6 MITIGATION AND MANAGEMENT MEASURES

6.1 INTRODUCTION

A key objective of the EIA is to develop and describe practical, commensurate and cost effective mitigation measures that avoid, reduce, control, remedy or compensate for negative impacts and enhance positive benefits. For the purposes of this EIS the term mitigation measures has been used to include design inputs, technical controls and procedures, and management activities.

The objectives of mitigation have been established through legal requirements or industry good practice standards (as described in *Chapter 2*). The approach taken to defining mitigation measures is based on a hierarchy of decisions and measures (see *Box 6.1*). The majority of mitigation measures fall within the upper two tiers of the hierarchy and are effectively built into the design of the project.

Box 6.1 Mitigation Hierarchy

THE MITIGATION HIERARCHY FOR PLANNED PROJECT ACTIVITIES
Avoid at Source or Reduce at Source **Avoiding or reducing at source is designing the project so that a feature causing an impact is designed out (eg a waste stream is eliminated) or altered (eg reduced waste volume).**
Abate on Site **This involves adding something to the design to abate the impact eg pollution controls.**
Abate at Receptor **If an impact cannot be avoided, reduced or abated on-site then measures can be implemented off-site (eg noise or visual screening at properties).**
Repair or Remedy **Some impacts involve unavoidable damage to a resource, eg land disturbance. Repair essentially involves restoration and reinstatement type measures.**
Compensate in Kind **Where other mitigation approaches are not possible or fully effective, then compensation, in some measure, for loss or damage might be appropriate.**

6.2 SUMMARY OF MITIGATION AND MANAGEMENT MEASURES

Table 6.1 provides a summary of environmental and social mitigation measures that have been identified in the description of the project design (*Chapter 2)* and through the impact assessment process (*Chapter 5*). The mitigation measures will be integrated into the project through the commitments made in the Monitoring Plan (see *Chapter 7*) and a series of plans and procedures that are outlined in the provisional Environmental Management Plan (see *Chapter 9*).

Table 6.1 Summary of Mitigation Measures with Reference to the Project Stage and Project Plans and Procedures

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)
Project Footprint				
Section 5.2.2	Impacts from subsea infrastructure.	• 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.	• Drilling • Design / Planning • Installation	• Basis of Design • Jubilee Field EMP
Section 5.2.3	Interaction from vessel and helicopter movements and underwater sounds with marine mammals, turtles and birds.	• 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.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• Jubilee Field EMP • Environmental Monitoring Plan • Helicopter Operations Plan • Marine Logistics Procedures
Section 5.2.1	Impacts on marine fauna as a result of marine debris.	• 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.	• Drilling • Design/ Planning • Completions • Installation • Commissioning • Operation • Decommissioning	• Waste Management Plan • Jubilee Field EMP
Annex B	Impacts on marine fauna as a result of drill cuttings discharge.	• 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	• Drilling	• Jubilee Field EMP • Environmental Monitoring Plan

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)
Operational Discharges				
Section 5.3.3	Impacts from operational discharges to the marine environment.	*Black Water and Food Waste* • 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.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• Basis of Design • Jubilee Field EMP • Environmental Monitoring Plan
Section 5.3.4	Impacts from operational discharges to the marine environment.	*Deck Drainage and Bilge Water* • 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.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• Basis of Design • Jubilee Field EMP • Environmental Monitoring Plan
Section 5.3.5	Impacts from operational discharges to the marine environment.	*Produced Water* • 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).	• Operation	• Basis of Design • Jubilee Field EMP • Produced Water Management Procedure

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)
Section 5.3.6	Impacts from operational discharges to the marine environment.	*Completion and Workover Fluids* • 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.	• Planning / Design • Completions • Operation (during workovers)	• Basis of Design • Jubilee Field EMP • Completions Plan • Waste Management Plan
Section 5.3.7	Impacts from operational discharges to the marine environment.	*Pre-commissioning Pressure Testing Fluids* • 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.	• Commissioning	• Basis of Design • Jubilee Field EMP • Hydrotesting Plan
Section 5.3.8	Impacts from operational discharges to the marine environment.	*Hydraulic Discharges from Subsea Equipment* • Use of biodegradable, low toxicity and low bioaccumulative hydraulic fluid within the subsea control system.	• Planning/Design • Installation • Commissioning • Operation • Decommissioning	• Basis of Design • Jubilee Field EMP
Section 5.3.9	Impacts from operational discharges to the marine environment.	*Ballast Water* • 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 15 ppm oil or grease.	• Design/ Planning • Installation • Commissioning • Operation • Decommissioning	• Basis of Design • Jubilee Field EMP

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)
Section 5.3.10	Impacts on the quality of the local physical environment in the vicinity of onshore bases.	*Waste Water* • 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.	• Drilling • Design/ Planning • Completions • Installation • Commissioning • Operation • Decommissioning	• Oil Spill Contingency Plan • Leasing Agreements • Basis of Design • Jubilee Field EMP • Cargo Tanker transfer and Fuel Oil Transfer Procedure • Preventative Maintenance Plan
Section 5.3.10	Impacts on the quality of the local physical environment in the vicinity of onshore bases.	*Chemical and Fuels Storage* • 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). *Air Quality Mitigation for Combustion Sources* • 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 (eg tank and piping leak detection and repair programmes).	• Drilling • Design/ Planning • Completions • Installation • Commissioning • Operation • Decommissioning	• Basis of Design • Jubilee Field EMP • Oil Spill Contingency Plan • Cargo Tanker Transfer and Fuel Oil Transfer Procedure • Leasing Agreements • Preventative Maintenance Plan

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)
Section 3.5.2	Impacts from operational discharges to the marine environment.	*Produced Sand* • 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.	• Planning / Design • Completions • Operation • Decommissioning	• Basis of Design • Jubilee Field EMP • Waste Management Plan
Section 3.7.3	Impacts from operational discharges to the marine environment.	*Natural Occurring Radioactive Material (NORM)* • 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.	• Planning / Design • Operation • Decommissioning	• Basis of Design • Jubilee Field EMP • NORM Management Plan

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)
Operational Emissions				
Section 5.4.3 Section 5.4.4	Impacts on air quality from atmospheric pollutant emissions and greenhouse gasses.	*Routine Operations* • 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.	• Drilling • Design/ Planning • Completions • Installation • Commissioning • Operation • Decommissioning	• Basis of Design • Jubilee Field EMP • Tanker Cargo Transfer and Fuel Oil Transfer Procedure • Preventative Maintenance Plan
Section 5.4.3 Section 5.4.4	Impacts on air quality from atmospheric pollutant emissions and greenhouse gasses.	*Flaring* • 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.	• Drilling • Completions • Commissioning • Operation • Decommissioning	• Basis of Design • Jubilee Field EMP • Environmental Monitoring Plan

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)
Waste Management				
Section 5.5.1 Section 5.5.2	Impacts on marine environment, terrestrial environment, local communities and waste facilities as a result of inappropriate storage, containment and transport of waste.	*Storage, Segregation and Transport of Waste* • 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.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• Waste Management Plan • Jubilee Field EMP • Transport Management Plan
Section 5.5.3	Impacts on marine environment, terrestrial environment, local communities and waste facilities as a result of inappropriate treatment/disposal.	*Management and Disposal of Wastes Onshore* • 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.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• Waste Management Plan • Jubilee Field EMP

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)
Oil Spill Risk				
Section 3.3.1 Section 5.6.7	Impacts from oil spills on vulnerable components of the ecosystem in offshore and coastal environments (eg seabirds, marine mammals, turtles, coastal habitats) and fishing activities and other livelihoods dependent on the coast.	*Oil Spill Prevention Measures* To minimise 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. • 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 non-routine events or equipment failures.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• Basis of Design • Formal Safety Assessment • Emergency Response Plan • Oil Spill Contingency Plan • Preventative Maintenance Plan

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)

Section 5.6.7	Impacts from oil spills on vulnerable components of the ecosystem in offshore and coastal environments (eg seabirds, marine mammals, turtles, coastal habitats) and fishing activities and other livelihoods dependent on the coast.	*Spill Response Measures*
		• 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
		  • access to external spill response equipment supplies and services for large scale spills.
			• Drilling
			• Completions
			• Installation
			• Commissioning
			• Operation
			• Decommissioning
				• Emergency Response Plan
				• Oil Spill Contingency Plan

Socio-economic Impacts				
Section 5.7.4 Section 5.7.5	Macro-economics, direct and indirect employment.	• 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.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• Corporate Social Responsibility Management Framework and Strategy • Human Resources Strategy

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)
Section 5.7.6	Procurement of services and goods	• 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.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• Corporate Social Responsibility Management Framework and Strategy • Jubilee Field EMP
Section 5.7.7 Section 5.7.8	Impacts of FPSO presence and vessel movements on fisheries and commercial shipping.	• 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.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• Basis of Design • Marine Logistics Plan • Jubilee Field EMP • Corporate Social Responsibility Management Framework and Strategy
Section 5.7.9	Impacts on onshore operations.	• 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.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• Jubilee Field EMP • Corporate Social Responsibility Management Framework and Strategy