

AFRICAN DEVELOPMENT BANK



GHANA

JUBILEE FIELD PROJECT

SUMMARY OF THE ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

OCTOBER 2009

LIST OF ACRONYMS

ABS	=	American Bureau of shipping
AALARD	=	As low As Reasonably Practical
Bbl/d	=	Barrel per day
Bcf	=	Billion Cubic Feet
BOPD	=	Barrels of Oil Per Day
ECO	=	Equivalent Carbon Dioxide
CBO	=	Community Based Organizations
CSR	=	Corporate Social Responsibility
EEZ	=	Economic Exclusion Zone
EIA	=	Environmental Impact Assessment
EHS	=	Environment, Health and Safety
EHSMS	=	Environment, Health and Safety Management System
EIS	=	Environmental Impact Statement (Report)
EPA	=	Environmental Protection Agency of Ghana
ERM	=	Environmental Resources Management
ESIA	=	Environment and Social Impact Assessment
EMP	=	Environmental Management Plan
GDP	=	Gross Domestic Product
Dwt	=	Deadweight ton
EHSMS	=	Environmental Health and Safety Management System
FAD	=	Fish Attracting Device
FLO	=	Fisheries Liaison Officer
FPSO	=	Floating, production, Storage and Offloading
FSU	=	Floating Storage Unit
GHG	=	Greenhouse Gases
GMA	=	Ghana Maritime Authority
GPHA	=	Ghana Ports and Harbor Authority
GNPC	=	Ghana National Petroleum Corporation
GPRS	=	Growth and Poverty Reduction Strategy
H&S	=	Health and Safety
HSMP	=	Health and Safety Management Program
IMO	=	International Maritime Organization
IPIECA	=	International Petroleum Industry Environmental Conservation Association
Km	=	Kilometer
Km/h	=	Kilometer per hour
MARPOL	=	International; Convention for the Protection of Pollution from Ships
MODU	=	Mobile Offshore Drilling Unit
MoE	=	Ministry of Energy
NGO	=	Non-Governmental Organization
Nm	=	Nautical mile
NOx	=	Nitrogen Oxides
PCDP	=	Public Consultation and Disclosure Plan
OGP	=	International Association of Oil & Gas Producers
OSCP	=	Oil Spill Contingency Plan
ROVs	=	Remotely Operated Vehicles
SMEs	=	Small Scale Enterprises
STIs	=	Sexually Transmissible Infections
TLP	=	Tension Leg Platform
TOR	=	Terms of Reference
UNCLOS	=	United Nation Convention on the Law of the Sea
VLCC	=	Very Large Crude Carrier
WMP	=	Waste Management Plan

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Project Name: Jubilee FPSO Project
Country: Ghana
Project Number: P-GH-FC0-001

1. INTRODUCTION

1.1 The African Development Bank (AfDB) will be providing funding to a consortium led by MODEC, who are a sub-contractor to the Jubilee Joint Venture (described below), for the provision of the FPSO under a lease-operate arrangement. Tullow Ghana Limited (Tullow) and its joint venture partners Kosmos Ghana HC (Kosmos), Anadarko WCTP Company, Sabre Oil and Gas, the EO Group, and the Ghana National Petroleum Corporation (GNPC), known as the Jubilee Joint Venture, are pursuing development of hydrocarbon resources within the Jubilee Field, which is located in deep water approximately 60 km offshore Ghana from the nearest coast and lies in deep water of 1100 – 1700 meters. The two concession blocks are operated by Tullow Ghana Ltd (Tullow) and Kosmos Energy (Kosmos), respectively. Under a Unitization (*combining of multiple wells to produce from a specified reservoir*) agreement Tullow has been designated as Unit Operator of the Jubilee Field Unit on behalf of the Jubilee Joint Venture parties. The management of the facilities project design and execution to be deployed in field is being lead by Kosmos Energy as Technical Operator.

1.2 The Jubilee Joint Venture is planning a multi-phase development of the Jubilee Field. Phase 1 of the development including a Floating Production Storage and Offloading (FPSO) vessel is the subject of this Environmental Impact Assessment (EIA- also equivalent to an Environmental and Social Impact Assessment or ESIA). The proposed project would be the first major deepwater offshore oil production project in Ghana and for projects of this type there is a legislative requirement to undertake an EIA. The regulatory requirements for an FPSO are generally set out by the coastal state, international conventions, and the classification society (naval architecture, private organizations which issue rules for the construction). An FPSO therefore needs to satisfy all of the requirements from these authorities. The EIA of the project has been prepared by Environmental Resources Management (ERM) and ESL Consulting (ESL), jointly referred to as the EIA team, and was appointed by Tullow in 2008 to undertake an EIA for the Phase I Development project. The EIA team comprises independent environmental and social specialists with experience in undertaking EIAs for similar projects in other countries and EIA experience in Ghana. In addition, a series of studies have been undertaken by specialist consultancies to address specific issues such as an oil spill simulation model. The EIA was carried out with input from specialists from the Jubilee Joint Venture team. Input included providing details on the project's technical aspects as well as with the development of mitigation measures and environmental management plans. The purpose of the EIA is to provide information to regulators, the public and other stakeholders (a total of 31 meetings involving approximately 2,500 people were held at national, regional, district and local levels during the EIA phase between February and September 2009) to aid in the decision making process. In accordance with Ghana EIA requirements, the draft EIA was advertised and made available for public review and comments. Comments received on the draft EIA from the technical review of Environmental Protection Agency (EPA) of Ghana, stakeholders written comments, and the outcome of any public hearings that were held, will be incorporated into the final report which will be submitted to the EPA for final review and approval.

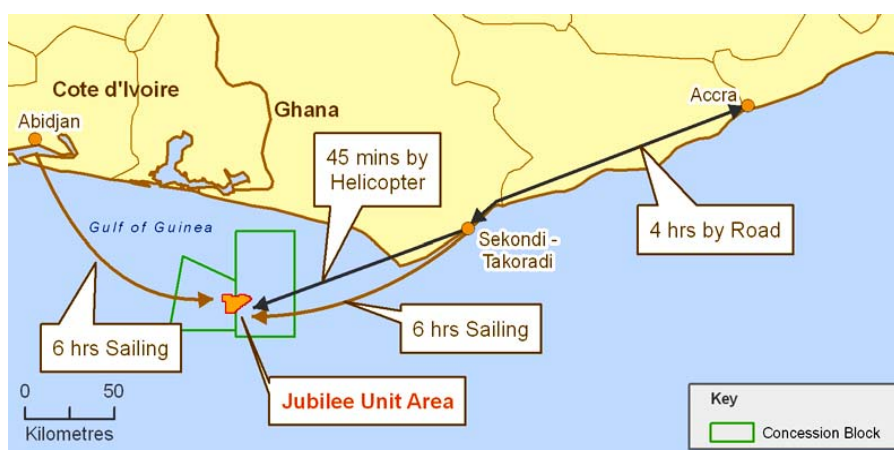
1.3 The main project activities include well completions, subsea infrastructure and FPSO installation, commissioning and operation (including production, hydrocarbon processing, crude oil offloading, and support and maintenance activities) and decommissioning at the end of the commercial life of the field. This EIA report and the findings of the studies have been submitted for public comments and review by the Ghana Environmental Protection Agency (EPA) and other government regulators. An EIA is a systematic process that predicts and evaluates the potential impacts a proposed

project may have on aspects of the physical, biological, socio-economic, and human environment. Mitigation measures are then developed and incorporated into the project to eliminate, minimize, or reduce adverse impacts and, where practicable, to enhance benefits. This EIA Executive Summary provides an overview of the project and outlines the approach taken to undertake the EIA.

2. PROJECT DESCRIPTION AND JUSTIFICATION

2.1 In 2007, the Jubilee Field was discovered offshore of Ghana. The discoveries identified a large accumulation of hydrocarbons. The field underlies portions of the West Cape Three Points and Deepwater Tano licence blocks. The study area is therefore located in the Jubilee Field in the Deep Water (1,100-1,700 m) Blocks approximately 60 km from the nearest coast in western Ghana. It is also about 75 km south-southeast of the border between Cote D'Ivoire and Ghana and 132 km southwest of the port city of Takoradi. The project location is presented in the following figure.

Fig.1: LOCATION OF JUBILEE FIELD



FPSO

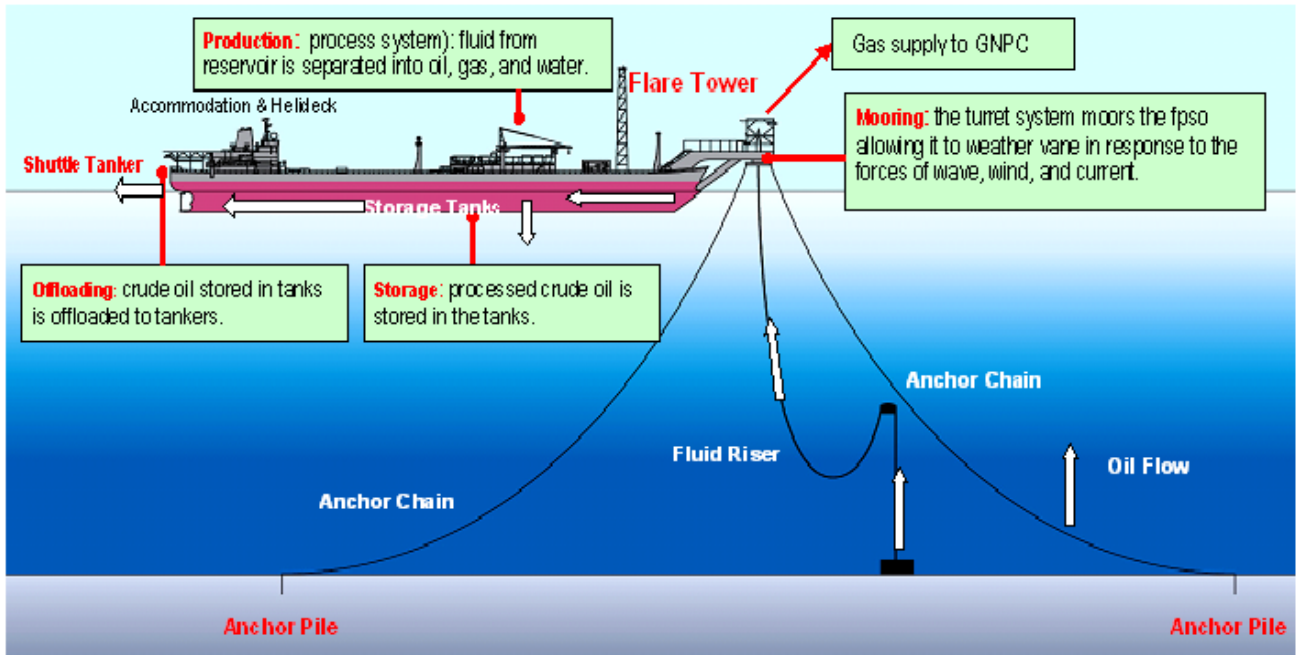
2.2 The Jubilee Project Phase I Development Plan was prepared as the first phase of a multi-phase development of the Jubilee Oil Field. This Phase will consist of production wells, water injection and gas injection wells. The FPSO is a ship-based hydrocarbon processing facility which separates the crude oil and natural gas from the produced water from the reservoirs. The wells (17) will be connected on the seabed through a series of sub-sea wellheads, manifolds, and pipelines to the FPSO vessel located on the surface in approximately 1,100-1700 m water depth. The FPSO will be used to process and store crude oil and gas. Crude oil will be exported to markets using export tankers. The project is expected to produce 120,000 barrels of oil per day (bopd) and 140 million standard cubic feet per day (mmscfd) of associated gas, a water capacity of 232,000 barrels per day and storage capacity of 1.6 million barrels (bbls) of oil. The crude oil will be processed and stored in the facility's storage tanks in the hull and offloaded to ocean going oil tanker vessels, while produced water is treated to reduce the concentration of oil in the water to meet permit standards and then discharged to sea. Some of the gas (*gas will not be routinely flared*) will be used for enhancing the liquid production through gas lift and for energy production onboard the FPSO vessel. The remainder will be transported to shore via a new pipeline for treatment in a gas processing plant and distribution through an offshore pipeline to power stations in Ghana as well as for export. The Ghana National Petroleum Corporation (GNPC) is considering constructing Gas Infrastructure Project (presently under design), which is separate from

the Jubilee Phase 1 Development Project (hereafter the project), and therefore not addressed in this report, but would be subject to a separate permitting process and EIA.

2.3 The FPSO vessel is being converted using an existing tanker in Singapore and is due for completion at the end of the first quarter of 2010. Upon completion it is scheduled to arrive during the second quarter of 2010 for mooring and installation. First oil production is planned for the fourth quarter 2010 and the field is expected to produce oil for at least 20 years based on current reserve estimates. Subsea equipment and FPSO installation is planned for late 2009 to mid 2010 respectively. The target for first oil production is between September and December 2010. The field development work will continue until early 2011 with further drilling and tie-in of new wells until the development plan is completed. It is expected that the field will be decommissioned after 20 years of operation i.e. after 2031, although subsequent appraisal and development of the reservoirs may extend this period significantly.

2.4 **FPSO Design:** A turret-moored FPSO was selected as the development concept for the receipt, processing, and storage of the Jubilee reservoir fluids. The primary factors influencing this choice were: (i) water depth; (ii) remote location of the field leading to a relatively high storage capacity to limit the number of export tanker visits; (iii) areal extent of the field not permitting a specialized drilling platform; (iv) safety and environmental performance (*specifically a turret moored FPSO weather vanes in alignment with current and wind conditions reducing collision and oil spill risks during export tanker offloading operations*); and (v) is a proven method in similar fields worldwide. There are now 138 FPSO vessels operating worldwide. FPSOs are either newly built hulls or converted from existing trading tankers with new topside facilities added on to the main deck. For the Jubilee field a tanker conversion of a single hulled Very Large Crude Carrier (VLCC) was selected. Tanker conversions into FPSOs are more prominent than newly built facilities due to their reduced procurement schedule, reduced cost and the large selection of used vessels available. Double sided hull configurations (usually newly built FPSOs) are normally used where conditions demand a specialized vessel, generally with increased or specialized storage capacity, or where harsh climatic conditions exist such as the North Sea or Australasia. The FPSO production and processing systems are presented in Figure.2 below.

Figure.2: FPSO PROCESSING SYSTEM



Project Justification

2.5 The Ministry of Energy (MoE) oversees the development of oil and gas extraction from Ghana's natural reserves. Under the Ghana National Petroleum Act, 1983, MoE is charged with the responsibility to: "(a) promote the exploration and the orderly and planned development of the petroleum resources of the Republic; and (b) ensure that the Republic obtains the greatest possible benefits from the development of its petroleum resources." MoE grants oil exploration, appraisal and production licenses with the goal to develop and exploit these resources for commercial purposes. In 2006 Ghana formulated its second edition medium-term national development strategy known as the Growth and Poverty Reduction Strategy (GPRS II), 2006 to 2009. The strategy places emphasis on economic growth as a means of reducing poverty. The strategy identified five priority areas: infrastructure development; agricultural modernization; good governance; private sector development, and social services enhancement. The strategy, policies, and practices of the MoE are aligned with GPRS II with the emphasis on two of the priority areas: *infrastructure development* and *private sector development*. To that end, the government has been engaging in activities intended to *reduce the cost of imported oil through facilitating private sector investment in the domestic oil and gas sector*.

Project Benefits

2.6 Another purpose of the project is to develop Ghana's natural resources for the benefit of the people of Ghana by generating income. This would occur by selling the oil extracted from the reserves and locally commercializing the gas instead of flaring it. This income would benefit the project's shareholders which include Government of Ghana (through participation of GNPC) as well as commercial entities. The Government of Ghana would generate additional income through royalties and taxes. The project will contribute to the Ghanaian economy and will have a positive impact in reducing the Ghana balance of payments with respect to energy. Income to the government from the project will facilitate economic development and growth, further benefiting Ghana directly from the project and indirectly through development of supporting and related enterprises. The project will also produce significant amounts of gas, which can provide substantial opportunities to address the shortage

of power in the country. Local oil and gas production will contribute toward the replacement of crude oil and gas imports, thereby conserving foreign exchange for the country.

2.7 The project will generate direct employment and training opportunities for the Ghanaian offshore oil and gas industry. The project will also generate indirect opportunities through service, supply, and support industries. Increase in demand for consumer goods and services will induce additional job creation and further raise per capita income. The establishment of an oil and gas infrastructure and development of skills capability within the country should encourage other companies to make similar investments in Ghana and further develop the economy. To achieve these benefits, the project will operate in a safe, environmentally sound and commercially viable manner.

3. POLICY, LEGAL ADMINISTRATIVE FRAMEWORK

3.1 This chapter summarises the policy, legal and administrative framework within which the EIA was carried out, including the relevant environmental and social requirements of the Bank, other lenders and Ghana, the host country. Also, it identifies relevant international environmental/social agreements that are related to the project. The project is subject to regulations implemented and enforced by Environmental Protection Agency of Ghana. The Ghana EPA is responsible for ensuring compliance with EIA procedures and issuing environmental permits for relevant projects. The Ministries and the key administrative bodies i.e. authorities, agencies and commissions with responsibilities related to the project are: Ministry of Environment, Science and Technology– represented through the Environmental Protection Agency (EPA); Ministry of Energy – represented through the Ghana National Petroleum Corporation (GNPC); Ministry of Transport – represented through the Ghana Maritime Authority (GMA) and the Ghana Ports and Harbors Authority (GPHA); Ministry of Food and Agriculture–represented through the Directorate of Fisheries and the Regional Departments of Fisheries; and Fisheries Commission.

3.2 The EIA process is legislated through the *Environmental Assessment Regulations (LI 652, 1999) as amended (2002)*, the principal enactment within the *Environmental Protection Act (Act 490 of 1994)*. The EIA Regulations require that 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 Regulations define what is to be addressed within the EIA, how the EIA process should involve the public and outlines the steps to be followed. The Ghana EPA has issued formal guidance on regulatory requirements and the EIA process. *The Petroleum (Exploration and Production) 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.

3.3 The Lenders to the project have also a number of specific project requirements that the sponsor must adhere to. This includes a series of social and environmental Performance Standards (PS) mandated by the International Finance Corporation (IFC) that have been adopted by the Jubilee Joint Venture for the project along with the following associated IFC Environmental, Health and Safety (EHS) Guidelines - EHS General Guidelines (April 2007), EHS Guidelines for Offshore Oil and Gas Development (April 2007), EHS Guidelines for Shipping (April 2007), and EHS Guidelines for Crude Oil and Petroleum Product Terminals (April 2007). The project has also adopted relevant good practice standards of the International Association of Oil & Gas Producers (OGP), which has established industry guidelines and standards on environmental protection and personnel safety; and the International Petroleum Industry Environmental Conservation Association (IPIECA) on oil spill response and contingency planning for the marine environment. Ghana is signatory to a number of

international conventions which are relevant to offshore oil and gas developments. These include the United Nations Convention on the Laws of the Sea (UNCLOS) which covers Ghana rights within its 200 nm Exclusive Economic Zone; and a number of International Maritime Organization (IMO) Conventions including the International Convention for the Prevention of Marine Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78).

3.4 The Bank has reviewed the EIA for the project and has determined that it generally meets AfDB's Environmental and Social Assessment Procedures (ESAP 2001) and standards. It is important to note that the Bank will provide funding to a consortium led by MODEC, who are a sub-contractor to the Jubilee Joint Venture, for the provision of the FPSO under a lease-operate arrangement. The Jubilee Joint Venture International partners are also stakeholders in the ownership of the FPSO. In addition to the EIA, the Bank has reviewed the EHS Management System (EHSMS) of MODEC and finds it sufficiently robust to meet the Bank's standards. MODEC has reviewed and is committed to comply with ESAP during FPSO conversion and operation phases within MODEC scope. Tullow have committed to assist MODEC via provision of reasonable information to support MODEC in this process. MODEC is also contractually compelled to assist Tullow in complying with all legislation and conditions of the EIA .

3.5 The project will be governed overall by the expectations and operating philosophy of the Project's EHS Management System (EHSMS), inclusive of the FPSO. Appropriate procedures, plans and programs will be implemented during the course of the project to ensure that these management expectations are met. These will be based on industry best practice and the Jubilee Joint Venture partners' own internal company EHS policies and standards. Applicable elements expected of subcontractors will be communicated and explicitly included in all contracts, and subcontractor systems, plans and procedures will also adhere to these key elements. Moreover, The Jubilee Joint Venture has developed a Corporate Social Responsibility (CSR) policy and strategy that requires all project activities to be undertaken to best industry standards and in a socially responsible manner. As part of the CSR strategy, the Jubilee Joint Venture will implement a plan to support community and social responsibility projects and initiatives.

3.6 Finally, the EIA Study has been prepared in line with the Ghanaian Environmental Protection Act (1994) and its Environmental Assessment Regulations (1999, LI652). Oil and gas field development is an undertaking for which an Environmental Impact Assessment (EIA) is mandatory as per the Regulations. The undertaking also requires registration and environmental authorization by the Ghana Environmental Protection Authority (EPA).

4. DESCRIPTION OF THE PROJECT ENVIRONMENT

4.1 *Climate and Hydrography:* The project area forms part of the Gulf of Guinea which is characterized by tropical climate. The main currents affecting the area are the Guinea Current, the North Equatorial Counter-current and the South Equatorial Current. Tidal regime is diurnal and relatively small and ranges average 1.2 m to 0.6 m at Takoradi and decreases offshore. The marine environment offshore Ghana is located within the Central West African Upwelling (*rising of deeper colder water to shallower depths*) 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.

4.2 **Topography:** The continental shelf off Ghana ranges from 13 to 80 km wide. The bathymetry (*study of underwater depth*) of the shelf is generally regular and then drops sharply at about the 75 m isobath, where there is a band of hard substrate formed by remnants of dead ancient coral reef. Beyond the belt, soft sediments (*mud and sandy mud*) predominate. According to survey data, the substrate in the project area comprises soft to firm clays and silts that forms a generally smooth and sloping seabed to the south-west. The most significant features of the bathymetry are two, 2-km wide seabed canyons occurring in the western portion of the West Cape Three Points block.

4.3 **Water and Sediment Quality:** No existing site specific water and sediment quality data was identified. An EBS has been commissioned to characterize relevant parameters of the offshore environment within the defined Jubilee Field development area, including sediment and water quality. In Ghana's near-coastal waters, pollution from human activities is a significant problem. Previous research detected a wide range of metallic elements that are discharged into the ocean from industrial and mining activities, along with urban and agricultural runoff. Trace metal and hydrocarbon concentrations have been detected in Fosu lagoon near Cape Coast, Ghana. These were attributed to industrial sources including a mechanical shop and burning of wood and coal in nearby residential areas. Nutrient enrichment (eutrophication) due to sewage discharges is another important problem along the coast.

4.4 **Benthic Communities:** Some of the most detailed accounts of the West African fauna associated with soft bottoms have been provided in studies of the sandy beaches and seabed off the Ghanaian coast. These studies only cover from the coastline to a water depth of approximately 100 m. The EBS will further characterize the benthic communities within the defined Jubilee field Development area

4.5 **Fish and fisheries:** During upwelling seasons, cool, nutrient rich water results in enhanced primary productivity. High nutrient concentrations during these seasons lead to high concentrations of phyto- and zooplankton. These conditions are characteristic of productive ecosystem and conducive to fish production. Egg and larval stages of important fish species such as sardines, sardinellas and tuna are also represented in zooplankton. Marine fisheries in Ghana are affected by these seasonal upwelling that result in increased production of fish food and abundance of most marine fish species. Over 300 different species of commercially important fish are caught from marine sources in Ghana. Activities in the marine fisheries sector range from artisanal canoe operations through inshore to industrial operations. Both pelagic and demersal fishery resources are exploited. Canoe fishers use a wide variety of fishing gears to exploit both pelagic and demersal fish species. The inshore fleet is made up of vessels ranging in size between 8 and 37m long that operate. They operate from seven centers along the Ghanaian coastline where there are facilities for landing. The fleet exploits both the small pelagic and demersal fish species. The industrial fleet is currently made up of trawlers, pair trawlers, shrimpers; tuna bait boats and purse seiners. The vessels operate from Tema and Takoradi where there are deepwater ports. The trawlers and shrimpers exploit demersal and semi-pelagic species. The tuna fishing vessels catch mainly yellow fin, skipjack and big eye tunas. Large steel-hulled industrial vessels from foreign nations also buy licenses to fish in the Economic Exclusion Zone. These vessels include trawlers, shrimpers, tuna pole and line vessels and purse seiners.

4.6 **Marine mammals:** The West African region supports a diverse marine mammal fauna. Six baleen whale species and 22 toothed whale and dolphin species most likely occur in the region. Three of these whale species are endangered (blue and fin whales), two are vulnerable (i.e. humpback and sperm whales) and several others are in lower-risk categories. Coastal areas offshore West Africa are possible breeding and nursery areas for the humpback whale, which migrates along the coast of

southern Africa to mate, calve, and nurse its young during the austral winter. The project will not impact on these mammals.

Socioeconomic Baseline

Economic Activity

4.7 The Jubilee Field is located approximately 60 km from the closest coastal village of Effasu in the Western Region. The Jomoro District is located closest to the Phase 1 development and the support base will be located at Takoradi port in the Sekondi-Takoradi Metropolitan Area. These coastal villages have limited service provision in terms of water, sanitation, and electricity. Economic activities in the districts are similar to the national trend. The major economic activities in the Western Region are related to the Takoradi port. The area is the third largest industrialized centre in the country and there are other significant industrial and commercial activities in the manufacturing and resources sector. The area has a large food and goods market which is a centre for small and medium size trading. Takoradi port, one of Ghana's main ports, serves as gateway for transit cargo. Annually, the Port handles over 600 vessels, 37% of total national seaborne traffic, 62% of national exports, and 20% of total national imports. The poverty incidence (18.4%) in the Western Region of Ghana ranked third highest and contributed about 6.5 percent to the national poverty level. The levels of unemployment in the Western Region are also considered to be high.

4.8 *Agriculture and Mining:* In the Western Region both commercial and subsistence farming is practiced. The region is the largest commercial producer of cocoa and timber and has the largest rubber plantation in the country and its only rubber-processing factory which processes the rubber into a semi-finished product for export. Coconut and oil palm are cultivated on a large scale for commercial production of vegetable oil. Mineral mining is extensively practiced in the Western Region. Minerals mined, include gold, diamonds, manganese and bauxite. The Region is the second highest producer of gold in the country. There are five major gold mines in the Region. Mining is undertaken by multinational companies. There are also some artisanal miners operating in the Region. There are other potential deposits in the Region however these have not as yet been fully explored for exploitation.

4.9 *Education, health & Services:* In the Western Region, nearly two-thirds of those currently in school are at the primary level, while 21 percent are in junior secondary school. Literacy in English and a Ghanaian language is highest in Sekondi Takoradi (42 percent) about 62 km from the project site. The Western Region has seen improvements in educational attainment and enrolment rates at the basic level over the last two decades, however, basic education levels are still relatively low at 34% of the population having completed schooling to primary level. The Jomoro District has only three health centers. These facilities are remote from the project site, making accessibility to healthcare for villages difficult. Malaria ranks first of the top ten diseases in the district.

5. PROJECT ALTERNATIVES

5.1 During the conceptual design phase of the project, the Jubilee Joint Venture evaluated a number of alternatives before defining the approach for final project design. The five main options were: (i) extended well test and later major field development using an FPSO or Tension Leg Platform (TLP); (ii) continued field appraisal with phases of development commenced by utilizing and FPSO; (iii) continued field appraisal with phases of development by TLP with Floating Storage Unit (FSU) or export line to shore with terminal; (iv) full field appraisal, then followed by full field development with FPSO's; and (v) full field appraisal, then followed by full field development with TLPs/FSUs. An alternative to the FSPO or FSU oil storage-export approach would be to consider an oil pipeline to

shore along with an oil terminal including subsequent buoy or jetty tanker export facilities. This approach requires a long lead time and was not justifiable for the first phase of the Jubilee development given the schedule for first oil. All alternatives considered safety, engineering, technical, financial and environmental considerations with the final choice based on the option that provides the best overall performance against these criteria. Underlying the option selection was a formal Safety Case which includes a number of Formal Safety Assessments (FSAs) and the studies of risks such as explosion, fire, ship collision, and gas release. Option (ii) was selected as this approach would allow first production to be achieved in 24 to 30 months from development permit approval and offers significant cost savings over the other development options.

5.2 Project Location Alternatives: The Jubilee Field Phase 1 development location was defined based on the geophysical seismic survey data and subsequent exploration and appraisal well drilling results to date. Results of the two discovery wells, Mahogany 1 and Hyedua 1, confirmed an accumulation of hydrocarbons that extends across the boundary between the West Cape Three Points and the Deepwater Tano blocks (s. fig.1). The proposed production drilling plan is based on the results of the exploratory drilling and is designed to optimize the extraction of hydrocarbons in the most efficient and cost effective manner.

5.3 Development Approach Alternatives: As part of the Development Plan for the Phase 1 development, the sponsors evaluated the technical, operational, and economic factors associated with various development approaches. Oil industry experience elsewhere in similar fields was used to define the approach and selected the preferred option (i.e. *continued field appraisal with phased development by FPSO¹*). The phased approach chosen provides for early oil production and significantly reduces development risk as an improved understanding of reservoir behavior during the early production phase and lessons learned will optimize subsequent phases of development. It is proposed to *use field proven subsea production and control systems that will be tied back to the FPSO*. Several factors were considered to determine the best subsea approach for the Phase 1 development including the remote location, water depth, depth of the reservoir and aerial extent of the Jubilee Field. As the Jubilee Field is located far from major oil refining centers, oil storage is required in the field area. The most cost and effective storage is via a turret-moored FPSO with oil being offloaded by shuttle tankers for onward transport to markets. To provide sufficient storage capacity for likely field production rates, it was decided that the permanently moored tanker should be a Very Large Crude Carrier (VLCC) with storage capacity of 1.5 to 2.2 million barrels of oil (MMbo). Conversion of an existing tanker into a turret-moored FPSO was selected as the most technically and economically attractive option. This approach has been used successfully elsewhere in West Africa and other deep water locations around the world. An advantage of using an FPSO conversion rather than a newly built FPSO or floating structures is that the work can be undertaken in a significantly shorter time period, reducing the time to first oil. The FPSO will be fully classified under the American Bureau of Shipping (ABS) and under that process it will be verified to ensure meeting required MARPOL standards for fatigue and impact.

5.4 Shore Base Location Alternatives: A shore support base will be needed for the offshore service vessels. The port of Takoradi was selected as the location for the support base as it is the nearest Ghanaian port that can meet the capacity requirements required and is currently being used by the offshore oil industry and has recently been expanded. It has the following key facilities: (a) dock space to serve as a loading/offloading point for equipment and machinery supporting offshore

¹ The primary factors influencing the FPSO choice were: Water depth, which precluded shallow water options; remote location of the field (remote also to any other infrastructure) leading to the need for a relatively high storage capacity that would in turn limit the number of export tanker visits required; large area of the field that precluded the use of a centralized drilling platform; Safety and environmental performance; and proven methods in similar fields worldwide.

operations; (b) facilities for dispatching personnel and equipment; (c) temporary storage for materials and equipment; and (d) availability of a 24-hour dispatcher. Helicopter support will be provided from the Ghanaian Air Force Base also at Takoradi. The other main port in Ghana is Tema. It was not considered for a support base because it is much farther from the development area (about 350 km compared with 132 km for Takoradi).

6. POTENTIAL IMPACTS AND MITIGATION/ENHANCEMENT MEASURES

6.1 The project activities with the potential to cause environmental and socioeconomic impacts were identified from discussion and workshops with the project team, consultations with stakeholders and from the previous major project experience of the EIA team. A methodical impact assessment was then carried out to predict the magnitude (*area impact, duration, and frequency of impacts*) of impacts and quantify these to the extent practicable. The significance of any particular impact was determined by considering the magnitude of impact in relation to the sensitivity of the affected resource or receptor. Moreover, the assessment of impacts took into account the mitigation measures that have been built into the project design. Additional mitigation measures were developed to reduce the severity of identified impacts to as low as reasonably practicable levels. Where impacts could not be fully eliminated by mitigation measures, the *residual impact*² was described. The assessment addresses the impacts associated with the FPSO installation and operations. Many of the impacts from drilling operations using Mobile Offshore Drilling Unit (MODU) and FPSO are similar, as both of them will have similar support vessel and supply requirements. Impacts associated with the project are Project Footprint; Operational Discharges; Air Emissions; Waste Management; Oil Spill Risk; Socioeconomic and Human Impacts; and Cumulative and Transboundary Impacts.

Project Footprint

6.2 **Subsea Infrastructure:** The Jubilee Phase 1 Development will have a physical footprint on the seabed through placement of infrastructure during the construction and commissioning of subsea infrastructure and from the long-term presence of this infrastructure. This will result in habitat loss or disruption to an area of the seabed of approximately 2 hectares with direct impacts to benthos (*all the plants and animals living on or closely associated with the bottom of a body of water, esp. the ocean*). The introduction of seabed infrastructure will also provide new substrates for colonization by benthic organisms and provide areas of shelter for demersal (*bottom-dwelling*) fish. To mitigate potential negative impacts the layout of the subsea infrastructure will be designed to avoid seabed features considered geo-hazards. This will also protect areas with potentially more diverse habitats and species. Most subsea flowlines will be laid directly on the seabed and flowlines burial using methods such as dredging and jetting will be avoided to reduce suspended sediments. The area of seabed habitat and associated species is *relatively small and not considered to be of high sensitivity* from the result of the baseline survey. The impacts would be long term but *small scale* and the overall significance of direct and indirect impacts is assessed as being of *minor significance*.

6.3 **Project Vessels (FPSO&MODU) and Underwater Noise:** Project generated noise includes noise from vessel propellers, FPSO power generation units, and subsea valves. Localized noise sources, if sufficiently loud, may be detrimental to certain marine species under some circumstances, and may result in behavioral changes. Of particular concern are the impacts of underwater sound on marine mammals due to the known reliance on sound for activities such as communication and navigation for some species. The impact assessment determined that the likelihood of impact on such animals is *small*. Turtles are less reliant on sound and are considered less sensitive to noise. West

² A residual impact is the impact that is predicted to remain once mitigation measures have been designed into the intended activity.

African manatees are also present in Ghana almost exclusively in continental waters and do not occur in deep offshore waters. Available information on marine fish, shellfish, and birds indicates that they are not particularly sensitive to underwater sound.

6.4 **Collisions** with marine mammals and turtles from vessel movements are also a source of potential impact, especially near large ports. To reduce the potential for impact the project will develop and enforce a specific policy and procedures to ensure that traffic and operations of drilling vessels, support vessels, and helicopters will minimize disturbance to marine mammals and turtles. Vessels will not be allowed to intentionally approach marine mammals and turtles and, where practicable, will alter course or reduce speed to further limit the potential for disturbance or collision. Vessel and helicopter operators will be trained in marine mammal and turtle observation and monitoring. *Noise* from project activities are generally continuous or near continuous and of lower energy than from other noisy marine activities such as seismic surveys. It is considered that marine mammals that frequent the area will become accustomed to these noise sources and will avoid any areas that are detrimental to them. Overall the residual impact on marine mammals is assessed as being of minor significance. It is recognized that there is a lack of information on marine mammal distribution in Ghanaian waters and a program of marine mammal observations will be undertaken as part of the project.

6.5 **Fish Populations**: Deep water fish species and large pelagic fish species (e.g. tuna and billfish) will be present in deep water in the Jubilee Unit Area and could be affected by the presence of subsea infrastructure on the seabed. Pelagic species which inhabit the surface layers of the water column are likely to be attracted to the FPSO. During the night fish species may also be attracted by light emissions from the FPSO. The exclusion zone placed around the FPSO will afford some protection from fishing activity. No mitigation measures are proposed and the residual impact of the physical presence of the FPSO and subsea infrastructure was assessed as being a positive impact of minor significance.

Operational Discharges

6.6 ***Routine Operational Discharges (FPSO& MODU)*** - Operational discharges will occur throughout the project lifespan from routine activities and non-routine or one-off discharges associated with commissioning and maintenance activities. Routine discharges will include: black water (sewage), grey water (washing) and macerated food waste (from FPSO, MODUs, construction and support vessels); Deck drainage and bilge water possibly contaminated with traces of hydrocarbons (from FPSO, MODUs, supply and support vessels); Occasional discharge of ballast waters (from export tankers and other vessels); Hydraulic fluid from daily subsea valve activation; and produced water from FPSO. In deep water offshore areas such as the Jubilee field the main environmental receptors are the waters in the vicinity of the discharges and the marine organisms that occupy these waters. The waters in the Jubilee field are of good quality, as would be expected in an offshore, deep water area. The water depth, distance offshore and hydrography provides a high level of dilution and dispersion for any discharges.

6.7 ***Mitigation measures***: (a) Discharge of black water, grey water, and food waste will be carried out in accordance with MARPOL requirements and good industry practice; (b) Black water will be treated prior to discharge to sea. Approved sanitation units onboard will achieve no floating solids, no discoloration of surrounding water and a residual chlorine content of less than 1 mg/l; (c) *Organic food wastes* generated will be macerated to pass through a 25 mm mesh and discharge more than 12 nautical miles (nm) from land including no floating solids or foam; (d) The FPSO will be equipped with segregated ballast tanks and all marine vessels will be operated in accordance with the applicable MARPOL requirements (no discharges with more than 15 ppm oil or grease); (e) *Visiting export*

tankers and other vessels discharging ballast water will be required to undertake ballast water management measures in accordance with the requirements of the International Convention for the Control and Management of Ships Ballast Water and Sediments; (f) *Water based, low toxicity and biodegradable hydraulic fluid* will be used for subsea valve activation; and (g) *Produced water* will be treated through a three stage treatment process to maintain a monthly average oil concentration of less than 29 mg/l and not to exceed an instantaneous maximum of 42 mg/l. The dispersion of produced water at a concentration of 42 mg/l of oil was modeled from a surface discharge at the FPSO using hydrographic data from the Jubilee field showed that the discharge would rapidly disperse, and get diluted. The concentration modeled was a worst case based on the maximum instantaneous discharge concentration and the impacts of a 29 mg/l monthly average concentration will be correspondingly lower. The residual impacts for routine discharges were assessed as being of low magnitude, short term and localized and therefore of minor significance.

6.8 ***Drilling Wastes:*** The MODUs will treat drill cuttings prior to disposal. For overboard discharge of cuttings the permit target for oil on cuttings for the exploration wells drilled to date was 6% to 8%, however with improved cleaning using modern solids control equipment a target for the remaining development wells is set at less than 5% oil on cuttings. Total volume of fluid and cuttings to be discharged from each well is expected to amount to approximately 383 m³ of water based drilling fluids, 283 m³ of cuttings drilled with water based drilling fluids, and 285 m³ of cuttings and residual enhanced mineral oil based drilling fluids. The following *mitigation measures* to minimize the impact of drill cuttings and fluid discharge are: (i) use of low toxicity and biodegradable drilling fluids; and (ii) *use of solids control systems including dryers and centrifuges to minimize oil on cuttings as far as is achievable with current technology. Program of continuous improvement by enhanced cuttings treatment to reduce oil on cuttings to less than 5% as a weighted average will be adopted.* Given the type of drilling fluid being used, the use of *improved drilling fluids and cleaning technology and the localized and temporary nature of impacts it is considered that the proposed discharges will have impacts of minor significance on seabed habitats and species.*

6.9 ***Non-routine Discharges:*** Non-routine discharges will include: *completion fluids and occasional discharge of workover* (1) fluids from MODUs such as drill flux; chemically treated hydrotest waters from the subsea infrastructure during installation and commissioning; and potential leaks or accidental releases from tanks, pipes, hoses and pumps, including during loading and unloading from the shore base to the supply vessels. *Mitigation measures* to reduce the potential impacts associated with the disposal of non-routine discharges will include (i) selection and use of completion, hydrotest and workover fluids will be managed taking into account its concentration, toxicity, bioavailability and bioaccumulation potential with selection based on the least environmental potential hazard. (ii) where possible, used completion and workover fluids will be collected in a closed system and injected into the formation, routed to the flare for combustion, or shipped to shore for recycling or treatment and disposal; and (iii) those completion and workover fluids that are discharged to sea will be treated to not more than a maximum oil and grease content of 42 mg/l (29 mg/l monthly average) and pH of 5 prior to disposal. *In the open ocean, discharges will be diluted rapidly and residual impacts are predicted to be of minor significance.*

Air Emissions

6.10 **Atmospheric Pollutant:** Project activities will emit varying amounts of primary atmospheric pollutants with the potential to impact air quality. These pollutants include carbon monoxide (CO), oxides of nitrogen (NO_x), oxides of sulphur (SO_x), volatile organic compounds (VOCs) and particulate matter (PM). Emissions from the offshore activities are unlikely to have significant direct impacts given the absence of sensitive receptors and the highly dispersive nature of the environment of the offshore location. Offshore receptors such as fishing vessels and commercial shipping are unlikely to be exposed to poor quality air other than for very short durations, for example if sailing close and downwind of the FPSO during flaring. *Mitigation measures* will include the following: the MODU, FPSO, construction/installation and support/supply vessels will comply with MARPOL³ standards; vessels visiting the port will egress at partial power; emission guidelines for small combustion sources, including exhaust emissions using liquid fuels, will be implemented; methods for controlling and reducing leaks and fugitive emissions will be implemented in the design, operation and maintenance of the offshore facilities; and routine inspection and maintenance of engines, generators, and other equipment will be carried out to maximize equipment fuel efficiency and minimize excess air emissions

6.11 **Greenhouse Gases:** Project activities (*MODU & FPSO*) will emit varying amounts of Greenhouse Gases (GHGs) (e.g. *carbon dioxide and methane, believed to contribute to global climate change*). Based on an estimated current total national GHG emission rate of 5.4 million tonnes per annum, the contribution from the Phase 1 Jubilee project would be about 5% of this value or 0.29 million tonnes per annum during operations. The principal sources of GHGs from the project will include the main power generation systems on the FPSO; combustion sources such as back up generators and support vessel engines; non-routine flaring of gas on the FPSO; and purging of oxygen for safety purposes. The mitigation measures aimed at reducing GHG emissions are built into the design of the FPSO through focus on: efficiency of power generation; optimization of overall energy efficiency; and reduction in venting. To monitor the effectiveness of measures to reduce the levels of emissions, the project will quantify annual GHG emissions from production in accordance with internationally recognized methodologies and reporting procedures. Residual impacts from emissions of GHGs are assessed as being of *minor significance* given the scale of emissions and in the context of relatively low national emissions in Ghana.

Waste management

6.12 **Storage and Segregation of Waste:** The main sources of potential environmental impact resulting from storage, segregation and containment of wastes include: i) accidental discharge or spillage of wastes to the marine environment due to inappropriate storage and containment of wastes on offshore facilities or vessels;(ii) accidental discharge or spillage of liquid wastes to soil and water resources due to inappropriate storage and containment of wastes at the onshore supply base; and (iii) degradation to visual appearance, release of odors, and exposure of local communities to health and safety risks due to inappropriate and insecure storage of wastes. Positive impacts could result from proper segregation of waste streams leading to recycling and reuse (which may allow for value recovery from the waste stream). Mitigation of potential impacts will be by operational controls. Procedures for controlling wastes will be contained in the project Waste Management Plan (WMP). The WMP will require that all facilities operated or controlled by the project will adopt specific procedures for the management of wastes in accordance with legal requirements and in a manner that minimizes the potential for environmental damage as far as reasonably practicable. To mitigate the

³ International Convention for the Prevention of Pollution from Ships

potential impacts on the environment and human health, the project will also construct a *secure waste reception, segregation, and storage facility at the Takoradi shore base*. Through the implementation of these operational controls the residual impacts from project-generated wastes would be of *minor significance*.

6.13 **Transport of Wastes:** Wastes from project facilities will need to be transported to waste disposal areas. This could result in accidental discharge or spillage of wastes to the marine environment due to inappropriate handling and containment of wastes during transport on supply vessels. Impacts on the onshore environment (soils *and groundwater*) and communities could result from spillage of potentially hazardous wastes during transport, poor security of waste due to inappropriate management and control of vehicles transporting wastes to storage and disposal sites. *Mitigation of potential impacts* of waste transport will be by the following operational controls: all wastes will be transported in a safe manner, in accordance with the associated Material Safety Data Sheet information for spent chemicals and other industry packaging and transport advice; transportation of wastes will be via well maintained, legally compliant and suitable vehicles or vessels, with appropriate documentation (including Waste Transfer Notes) and operated by fully trained operators; and only project and Ghana EPA approved waste contractors, which meet the appropriate standards, will be allowed to transport wastes. With these good practice controls in place the residual impacts are assessed as being of *minor significance*.

6.14 **Onshore Waste Disposal:** Project generated waste will need to be disposed of in a manner that avoids significant environmental impacts. Most project wastes will be disposed of at landfill sites in Ghana. Potential impacts could result from: (i) contamination of soils, groundwater and surface waters, and/or release of vapor emissions with the potential to adversely affect air quality or cause a health risk to local communities due to disposal of wastes at dump sites (non-engineered landfills) not designed or operated to the appropriate standards; (ii) littering and health and safety risks associated with uncontrolled public access to wastes at landfill sites with inadequate security; (iii) impairment of local air quality and increased health risks due to open burning of wastes; (iv) contamination of soils, and surface or groundwater, potentially impacting on human health or ecosystems due to illegal dumping (fly-tipping- *illegal deposit of any waste onto land*) of hazardous wastes (solid or liquid); and (v) adverse effects on air quality and secondary impacts on the local community health due to improperly treated combustion emissions from incineration. Potential impacts associated with waste disposal will be mitigated by selecting of a *suitable disposal facility* (s), likely to require investment by the project to upgrade standards in areas such as landfill, incineration, and liquid waste treatment; and by ensuring proper continuous operation and monitoring of the disposal facility.

Impacts from Oil Spills

6.15 **Oil Spill Risk (FPSO):** The risk of an oil spill (including crude oil and fuel oil) into the marine environment is inherent in all offshore oil developments. The likelihood of significant oil spills (*i.e. those that can reach the coastline or other sensitive areas*) from FPSO operations is very low with oil spills that do occur being very small and having only limited environmental effects. The assessment of risk therefore requires consideration of the likelihood of a particular type and size of spill event occurring and the environmental consequences in the event of a particular spill. The industry approach to dealing with potential oil spills is to develop technology and operational procedures to reduce the likelihood of oil spills whilst planning appropriate responses (s.7.1) to reduce the severity of impacts in the event of a spill. The response procedures form part of the Oil Spill Contingency Plan (OSCP) which is one part of Tullow's overall Emergency Response Plan for the project. The assessment of the potential impacts of an oil spill to the marine and coastal environment requires consideration of the likelihood of various types of spill occurring and the consequences of these spills.

6.16 A Quantified Risk Assessment (QRA) was undertaken that examined the frequency of accident events that could result in oil spills of various types and sizes from the project activities. A series of oil spill scenarios were then defined for subsequent quantitative modeling to predict the likely trajectory and fate of an oil spill if it occurred and to give an indication of the likelihood of a particular location area of sea or coast being affected. Evaluation of frequency, size, and nature of historic spills indicated that 99% of spills result from small leaks and spills with the most likely source of a spill being from the transfer hose during oil unloading from the FPSO. Based on historical data a spill of this kind is predicted to occur approximately *twice every 10 years*. It would be a relatively small spill of less than 1 tonne. Large spill events, such as ship collision, FPSO hull damage, blowouts and cargo tank explosions are highly unlikely to occur. For example an oil spill from a ship collision is predicted to happen only once every *10,000 years*.

6.17 **Mitigation Measures:** Mitigation of oil spills will take two forms: spill prevention and spill response. The primary mitigation measure for avoiding the impacts of an oil spill is to prevent any such spill taking place in the first place. This will be done through technology applications as well as operational controls. Oil spill prevention measures that will be implemented as part of the design of the project will include the following (i) Blow-out Preventers and subsea valves will be permanently installed on the wells during well completions, and the double mechanical barrier system will be used during production and injection operations; (ii) Wells, subsea flowlines, risers and FPSO topsides will be designed to international process codes and with alarm and shutdown systems to maintain the system within its design criteria at all times. The system will be tested, inspected and maintained to ensure that performance standards are met; (iii) The FPSO deck and drainage system will be designed to *contain spills* on the FPSO (*as well as leaks and contaminated wash-down water*) to minimize the potential for overboard release; and (iv) Notification to other marine users, safety navigation systems (e.g. *radar*) and a safety exclusion zone, maintained by the support vessels, will reduce risks of collision incidents that could lead to an oil spill.

6.18 **Fishing Activities (FPSO):** Potential impacts on fisheries can arise from loss of access to the area of the FPSO during completions, installation and operations due to presence of vessel, FPSO and the safety exclusion zones; attraction of fish to the FPSO, due to the FPSO acting as a fish aggregating device (FAD); and disturbance of fishing activities and damage to fishing gear from project support vessels and supply vessels transiting to and from Takoradi. A legally enforceable safety exclusion zones (*1,000 m and 500 m around FPSO and MODU, respectively*) will be maintained around the project facilities to reduce the risk of collisions at sea and to ensure personnel safety. Fishing vessels *will not be able to fish within the safety exclusion zone*. Given the area available to fish for the target species in this location, exclusion from a relatively small area around the project site is not likely to significantly affect catches. The FPSO is likely to attract fish through its presence on the waters surface acting as a FAD. Some pelagic fish species would be attracted to the FPSO and would not be available to the fishery while beneath the FPSO and within the exclusion zone. Generally, FADs work for only a relatively short period of time as fish shoals and fish will only be present for a number of days or weeks. Given the large areas that pelagic species in this area occupy, impacts on the fishery are *considered to be of minor significance*.

6.19 The infrequent nature of vessel movements during construction and the low frequency of vessel movements during operations mean that the probability of an interaction between supply vessels and *fishing activity is low and the impact is expected to be of minor significance*. The following mitigation measures will be implemented to minimize any potential impact on the fishing industry: (i) the project will employ a Fisheries Liaison Officer (FLO) to liaise between fishermen and the project and to provide information to fishing communities, companies regarding Tullow's activities; (ii) a vessel

transit route will be agreed with the Ghana Maritime Authority and communicated to fishermen and other marine users through the Fisheries Liaison Officer; (iii) the project and contractors will notify mariners of the presence of the FPSO and other marine operations within the Jubilee field; and (iv) interaction with fishermen and other users will be monitored through the FLO and the project's grievance procedure. The project will work with the Directorate of Fisheries to identify opportunities to improve understanding of current fishing activity within the Ghanaian Economic Exclusion Zone (EEZ). This information will provide a better indication of fishing activity that occurs in the project area and will serve to ensure that the project is better informed as to the potential interaction between future projects and the Ghanaian fishing industry. The residual impact on fishing activities was assessed as being of *minor significance*.

6.20 **Onshore Operations:** While increased or sustained economic activity and employment at the onshore base will generally be a positive socioeconomic impact there is also the potential for negative impacts associated with the proposed onshore activities such as: the project could strain the capacity of the public utilities and impact use of shared services by local communities; expansion of the workforce in a local community could lead to increased risk of negative social impacts, including traffic accidents, security incidents, alcohol and drug misuse, and prostitution; and industrial activities at the base could result in disturbance or damage to the public health of local communities by elevated noise levels, increased traffic on local roads, and activities associated with increased 24 hour port operations. The environmental and social performance at the project's shore based locations will be covered by the project EHS-MS. This will ensure EHS policies and procedures are in line with project expectations, particularly regarding community impacts such as interactions with neighbors, noise abatement, traffic management and storage of wastes. A grievance procedure will be implemented and made known to the surrounding communities and the general public. Given the location of the shore base at an existing port and the scale of employment and service industry requirements the residual impacts of the project activities at the shore base and surrounding areas are assessed as being *not significant*.

6.21 **Ballast Water:** Ballast water that is discharged will be subject to MARPOL 73/78 requirements. MARPOL 73/78 requires that discharges into seawater outside of special areas contain no more than 15 mg/l oil and grease. In addition, requirements of the *International Convention for the Control and Management of Ships Ballast Water and Sediments* will be adhered to. Ships are required to have onboard and implement a Ballast Water Management Plan. All ships (*shuttle tankers*) using ballast water exchange will do so at least 200 nautical miles from nearest land in water at least 200 m deep. All vessels that operate in the field will comply with MARPOL 73/78 with respect to any ballast water discharge impacts and their potential oil-in-water levels.

6.22 **Decommissioning and Abandonment:** At the completion of oil production, the project will seek approval from GNPC to decommission the facilities and abandon the field. Under the Jubilee Unit Agreement, Tullow, on behalf of the Joint Venture Partners, is required to develop detailed and costed decommissioning plans from the early stages in the project life and provide an update to this at least every few years. The decommissioning plan will also be used as part of the assessment required for decommissioning funding as required by the Unit Agreement. Once approval for decommissioning is granted, the project will finalize and implement the detailed plan for facility decommissioning and abandonment. The plan will include details on all aspects of facility and well decommissioning and abandonment.

Socioeconomic and Human Impacts

6.23 Socioeconomic and human impacts include those impacts that may be reasonably expected to affect Ghana at a national level and those that are likely to be experienced at a more regional and local scale (*e.g. in the offshore environment and in the vicinity of the shore base and port*). The project operations are primarily located offshore and there will be few direct interactions with other human activities other than limited numbers of marine users who operate in the area (*i.e. commercial vessels and fishermen*). The majority of the deepwater offshore infrastructure will be transported to the field by sea from international locations, and the shore base operations in Ghana will be limited to routine project support, supply runs, equipment and materials storage and waste handling. This project is the first significant oil development in Ghana and although other discoveries may be made in the near future an assessment of potential socioeconomic and human impacts from the potential future development of undiscovered hydrocarbons is not possible.

6.25 **Macroeconomic Impacts:** The revenues generated by the project through oil sales, taxes, royalties and dividends (*according to Production Sharing Agreement*) will be a valuable source of revenue for the government with the potential to facilitate investment in the country's socioeconomic development (*e.g. development of infrastructure such as road networks, power grids, water supply, solid and liquid waste treatment and disposal systems, telecommunication networks, agricultural development, investments in health and education, etc.*) through central government funding. In addition, the revenue could stimulate investment loans providing further sources of revenue. With the development of the Jubilee field there is also the potential for larger scale development of the oil and gas industry in Ghana. Overall these revenues have the potential for significant positive benefits at a national level over at least the medium term), although revenue would be highest in the first 5 to 10 years of production. Revenue from oil can be unpredictable as it depends on world market prices and the management of these revenues requires good fiscal discipline. Consequently, the benefits of oil revenue will depend on the policies and actions adopted by the Government of Ghana.

6.26 The project will support the *country's Growth and Poverty Reduction Strategy* (GPRS 2006 to 2009) in the priority areas of infrastructure development and private sector development. Income from the project through oil sales, taxes and royalties will contribute to the Ghanaian economy directly, and has the potential to reduce the Ghana balance of payments with respect to energy import costs, and facilitate economic development and growth. There will also be economic benefits through direct employment opportunities and indirectly through training opportunities and the development of oil and gas industry support and related enterprises. Where the project can influence expenditure at the macroeconomic level is through the establishment and financial support for projects through the project's Corporate Social Responsibility (CSR) strategy and in sponsoring training programs and education in oil industry skills. Tullow is developing a CSR framework plan which will provide details of Tullow commitment to enhancing the positive impacts of its activities. Overall the socioeconomic impacts at a macroeconomic level are predicted to be positive at a national level.

6.27 **Employment and Training:** Direct employment by the project and indirect employment through contractors and suppliers will have a positive impact on those people employed, their families and their local communities from wages and other benefits. There will also be minor benefits to the wider economy through spending of earnings and income taxes. In general, the oil industry is not a large employer in relation to the revenues it can generate; therefore, the spread of money through wages into the wider local economy is less than that experienced for similar sized industries such as manufacturing, or service based industries. Expectations of some of the public in terms of direct access to revenues through employment from the project are likely to exceed what is possible. The skills developed through training received and experience gained when employed in the oil and gas sector

will be transferred to other sectors of the economy and will provide positive benefits. It will also make Ghanaians more competitive in the international market place, facilitating increased opportunities and skills transfer. Employment opportunities are shown in **Annex.1**.

6.28 **Procurement of Goods and Services:** Impacts from procurement of goods and services will have positive impact through stimulating small and medium sized (SMEs) business development with investments in people (jobs and training) and generation of profits. Business investment in new and existing enterprises that provide goods and services can provide the basis for their longer term sustainable growth as they diversify to provide goods and services to other industries. Secondary, wealth generation from the development and use of local providers of goods and services can be reasonably expected to have a positive impact through the generation of revenue able to flow into the local economy. To enhance the benefits from procurement of goods and services the project will adopt a procurement strategy with the following elements: (a) a policy of procuring services and equipment locally (within available capacity) and of helping to expand local businesses and strengthen their ability to respond to the needs of the oil and gas industry, thereby providing in the longer term a stronger and more experienced service industry; (b) contracting companies to establish longer term commitments to the businesses which will promote sustainable long term growth and help new businesses become established; (c) conduct contractor screening and develop contract conditions to ensure the requirement for local content (nationalization) is passed to contractors, so goods are purchased locally where possible, and employment rights and conditions are respected; and (d) working with suppliers to help them meet the required standards in areas such as business awareness, employee rights, training, environment and health and safety. Tullow and MODEC will also monitor pressures on local goods and services through community consultations to determine if project related demand is creating a significant effect on the communities. For residual impacts and mitigation measures refer to **Annex.2**.

7. ENVIRONMENTAL HAZARD MANAGEMENT

7.1 **Oil spill (FPSO):** The only potentially significant impact is associated with an unlikely, accidental major oil spill. Based on technological measures in place, it was found that they will minimize the risk of an oil spill. In the unlikely event that an oil spill should occur, it is likely to be small (1,000 barrels or less) and can be addressed almost immediately with equipment and trained personnel based in Ghana. In the remote event of a major spill, an immediate response can be affected utilizing locally staged equipment. An oil spill trajectory model simulation will be available well before first oil and commencement of operations at the FPSO to better inform the oil spill response plan during production (*a drilling phase oil contingency plan is already in place*), when the risk of a spill can be higher. Additional oil spill prevention measures and procedures to minimize the risk of oil spills will include fire and explosion prevention systems; equipment and instrument inspection programs; corrosion control programs; and spill prevention training program provided to its personnel.

7.2 Specific procedures will be developed for offloading crude from the FPSO onto the shuttle tankers. These will include inspection of tankers involved in offloading, management by trained and experienced personnel in all aspects, the use of a quality marine fleet to undertake the operation of hose handling and tanker movements (*including contingencies for any engine failures*), and the continuous monitoring and actions to be taken in the event of any non-routine events or equipment failures. Despite the prevention measures and management procedures built into the design of the FPSO project there is always a risk that an oil spill can occur. The project has established an Oil Spill Contingency Plan (OSCP), which contains detailed procedures that will be taken in the event of small, medium, and large oil spills (known as Tier 1, 2 and 3). For example, OSR, a U.K. based global leader on spill response can mobilize Tier III (*response level for a major spill*) equipment on-site within 16

hours. Given the distance to the shore (63km) and existing water currents, this mobilization time will be sufficient to address such a spill. The project sponsors have mapped the ecologically sensitive areas along the Ghana coast to ensure special protection in the remote chance of a spill reaching shore. The likelihood of a large spill is *very low*.

7.3 Hazardous & non-hazardous waste disposal: The Jubilee Field FPSO is also expected to produce a range of hazardous wastes. The *hazardous waste* that would be expected to be generated from the FPSO includes batteries, filters, old oil rags, sludge (from bottom of oil tank), fluorescent tubes, bulb, paints, while the non-hazardous solid waste to be generated from the FPSO consists of (bottles), grease (from oil separates), metals (drinking cans-Al), paper and card, plastic bottles, etc. The waste disposal sites will be used for the project. A study conducted revealed the availability of suitable waste disposal sites in Ghana for suitability and adequacy of the facilities. The results of this study will be used to determine options for medium and long-term treatment of hazardous wastes. The project will likely invest, or partner, with national and international companies to upgrade existing facilities or even install suitable facilities for the first time. The residual impacts associated with the onshore disposal of wastes from the project activities are assessed as of moderate significance. This rating is given in the context of the limited availability of waste treatment and disposal options and since the project will not have direct control over waste facility operations other than through contractual terms and conditions and by periodic audits. Once suitable facilities have been developed the impacts are likely to be of minor significance or not significant. **Annex.3** presents the EMP Hierarchy of key Plans.

8. ENVIRONMENTAL MONITORING PROGRAM

8.1 Requirements for an EMP and guidance on scope and application are given in Ghana environmental regulations and in lender performance standards. The elements of the provisional plan will be taken forward and incorporated into a comprehensive Jubilee Field EMP that will be used to deliver the project's health, safety and environmental (EHS) regulatory compliance objectives, lenders requirements and other related commitments. The Jubilee Field EMP is a component of sponsor's (Jubilee JV) overall Environment Health and Safety Management System (EHSMS), which is the system the project will use to ensure environmental and social performance. This EMP provides the procedures and processes that will be applied to activities to check and monitor compliance and effectiveness of the mitigation measures to which the Jubilee JV has committed. In addition, this EMP is used to ensure compliance with statutory requirements and corporate safety and environmental policies. Tullow will manage its key contractor parties to ensure that the EMP is implemented and monitored. Tullow will conduct this process through contractual mechanisms and day-to-day management. For example, the subsea installation will be undertaken by Technip and the FPSO will be operated by MODEC but both sub-contractors will report to Tullow.

8.2 Tullow will have its own supervisory personnel on-board and the Ghanaian Government will have an oversight of the project through its various agencies. With respect to the significant impacts identified by the EIA, the EMP provides the linkage between each significant impact, the relevant mitigation measures and the monitoring approach. Further, through this EMP, significant impacts are referenced to (i) applicable regulatory requirements, lenders requirements and other commitments; and (ii) relevant operational controls (e.g. *management best practices, construction and operation specifications, procedures, and work instructions*). The objectives of the EMP are to: (i) develop a commitments register to address legal and other requirements; (i) promote environmental management and communicate the aims and goals of the EMP amongst the Jubilee JV; (iii) ensure that all workers, subcontractors and others involved in the project meet legal and other requirements with regard to environmental management; (iv) incorporate environmental management into project design and operating procedures; (v) address concerns and issues raised in the EIA's stakeholder consultation

process and those that will likely continue to arise during the project's lifetime; (iv) serve as an action plan for environmental management; (vii) provide a framework for implementing project environmental commitments (i.e. *mitigation measures identified in the EIA*); and (viii) Prepare and maintain records of project environmental performance (monitoring, audits and non-compliance tracking).

8.3 **Management Plans:** The key plans include Pollution Prevention Plan, Waste Management Plan; Environmental Monitoring Plan; Emergency Response Plan and Oil Spill Contingency Plan; Transport Management Plan; and Corporate Social Responsibility Management Plan. Other plans include related management plan (EHSMS that comprises a number of related detailed management plans and procedures that lay out the requirements for compliance with specific environmental and social elements) and Subcontractor Environmental Management Plan(s), which will be reviewed and approved by Tullow and incorporated into, and form part of, the project's overall EMP. Adaptive changes may also occur during the course of final design, commissioning or even operations and the project will implement a formal procedure to manage them. A summary of mitigation measures with reference to the project stage, plans, and procedures and is presented in **Annex.4**.

8.4 **Monitoring:** Monitoring will be conducted to ensure compliance with Ghanaian 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 EIA, Tullow has developed a program to monitor the effectiveness of the mitigation measures (i.e. *effects to be measured and the frequency*). Monitoring will also be required to meet the requirements of the various lenders, including AfDB and IFC. In conjunction with monitoring of the effectiveness of specific mitigation measures, Tullow has developed a program to monitor for compliance with relevant regulatory standards. This program also ensures that subcontractors are meeting contractual obligations with respect to work practices and design specifications. Monitoring is carried out by the Tullow's EHS Department and/or by subcontractors under contractual obligations.

8.5 **Auditing and Reporting:** Beyond the routine inspection and monitoring activities conducted, audits will be carried out internally by both Tullow and its partners in the Jubilee JV (including the Government of Ghana) to ensure compliance with regulatory requirements as well as their own EHS standards and policies. Audits to be conducted will also cover the subcontractor self-reported monitoring and inspection activities. The audit will include a review of compliance with the requirements of the EIA and EMP. Furthermore, throughout the project, Tullow, the project operator, 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. Tullow will prepare a monthly report on environmental and social performance and submit it to Ghana EPA. Copies may be made available to other interested authorities upon agreement with Ghana EPA. Tullow shall release corporate annual reports on environmental and social performance which will be available to the public. In addition, there will also be lenders' reporting requirements.

9. PUBLIC CONSULTATION

9.1 **Regulatory Requirements:** As per Ghana environmental regulations and international standards, stakeholder consultations undertaken during the EIA were to address issues relevant to the EIA process with the objective of (i) facilitating an open and inclusive approach to consultation that provided timely and transparent information on the project to stakeholders; (ii) providing an opportunity for stakeholders to provide feedback on the project and to voice their concerns; (iii) gathering baseline environmental, health and social data held by stakeholders; and (iv) assisting project planning and development of mitigation measures and monitoring plans to address issues raised. The

Public Consultation and Disclosure Plan (PCDP) cover consultation up to the determination of the EIA. They were divided into two key stages – Scoping and Undertaking the EIA and Disclosure. The following stakeholders participated in the public consultation: (a) *National government* (EPA, Ministry of Energy, Ministry of Fisheries, Ghana National Petroleum Company and Ghana Navy): these stakeholders are of primary national political importance to the project and the EIA process; (b) *Regional government and District Assemblies*: these stakeholders are of Regional and local importance to the project; (c) *Directly affected communities*: communities at local level that will directly impacted (positive and/or negative) by the project; (d) *National and Local NGOs*: these are local NGOs (based mainly in Accra) and Community Based Organizations (CBOs) with potential interests in the project. NGOs may also have useful data or insights into the local and national issues raised by the project; (e) *International organizations*: these comprise organizations based within and outside Ghana with an interest in the project. These include NGOs, multilateral and bilateral organizations; (f) *Academic institutions*: these are universities, colleges and research organizations which may have an interest in the project and may be able to provide useful baseline information related to the culture, history, or environment of the area; (g) *Other interest groups*: these comprise, for example, media (both national and international), and political parties/groups, religious organizations; and (h) *Economically interested parties*: organizations, businesses and individuals with direct interest in the project e.g. running businesses or providing services and supplies to the project.

9.2 Stakeholder consultation started at the scoping stage of the project and continued throughout the EIA. It will continue throughout the operational phase of the project. The objective of this engagement is to ensure that sources of existing information and expertise are identified, legislative requirements are met and that stakeholder concerns and expectations are addressed. A Public Consultation and Disclosure Plan (PCDP) for the EIA phase of the project was developed at an early stage in the project to ensure that engagement was undertaken in a systematic and inclusive manner and provided important input to the EIA process. A series of consultation meetings (a total of 26) with national and local government stakeholders and other parties such as fishermen’s organizations and NGOs were undertaken during the EIA (between November 2008 and May 2009) to provide project information, collect baseline data and understand key stakeholder concerns. To facilitate effective consultations a Background Information Document (BID) was produced and circulated at stakeholder meetings (Appendix III of the full EIA report). The BID was written in non technical language with photographs and graphics to illustrate the main project components. The use of graphics allowed the BID to be used as an illustrative tool in consultation meetings with non English readers/speakers and those who are illiterate. Translators were also used to communicate in the local languages. In addition six Public Hearings were held in the Western Region during 14-18 September, 2009 and these were all held in local language and in accordance with local custom.

9.3 The PCDP for the EIA, including a list of stakeholders who were consulted and issues raised were registered. A list of issues is presented in Appendix II of the full EIA report and defines the issues, who raised them and where they have been addressed within the EIA report. Ongoing stakeholder engagement activities planned during the FPSO and subsea infrastructure, operational and decommissioning phases of the project will be included in Tullow’s longer term stakeholder engagement strategy for the project. This strategy does not form part of the EIA, however, it will build on the work undertaken during the EIA process and will form part of the Environmental Management Plan (EMP) for the project. Following the EPA’s approval of the Scoping Report, it was advertised to Government Ministries and the general public (*through newspaper advertisements*), and comments were sought on the scope of the planned EIA.

10. CUMULATIVE AND TRANSBOUNDARY IMPACTS

10.1 Cumulative impacts can result from individually slight but collectively significant activities taking place over a period of time. An assessment of these considered other plans or projects that may act in combination with the proposed project to cause environmental and social impacts. The main activity that could result in cumulative impacts with the Jubilee Phase 1 Development is the previously approved drilling program currently underway. The latter stages of the drilling program will occur in parallel with the well completions, facility installation and the early stages of production. The period of physical overlap would be up to 14 months. The types and nature of reasonably foreseeable future development that may result in cumulative impacts with the Jubilee Phase 1 Development include: expansion of the Jubilee development in future phases; new oil and gas exploration and production close to the Jubilee field; onshore oil and gas processing; and other industrial development induced by oil and gas availability (e.g. *power plants*).

10.2 The project has the ability to mitigate potential impacts associated with the Jubilee Phase 1 development activities, its drilling program and any future developments in the Jubilee field. However, it has limited ability to manage or influence activities by others which may result in cumulative impacts. The general approach for mitigating and managing potential cumulative impacts will therefore require coordination of all the relevant industries, enterprises and agencies under the direction of the Government of Ghana. Strategies that could help manage potential future cumulative impacts are: (i) a government-led Strategic Environmental Assessment (SEA) would enable a comprehensive consideration of potential impacts that may result from the development of the oil and gas sector in Ghana; (ii) build capacity of local administration; (iii) oil companies and the Government should agree on common standards and approaches for managing cumulative impacts; (iv) the environmental standards should be collectively applied by the government on all businesses operating in Ghana and especially the Western Region; and (v) collaboration of the oil and gas industry, shipping interests and the Government to develop and support an integrated approach to oil spill response.

10.3 Assessment of potential cumulative impacts indicated that there would be *no significant impacts*. *No significant transboundary impacts* are expected to occur as a result of the project. The project is however located near the border with Cote d'Ivoire and ecological systems (e.g. fisheries, marine waters) are connected so some limited interaction may occur. Therefore, *no significant* cumulative impacts from other planned activities are predicted.

11. COMPLEMENTARY INITIATIVES

11.1 Tullow is developing a Corporate Social Responsibility framework strategy and plan which will provide details of its commitment to creating and enhancing positive impacts of its activities. The Key factors for the strategy are health, *education, enterprise development and community development*.

11.2 ***In-country Skills development:*** Tullow will employ local nationals as many as possible. Tullow is developing a Human Resources Strategy for the recruitment, training and development of national staff in its operation (known as “nationalization”). Tullow is currently training 14 seconded staff from GNPC at various locations, including overseas and has commenced graduate and apprentice recruitment and training across all departments. This strategy is being rolled out to national and international contractors and service providers who are required to provide details of their own national employment and training plans. The project expects to employ up to 760 staff at its peak during installation, reducing to approximately 380 during the operational phase. Through training, mentoring and job shadowing programs for national staff, the number of national personnel is expected to be 80 to 90% within 2 to 5 years (i.e. 2012-2015) all positions across seniority and technical positions. Contractor support services also provide employment opportunities covering the FPSO (120) operations, well engineering activities, maintenance and support across the spectrum of disciplines including offices

and shore bases. Other job opportunities include- (i) 40 further jobs for Ghanaian personnel in the logistics services that will be contracted through aviation and marine supply vessels; (ii) MODU Phase 1 development drilling program or carrying out well maintenance, will have a direct crew of 100-120 persons; and (iii) services and contractor support to the operation provides further opportunity over time.

11.3 **Working with communities:** This program is designed to bring both short-term benefits and long-term sustainable empowerment. The main focus of this initiative includes basic human needs, education, health, local enterprises development. A number of new community development initiatives were undertaken (water supplies from water wells, vaccinations and school refurbishment projects have already been carried out in 2007. These programs are designed to go further than offsetting potential negative impacts and provide benefits to individuals and communities.

11.4 **Health Awareness Building:** This initiative largely focuses on community awareness practices. Tullow will work together with NGOs to treat preventable diseases and spread of viruses. This includes raising awareness of HIV/Aids, tuberculosis, sexually transmittable diseases and malaria.

11.5 **Procurement of Goods and Services & SMEs:** To enhance the benefits from procurement of goods and services Tullow will adopt a procurement strategy covering (i) the policy of procuring Ghanaian goods and services locally and of helping to expand local businesses and strengthen their ability to respond to the needs of the oil and gas industry, thereby providing in the longer term a stronger and more experienced service industry; (ii) adopting contracts with companies to establish longer term commitments to the businesses which will promote sustainable long term growth and help new businesses become established; (iii) conduct contractor vetting and develop contract conditions to ensure the requirement for local content is passed to contractors, so goods and services are purchased locally where possible, and employment rights and conditions are respected; (iv) working with suppliers to help them meet the required standards in areas such as business awareness, employee rights, training, environment and health and safety.

11.6 Other complementary initiatives include Norwegian institutional capacity-building for the GNPC, Ministry of Energy, and Environment Protection Agency for the oil and gas sector. Another important aspect of complementary initiative is the development of local gas infrastructure project that would be sponsored by GNPC.

12. CONCLUSION

12.1 The objective of the EIA process is to aid decision-making and environmental accountability as part of safeguarding sustainable development. This EIA process for the Jubilee Phase 1 Development project has been carried out in accordance with the Ghana *Environmental Assessment Regulations (LI 652, 1999) as amended (2002)*. The requirement for an EIA to be undertaken for projects that have the potential for significant environmental impacts is stipulated under this regulation and an EIA is mandatory for an oil and gas field development. This EIA considered all project activities, including a range of project alternatives that have the potential to cause potential environmental impacts and developed a range of mitigation measures to avoid or reduce potential impacts to As Low As Reasonably Practicable (ALARP) levels. A process of stakeholder consultations was undertaken to solicit input and to consider the issues and concerns that were raised. The Bank has also reviewed this EIA and finds that it generally meets the AfDB Environmental and Social Assessment Policies and Procedures.

12.2 **Annex.2** presents a summary of the assessment of impacts showing the magnitude of the potential impacts and the sensitivity or value of the receptors and resources that may be impacted. The significance rating for the potential impact is given along with the key mitigation measures and the significance of the residual impacts. The assessment of impacts is based on review of the project activities and addresses the issues identified during the EIA scoping phase and stakeholder consultations. The assessment acknowledges that any development will have effects on the biophysical and socioeconomic environment. The impact assessment did not identify any issue of major significance that could not be mitigated such that the proposed project was not acceptable from an environmental and social perspective. All potential negative impacts identified through the EIA could be mitigated to reduce severity and significance to acceptable levels or to ALARP through design, use of control technology, and operational management controls. No significant Transboundary impacts are expected to occur as a result of the project. At this stage, cumulative macro-economic and employment impacts from other activities with the Jubilee Phase 1 Development project are considered as being *not significant*.

12.3 In addition, the project will result in a number of positive impacts that will benefit the government and people of Ghana. The Phase 1 Jubilee field development will provide significant economic benefits to the Government of Ghana. It is likely that future oil and gas industry developments will increase these benefits and in the longer term, a large scale increase in oil and gas developments in Ghana could lead to cumulative impacts of *major* significance at the macro-economic scale. Employment and procurement impacts are likely to be more localized; nevertheless they are likely to be positive and significant. The project is expected to contribute to the development impact particularly in terms of significant savings in oil and gas importation as well as diversifying Ghana's economy from Cocoa and mineral exports. It will create employment, generate revenues for the government and create new infrastructure as the foundation for a vibrant petroleum and petrochemical industry. It will also develop a domestic source of energy and support the transfer of know-how to local staff. Finally, the project will stimulate demand for local goods and services and promote Foreign Direct Investments.

13. REFERENCES AND CONTACTS

13.1 Reference: The following documents were consulted to prepare this EIA Executive Summary:

1. Feasibility study;
2. Preliminary Information Memorandum (PIM);
3. Project Concept Note (PCN);
4. EIA study (10 Chapters and 6 Annexes);
5. Field Mission findings
6. MODEC's Environmental Health and Safety Management System

Web Link for the documents <http://www.erm.com/tulloj jubilee>

13.2 Contacts: Persons to contact for comments or further information are as follows:

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EMPLOYMENT OPPORTUNITIES PROJECT COMONENT*Summary of Personnel Requirements by Stage*

Stage of Phase 1 Activity	Duration	Total Manning Level	Approximate Local Content
FPSO and Project Construction and Installation Phase			
Tullow Accra Headquarters	To first oil 4Q 2010	80 growing to 120	80 growing to 110
Tullow Takoradi shore Base	To first oil 4Q 2010	80 growing to 50	20 growing to 45
FPSO field installation, commissioning and start-up	9 months	200	40
Port Support - marine	9 months	60	35
Aviation Support - Helicopter and fixed wing	9 months	40	20
Onshore construction	9-18 months	30 - 150	25-140
Drilling			
MODUs(x2 if 2 MODUs in field)	To nud 2011	120	30-40
Supply vessels (x 2 assured)	To nud 2011	20	10
Total Drilling, Construction and Installation		585-760	260 - 440
FPSO Operation (Production, Oil Transfer)			
Tullow Accra Headquarter	20 years	120	110
Tullow Takoradi shore Base	20 years	50	45
FPSO Production phase	20 years	80	10 later 60
FPSO Hold Back Vessel	20 years	10	4 later 10
FPSO Multi Service Vessel	20 years	17	5 later 15
FPSO Supply Vessel	20 years	10	4 later 10
Onshore Support			
Aviation Support	20 years	20	18
Total Operations and Support		307	196-250

Notes: Duration denotes the need for designated manning levels for entire stage of the project
 Local content target - Indicates a target level for local employment actual levels will be dependant on available personnel and training results

SUMMARY OF RESIDUAL IMPACTS

The following table summarizes the key issues and residual impacts. The conclusions of the EIA are that with the proposed mitigation and management measures in place during the design, installation, operation and decommissioning stages of the Jubilee Phase 1 Development project all impacts of major significance can be avoided and impacts of moderate and minor significance reduced to as low as reasonably practicable levels.

Summary of Residual Impacts

Issues	Resources	Residual Impact
Project Footprint (physical presence, noise and light)	Seabed habitats and species Marine mammals and turtles Fish, marine invertebrates, birds, manatees	Minor Minor Not Significant
Operational Discharges (routine, drill fluid and cuttings and non-routine)	Water quality Seabed habitats Marine organisms	Minor Minor Minor
Air Emissions (of atmospheric pollutants and Greenhouse gases)	Local air quality Green House Gasses (Regional)	Minor Minor
Waste Management storage, transport and Disposal)	Water quality, soil quality and human health from storage Water quality, soil quality and human health from poor disposal facilities	Minor Moderate
Impacts from Oil Spills	Water quality from small diesel spills from bunkering Water quality, coastal resources and economic activities from medium and large crude oil spill	Minor Moderate
Socioeconomic and Human Impacts (Macroeconomics, employment, training, procurement of goods and services, interference with other activities)	Revenues to the Government of Ghana Employees and local businesses Draw down of resources and interference of onshore economic activities Fishing activities Commercial shipping and vessel passage Disturbance effects on communities and use of public utilities	Moderate Positive Minor Positive Not Significant Minor Not Significant Not Significant
Cumulative Impacts	Water quality, air quality, habitats, species and human receptors	Not Significant
Transboundary Impacts	Water quality, air quality, habitats, species and human receptors	Not Significant

JUBILEE EMP HIERARCHY OF KEY PLANS

Plan Name	Includes	Plan Owner
Jubilee Field EMP	Overarching plan linking all the other plans to the project EHSMS	Jubilee Development Manager
Jubilee Field Environmental Monitoring Plan	Seabed monitoring, routine effluent and discharge monitoring and Marine Mammal Observation Program	EHS Manager
Waste Management Plan	Project-related waste handling procedures for hazardous and non hazardous solid wastes. Including chemical handling procedure.	EHS Manager
Emergency Response Plan	Accident and Incident Investigation and Reporting Procedure Investigation process to determine accident root cause and feedback for process improvement or prevention	EHS Manager
Oil Spill Contingency Plan	Spill preventative measures and spill response procedures	EHS Manager
Helicopter Operations Plan, Marine Logistics Plan and Transport Management Plan Preventative Maintenance Plan	Transport risk assessment, water transport routes, overland routes, air routes, transport rules Maintenance procedures and description of the maintenance management system.	Supply Chain Manager / Base and Logistics Manager Production Operations Manager
Marine Operations Plan	Tanker Cargo Transfer Procedure & Fuel Oil Transfer Procedure	Asset Manager
Corporate Social Responsibility Management Framework and Plan	Public Consultation and Disclosure Plan addressing interactions with community and other stakeholders, and the grievance procedure. CSR and Community Investment Program	Government Affairs and External Relations Manager
Human Resources Strategy and Plans	Local hiring, training and procurement program and procedures.	Human Resources Manager

SUMMARY OF MITIGATION MEASURES WITH REFERENCE TO THE PROJECT STAGE AND PROJECT PLANS AND PROCEDURES

Activity	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure
Project Footprint				
	Impacts from subsea Infrastructure	<ul style="list-style-type: none"> Pre installation sidescan sonar surveys will determine if there are significant seabed features that should be avoided where possible, such as channels. Subsea flowlines are to be laid on the seabed. Use of trenching or jetting for pipeline burial will be avoided. 	<ul style="list-style-type: none"> Drilling Design / Planning Installation 	<ul style="list-style-type: none"> Basis of Design Jubilee Field EMP
	Interaction from vessel and helicopter movements and underwater sounds with marine mammals, turtles and birds.	<ul style="list-style-type: none"> A programme for training supply vessel and helicopter operators in marine mammal and turtle observation and monitoring will be developed and implemented. Procedures to reduce disturbance to marine and coastal ecology from vessels and helicopters through specifying travel routes, speeds and flight heights, including helicopter pilots being required to fly at a minimum altitude of 2,300 feet (710 m) when flying over the Amansuri Wetland IBA to minimise disturbance to wildlife. 	<ul style="list-style-type: none"> Drilling Completions Installation Commissioning Operation Decommissioning 	<ul style="list-style-type: none"> Jubilee Field EMP Environmental Monitoring Plan Helicopter Operations Plan Marine Logistics procedures
	Impacts on marine fauna as a result of marine debris.	<ul style="list-style-type: none"> Development of Waste Management Plans to minimise the chance of accidentally losing items overboard. Compliance with MARPOL prohibitions on dumping trash and debris in the ocean. 	<ul style="list-style-type: none"> Drilling Design/ Planning Completions Installation Commissioning Operation Decommissioning 	<ul style="list-style-type: none"> Waste Management Plan Jubilee Field EMP
	Impacts on marine fauna as a result of drill cuttings discharge	<ul style="list-style-type: none"> A programme of continuous improvement will be undertaken to investigate, and where practicable implement, alternative options for drill cuttings treatment and disposal. Seabed impacts from drill cuttings disposal at sea will be assessed and monitored through a seabed environmental monitoring programme 	<ul style="list-style-type: none"> Drilling 	<ul style="list-style-type: none"> Jubilee Field EMP Environmental Monitoring Plan
Operations Discharge				
	Impacts from operational discharges to the marine environment.	<p><i>Black Water and Food Waste</i></p> <ul style="list-style-type: none"> Black Water: Compliance with MARPOL. Treat to achieve no floating solids, no discolouration of surrounding water and a residual chlorine content of less than 1 mg/l prior to discharge. Organic Food Waste: Compliance with MARPOL. Passed through a grinder and macerated to <25 mm and discharge to achieve no floating solids or foam. 	<ul style="list-style-type: none"> Drilling Completions Installation Commissioning Operation Decommissioning 	<ul style="list-style-type: none"> Basis of Design Jubilee Field EMP Environmental Monitoring Plan
	Impacts from operational discharges to the marine environment.	<p><i>Deck Drainage and Bilge Water</i></p> <ul style="list-style-type: none"> Vessel drainage system designed to contain leaks, spills and contaminated wash-down water and comply with MARPOL requirements. Oily deck drainage will be contained by absorbents or collected by a pollution pan for recycling and/or disposal. Compliance with MARPOL Annex 1 for discharges from FPSO, MODUs and support vessels - treat oily water to 15 ppm oil and grease. 	<ul style="list-style-type: none"> Drilling Completions Installation Commissioning Operation Decommissioning 	<ul style="list-style-type: none"> Basis of Design Jubilee Field EMP Environmental Monitoring Plan

Impacts from operational discharges to the marine environment.	<p><i>Produced Water</i></p> <ul style="list-style-type: none"> • Three stage produced water treatment system on FPSO with continuous monitoring of oil-in-water levels and alarm/re-routing system to an off-spec tank with 24 hour storage capacity for re-treatment if required. • Follow IFC Guidelines (29 mg/l maximum 30 day average and 42 mg/l maximum oil content and no visible sheen). 	<ul style="list-style-type: none"> • Operation 	<ul style="list-style-type: none"> • Basis of Design • Jubilee Field EMP • Produced Water Management Procedure
Impacts from operational discharges to the marine environment.	<p><i>Completion and Workover Fluids</i></p> <ul style="list-style-type: none"> • Where possible collect used fluids in a closed system and inject fluids into the formation, or ship used fluids to shore to the original vendors for recycling or treatment and disposal. • Only discharge used wellbore cleanup fluids (ie brine, diatomaceous earth filter and surfactant) to sea after treatment • Follow IFC Guidelines. Maximum one day oil and grease content of 42 mg/l. and monthly average less than 29 mg/l. • Preferential use of low toxicity and readily biodegradable chemical systems. 	<ul style="list-style-type: none"> • Design/ Planning • Installation • Commissioning • Operation • Decommissioning 	<ul style="list-style-type: none"> • Basis of Design • Jubilee Field EMP • Completions Plan • Waste Management Plan
Impacts from operational discharges to the marine environment.	<p><i>Pre-commissioning Pressure Testing Fluids</i></p> <ul style="list-style-type: none"> • Minimise volume by testing equipment prior to importing to Ghana. • Preferential use of low toxicity and readily biodegradable chemicals. • Ensure correct chemical dilution with seawater in the testing fluids. 	<ul style="list-style-type: none"> • Commissioning 	<ul style="list-style-type: none"> • Basis of Design • Jubilee Field EMP • Hydrotesting Plan
Impacts from operational discharges to the marine environment.	<p><i>Hydraulic Discharges from Subsea Equipment</i></p> <ul style="list-style-type: none"> • Use of biodegradable, low toxicity and low bioaccumulative hydraulic fluid within the subsea control system. 	<ul style="list-style-type: none"> • Design/ Planning • Installation • Commissioning • Operation • Decommissioning 	<ul style="list-style-type: none"> • Basis of Design • Jubilee Field EMP
Impacts from operational discharges to the marine environment.	<p><i>Ballast Water</i></p> <ul style="list-style-type: none"> • FPSO equipped with segregated ballast tanks. • Compliance with International Convention for the Control and Management of Ships Ballast Water & Sediments to minimise the transfer of organisms. • Compliance with MARPOL (Annex I) for marine vessels. Discharges to contain less than 15ppm oil or grease. 	<ul style="list-style-type: none"> • Design/ Planning • Installation • Commissioning • Operation • Decommissioning 	<ul style="list-style-type: none"> • Basis of Design • Jubilee Field EMP
Impacts on the quality of the local physical environment in the vicinity of onshore bases.	<p><i>Waste Water</i></p> <ul style="list-style-type: none"> • Effective spill prevention and control measures and secondary containment procedures to avoid accidental or intentional releases of contaminated containment fluids. • Logistics base in Takoradi /Port Operators will have waste water collection, storage and transfer or treatment facilities of sufficient capacity and type for wastewater generated by project related port activities to meet the requirements of national regulations and .MARPOL. 	<ul style="list-style-type: none"> • Drilling • Design/ Planning • Completions • Installation • Commissioning • Operation • Decommissioning 	<ul style="list-style-type: none"> • Oil Spill Contingency Plan • Leasing Agreements • Basis of Design • Jubilee Field EMP • Cargo Tanker transfer and Fuel Oil Transfer Procedure • Preventative Maintenance Plan

<p>Impacts on the quality of the local physical environment in the vicinity of onshore bases.</p>	<p>Chemical and Fuels Storage</p> <ul style="list-style-type: none"> • Provide appropriate secondary containment, and procedures for managing the secondary containment for chemical and fuel storage areas. • Impervious concrete surfaces will be in place at all areas of potential chemical and fuel leaks and spills, including below gauges, pumps, sumps and loading /unloading areas. • Storage tanks and components will meet international standards, such as those of the American Petroleum Institute for structural design and integrity. • Storage tanks and components will undergo periodic inspection for corrosion and integrity and be subject to regular maintenance. • Fuelling and loading and unloading activities will be conducted by properly trained personnel according to pre-established formal procedures. • Spill control and response plans will be developed in coordination with the landowners (ie GPHA Takoradi and Takoradi Air Force base). <p>Air Quality Mitigation for Combustion Sources</p> <ul style="list-style-type: none"> • Support vessels will shut down main engines when docked in port. • Minimise VOC emissions from fuel storage and transfer activities by means of equipment selection and adoption of management practices (e.g. tank and piping leak detection and repair programmes). 	<ul style="list-style-type: none"> • Drilling • Design/ Planning • Completions • Installation • Commissioning • Operation • Decommissioning 	<p>Oil Spill Contingency Plan</p> <ul style="list-style-type: none"> • Leasing Agreements • Basis of Design • Jubilee Field EMP • Cargo Tanker transfer and Fuel Oil Transfer Procedure Preventative • Leasing Agreement • Maintenance Plan
<p>Impacts from operational discharges to the marine environment.</p>	<p>Produced Sand</p> <ul style="list-style-type: none"> • Install sand control in all wells during well completions to prevent produced sand. • Sand monitoring installed for each well. • Any produced sand with residual oil >1% dry weight will be shipped to shore for proper treatment and disposal. 	<ul style="list-style-type: none"> • Planning / Design • Completions • Operation • Decommissioning 	<ul style="list-style-type: none"> • Basis of Design • Jubilee Field EMP • Waste Management Plan
<p>Impacts from operational discharges to the marine environment.</p>	<p>Natural Occurring Radioactive Material (NORM)</p> <ul style="list-style-type: none"> • Water injection sulphate removal plant to be installed on the FPSO for removal of the sulphates from injection water to prevent scale formation. • Injection of scale inhibitor into the wells and process facilities 	<ul style="list-style-type: none"> • Planning / Design • Completions • Operation • Decommissioning 	<ul style="list-style-type: none"> • Basis of Design • Jubilee Field EMP • Waste Management Plan
<p>Operational Emissions</p>			
<p>Impacts on air quality from atmospheric pollutant emissions and greenhouse gasses.</p>	<p>Routine Operations</p> <ul style="list-style-type: none"> • High efficiency gas turbines on FPSO. • Minimise the process electricity demand through selection of energy efficient equipment. • Compliance with MARPOL. Limits on SOx and NOx, no deliberate emissions of ozone-depleting substances and no incineration of certain products on board (eg plastics). • Follow IFC Guidelines for management of small combustion sources, including exhaust emissions using liquid fuels and gas-fired turbines. • Use of low-sulphur diesel fuel if it is available locally. • Programme of leak detection and repairs to reduce fugitive emissions. • Routine inspection and maintenance of engines, generators and other equipment. • Reduce VOC emissions from hydrocarbon and chemical storage and transfer activities by means of equipment selection and fuelling activities. • Cargo tanks to be maintained in a pressurised state and vapour space filled with an inert gas. • A Vapour Recovery Unit (VRU) will be installed to collect the vapours from the gas treatment system's TEG dehydration reboiler unit to mitigate the venting of aromatic hydrocarbon compounds that can be released by these units 	<ul style="list-style-type: none"> • Drilling • Design/Planning • Completions • Installation • Commissioning • Operation • Decommissioning 	<p>Basis of Design</p> <ul style="list-style-type: none"> • Jubilee Field EMP • Tanker Cargo Transfer and Fuel Oil Transfer Procedure • Preventative Maintenance Plan

	Impacts on air quality from Atmospheric pollutant emissions and greenhouse gasses.	<p><i>Flaring</i></p> <ul style="list-style-type: none"> Pre-commissioning of the FPSO process systems to reduce the offshore time required to complete later commissioning in-field with hydrocarbon gas. Avoid flaring during operations other than during commissioning, start-ups, upsets and maintenance periods. Establish a targeted maximum abnormal flaring rate of 2.5% of the monthly average total gas production. 	<ul style="list-style-type: none"> Drilling Completions Commissioning Operation Decommissioning 	<ul style="list-style-type: none"> Basis of Design Jubilee Field EMP Environmental Monitoring Plan
Waste Management				
	Impacts on marine environment, terrestrial environment, local communities, and waste facilities as a result of inappropriate storage, containment, and transport of waste.	<p><i>Storage, Segregation and Transport of Waste</i></p> <ul style="list-style-type: none"> Develop project specific Waste Management Plan (WMP) and manage through project EHSMS. Reduce waste generation and maximise reuse and recycling. Waste identification and classification. Waste collection, storage and segregation onboard the FPSO and vessels. Use of specified waste transport containers only ie UN drums. All wastes to be transported in a safe manner, in accordance with Material Safety Data Sheet information and via well maintained, legally compliant and suitable vehicles or vessels, with appropriate documentation and driven/crewed by fully trained operators. Waste to be transported by Tullow approved waste contractors only. 	<ul style="list-style-type: none"> Drilling Completions Installation Commissioning Operation Decommissioning 	<ul style="list-style-type: none"> Waste Management Plan Jubilee Field EMP Transport Management Plan
	Impacts on marine Environment, terrestrial environment, local communities, and waste facilities as a result of inappropriate treatment/disposal.	<p><i>Management and Disposal of Wastes Onshore</i></p> <ul style="list-style-type: none"> Appropriate treatment and disposal routes for different waste streams to be defined as part of the WMP. Waste disposal and treatment facilities and contractors to be Tullow and EPA approved. Undertake waste study to identify potential options for medium and long term waste treatment of hazardous wastes where in-country solutions have not been identified. Support national efforts to improve waste management standards. 	<ul style="list-style-type: none"> Drilling Completions Installation Commissioning Operation Decommissioning 	<ul style="list-style-type: none"> Waste Management Plan Jubilee Field EMP
Oil Spill Risk				
	Impacts from oil spills on vulnerable components of the ecosystem in offshore and coastal environments (e.g. seabirds, marine mammals, turtles, coastal habitats) and fishing activities and other livelihoods dependent on the coast	<p><i>Oil Spill Prevention Measures</i></p> <p>To minimize the risk of potential spills, Tullow has designed the project facilities with a range of inherent measures designed to reduce the risk of oil spill. Oil spill prevention measures that will be implemented as part of the design of the project will include the following.</p> <ul style="list-style-type: none"> Blow-Out Preventers (BOPs) permanently installed on the subsea wells during well completions, and the use of a double mechanical barrier system during production and injection operations using the subsea Christmas trees and other barriers. A system of wells, subsea flowlines, risers and FPSO topsides designed to international process codes and with alarm and shutdown systems to maintain the system within its design criteria at all times. The system will be tested, inspected and maintained to ensure performance standards are met. The FPSO deck and drainage system will be designed to contain spills (as well as leaks and contaminated wash-down water) to minimise the potential for overboard release. Specific procedures will be developed for offloading crude from the FPSO onto the shuttle tankers. These will include vetting of tankers involved in offloading, management by trained and experienced personnel in all aspects, the use of a quality marine fleet to undertake the operation of hose handling and tanker movements (including contingencies for any engine failures), and the continuous monitoring and actions to be taken in the event of any nonroutine events or equipment failures. 	<ul style="list-style-type: none"> Drilling Completions Installation Commissioning Operation Decommissioning 	<ul style="list-style-type: none"> Basis of Design Formal Safety Assessment Emergency Response Plan Oil Spill Contingency Plan Preventative Maintenance Plan

	<p>Impacts from oil spills on vulnerable components of the ecosystem in offshore and coastal environments (e.g. seabirds, marine mammals, turtles, coastal habitats) and fishing activities and other livelihoods dependent on the coast</p>	<p><i>Spill Response Measures</i></p> <ul style="list-style-type: none"> Oil Spill Contingency Plan (OSCP) and Oil Record Book on all vessels. The project OSCP will be linked to the Ghana National Oil Spill Plan and describes: the response strategies for minor, medium and major spill scenarios spill alert and notification procedures for emergency response authorities and potentially affected groups; the response organisation and key job functions of the participants in spill response; types and frequency of spill response training and practice exercises; the procedures for removal of waste resulting from the spill cleanup; site specific response scenarios for coastal sensitive habitats potentially affected by oil spills; permanent oil spill equipment contained onboard the FPSO, which can be offloaded onto the standby vessel or other suitable vessel at short notice; and <p>Access to external spill response equipment supplies and services for large scale spills.</p>	<ul style="list-style-type: none"> Drilling Completions Installation Commissioning Operation Decommissioning 	<p>Emergency Response Plan</p> <ul style="list-style-type: none"> Oil Spill Contingency Plan
<p>Socio-economic Impacts</p>				
	<p>Macro-economics, direct and indirect employment</p>	<ul style="list-style-type: none"> Establishment and financial support for projects through CSR strategy and sponsoring training programmes/education in the oil industry. Human Resource Strategy for the recruitment and development of national staff in its operations. The strategy will include methods for effective communication of employment opportunities, selection, evaluation and appropriate induction and dedicated staff training programmes. 	<ul style="list-style-type: none"> Drilling Completions Installation Commissioning Operation Decommissioning 	<ul style="list-style-type: none"> CSR Management Framework and Strategy Human Resources Strategy

	<p>Procurement of services and goods</p>	<ul style="list-style-type: none"> • A policy of procuring services and equipment locally and assisting local businesses. • Contracting companies to establish longer term commitments to local businesses. • Conduct contractor screening and develop contract conditions to ensure the requirement for local content is met. • Work with suppliers to help them meet the required standards. 	<ul style="list-style-type: none"> • Drilling • Completions • Installation • Commissioning • Operation • Decommissioning 	<ul style="list-style-type: none"> • Corporate Social Responsibility Management Framework and Strategy • Jubilee Field EMP
	<p>Impacts of FPSO presence and vessel movements on fisheries and commercial shipping.</p>	<ul style="list-style-type: none"> • Safety exclusion zone will be established around facilities and marked on navigational charts. • Notify mariners of the presence of the FPSO and movements of other vessels. • Employ a Fisheries Liaison Officer to liaise between Jubilee Joint venture and fishermen. • Project vessels to be equipped with radar, navigation equipment and ship to- ship communications. • Agree with the Ghana Maritime Authority on a vessel transit route and communicate it to fishermen through the Fisheries Liaison Officer. • Identify opportunities, with the Directorate of Fisheries, to improve understanding of current fishing activity within the Ghanaian EEZ. 	<ul style="list-style-type: none"> • Drilling • Completions • Installation • Commissioning • Operation • Decommissioning 	<ul style="list-style-type: none"> • Basis of Design • Marine Logistics Plan • Jubilee Field EMP • Corporate Social Responsibility Management Framework and Strategy
	<p>Impacts on onshore operations.</p>	<ul style="list-style-type: none"> • EHS policies and procedures to manage environmental and social impacts from onshore activities. • CSR strategy to enhance local benefits by supporting and investing in local projects and initiatives. • A grievance procedure to be implemented and made known to the surrounding communities and the general public. 	<ul style="list-style-type: none"> • Drilling • Completions • Installation • Commissioning • Operation • Decommissioning 	<ul style="list-style-type: none"> • Jubilee Field EMP • Corporate Social Responsibility Management Framework and Strategy