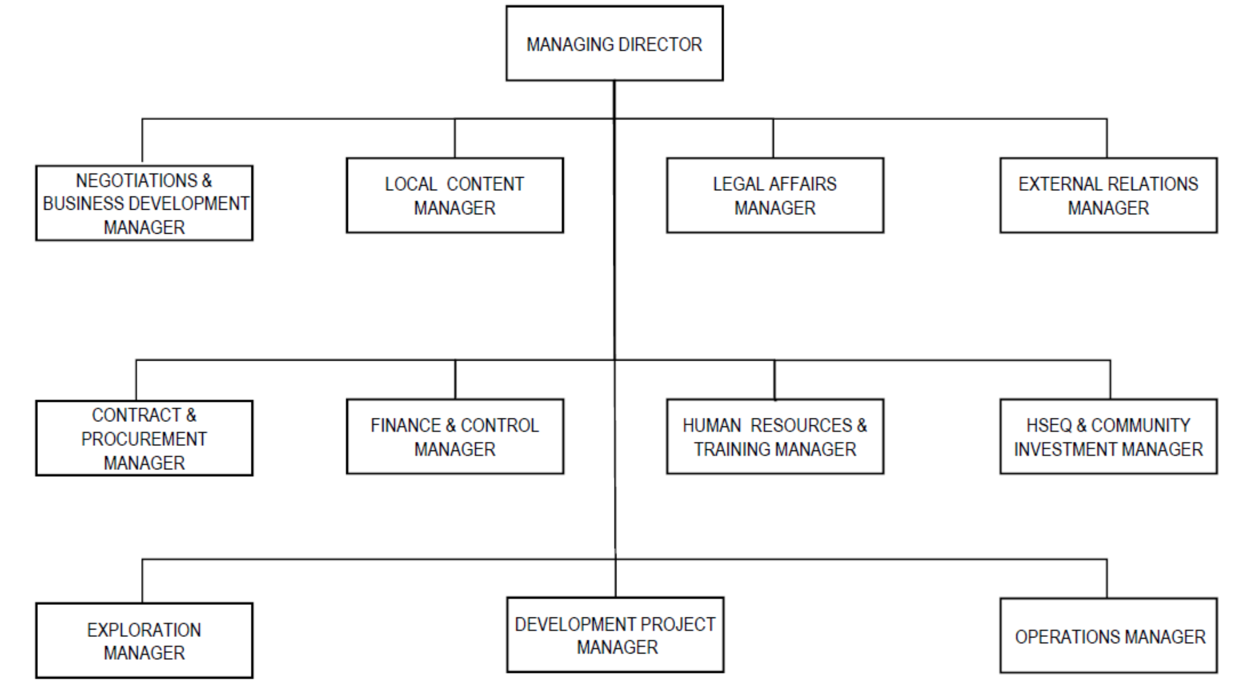
12.7 PLANNING AND IMPLEMENTATION

12.7.1 Environmental and Social Management Organisation

Eni Ghana is committed to provide resources essential to the implementation and control of the ESHMP. Resources include the appropriate human resources and specialised skills. As a contractual requirement, contractors are required to provide sufficient resources to manage the HSE aspects of their work. This includes providing adequate resources to monitor compliance of their subcontractors.

Eni Ghana is the Project Operator and is ultimately responsible for the management and supervision of all project activities. Eni Ghana has a HSE & CI department which has responsibility for both HSE and Community Investment with dedicated staff, competent on the basis of appropriate education, training and experience. A representation of eni Ghana"s organisational structure is summarised in Figure 12.3.

Figure 12.3 eni Ghana Macro-Organisation (Execution Phase)



Source: eni Ghana, 2013

The eni Ghana HSE Guidelines and Protocols assigns responsibilities to all personnel throughout the Company, and requires contractors to manage HSE in line with the Guidelines and Protocols.

The MD is responsible for assuring that the HSE-IMS is developed and implemented in line with the JV requirements via the provision of adequate resources.

Managers are responsible for:

- Managing resources in an effective manner to achieve the Company's HSE Guidelines and Protocols & strategic HSE objectives.
- Develop, implement, monitor and maintain functional processes and procedures to ensure best practice within own area of responsibility.

Supervisors are responsible for:

- Through their own actions and behaviour, and workplace presence, show visual leadership and commitment to the health and safety of employees, protection of the environment and the avoidance of loss.
- Ensure that safety, health and environmental considerations are taken into account when work tasks that come under their areas of responsibility, are being planned and carried out. This includes ensuring that all significant safety and environmental aspects are adequately managed in accordance with the HSE Risk Register, Standards and Operational Procedures of the Company.

- Follow-up implementation of measures within their areas of responsibility.

All employees are responsible for:

- The quality of their own work, and the safety and impact of their actions. Individuals shall report incidents and are encouraged to propose improvements. An individual, who finds that the work cannot continue without danger to life or health, shall take the required action to stop the work.

The eni Ghana HSEQ & CI department is headquartered in Accra, where staff overseeing commissioning and operations will be located. Staff will also be located in Takoradi to facilitate HSE and social performance oversight of site activities as well as to allow direct interface and access for stakeholders in the Western Region. These functions will manage the successful implementation of the ESHMP and the continuation of the stakeholder consultation process.

During commissioning and operations, HSE staff will also be located offshore.

Supervision of contractor activities will be conducted by the relevant eni Ghana technical team. This will be accomplished through management controls over strategic project aspects and interaction with contractor staff where project activities take place.

12.7.2 Training and Awareness

eni Ghana will identify, plan, monitor, and record training needs for personnel whose work may have a significant adverse impact upon the environment or social/health conditions. The project recognises that it is important that employees at each relevant function and level are aware of the project's environmental and social/health policy; potential impacts of their activities; and roles and responsibilities in achieving conformance with the policy and procedures.

Training and awareness (raising) therefore forms a key element of both EHS/operational control and the expediting of this framework ESHMP. Key staff will, therefore, be appropriately trained in key areas of EHS management and operational control with core skills and competencies being validated on an on-going basis.

The identification of training and awareness requirements and expediting of the identified training/awareness events will be the responsibility of the eni Ghana Human Resources & Training Manager.

The HSE Manager, in cooperation with the Department Managers, shall coordinate people to attend their designated HSE training and monitor attendance in the HSE Training Matrix. As part of the training all employees shall be made aware of:

- The importance of conformity with the HSE Guidelines, Protocols, Standards, Procedures & the requirements of the HSE-IMS.
- The significant HSE hazards & associated risks and potential impacts associated with their work, and the HSE benefits of improved personal performance.
- Their roles & responsibilities in achieving conformity with the requirements of the HSE-IMS.
- The potential consequences of departure from specified procedures.

Specific knowledge or skill gaps that are identified for any person through the application of the competency assessment process can be met through either formal training or structured learning & development in the workplace. Training to close competency deficiencies may be coordinated by the HR Department or by the respective Department (e.g. on-the-job training).

Subcontractors engaged during the pre-Operations phase of the development will be responsible for the training and awareness of their staff. As a minimum it is expected that this will cover the environmental and social setting within which the work is carried out; the potential environmental and social impacts of their work activities; the management and mitigation measures to address these; and the existence of, and importance of complying with, the OCTP Phase 2 Project ESHMPs.

12.7.3 Communication

eni Ghana will maintain a formal procedure for communications with the regulatory authorities through its Stakeholder Engagement Plan (SEP). The HSE Manager is responsible for communication of EHS issues to and from regulatory authorities. This is coordinated with the project's Communications and External Relations Manager. The Managing Director will be kept informed of such communications. Pertinent information arising from such interactions will be communicated to subcontractors through the EHS Manager.

Whereas it is anticipated that the subcontractor EHS staff may interact with representatives from regulatory authorities on an informal, day-to-day basis regarding routine matters, the HSE Manager shall be the point of contact for formal communications. The HSE Manager will be responsible for communicating any pertinent information arising from such discussions to appropriate subcontractor through the technical department.

Internal communication is used to ensure that all persons are aware of the:

- HSE risks posed by their work activities & the controls to minimize these risks.
- Emergency response procedures that are in place.
- Lateral learning points arising from incident investigations.

eni Ghana uses several mechanisms to communicate to employees, recognizing at all times the possible cultural differences that exist. These include meetings, workshops, forums, presentations, phone, e-mail, and noticeboards.

The Company holds several regular meetings that relate to the implementation and functioning of the HSE-IMS. The highest level forum in the Company dedicated to HSE issues is the HSE Steering Committee (HSE SC). The aims of the HSE SC are to:

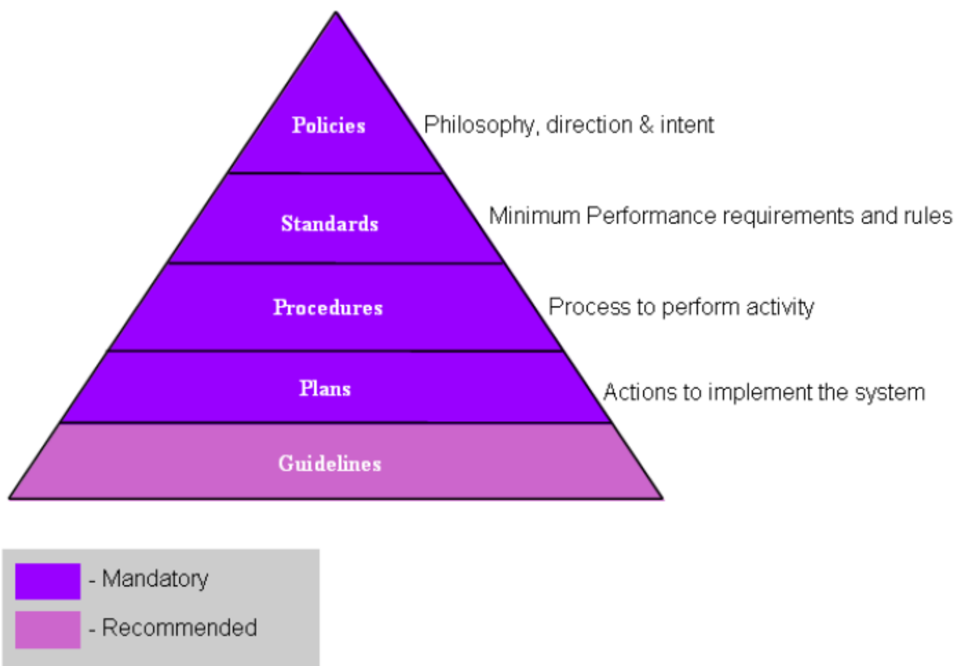
- Monitor execution of the HSE Plan.
- Monitor progress towards the HSE objectives and annual performance targets.
- Ensure appropriate resources are available to implement the HSE IMS.
- Review incident investigations.

12.7.4 Documentation & Document Control

eni Ghana will control HSE documentation, including management plans; associated procedures; and checklists, forms and reports, through a formal procedure named HSE Documentation Management. This document control procedure describes the processes that the project will employ for official communication of both hardcopy and electronic documents. In addition, it describes the requirement for electronic filing and posting and for assignment of a document tracking and control numbers (including revision codes).

The documents determined by the Company as necessary to ensure the effective planning, operation and control of the processes that relate to the Company's significant HSE risks are listed in the HSE-IMS Document List and are organised in line with the hierarchical structure shown in Figure 12.4.

Figure 12.4 HSE MS Documentation Hierarchy



Source: eni Ghana, 2013

During operations, the HSE Manager will be responsible for maintaining a master listing of applicable EHS documents and making sure that this list is communicated to the appropriate parties. The EHS Manager will be responsible for providing notice to the affected parties of changes or revisions to documents, for issuing revised copies and for checking that the information is communicated within that party's organisation appropriately.

Subcontractors will be required to develop a system for maintaining and controlling their own EHS documentation and describe these systems in their respective EHS plans.

12.7.5 Operational Control

Each potentially significant impact identified in the EIS will have an operational control associated with it that specifies appropriate procedures, work instructions, best management practices, roles, responsibilities, authorities, monitoring, measurement and record keeping for avoiding or reducing impacts.

It is the responsibility of the Department Managers to develop and implement operational control documents (e.g. Operating Manuals & Procedures). These should always be in place for HSE Critical Activities. It is also important that Procedures include measures aimed at improving HSE performance or managing HSE risk, in addition to controlling activities and tasks.

It is the responsibility of Contractors to develop and implement operational & activity control documents (i.e. Standards, Procedures & Work Instructions) for all HSE-Critical Activities which they undertake on behalf of the Company. Where relevant, these Procedures must, as a minimum, meet the performance criteria defined in eni Ghana"s HSE Standards.

12.7.6 Emergency Response

Although every effort is made to ensure that incidents do not occur, the potential for incidents and emergency situations still exists. A system and resources are in place to respond swiftly and effectively to any emergency situation.

eni Ghana has developed plans and procedures to identify the potential for and response to environmental accidents and health and safety emergency situations and for preventing and mitigating potentially adverse environmental and social impacts that may be associated with them.

The eni Ghana Emergency Response Plan describes the process, actions and responsibilities by which eni Ghana deals with emergencies.

Other Procedures for implementing Emergency Response actions are:

- Emergency Medevac Procedure
- Emergency Evacuation Procedure – ACCRA Premises
- Oil Spill Contingency Plan

Emergency preparedness and response will be reviewed by eni Ghana at least annually and after any accidents or emergencies to ensure that lessons learnt inform continuous improvement. Emergency exercises will be undertaken regularly to confirm the adequacy of response strategies. Investigations of accidents or incidents will follow formal documented procedures.

12.8 IMPLEMENTATION AND MONITORING

Continual examination by eni Ghana of the performance of the HSE-IMS as well as actual performance against HSE targets, are necessary to gauge whether progress is being made towards the strategic HSE objectives of the Company. Full implementation of the HSE-IMS means that people are doing as directed by the Management System at all levels.

Effective implementation involves:

- Setting performance targets and performance indicators;
- Monitoring to measure performance against targets;

- Keeping performance monitoring records;
- Addressing non-compliance & ensuring that corrective action is taken;
- Reacting to incidents to make sure that they are reported & investigated.

12.8.1 Monitoring & Measurement

Monitoring will be conducted to ensure compliance with regulatory requirements as well as to evaluate the effectiveness of operational controls and other measures intended to mitigate potential impacts.

With respect to the impacts identified in the EIS, eni Ghana will develop a number of programs to monitor the effectiveness of the mitigation measures (see section 12.5). The programs will describe what effect is to be measured and the frequency.

The monitoring programs shall:

- Identify the information to be obtained;
- Define the required accuracy of the results;
- Specify the monitoring methods and identify monitoring locations;
- Specify the frequency of measurement;
- Define roles and responsibilities for monitoring.

12.8.2 Nonconformity, Corrective & Preventive Action

Identifying potential impacts, hazards and risks is an important part of the HSE IMS approach. Equally important is the investigation of 'near miss' or accidents/incidents so that valuable lessons and information can be learnt and used to prevent similar or more serious occurrences in the future.

Non-compliance may be sudden and temporary or it may persist for long periods. It may result from deficiencies or gaps in the HSE-IMS itself, failures in plant or equipment, or from human error. Non-compliance can be reported directly by those in control of activities, or found through inspections and audits of activities.

Investigations should fully establish the root causes including failures in the HSE-IMS. Investigations enable the planning of corrective action including measures for:

- Restoring compliance as quickly as possible;
- Preventing any recurrence;
- Evaluating and mitigating any resultant adverse HSE effects;
- Assessing the effectiveness of the above measures.

The process and responsibilities for the reporting and investigation of non-conformances with the requirements of the HSE-IMS, and to ensure that corrective actions are planned, implemented and recorded is defined in a formal procedure.

12.8.3 Reporting

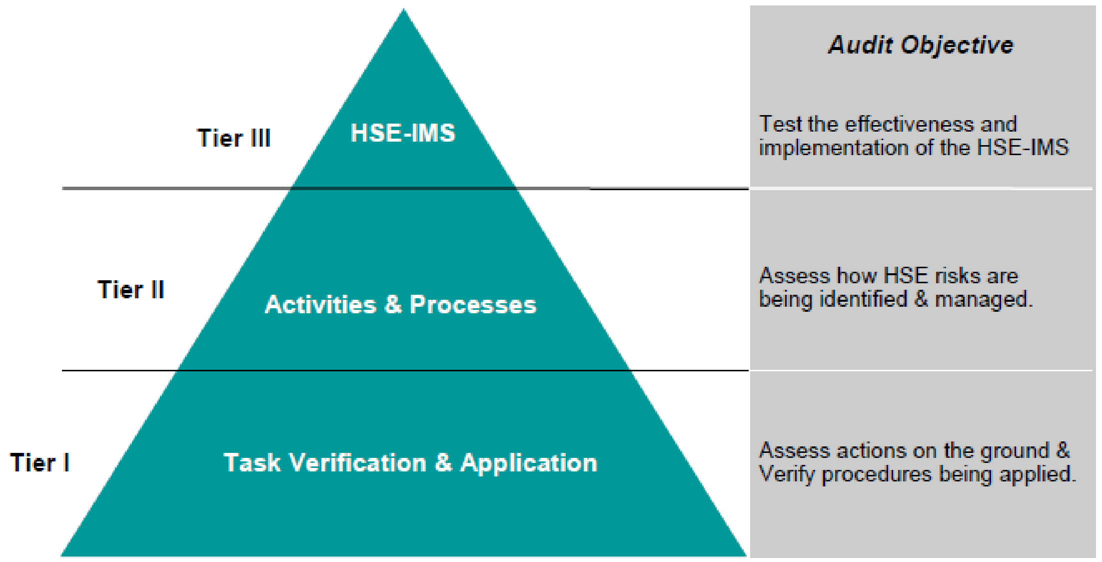
Throughout the project, eni Ghana will keep regulatory authorities informed of the project performance with respect to EHS matters by way of written status reports and face-to-face meetings. eni Ghana, upon request and format definition, will prepare a monthly report on environmental performance and submit it to Ghana EPA. Copies may be made available to other interested authorities upon agreement with Ghana EPA. For social performance activities, eni Ghana will submit twice a year reports to the six District Assemblies and the Regional Coordinating Council in Takoradi.

eni Ghana will release corporate annual reports on environmental and social performance which will be available to the public via eni's website. The content will be determined with consideration of national requirements and lender requirements.

12.9 Audits

Beyond the routine inspection and monitoring activities conducted, audits will be carried out internally by both eni Ghana and its Partners (including the Government of Ghana) to ensure compliance with regulatory requirements as well as their own EHS standards and policies. eni Ghana uses a hierarchical system of HSE audits as shown below.

Figure 12.5 eni Ghana hierarchical system of HSE audits



Source: eni Ghana, 2013

eni Ghana performs a number of internal and external HSE audits and inspections annually and publishes an audit schedule in the HSE Audit & Inspection Program. Contractors are also required to carry out audits and publish their program for these audits in their respective Contract HSE Plans.

The audit programme will include a review of compliance with the requirements of the EIS and of this framework ESHMP and include, at minimum, the following:

- completeness of EHS documentation, including planning documents and inspection records;
- conformance with monitoring requirements;

- efficacy of activities to address any non-conformance with monitoring requirements; and
- training activities and record keeping.

Where a pre-start up HSE audit is deemed necessary, the HSE Manager shall undertake the audit to determine that the Contractor has achieved the pre-execution targets stated in the Contract HSE Plan, and that the requirements of the Contract HSE Plan are in place to the satisfaction of the Company.

In addition to the internal audits previously described, assuming Project financing, it is foreseen the WB/IFC supervision and monitoring and the involvement of an independent E&S monitoring group for monitoring compliance with WB/IFC requirements and agreed E&S Action Plan.

ESHIA for GHANA OCTP BLOCK Phase 2

ABSTRACT

Chapter 13 provides a summary of the Project and the main conclusion of the ESHIA Report.

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Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

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13 SUMMARY AND CONCLUSIONS

13.1 INTRODUCTION

This EIS for the proposed OCTP Phase 2 Project was undertaken in accordance with the Ghanaian Environmental Assessment Regulations (LI 1652, 1999) and IFC/WB performance standards. An EIS is mandatory for a gas field development and the scope of this EIS includes drilling, installation, commissioning, operation and decommissioning project phases.

A Scoping process was undertaken in December 2014 during which a range of stakeholders with a national or regional interest in the project were consulted. The scoping process will culminate in the approval and disclosure of the Scoping Report and Terms of Reference.

Baseline and quantitative studies were undertaken both offshore and onshore to inform the impact assessment. As part of the baseline studies, community-level consultations were undertaken involving 5 communities in the projects DAoI. Issues and concerns that were raised during the scoping and community consultations were considered in identifying key impacts that needed to be addressed in the EIS.

Potential impacts were assessed as being of low, medium, high or critical significance. The assessment of impacts took into account mitigation measures that have been built into the project design. Additional mitigation measures were identified to reduce the severity of identified impacts to the extent that was practicable.

The assessment took into account the temporal and spatial scale of impacts, the sensitivity, resilience and/or importance of the receptor, and the number of elements that could be affected by the impact.

13.2 SUMMARY OF IMPACTS AND MITIGATIONS

Chapter 10 presents summary tables showing the temporal and spatial scale of each impact, the sensitivity, resilience and/or importance of the receptor, and the number of elements that could be affected by the impact. They also present the final rating and associated significance of the impact. Tables are presented in section 10.12.

In turn, Tables 12.1 to 12.4 in Chapter 12 present a summary of the impacts identified and the key mitigation measures outlined.

13.3 OVERALL CONCLUSION

The findings of the EIS presented in Chapter 10 indicate that there are no issues of Major significance that could not be mitigated such that the proposed project was not acceptable from an environmental and socio-economic and health perspective. The significance of all negative impacts could be reduced to Medium or Minor significance through design, use of control technology and operational management controls with the exception of the economic displacement of farming in land acquisition Area.

For this impact, an assessment of the proportional scale of livelihoods losses to Sanzule, along with information on the availability of alternative agricultural land in the direct area of influence to allow for like-for-like replacement of acquired farmland, will be confirmed following supplementary baseline livelihoods survey work to be conducted in parallel with the resettlement planning process in April 2015.

For the moment, other alternatives such as compensation of both the leased land and the assets, and future alternative livelihood training activities and specific investment projects at Sanzule are foreseen.

For other impacts, the residual effect of a number of activities from the construction and operation phases is expected to remain Medium despite the mitigation measures proposed. For this reason, eni Ghana should pay special attention to these activities and ensure that practicable, feasible and cost-effective mitigation is implemented wherever practicable.

It should be noted that the methodology used grants impacts continuing over 10 years a "critical" score which automatically raises impacts significance to "Medium". As an outcome, the impacts that are continuous or semi-continuous across the operations phase of the project are all classified (at least) as Medium.

This is a reflection of the methodology's conservative approach, where eni wants to ensure that adequate management, monitoring and control measures are applied in a timely manner to any possible impacts whose duration would be more than 10 years.

The EIS also identified a number of positive impacts. Increased government revenue was assessed as having the potential benefit of High significance during construction and Critical positive during operation. Other positive impacts of High significance are increased procurement during construction and operation phases and employment and skills development during operation phase.

Granting of environmental authorization for the eni Ghana OCTP Block Phase 2 Project by the EPA will be contingent on a series of conditions. These are likely to include the implementation of the safeguard measures described in the EIS and a programme of monitoring for potential environmental, social and health impacts.

ESHIA for GHANA OCTP BLOCK Phase 2

ABSTRACT

Chapter 14 provides the list of References used for the preparation of this ESHIA report.

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